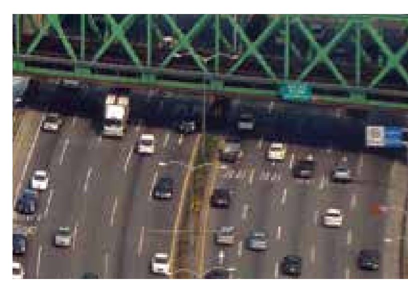
International Transport Forum

Halving the Number of Road Deaths in Korea

Lessons from other Countries

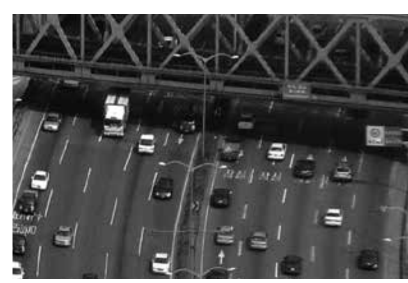


Case-Specific Policy Analysis

OECD

Halving the Number of Road Deaths in Korea

Lessons from other Countries



Case-Specific Policy Analysis

The International Transport Forum

The International Transport Forum is an intergovernmental organisation with 57 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

The Members of the ITF are: Albania, Armenia, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China (People's Republic of), Croatia, Czech Republic, Denmark, Estonia, Finland, France, Former Yugoslav Republic of Macedonia, Georgia, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Republic of Moldova, Montenegro, Morocco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom and the United States.

International Transport Forum
2, rue André Pascal
F-75775 Paris Cedex 16
contact@itf-oecd.org
www.itf-oecd.org

Case-Specific Policy Analysis Reports

The International Transport Forum's Case-Specific Policy Analysis (CSPA) series are topical studies on specific transport policy issues of concern to a country carried out by ITF on request. This work is published under the responsibility of the Secretary-General of the International Transport Forum. The opinions expressed and arguments employed herein do not necessarily reflect the official views of International Transport Forum member countries.

Table of contents

Figures

Tables

Executive summary

Objectives

This report presents the findings and conclusions of a short peer review of road safety policy in Korea. This was centred on a meeting of road safety experts from Korea and from OECD countries held in Seoul in December 2014. The objective was to address the challenge of how to move Korea from its current position as one of the worst performers among the OECD countries in the annual number of road fatalities to being one of the best, in line with the targets set under the United Nations Sustainable Development Goals.

Findings

The government of Korea has adopted ambitious targets for improving road safety nationally, including an overall objective to rank among the best performing OECD countries. Currently overall deaths and injuries are among the highest per capita or per vehicle of any OECD country, with deaths per capita over three times the rates in the best performing countries. Vulnerable road users are particularly exposed to crash risks. In 2014 Korea had the highest rate of pedestrian fatalities anywhere in the OECD and the number of elderly fatalities per capita was triple the OECD average.

From a peak in road casualties in the 1990s, fatalities have been cut substantially but, if the targets are to be met, policies will need to be adopted to generate a step change in the rate of improvement. Korea has had some notable successes, including in cutting the rate of fatal crashes involving children to low levels, and has adopted many of the policies required on the basis of solid research. Crucially, however, enforcement efforts need to be stepped up to achieve critical mass and a more integrated, safe system approach, adopted to ensure interventions deliver maximum results. A number of regulatory gaps and divergence from best practice also need to be addressed. This will require leadership from a revitalised high-level co-ordination unit in government.

Key messages

The safe system approach should guide policy

The Safe System approach provides the template for Korea to develop a successful road safety strategy. This implies a fully co-ordinated approach with interventions from each agency with responsibilities for road safety implemented in concert. It also demands enforcement effort dosed to achieve optimal results and ensure measures are mutually reinforcing. It requires effective leadership from a unit at the highest levels of government to facilitate the work of the road safety agencies, co-ordinate their interventions and be the main interface with NGOs and the private sector.

Korea's road safety vision needs interim targets with clear deadlines linked to funded interventions

The Government of Korea has adopted ambitious targets for transport to maximise the welfare and wellbeing of citizens. Articulating this vision in terms of a road transport system free of deaths and serious injuries will encourage the necessary shift in thinking needed for transformational change in road safety performance. Such a vision requires interim targets with clear deadlines to drive adoption of sufficient measures with adequate funding for comprehensive implementation.

The current short term target is commendable but will not be met

Road safety agencies in Korea currently use a range of targets to communicate the level of ambition for improving performance. These include becoming one of the top ten performers in the Organisation for Economic Co-operation and Development (OECD) in terms of deaths per head of population, from the current position as one of the worst. The current target of a reduction of fatalities by 45% over the period 2010 to 2016 is commendable but it will not be met. Korea has also agreed to the United Nations Sustainable Development Goals that include a target of reducing deaths and injuries from road accidents 50% by 2020. Targets of this kind need to be made operational by outlining how they will be achieved by measures that have been adopted by government with allocated funding. A process of modelling the expected results of the government's road safety programme needs to be undertaken on a routine basis by one of the road safety agencies. Where projected results fall short of targets the programme should be revised and reinforced.

Additional measures, assessed for effectiveness, are needed

Although a number of the road safety measures adopted have been successful in reducing the number of road casualties, it is already clear that these are not sufficient to deliver on the targets and additional effective measures are needed.

Re-establishing a high level coordination unit should be considered to strengthen leadership

Stronger leadership and more coordinated management for road safety would help to achieve more ambitious road safety results in Korea. Resourcing and coordination would be improved by re-establishment of a unit reporting to the highest levels of government responsible for the delivery of government road safety targets. This unit would be charged with leading development of a coordinated strategy for delivering the improvements targeted and ensuring the resources made available by government for implementing agreed measures are sufficient to achieve the results expected. Western Australia's Office of Road Safety provides a good example of this kind of lead agency for road safety (the Office was reorganised and renamed the Road Safety Commission in July 2015).

Protection pedestrians, and especially elderly pedestrians, is the first priority

Pedestrians constitute the largest category of fatalities and elderly pedestrians represent a very high share of the casualties. This highlights the need for urgent and significant action using the holistic, safe system approach to effectively manage speeds and infrastructure improvements to protect pedestrians and cyclists, particularly in locations where there is high crash risk.

The resources committed to enforcement are sub-optimal

The level of enforcement for many road safety measures, including speed violations, drink-driving and seatbelt wearing, is too low when compared to good practices in other OECD countries and inadequate to contribute significantly to improved results. The importance of enforcement is clearly understood and given priority in Korea but in many cases it seems that the intensity of enforcement effort and resources allocated to enforcement do not reach the critical level needed to realise the full potential of measures adopted.

Seatbelt wearing on rear seats should be compulsory on all roads and regulation of driving and rest time for professional drivers is urgent

In some cases, effective traffic enforcement may require to review the existing legislation. In particular, it is strongly recommended to make seatbelt wearing compulsory in rear seats on the whole road network (not only on motorways as is currently the case). The lack of regulation and enforcement of professional (in particular self-employed) drivers' hours of service needs urgent attention. An enforcement programme should be supported with a complementary supporting advertising programme to maximise investment value. Enforcement and advertising when combined are significantly more effective than increasing enforcement alone.

Safe mobility for the elderly is a key challenge

Addressing the safe mobility of the elderly is a priority. Driving should be facilitated for citizens as long as possible subject to their physical ability to drive safely. In the absence of specific impairment licensing should not be limited by age. Measures to reduce fatalities and serious injuries among the elderly should also focus on creating conditions for safe walking, cycling and using public transport.

Better speed management is critical

Speed management is a key element in the Safer System approach. Korea should adopt a strategic approach to speed management, including a comprehensive review of road functions and speed limits. Current urban speed limits in Korea, typically 60 km/h, are too high and compliance is poor. This is to the detriment of safety, particularly of vulnerable road users including elderly pedestrians. The promotion of Intelligent Speed Assistance (ISA) as a means to address driver compliance with speed limits could help to deliver a quick and substantial improvement.

Serious injuries should be targeted

There should be a focus on reducing serious injuries and not solely on fatalities. This could take the form of adoption of an injury reduction target.

Safety performance indicators should be monitored and publicised

Identifying key risks requires the collection and analysis of an adequate set of crash and exposure data. A set of safety performance indicators should be developed, including on speed compliance and drink-driving and a programme of monitoring and reporting on these indicators should be established. Safety data should be shared among stakeholders and published on a regular basis to ensure full availability to the public and expert community.

Safety policy should be supported by modelling of the effectiveness of proposed interventions

Modelling (for ex-ante evaluation) is a powerful tool to set targets and gain political and community support for the implementation of a road safety strategy. Korea would benefit from conducting modelling to identify where significant gains have come from in the past and identify a package of countermeasures and the levels of implementation (dose response) required to achieve further ambitious improvements in results. Communication and engagement with political leaders and the community is vital to build understanding of the problem and to build support for effective responses.

A comprehensive external peer review of road safety is recommended

In preparing to make the changes needed for the achievement of ambitious road safety results, Korea would benefit from the experience of leading countries by commissioning a comprehensive external peer review through the OECD/ITF.

Chapter 1. Summary of discussions

This chapter summarises the context for road safety policy-making in Korea and the ambitious targets set by the Government and introduces the short external peer review conducted by the International Transport Forum at the OECD. This was designed to benchmark performance and make available the road safety policy experience of leading countries to the research and policy-making community in Korea.

Introduction

Korea has achieved a 50% reduction in fatalities as compared with ten years ago. This is a strong performance that needs to be replicated in the coming decade if Korea is to reach its ambitious targets to rank among the best OECD countries. In 2014, it had the largest number of pedestrian fatalities per 100 00 population in the OECD, and the number of elderly fatalities per 100 000 was triple the OECD average.

There is a desire within the Korean government to move towards zero fatalities and serious injuries. To achieve this, there is a need for a holistic road safety strategy, based on a Safe System approach.

Safe system and "vision zero" goals, and aspirational targets in general, are vulnerable to criticism that they are unrealistic if they are not supported by operational targets. Most importantly, short-term targets backed by a package of interventions that have been agreed and funded by decision-makers are required. The measures need to be selected based on evidence of the results they can be expected to produce. Detailed ex-ante assessment is employed in countries at the leading edge of achievement. In the United Kingdom, for example, targets for specific users or types of crash are based on ex-ante assessments. In the Netherlands, overall targets for reducing deaths and serious injuries are tightened periodically and the accompanying measures modelled to assess whether they will deliver the improvement required to meet the new target.

The United Nations adopted intermediate targets in September 2015 as part of its Sustainable Development Goals.[1] The health goal requires cutting deaths and injuries by 50% by 2020 compared to the 2010 level. This target is based on benchmarking national performance by income group – low, middle and high income country. If all countries matched the best in class, deaths would be half their current rate. This provides a goal that is clearly achievable in principle but short-term operational targets, backed by specific interventions, will now need to be adopted country-by-country to realise the ambition. Korea is committed to meeting this ambitious goal.

This report presents the findings of a short peer review of road safety policy organised by the International Transport Forum at the OECD and the Korea Transport Institute. The work was centred on roundtable discussions at a meeting of experts in Seoul to examine how Korea might achieved the step change in performance required to meet its targets on the basis of experience in leading road safety agencies and research institutes in other OECD countries. The aim was to address together the challenge of how to move Korea from its current position as one of the worst performers among the OECD countries in road safety (based on fatalities per 100 000 population and fatalities per 10 000 vehicles) to being one of the best, in line with the UN target.

The roundtable discussions addressed the following key issues: road safety management; road safety data; enforcement policies; safety in an ageing population; and speed management. This report presents the input papers prepared for the roundtable meeting by international road safety leaders, the summary of discussions and key messages and recommendations to the attention of Korean stakeholders.

Table 1.1. **Participants in the Expert Roundtable Meeting**

MOLIT	Ministry of Land Infrastructure and Transport
MOPSS	Ministry of Public Safety and Security
KOTI	Korea Transport Institute
KOROAD	Korea Road Traffic Authority

KOTSA	Korea Transportation Safety Authority
Iain Cameron	Office of Road Safety, Western Australia
Fred Wegman	IRTAD Chair, Delft University, Netherlands
David Cliff	New Zealand Police
Oliver Carsten	Institute of Transport Studies, University of Leeds, United Kingdom
Ralf Risser	Factum, Austria
Veronique Feypell	International Transport Forum at the OECD
Stephen Perkins	International Transport Forum at the OECD

Challenges for road safety in Korea

Overall, the rate of reduction in fatalities over the period 2000 to 2012, while near the OECD average, has been much less than the largest reduction. It was also less than that for Sweden and the UK, which have already achieved the lowest rates of fatalities per head of population. The reduction in road fatalities in recent years has been greatest for vehicle occupants, now overtaken by pedestrian fatalities as the largest category of people killed annually. It is also notable that Korea has the highest pedestrian fatality rate per 100 000 population among OECD countries, but is average for car occupant fatalities. Pedestrians account for 39% of fatalities, with 64% of these occurring while crossing the road. Related to this is the fact that those aged over 65 account for 36% of fatalities. An important factor in car occupant fatalities is that rear seatbelt use is low.

As reported by Korean experts, reasons for the current elevated levels of death and serious injury on the roads include the Korean culture of being in a hurry, high alcohol consumption, wide junctions, the lack of sidewalks on rural roads, the high speed limits on urban roads (normally 60 km/h and sometimes 80 km/h), parked vehicles blocking driver’s view of pedestrians , lack of road safety education in high schools, the low priority of road safety by local government (attributable in part to lack of resources) and reluctance to prosecute those at fault in crashes unless there was a major violation.

There have, however, been some notable successes. One was the very large reduction in child fatalities after this was adopted as a top priority in the 1990s by the Inter-Ministerial Commission on Road Safety. A recent development is the installation of black boxes in a substantial number of cars, in particular commercial fleet (as of 2012, 2 million vehicles were equipped with black boxes). Black boxes are installed to reduce dispute in the case of crashes, but it has been proved useful to make commercial vehicle drivers drive safer.

Review road safety management systems in OECD countries

The fundamental principles of the Safe Systems approach are:

- People will make mistakes.
- There are limits to the kinetic energy that humans can absorb.
- Roads, vehicles and speeds need to be “forgiving”.
- There are shared responsibilities.

The human is at the centre of the approach. Key elements in the successful execution of the Safe Systems approach are:

- Leadership to achieve ambitious targets.
- Systematic and co-ordinated interventions.
- An effective road safety management system to generate and deliver the interventions, normally with a lead agency or coordinating unit responsible for delivering results and reporting performance against targets to the highest levels of Government.

Many countries have conducted road safety peer reviews as a starting point. There is also a role for demonstration projects to lead innovation.

Monitoring the effectiveness of measures

The effectiveness of road safety measures needs to be evaluated; otherwise it is not possible to know whether these measures are worthwhile. In Korea, there is no systematic procedure to evaluate the impact of safety measures. As an example, it would be very useful to evaluate the impact of black box fitment in vehicles in order to assess whether this should be expanded. Preliminary research found the installation of black boxes by a Korean taxi fleet had achieved a 15% reduction in fatalities, although another review suggested that black box fitment did not secure a change in behaviour.

Modelling

Many countries use modelling techniques to identify the key safety measures that need to be adopted in order to achieve their targets.[2] Modelling is also a powerful tool to provide decision makers with evidence on the potential effects of the proposed measures and to identify sectors where resources should be targeted. In Western Australia, for example, thorough modelling was undertaken to assess the resources needed for police, road engineers and other sectors to achieve the government's targets (Corben et al., 2010). In the Netherlands, the independent road safety data and analysis agency SWOV is charged with reviewing the national road safety programme each time it is revised, modelling the potential for measures announced to meet the targets adopted and proposing complementary measures when targets appear impossible to meet (Aarts et al., 2014).

In Korea, important work is being undertaken to evaluate past road safety programmes, however, less is being done to assess the impact of future measures. It is recommended to review the modelling techniques used in other OECD countries, and how their results impact the decision making process, budget allocation and communication with the public, and to develop a similar approach in Korea.

Leadership and co-ordination

Leadership and co-ordination by a designated lead agency is a crucial element in success and ensures that resources are not duplicated and wasted. The lead agency does not have to be responsible for conducting all activities but it does have to co-ordinate and to report regularly on progress towards targets to the highest levels of government. In Korea, road safety responsibility is shared between various agencies. The Transport Safety Act is managed by The Ministry of Land, Transportation and Infrastructure (MOLIT) while the Road Traffic Act, covering key areas of safety, is managed by the Police. Each ministry can propose road safety-related measures as well as a budget to achieve them, however, there is no overall co-ordination process for the allocation of a road safety budget. The following ministries and agencies have key road safety responsibilities:

- The Ministry of Land, Transportation and Infrastructure (MoLIT) is responsible for the national trunk road network consisting of motorways and national highways. It also manages vehicle safety and runs the New Car Assessment Program.

- The Ministry of Public Safety and Security oversees road safety, particularly for local governments. It contributes to the strategies to enhance safety of provincial, municipal and county roads.

- The National Police Agency (NPA) is responsible mainly for traffic enforcement, crash investigation and drivers' license issues. It also operates traffic signals, crossings and speed enforcement cameras.

- The Korea Transportation Safety Authority (KOTSA) is a governmental Agency, supporting the MOLIT, and is mainly in charge of vehicle safety.

- The Korea Road Traffic Authority (KOROAD) is a governmental agency, supporting NPA, responsible for road traffic management. The agency is in charge of traffic monitoring, driver's license examination and management, as well as training and education.

- The Korea Transport Institute (KOTI) is a governmental agency, supporting MoLIT, responsible for advising the government on Korea's transport policy, including its road safety strategy, based on research evidence.

An Inter-Ministerial Commission, under the office of the Prime Minister, drove innovation and significant improvement in a number of areas in the 1990s. It still exists but no longer leads policy development or implementation. This role needs to be filled again, either by a reinforced Commission or a new unit in central government. Alternatively, consideration could be given to assigning a broad co-ordination role to one of the agencies involved in road safety. This may be a more difficult approach, however, given the important operational responsibilities of each of the existing agencies.

Any peer review of road safety would need to work with all of the existing agencies as equal partners but one of its key areas of reflection would be on developing an effective mechanism for co-ordination, leadership and accountability.

Public engagement, local communities

Public engagement is important. Strategy should be discussed with the community, which might not be willing to accept a maximal approach to casualty reduction but thorough consultation is likely to result in more rather than less demand and support for road safety interventions. Local communities need to be involved, not just nationally organised groups; crashes occur on local roads and local discussion will help establish the most effective response.

In Western Australia, for example, the public was presented with the choice of two alternative strategies: one with a very large contribution from speed management including a substantial lowering of speed limits and very strict enforcement; and another with a smaller contribution from speed management -- leaving more reliance on road and roadside engineering improvements, safer vehicles and improvements in driver behaviour to reduce risk taking behaviour such as speeding and drink driving. In the end, based on public feedback, the less stringent approach was adopted on the grounds that maintaining community support for effective implementation was vital.

Adopting a Safe System approach in Korea

The adoption of a bold vision with the Safe System approach will enable Korea through its leading agencies and organisations, together with the community, to fundamentally change the way it approaches road safety improvement. This will involve moving current thinking and practice from decisions about the next incremental improvement to decisions on making major changes in performance. A focus on how to achieve the ultimate outcome of zero serious harm and then working backwards from the ultimate to the current will determine the next steps along the safe system path.

The Safe System principles need to be turned into practical guidelines. Korea needs to work out its own mix of solutions adapted to its situation and culture. A Korean approach, with public support, needs to be developed. What the Safe System approach will deliver is new energy.

Targets

The argument that it is too difficult to tackle the safety problems is all too common in many countries. The approach should be stepwise, with realistic interim targets to short/medium term deadlines complementing the ambitious long term vision.

Interim targets need to be clearly related to packages of measures designed to achieve the reductions in deaths and serious injuries required to meet them. The measures need to be included in national and local road safety programmes and fully funded. Targets should be set ‘bottom-up’; that is based on the modelled potential to reduce deaths and serious injuries of the interventions planned for introduction or intensification of enforcement. Preferably, a target should be expressed in terms of an absolute number of casualties (deaths or seriously injured) to be saved rather than in terms of a rate (e.g. number of deaths per 100 000 population).

Recommendations

Korea can achieve further substantial reductions in serious road trauma by adopting the Safe System approach together with an ultimate vision of achieving no deaths and no serious injuries as used in the countries that are leading road safety performance. The application of the Safe System approach and its guiding principles will drive transformational changes in the way the safety problem is viewed and responded to.

Korea will benefit from conducting further analysis and modelling to identify where significant gains have come from in the past improvements and to identify a package of safe system countermeasures and the recommended levels of implementation (dose response) required to achieve further ambitious improvements in results.

The 45% reduction in road deaths by 2016 identified by Korea can be utilised as the first milestone improvement target in the Safe System approach. New road safety targets for 2020, including a target for serious injuries are recommended as well as further analysis to identify the range of measures and the level of implementation required to achieve this milestone improvement.

Introduce explicit and realistic, short-term and long-term timeframes to achieve road safety targets and use the bottom-up approach when formulating targets;

High-level co-ordination and accountability involving the key governmental agencies is vital to ensure a holistic and co-ordinated results-focused management approach to road safety improvement that prioritises the use of the countries’ resources, shares data and analysis, monitors progress and facilitates effective cross agency actions to maximize the effectiveness of responses. Efficiency gains could be made through the formal designation of a lead agency, Commission, or unit, reporting to the highest levels of government to co-ordinate all safety-related activities and assist the existing road safety agencies to implement policies effectively and access sufficient resources.

Korea would benefit from the experience of other leading countries to determine the functions, management and coordination arrangements needed to manage by objectives and achieve ambitious results.

Road safety data collection, analysis, indicators and targets

Designing an effective road safety strategy and conducting good quality road safety studies are impossible without the availability of good data. These data are necessary to obtain an accurate picture of the road safety problems. Good data are also required to be able to design strategies to reduce the consequences of crashes. Data need to be analysed in detail to determine why crashes occur and how they can best be prevented. These analyses lead to the identification of the main problems, provide an understanding of the causes of crashes and their outcomes, and enable the identification of risk factors. Once this understanding exists, specific interventions can be considered. All these steps require the availability of good data as well as the know-how to analyse the data correctly. The data needed covers not just crashes, but other information as well, such as weather, seatbelt use, helmet use, etc.

As already discussed, modelling is a very useful tool to predict crash and casualty trends and assess the impact of countermeasures and policies ex-ante. It can only be done with good quality data.

It is important to complete crash data provided by the police with other sources of data, including health data. Police reports do not always reveal the full range of contributing factors to crashes -- for example, reporting only a single cause for these, while a crash is often the consequences of several factors.

Benchmarking (comparing performance against that of other countries) is a useful tool to assess the road safety performance of a country. The experience of Sweden, the United Kingdom and the Netherlands through the SUNFLOWER project afforded these countries useful perspectives on their strengths and weaknesses in various aspects of traffic safety. Korea would benefit from benchmarking with countries presenting similar traffic and population patterns.

Injury data

Sound safety analysis requires paying attention to serious injuries as well as deaths since such injuries cause long-term impairment and are a significant element in the overall social cost of crashes. The Safe System approach, therefore, aims at eliminating serious injuries as well as road fatalities. For the OECD overall, fatalities have gone down faster than injuries, and it is useful to understand the reasons behind this lag.

Measures which have been effective in reducing the number of road fatalities may not necessarily be as effective in reducing the number of seriously injured. This raises some issues in Korea as injuries are not systematically reported, since injury crashes are often settled between the participants. The response was that underreporting should be addressed by the linking of data sources, in particular by linking police data and health data. Getting access to health data is necessary to better estimate the number of casualties and better understand the impact of crashes on the severity of injuries. The IRTAD report “Reporting on Serious Road Traffic Casualties” (ITF, 2011) described the various linkage methods. While there is no doubt about the utility of health (hospital) data, it is less clear whether insurance data can be easily and usefully exploited.

It is important to use standardised definitions to generate comparable data. Currently, in Korea crash injuries are defined based on the length of stay at hospitals (e.g. an injury is classified “severe” when the injured person spends more than 21 days in hospital). It is recommended to adopt the recommendation of the IRTAD Group to define the severity of an injury based on a medical diagnosis, using the WHO classification. The recommendation of the IRTAD Group is to define an injury as serious when it has a Maximum Abbreviated Injured Score of 3 or more (MAIS 3+).

Monitoring progress

A regular and systematic monitoring of road safety performance is a core element of an effective road safety policy. The monitoring needs to be based on a national road safety performance framework comprising a set of outcome indicators (number of deaths and seriously injured) and performance indicators. The latters may include indicators for driving behaviour (speeding, driving while intoxicated, etc.), for the safety quality of vehicles (e.g. NCAP stars), of roads (e.g. RAP stars) and for the quality of the trauma system (e.g. the arrival times of ambulances).

Sharing crash data

Sharing crash data between various stakeholders for research purposes is important to better understanding crash circumstances and consequences. While privacy is a critical issue in most countries, there are protocols that allow data sharing, while keeping privacy integrity. In Korea, official crash statistics are compiled in the Traffic Accident Analysis System (TAAS), managed by KOROAD. Crash data can be accessed on official request; however, a simpler procedure for stakeholders to access these data would be very useful. The experience of other OECD countries in their procedures to share crash data for research and policy-making would be useful to consider.

Recommendations

Korean authorities are invited to:

- Consider the adoption of a National Road Safety Performance Monitoring Framework consisting of key safety performance indicators for final outcomes, intermediate outcomes and programme output measures, which would assist Korea in assessing progress and making decisions about resources and programmes.
- Put more emphasis on severe injuries and collection of data on injuries.
- Make road safety data more widely available (e.g. by publishing them on the internet) and not limiting their use simply to publishing them as aggregate statistics.
- Invest in well-trained analysts with knowledge of databases, road safety and analysis techniques.

Effective enforcement policies

Enforcement is an essential component of a comprehensive road safety strategy. The authorities should work out what are the most effective actions the police can take. In this respect, there is a distinction between:

General deterrence, which is the process whereby drivers are deterred from offending by the perceived risk of detection without the actual experience of that detection When general deterrence is sufficiently visible and regular – to create a perception that a driver will be detected – it is highly effective in deterring 'simple' offending behaviour types such as alcohol impaired driving or breaches of driver licensing.

Specific deterrence, which is the actual experience of being sanctioned for a traffic violation (e.g. speeding). This may be an immediate sanction in the form of being stopped by a police officer and issued an infringement notice, or receiving an infringement later if detected by a speed camera. Research suggests that complex behaviours are not deterred by highly visible enforcement, but through the actual experience of detection.

Enforcement should focus on:

- excessive speed
- drink driving
- the use of protective equipment (such as seatbelts or helmets)
- violations at intersections (for red light, stop and give way violations).

New Zealand has achieved dramatic improvements through the doubling of police enforcement and lowering of tolerance on speeding, i.e. their summer campaign. Police Districts were held accountable for their levels of enforcement.

The authorities should focus on the key risks and address them with sufficient intensity of enforcement to reach the thresholds for significant returns on effort. To arrive at the strategy on enforcement Korea might follow practice in some other OECD countries. For example, in New Zealand (with a total police force of 12 000 for a population of 4.5 million) fully 20% of the staff (around 2 400 officers) and budget are dedicated to road safety.

Relationships and partnerships between relevant stakeholders are essential to an effective enforcement strategy and require regular consultation and joint strategy discussions to be successful. Enforcement is most effective when it is accompanied by a well-resourced public awareness campaign that highlights the areas being targeted by Police. For example, effective publicity campaigns alongside enforcement that targets speed and drink driving are highly cost beneficial.

Nature and level of enforcement

The discussions at the expert meeting highlighted that the road safety policies adopted in Korea are similar to those of the best performing countries but there are issues about the level and intensity of enforcement and the appropriate level of enforcement for the public to accept.

The “dose” of enforcement needs to be such that it really has an effect on behaviour. The New Zealand level of breath testing was one test per driver per year; while it was reported that only around one out of 80 drivers were tested each year in Korea. Similarly, the level of speed enforcement should be such that it could be identified as having a significant effect on road trauma.

Speed cameras

As regards speed cameras, there was a discussion on the ideal ratio between fixed and mobile cameras, since mobile cameras require police presence. In New Zealand there are equal quantities of mobile and fixed (camera-based) enforcement. The aim is to make drivers slow down everywhere. A discussion on speed limits is included in the section on Speed Management in this chapter.

Regarding the potential benefit of outsourcing speed camera operation, it was reported that in the United Kingdom this practice is permitted, but not very widespread. In the Australian State of Victoria, it is permitted but only under close police supervision. The speed camera work there has been automated and 10 million violations a year are handled.

Section control enforcement (i.e. measuring the average speed on a section of a road) is being implemented progressively in several OECD countries, including in Korea, and has proven to be an effective method to reduce speed and diminish crashes.

Drink driving

There was extensive discussion on the amount of drink driving enforcement and the maximum legal level of blood alcohol content.

Regarding drink driving, it was felt that the level of drink driving enforcement was not adequate. Korea has some 20 million drivers and around 260 000 breath tests are conducted every year, which means that only one out of 80 drivers are tested each year, while in New Zealand each driver is tested, on average, at least once a year.

In 2014, the maximum blood alcohol content in Korea was 0.5 g/l. Some people are calling for a lower limit. Is there justification for such a move? The expert response was that there were two general movements: to go to a legal level of 0.2 (zero for practical purposes) or to 0.5 but with lower limits for novice and professional drivers. Consideration could therefore be given to a lower blood alcohol content for these latter categories.

It was also recommended to associate enforcement actions with strong communication, in order that drink driving becomes socially unacceptable.

Enforcement for commercial drivers

Regarding commercial drivers, it was noted that there are no legal limits on drivers' hours of service, although discussion is underway on legislating this area. One issue is the large proportion of owner-driver-owners who are not subject to company regulations. In most OECD countries, including Korea, electronic logbooks are used to ensure compliance with the regulations on driving hours. There could be safety potentials in better exploiting these devices. In some countries, enforcement is targeted at companies with a record of violations. The safety of professional drivers in Korea, in public transport as well as freight transport, is an area for attention as a matter of priority.

Seatbelt use

In Korea, seatbelt wearing rates are low compared to the OECD average, particularly for rear seats where seatbelt wearing is mandatory only on motorways and the wearing rate is very low (around 9% in 2012). It is strongly recommended to make it mandatory to wear rear seatbelts on the whole road network. This measure should be accompanied by strong communication and enforcement activities.

Penalty

Regarding penalties, the deterrence effect of financial fines is proven. Although there is no literature to scientifically link the deterrence effect with the exact amount of the fine, it was felt that the levels of fines in Korea could be too low. As an example, the current penalty in Korea for very excessive speeding (i.e., for driving 60 km/h above the limit) is a fine of KRW 130 000 (around EUR 100). This is a relatively low penalty when compared with practices in other OECD countries: for the same violation in Western Australia, drivers will be issued with a fine of AUD 1 000 (around EUR 720) as well as having 7 points (out of 12) deducted from their driving license. In France, the penalty is a EUR 1 500 fine and the loss of 6 points (out of 12).

Some countries have required speed awareness courses as an alternative to fines and penalty points for less serious speeding violations. The effectiveness of such courses is about to be evaluated in the United Kingdom. In Austria, courses take place over four evenings and a psychologist leads group discussions. Victoria in Australia has just conducted a trial with recidivist speeders that combined a course with installing a voluntary ISA system on the vehicle. Results will be available shortly.

Recommendations

The expert group recommends:

- Undertaking an independent peer review of road policing in Korea and to benchmark the methods and volume of enforcement against best international practice and current research in the areas of alcohol impaired driving enforcement, speed enforcement, restraint (seatbelt) enforcement, commercial vehicle enforcement (focusing on maximum permissible driving hours), road policing training and road safety intelligence.
- Conducting an independent peer review of crash investigation and reporting practices and standards and benchmarking these against best international practice.
- Developing safety performance indicators and intermediate outcome targets and arrange on-going independent surveys to monitor over time and by geographic areas the following behaviours: mean and 85^{th} percentile free traffic speeds in urban, rural and motorway environments, restraint wearing rates in the front and rear of vehicles (including child restraints), alcohol and drug impaired driving rates, commercial vehicle safety compliance.
- Reviewing current road safety legislation and benchmark it against best international practice. The review should focus upon legislation and penalties (fines, driver demerit schemes) relating to alcohol impaired driving, speed offending, failure to wear safety belts/utilise child restraints, commercial vehicle safety standards and permissible maximum driving hours.

Safety in an ageing society

Mobility and safety need to be addressed in combination – especially for the elderly, who are exposed to a higher risk of death or serious injury while using the roads than other age groups (with even higher levels of risk in Korea than in most other OECD countries). Walking is generally the most common mode of transport for the elderly and particularly for the very old although they tend to accumulate less mileage than other age groups. With income growth and technology improvement driving by the elderly is likely to increase substantially in the future. Cycling also needs to be considered as it has major potential for the elderly population. This group is very heterogeneous and cannot be treated as a uniform user group.

Cessation of driving causes psychological problems and these are particularly acute for men. Those who regularly also use other modes prior to cessation have fewer problems. The risk factors for elderly drivers are complex. They drive low mileages (and low annual mileage is generally a factor for reduced individual risk), they are more frail, and they tend to use roads with a higher rate of crashes per vehicle kilometre carried (i.e. avoiding motorways).

Elderly drivers do not pose a disproportionate danger to other road users and should have support in keeping their licences, including retraining, and support in the transition to loss of license, including the provision of safe alternatives to driving.

The design of road infrastructure should consider the needs of the elderly both as drivers and as vulnerable road users. Falls are a major problem for the elderly, both on pavements and in public transport vehicles; however data is seriously lacking.

Speed is a major factor in problems for elderly drivers at intersections, and speed needs to be limited at places where vehicles interact with pedestrians. Initiatives such as Silver Zones, where the presence of older pedestrians is also indicated by road signs, can increase the safety of areas frequently visited by vulnerable road users.

Medical tests

The discussion at the expert meeting focused on the value of age-related driving restriction and medical tests. A major study was conducted by Liisa Hakamies-Blomqvist in Finland and Sweden (Hakamies-Blomqvist et al., 1996). Finland had age-related medical tests, but Sweden did not. She found that the tests were detrimental to traffic safety because they forced people into walking and cycling (the modes most exposed to risk). In the Netherlands, the age for medical testing has been raised from 65 to 75 and there is now a discussion on the justification of these tests, even at the age of 75, as no valid test has been found to predict safety in driving. Western Australia has removed compulsory testing but retains referral by doctors, as well as referral by family or friends, to the licencing authority to withdraw licences on the basis of evidence, including eyesight checks. In Korea, car drivers from 70 years onwards are subject to a driving ability test every five years. Currently, no regulation is in place for commercial car drivers in Korea; however mandatory driving ability tests for bus drivers are being discussed.

Professional drivers

The issue of the age of taxi drivers in Korea was raised. In Korea many professional drivers are self-employed and as such are not subject to corporate legislation. The expert response was that all professional drivers, regardless of age, should be subject to medical tests.

Recommendations

Protecting elderly road users -- and reducing their exposure to risk -- requires measures that affect the traffic system as a whole as they use all parts of the system. Motor vehicle speed management and speed controls have a central role. Silver Zones in places where older road users frequently walk (i.e. parks, cultural areas, etc.) seem to be very promising, as other countries report decreases in crashes around these areas.

Driving should be facilitated for citizens as long as possible -- subject to physical ability to drive safely. In the absence of specific impairment, licensing should not be limited by age. Awareness raising on personal abilities as well as training of compensatory skills have been proven to significantly improve the subjective safety of older drivers.

Measures to reduce fatalities and serious injuries among the elderly should also focus on creating conditions for safe walking, cycling and using public transport. With 68% of trips by Korean seniors above 65 years of age being travelled by bus and subways, accessibility (design), usability (information) and safety issues of public transport must be a focus.

A whole set of measures addressing older pedestrians, cyclists, car drivers and passengers, and public transport users should be developed, focusing on:

- Infrastructure design, with the heterogeneous need of the ageing population in mind. This will increase accessibility, usability and comfort in the public space and prolong general mobility.
- Training and awareness, raising to support individual modal choice decisions of older road users. Older car drivers especially need support, in view of their abilities and deficiencies in certain situations, as well as information on how to compensate for cognitive and sensory limitations.

Speed management

Speed is the most important risk factor in crashes, and impact-speed the major factor in crash outcome, hence the crucial role of speed management in road safety strategy.

The major tools of speed management are:

- adequate speed limit setting
- engineering and design of the system
- functional road classification
- weather-related dynamic speed management
- traffic calming (e.g. 30 km/h speed limits on urban streets)
- encouragement by design
- self-explaining roads
- dealing with transitions: "psychological traffic calming"
- enforcement
- fixed speed cameras
- time-over-distance cameras (or section control)
- awareness campaigns
- intelligent transport systems
- smart motorways
- intelligent speed adaptation (ISA)
- for the future, cooperative intelligent transport system (ITS)
- lowering speed limits.

There was extensive discussion at the expert meeting on lowering speed limits – particularly on urban roads. In Korea, the prevailing view was that lowering speed limits is an inconvenience to drivers, and that reductions without a clear reason would be seen as unfair and lead to increased social costs. There was strong disagreement from the external experts with this point of view. The Western Australia experience is that lowering the general urban speed limit from 60 km/h to 50 km/h had actually led to a 20% decrease in serious trauma, with the biggest winners being pedestrians, cyclists and children. This reduction conformed to the prediction from the modelling that was carried out in advance of changes to the speed limit. In Korea, where there is a high share of pedestrian fatalities, it was highlighted that all pedestrians including the elderly will benefit from a lowering of speed limits.

There are substantial wider benefits from the lowering of speed limits, including not only reductions in crashes but also mobility and environmental benefits. The impact of lower speed limits on journey time is often exaggerated. The average trip was extended by 6 seconds when the urban speed limits in Western Australia were reduced from 60 km/h to 50 km/h. Truck operators often require their drivers to go below the speed limit in order to save fuel. Max Cameron's work on the economic benefit of lower rural speed limits was mentioned (Cameron, 2009) .

In New Zealand, the support for lower limits has increased year-on-year following implementation. There is also generally very high public support there for enforcement: nearly 100% of the public want the level of road policing to be maintained at the current level or increased. The consensus was, however, by a police campaign over the December 2015 holiday period, to cut serious crashes by reducing the tolerance to exceeding speed limits to zero per cent of the posted speed from the previous margin of error allowed.

It was suggested that Korea focuses initially on a reduction of the speed limit in urban areas, including urban arterial roads, from 60 km/h to a 50 km/h speed limit. It was also suggested that, rather than implementation through mass change, demonstration schemes could be deployed, i.e. this should be done gradually, focussing on areas/lengths of roads of high priority/crash risk. A speed limit of 30 km/h should also be progressively implemented in city centres and residential streets.

The speeds at which express buses pass boarding points for regular bus services on dedicated bus lanes merits specific attention, given the proximity of high speed vehicles and pedestrians in potentially crowed areas – often hidden from view by stationary buses.

Cost of Intelligent Speed Assistance (ISA)

The issue of the cost of ISA equipment was raised. The response was that the extra cost on a new vehicle was negligible. Road safety management, speed enforcement plus ISA are tools that deliver.

Recommendations

The relevant agencies in Korea are invited to consider the following suggestions:

- Prepare an overall plan for speed management, which would include conducting an in-depth review of the existing speed limits, in particular on the urban network. Serious consideration should be given to reducing the urban speed limit from 60 to 50 km/h, accompanied by additional implementation of 30 km/h speed zones.
- Conduct campaigns to increase understanding among drivers of the risk associated with speeding and the need to consider prevailing conditions in choosing appropriate speeds as well as the small reduction in journey time that is obtained by speeding.
- Take measures to harness community support for speed management policies. This should be done through engagement with community groups such as parents of school children, local residents and campaign groups, including the families of those seriously injured and killed. These groups should be treated as partners in planning and decision-making.
- Review the potential of Intelligent Speed Assistance to help drivers conform to speed limits and thereby deliver a substantial improvement in road safety. As a country that promotes advanced technology and which is a major producer of motor vehicles, Korea could be a world leader in introducing ISA. It can be noted that the 2014 Kia Sorrento sold in Europe already has the option of providing speed limit information to the driver based on map and camera technology. The same model also has a driver-set speed limiter function. A full ISA system is only a small additional step in terms of vehicle electronics but a major step in terms of functionality and safety impact.

References

Aarts, L. Eenink, R. & Weijermars, W. (2014), Opschakelen naar meer verkeersveiligheid. Naar maximale verkeersveiligheid voor en door iedereen. R-2014-37. SWOV, Den Haag.

Cameron, M (2009), “Economic evaluation of the introduction of lower rural default and national highway speed limits in Tasmania”, Monash University Accident Research Centre.

Corben, B.F. et al. (2010), "Strengthening road safety strategy development Towards Zero 2008-2020: Western Australia’s experience", Scientific research on road safety management, SWOV workshop 16-17 November 2009. *Safety Science*, Vol. 48/2010, pp. 1085-1097. Elsevier

Hakamies-Blomqvist, L., Johansson, K. and Lundberg, C. (1996), "Medical screening of older drivers as a traffic safety measure: a comparative Finnish-Swedish evaluation study". *Journal of the American Geriatrics Society*, Vol. 44, pp. 650–653.

ITF (2011), *Reporting on Serious Road Traffic Casualties: Combining and using different data sources to improve understanding of non-fatal road traffic crashes*, IRTAD report. http://internationaltransportforum.org/irtadpublic/pdf/Road-Casualties-Web.pdf

Notes

1. At the UN Sustainable Development Summit on 25 September 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals to end poverty, fight inequality and injustice and tackle climate change. The health goal includes the target to *"halve the number of global deaths and injuries from road traffic accidents by 2020"* http://www.un.org/sustainabledevelopment/health/. The goal for cities includes the target *"By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons"* http://www.un.org/sustainabledevelopment/cities/.

2. There is a special issue of Safety Science (volume 48, issue 9, November 2010) on such safety modelling.

Chapter 2. Road safety challenges in Korea

Sangjin Han, Korea Transport Institute (KOTI)

This chapter describes road safety trends and the current organisation of road safety in Korea. It reviews in particular the following areas that were discussed during the round table: safety data, enforcement, safety management, speed management and the safety of the elderly.

Road safety trends in Korea

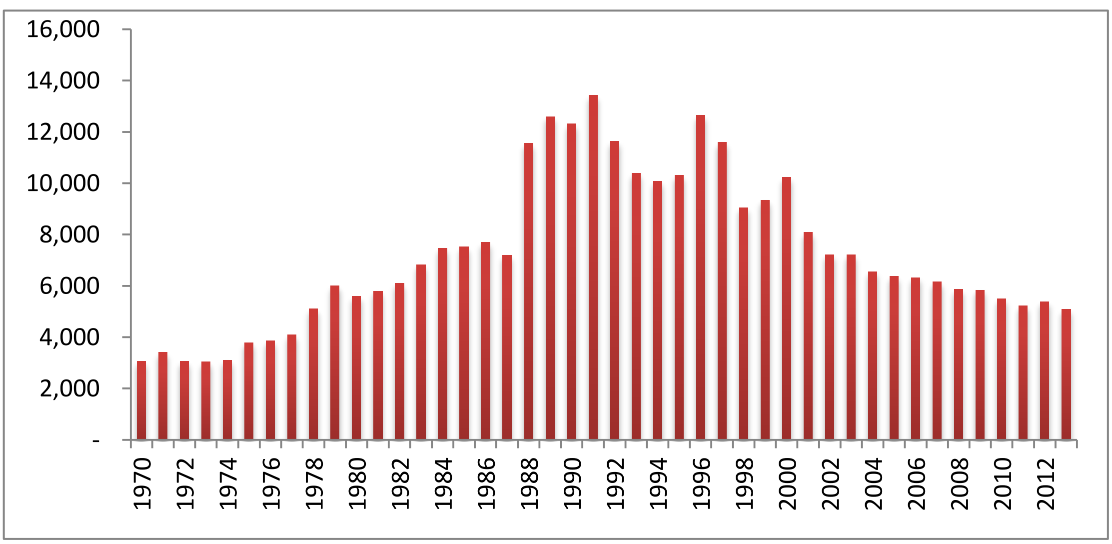
Evolution of road safety since 1991

Fatalities peaked in 1991 at 13 429. Since then, road deaths have steadily decreased (with some fluctuations) and were halved by 2004. In 2013, Korea counted 5 092 road deaths, a 62% decrease when compared to the level of 1991.

Motorisation is steadily increasing in Korea. With a population of 50.2 million, there are 19.4 million registered vehicles (i.e. around 400 vehicles per 1 000 inhabitants). Korea's road network totals 106 414 km, which includes 4 111 km of motorway.

Traffic crashes represent a very significant cost for society, estimated at KRW 38 trillion (South Korea won), which represents 1.5% of the Gross Domestic Product of Korea. The total number of crashes reported to police in 2013 was 215 354 and the number of causalities was 328 711 in 2013. Figure 2.1 shows the trend of road fatalities in Korea.

Figure 2.1. **Evolution in the number of road fatalities in Korea, 1970-2013**



Source: KOTI.

Comparison with OECD countries

Between 2000 and 2013 road fatalities declined from 10 236 to 5 092 (-50.3%), which is an important achievement. However during the same period, other countries in the Organisation for Economic and Co-operation Development (OECD) reduced the number of fatalities even more: Spain (-71%), Portugal (-69%), Denmark (-62%), France (-60%). Even countries that had already achieved an important decrease in the number of road deaths in the previous decade continued to see a large decrease in the period 2000-2013: Sweden (-56%), The Netherlands (-51%), United Kingdom (-50%) (Figure 2.3).

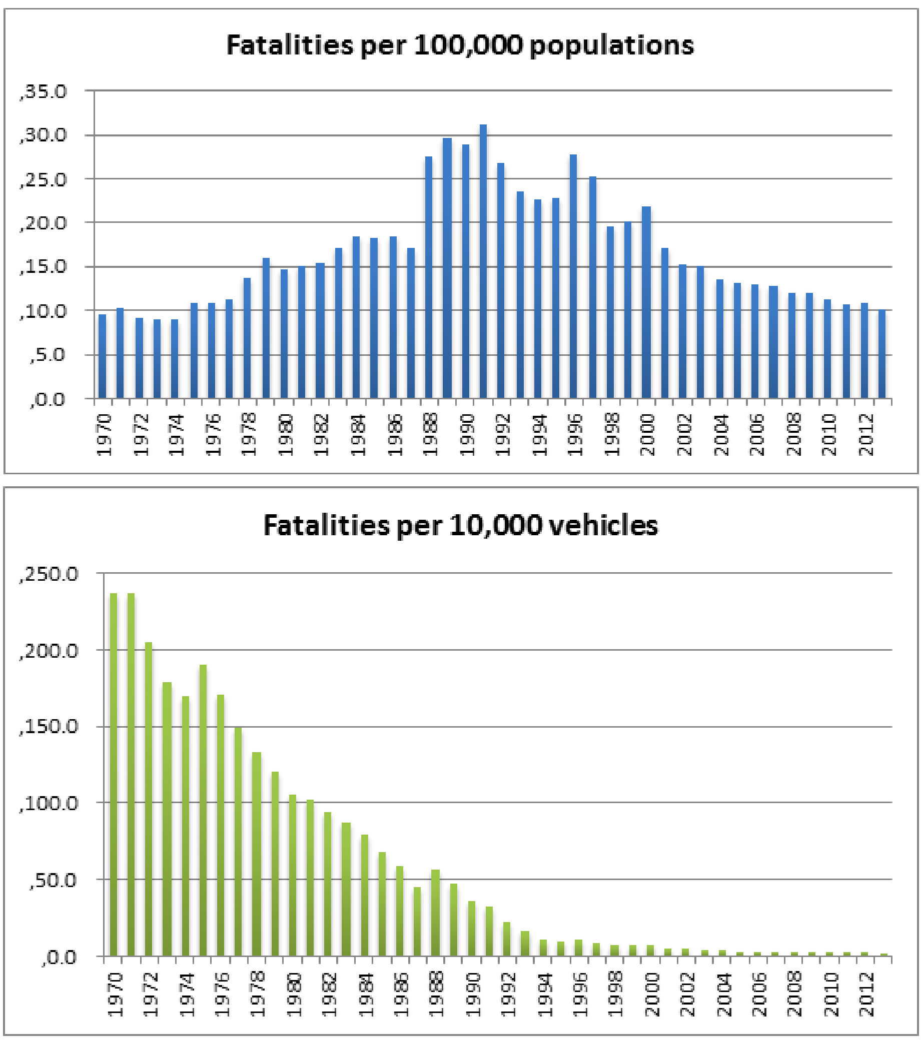
When examining fatality rates per 100 000 inhabitants or per 10 000 vehicles, Koreans are at a much higher risk than most other OECD countries:

- In 2013 in Korea, the fatality rate per 100 000 inhabitants was 10.1 while the OECD average was 6.8.
- In 2013 in Korea, the fatality rate per 10 000 vehicles was 2.3, while the OECD average was 1.2.

The risk expressed by the number of fatalities per 10 000 vehicles has decreased much faster than the risk expressed by the number of fatalities per 100 000 inhabitants (Figure 2.2). This is due to the rapid increase of car ownership.

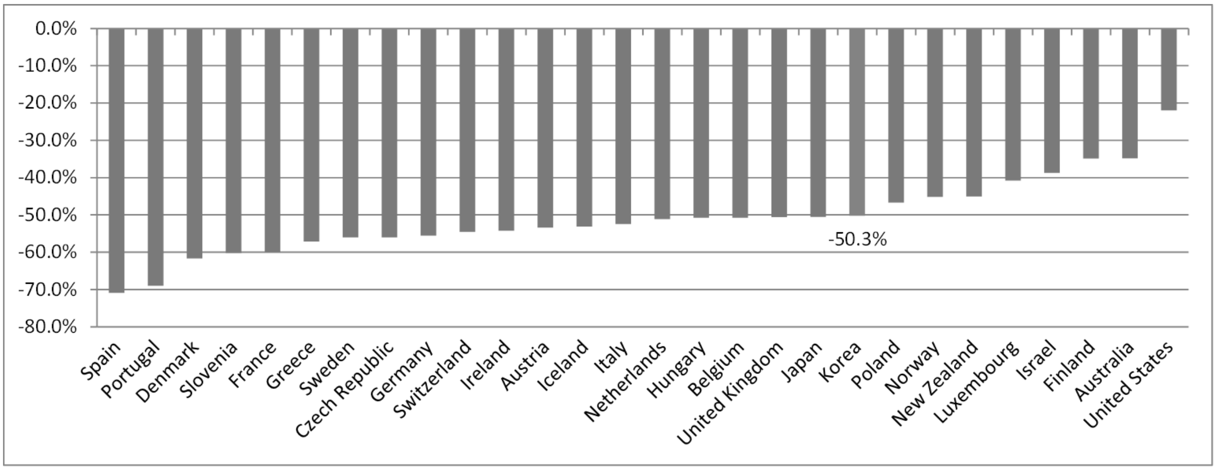
Despite the important progress achieved in Korea, the country still ranked lower than most OECD countries, because all OECD countries have achieved substantial reductions in fatalities in the past decade. To reach its objective to rank among the best OECD countries, stringent safety measures must be implemented.

Figure 2.2. **Fatality rate per 100 000 inhabitants and per 10 000 vehicles Korea, 1970-2013**



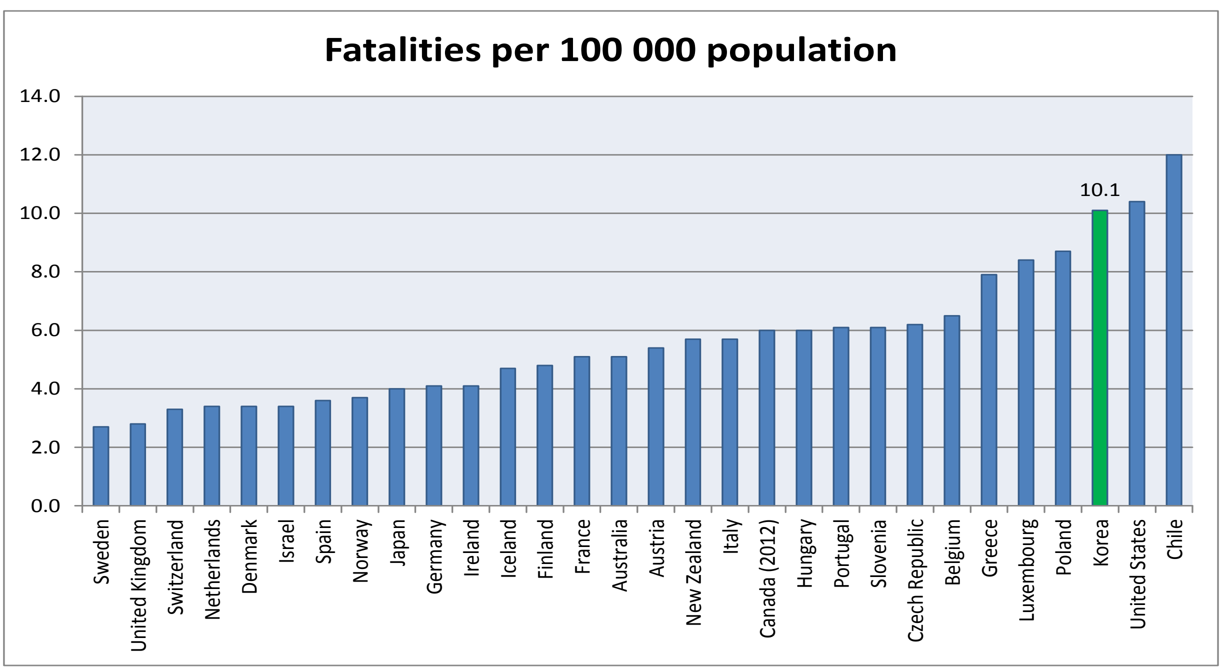
Source: KOTI.

Figure 2.3. **Change in road fatalities in OECD countries, 2000-2013**



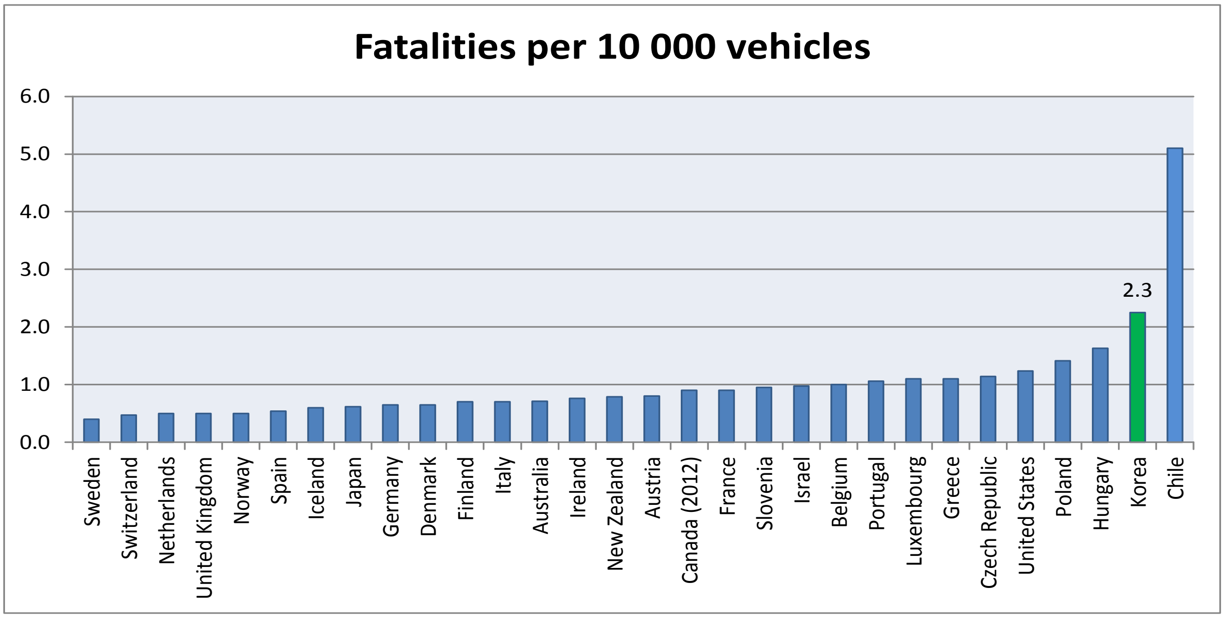
Source: OECD/ITF (2014).

Figure 2.4. **Road fatalities per 100 000 inhabitants in OECD countries, 2013**



Source: OECD/ITF (2014).

Figure 2.5. **Road fatalities per 10 000 registered vehicles in OECD countries, 2013**



Source OECD/ITF (2014).

Main findings from crash statistics

Analysis of crash data revealed a number of crash patterns that are different from the OECD average:

- Around 70% of fatalities occur on urban roads (in most OECD countries, the majority of fatalities occur on rural roads).
- In 2012, pedestrians represented 38% of total fatalities (the average for other OECD countries is 18%). Pedestrians hit by cars while crossing roads account for 63.5% of pedestrian fatalities. The age group 65 and over represents 12% of the population and 35% of all fatalities (the average for other OECD countries is respectively 12% and 22%).

Other noteworthy findings were that 58% of fatalities occur on roads of less than 9 meters width, and crashes at junctions account for 44% of the total, an increasing share. In 2010, one third of fatalities occur at a junction. Among the crashes occurring at a junction, 39% occur at non-signalised junctions (detailed graphical analysis in Annex 2).

Korean national transportation safety master plan (2012–2016)

National targets

The target of the 7th National Transport Safety Master Plan (2012-2016) for the road sector is to reduce the number of fatalities to 3 000 by 2016, a 45% decrease from 2010. The target for the rate per 10 000 vehicles, which was 2.6 in 2010, is 1.3 for 2016.

The plan also set specific targets for pedestrian and cyclist fatalities and fatalities from commercial vehicles. Detailed sub targets are set for fatalities at junctions, on urban roads and on roads with less than 9 m width, as well as targets to reduce traffic violations.

Table 2.1. **Specific road safety targets by year**

Targets		2010	2012	2013	2014	2015	2016
Fatalities per 10 000 vehicles		2.6	2.1	1.8	1.6	1.5	1.3
Number of fatalities		5,505	4,497	4,064	3,673	3,320	3,000
Pedestrians	Pedestrian fatalities	2,082	1,514	1,291	1,101	939	800
	Child fatalities	126	109	101	94	87	80
	Fatalities of people 65 and above	1,752	1,404	1,256	1,124	1,006	900
Vehicles	Fatalities from commercial vehicles	979	750	657	575	503	440
	Cyclist fatalities	297	261	244	229	214	200
Road	Fatalities at junctions	1,499	1,163	1,025	903	795	700
	Fatalities from urban roads	1,345	1,056	936	829	734	650
	Fatalities on roads less than 9m width	3,185	2,451	2,150	1,885	1,654	1,450
Drivers	Fatalities of old drivers	547	422	370	325	285	250
Traffic Violations	Fatalities from speeding	138	108	95	84	74	65
	Fatalities from alcohol	781	598	523	458	401	350

Source: KOTI.

Main strategies and actions

The 7th National Transportation Safety Master Plan includes five strategies:

- improvement of road user behaviours
- provision of safe transport infrastructure
- operation of smart transport system
- enforcement of safety management system
- enhancement of emergency response system.

A detailed set of measures have been proposed to support these strategies (Table 2.2). Some of the measures are similar to those implemented in other countries; some are specific to Korea.

Some specific measures include:

- installation of ignition interlock device for drink drivers
- promotion of distance based insurance
- passing priority at unsignaled junctions
- sidewalk provision in residential areas
- increase of silver zones for the elderly
- installation of signal posts on the near side rather than the far side of junctions
- implementation of advanced safety technologies
- introduction of road assessment program
- introduction of e-call system
- introduction of weather forecasts along roads.

These measures have not been fully implemented as planned, mainly due to a shortage of budget. The previous National Transportation Safety Master Plan must be evaluated as to what has been done, what has not been done, and why. It has been estimated that an annual budget of KRW 2.4 trillion was necessary to implement the plan. Around half of the budget needs to be funded by the central government, 30% by local government, and 20% by others including private sectors.

Table 2.2. **Road safety strategies and actions**

Strategies	Areas	Actions
Improvement of road user behaviours	Better safety for school routes	·Walking school bus ·Registration of school buses ·Child car seat enforcement
	Children - oriented road safety education	·Development of education textbooks ·Increase of road safety classes ·Promotion of road safety instructors
	Better safety for the elderly	·Self-diagnosis manual ·Education program ·Provision of the older-friendly cars
	Enforcement on drink driving	·Reinforcement on BAC level ·Installation of ignition interlock device ·Increased penalties for violation
	Improvement in insurance policy	·Premium reduction for cars with safety equipment ·Differentiation of premiums by regions ·More responsibility to rental car drivers ·Distance based insurance
	Working hour limit for commercial vehicle drivers	·Research on working hours per day for various types of drivers ·Amendment of Labour Act
	More education and promotion	·Passing priority at unsignaled junctions ·More TV advertisements ·Road safety experience centre
Provision of safe transport infrastructure	Safe and comfortable pedestrian space	·Sidewalks for roads in residential areas ·More pedestrian priority zones ·LED lights over pedestrian crossings
	Special zones for vulnerable road users	·Silver zone increase ·More safety facilities for disabled people
	Better safety facilities	·Installation of signal posts before junctions ·Safety improvement at entrance to villages
	Area-wide road safety improvement	·Designation of pilot road safety cities
	Bicycle safety	·Better cycle paths and education
	Sharing road safety information	·National road safety data sharing system ·Sharing in-depth crash investment data
Operation of smart transport system	Advanced safety assistance equipment	·Introduction of various sensors, alarms, and occupant protection to reduce vehicle to vehicle accidents
	Safety equipment for commercial vehicles	·More installation of maximum speed limiters and digital tachometers
	Meeting global standards in vehicle safety	·More testing areas in NCAP ·Life-cycle management for motorbikes ·Safety standards for Green cars
Enforcement of safety management system	Speed management for people	·60 km/h speed limit for minor arterial roads ·30 km/h speed limit in residential areas
	Scientific investigation of accident causes	·More in-depth investigation on major crashes ·Introduction of Korea Road Assessment Program
	Safer logistics systems	·Information system for hazardous materials movement
Enhancement of emergency response system	Emergency response by areas	·e-call system ·Emergency routes along congested areas ·Emergency response by helicopters
	Weather information system	·Provision of weather forecasts along roads

Source: KOTI.

Organisational structure for road safety

Road safety responsibility is shared by three ministries and two governmental agencies. Each Ministry is empowered to design legislation for road safety:

The Ministry of Land, Transport and Infrastructure (MOLIT) is responsible for the national trunk road network consisting of motorways and national highways. It also manages vehicle safety and runs the New Car Assessment Program.

The Ministry of Public Safety and Security (MPSS) oversees road safety particularly for local governments. It contributes to safety strategies for provincial, municipal and county roads. The ministry was restructured in 2014, following the Sewol ferry disaster.

The National Police Agency (NPA) is mainly responsible for traffic enforcement, crash investigation. It also operates traffic signals, crossings and speed enforcement cameras.

The Korea Transportation Safety Authority is a government agency supporting MOLIT, mainly in charge of vehicle safety.

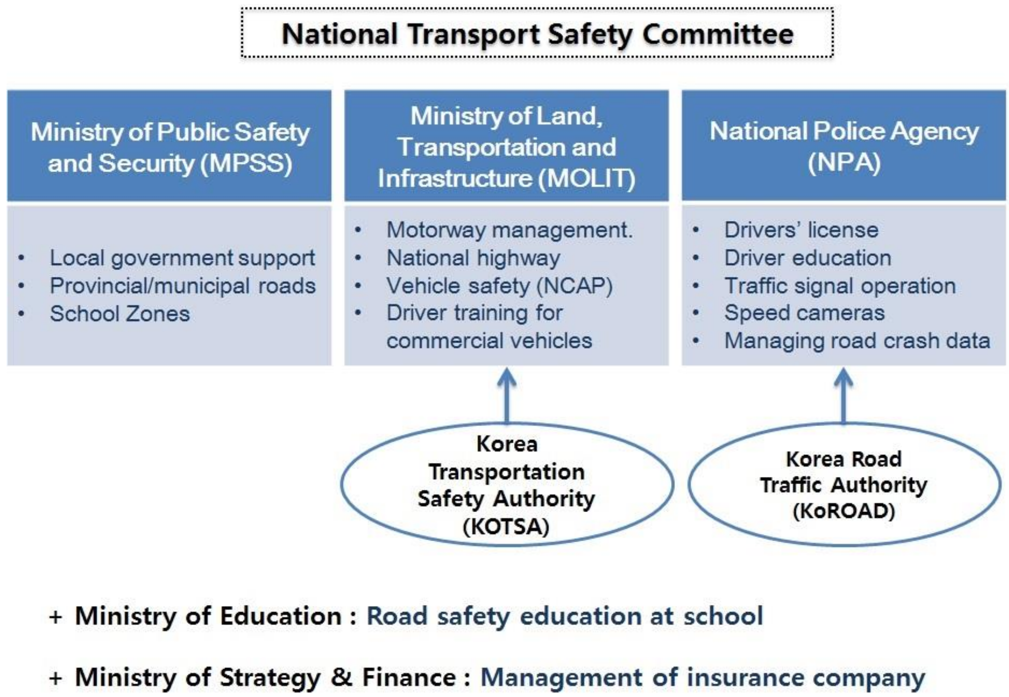
The Korea Road Traffic Authority is a government agency supporting the NPA, responsible for road traffic management. The agency is in charge of traffic monitoring, drivers' license examinations and management, training and education.

Road safety policy is co-ordinated by a **National Transport Safety Committee**, an intergovernmental body. The committee is chaired by the Minister of Land, Transport and Infrastructure. Some private professionals can participate in the committee according Transport Safety Act. In practice, the committee does not convene often.

The role of the committee is to review road safety policies and measures implemented by the various agencies; however, it does not have a monitoring function as in Sweden for example, nor does it have a budget or budget allocation power.

Therefore, in Korea, no one government body is accountable for road safety. Attempts have been made to create such a body. In 2000-2002, the prime minister created a **Safety Management and Improvement Committee** responsible for co-ordinating safety policies and measures among various governmental agencies. During this period the number of fatalities was reduced by 30%. Although it is difficult to make a direct correlation between the good results and the establishment of this committee, it is likely that this strong co-ordination function at the highest level of the government was instrumental.

Figure 2.6. **Organisational structure for road safety in Korea**



Source: KOTI.

National road safety budget

In Korea, there is no official account dedicated to road safety; however one can clearly identify the spending by each ministry (see Table 2.3). Korea has no coordination process for safety budget allocation from a holistic perspective. Each ministry proposes its plan and required funding to the Ministry of Finance, which reviews and endorses the budget.

In 2012, **The Ministry of Land, Infrastructure and Transport** spent KRW 159 billion for road infrastructure safety, including black spot improvement, and KRW 46 billion to improve the safety of commercial vehicles and vulnerable road users. This budget includes the operating cost of the **Korea Transportation Safety Authority**.

- The Ministry of Security and Public Administration, which is now renamed as **Ministry of Public Safety and Security,** spent KRW 193.6 billion to improve safety in school zones and black spots on local government roads. It also spent substantial money for improving pedestrian safety.
- The **National Police Agency** spent KRW 315.9 billion for road safety including the operating cost of Korea Road Traffic Authority. A substantial amount is for management of traffic operation facilities including traffic signals, speed enforcement cameras, and other safety measures.

Table 2.3. **Road safety expenses by the three main ministries**

Classification			Budget (KRW 100 million)
Ministry of Land, Infrastructure and Transport	ITS & Road Environment Division	Sub-total	1 590
		Installation of safety barriers	284
		Improvement of safety facilities	74
		Improvement of accident black-spots	327
		Improvement of road signs	60
		Improvement of dangerous roads	610
		Improvement of pedestrian facilities	217
		Installation of lighting at pedestrian crossings	18
	Transport Safety and Welfare Division	Sub-total	466
		Investment to Korea Transportation Safety Authority	325
		Development of digital tachometer analysis program	115
		Research on automobile and transportation safety policies	7
		Establishment of transportation safety information management system	5
		Pilot project on pedestrian priority zone	6
		Assistance to Korea Traffic Disabled Association	8
Ministry of Security and Public[1] Administration	Sub-total		1 936
	Improvement of school zones		422
	Improvement of accident black-spots		129
	Improvement of dangerous roads		742
	Project aimed to create a safe pedestrian environment		545
	Installation of advanced country-style roundabouts		99
National Police Agency (NPA)	Sub-total		3 159
	Education and public awareness campaigns on transportation safety		31
	Transportation safety activities		771
	Management of scientific transportation equipment		923
	Investment to the Road Traffic Authority		1 160
	Computerization of transportation administration		34
	Improvement of wide-area transportation management system		240

1) The Ministry was recently restructured and renamed Ministry of Public Safety and Security

Source: KOTI, Korea Transport Institute

Some reasons why Korea shows higher road fatalities among OECD countries

Korea's successful economic growth attributed to the inherit characteristics of the Korean people who wish to do everything faster than others. However, the same characteristics may be detrimental to road safety. A number of factors may explain the relative lesser performance of Korea regarding road safety:

Some people point out that some **drivers never understand** what is safe or dangerous driving behaviour even though they have passed driving license tests. Some **reckless pedestrians** cross roads without care and this causes a lot of accidents.

Korea sells a substantial amount of alcohol and traditionally the culture is generous regarding alcohol consumption. This has improved recently, but **alcohol consumption** has not dropped significantly.

It is common to come across **wide junctions** particularly in new towns, where multi-lane roads often of six lanes must be crossed by pedestrians. Wide junctions require more crossing time, which increases the risk of crashes at signal changes.

Sidewalks are not found in rural highways in certain sections, and this results in many pedestrian fatalities, particularly for elderly male farmers.

The standard **speed limit in urban area is 60 km/h** in Korea, which is rather higher than in European cities, and some cities allow **80 km/h** within urban areas. This may be related to urban sprawl, as higher speeds reduce travel times between suburbs and the city centre.

Parking may be a principal cause of crashes and congestion in urban areas. Cars engaged in parking can **hinder** sight distance of other drivers, causing accidents particularly around junctions and crossings in residential areas.

Timing of traffic signals is important to reduce travel times and to make drivers to follow traffic signals. However, **traffic signal times are not revised properly** according to changes in traffic conditions. In general, the initial design of traffic signal timing is not reviewed for long times. Subsequently, Long delays at traffic signals along certain routes can cause **speeding**.

Between 2001 and 2003, the number of fatalities dropped significantly. Many experts credit the Safety Management Task Force under the prime minister's office that coordinated various road safety policies.

Some people blame **low penalties** for continued traffic violations of drivers. Money collected from fines is not necessarily used for the improvement of road safety.

There are excellent road safety programs for primary schools, but there is **no road safety program for middle schools** or high schools. Road safety education for teenagers could induce a desirable driving culture.

Local governments care for most urban roads, but they cannot spare money for road safety projects. The **priority of road safety is still very low for most local governments**. People wish to spend taxes to promote income rather than to promote safety. This is getting worse for local governments that are heavily dependent on subsidies from central government.

A law prohibits prosecution of people who caused accidents if they have not committed one of 10 major violations such as speeding, intrusion into median lines, etc. This helps reduce criminal records, but it may not encourage careful driving.

Figure 2.4. **Some possible causes of high road fatalities**

People	Competitive people hurry too much
	Lack of knowledge for safe driving
	Careless crossing behaviour (both young and old)
	Careless driving of commercial vehicles (taxis, trucks, buses)
	Lower seatbelt use in rear seats
	Culture forgives alcohol consumption
Road environment	Wide junctions with multi-lane roads
	Lack of sidewalks for rural highways
	High speed limit in urban areas
	Illegal parking in residential areas
	Inadequate traffic signal design
Institutions	Lack of coordination of road safety policies in various ministries
	Low penalties for traffic violations
	Insufficient road safety education after primary school
	Lack of interest in road safety from local governments
	Insufficient campaign for road safety nationwide.
	Special law that exempts prosecution of traffic offenders in accidents except for 10 major offenses

Success stories in Korea and discussion

Child road safety

Korea has shown good progress when it comes to child road safety. Fatalities have been reduced from 1 776 in 1988 to 82 in 2013. It is around 95% reduction. The success can be attributed to strong government interventions around schools. More than 9 021 school zones were designated between 2003 and 2012 at a cost of more than USD 1 456 million. The maximum speed in school zones is 30 km/h and parking is prohibited and enforced in the designated zones. The Green Mothers Organisation (a grass root organisation to help child road safety) played significant roles in reducing child road fatalities by helping children cross roads safely around schools.

Black box installation for cars

Car black box installation is popular in Korea because it can provide crucial evidence when a crash occurs. Black boxes were initially mounted to reduce dispute over crashes, but they have proved useful to encourage safer driving of commercial vehicles. By 2012, more than 2 million cars, mainly in business fleets, were equipped with this device.

According to a recent analysis by Korea Transport Institute (KOTI), fatalities from taxis were reduced by more than 15% after the introduction of black boxes. KOTI also estimates that the benefit over cost ratio would be around 1.7 if all cars were equipped with black boxes. Currently car insurance companies reduce insurance premiums by 3% to 5% when black boxes are installed.

Discussion

In addition to the child road safety and black box installation, other evidence suggests that Korea can improve its road safety record. Seat belt use in front seats increased rapidly in Korea after intensive publicity and enforcement early in the 2000s. The government showed strong willingness to achieve the target, and it was achieved.

Korea can achieve a good road safety record if government can cooperate to develop Safe System management and if people can actively participate in new initiatives with the help of strong political leadership. Most of all it seems to be imperative to evaluate success and failure of road safety measures and to monitor progress toward targets with various Safety Performance Indicators. Monitoring and evaluation seem to be the most conspicuous gap compared to safer countries such as Sweden, the Netherlands, and Australia.

Review of Korea experience in key fields examined in the expert meeting

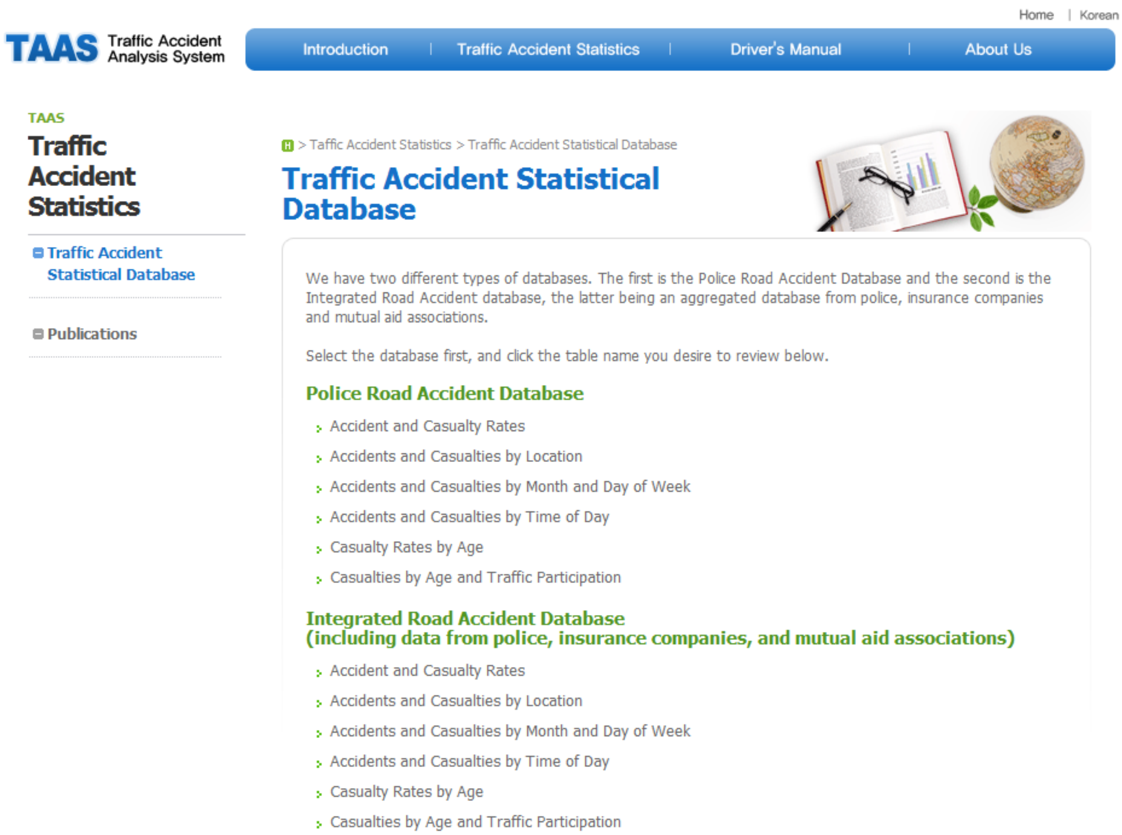
Safety data collection and analysis

Any road crash in which at least one person is killed or injured must be reported to police. The police investigate the crash, fill out a form and enter the information in the police road crash database Traffic Accident Management System (TAMS). The police refer to a medical diagnosis to classify injuries by severity.

KoROAD has created an integrated road accident database, Traffic Accident Analysis System (TAAS). This contains not only police data, but also information from car insurance companies and mutual aid associations. From the TAAS system, it is possible to make statistical analysis by cities, by age group, by month, etc.

Recently TAAS has included crash location data based on the Geographic Information System, and details of individual accidents are only available upon official request. Data sharing is limited compared to other OECD member countries. It would be useful to know how other countries share crash data with other ministries, academics, and the general public.

Figure 2.7. **Webpage of Traffic Accident Analysis System**



Regarding serious injuries, the international recommendation to define an injury based on the "Abbreviated Injury Score" is not yet applied. However, some medical doctors recommend that governments apply this classification rule. Currently, injury accidents are classified according to the duration of hospitalization. Hospitalization from five to 21 days corresponds to a minor injury, while more than 21 days corresponds to a severe injury.

Safety Performance Indicators are not commonly used in Korea. There is no Safety Performance Indicator to measure outcomes, outputs and projects in Korea. Benchmarking with other OECD countries could be useful in identifying and reviewing priorities.

Traffic enforcement

The Korean traffic police are in charge of enforcing road traffic law. Activities focus on violations related to drink-driving, speeding, non-respect of traffic signals, non-respect of right of way at junctions and illegal parking.

According to the police statistics, in 2013, 9 510 police officers reported 12 499 256 violations, including:

- Drinking and driving: 269 836
- Speeding : 7 928 073
- Non respect of traffic signals: 1 909 004
- Illegal parking: 28 309
- Crossing a solid line 83 200.

In addition to traditional enforcement measures, Korea's National Police Agency has implemented specific measures such as:

- Using of high quality video cameras to enforce traffic signals around junctions, seatbelt wearing, mobile phone use, etc.
- Awarding bonus points to drivers who have not committed a traffic violation. Bonus points can be used to reduce penalty points should driver eventually commit an offence.
- Encouraging use of smart phone applications to notify police in real time of traffic violations with pictures or video clips.
- Installing both fixed and mobile speed enforcement cameras.

A recent study shows that the number of police officers assigned to road crash investigation is relatively low. On average, such a police officer deals with 32.4 crashes per month, while an optimal level should be 7.3. There were 9 510 traffic police officers in 2013.

Some experts argue that the level of traffic fines is not high enough to prevent violations considering the average income in Korea. Fine levels are summarised in Table 2.5:

Table 2.5. **Financial fines applied in Korea for traffic violations**

Violation types		For car drivers	
		General	Special Zones
Entrance to restricted area		40 USD	80 USD
Illegal Parking/Stopping		40 USD	80 USD
Speeding	>60km/h	120 USD	150 USD
	40-60km/h	90 USD	120 USD
	20-40km/h	60 USD	90 USD
	<20km/h	30 USD	60 USD
Non respect of Traffic signal		60 USD	120 USD
Not giving way to pedestrians	Crossing	60 USD	120 USD
	General	40 USD	80 USD

Safety of the elderly

The proportion of elderly fatalities from road crashes has increased rapidly during the last decade. People aged 65 and above represented 24% of all road fatalities in 2001 and 36% in 2013, while this share in OECD countries is 22.6%. The number of elderly fatalities per 100 000 people is around 30, or three times higher than the average level in OECD countries.

A recent study from Korea Institute for Health and Social Affairs (Youm, 2013) shows that people aged 65-69 use private cars more than those who are older, in part because they are healthier and have higher incomes. However, public transport is the most common means of transport for the people 65 and above, with 49% of trips made by bus, 19% by subways and 18% by car.

To promote the safety of elderly people, more than 1 494 Silver Zones have been designated around cultural centres and parks frequented by the elderly. In these dedicated Silver Zones, the speed limit is 30 km/h and crossing times at traffic signals are extended.

Speed management

There is no national speed management policy in Korea. However, 30 km/h zones are being progressively implemented in urban safety zones being developed. Those include Children Protection Zones, Pedestrian Priority Zones, Silver Zones, and Living Road Zones. Traffic calming measures commonly placed in those zones included speed humps, raised crossings and zigzagging roads.

In urban areas, the general speed limit is 60 km/h although some local governments may allow 70 km/h and the speed limit on urban motorways is typically 80 km/h. Most national motorways have speed limits of 100 km/h or 110 km/h, with the exception of sections built to lower standards where the speed limit is 80 km/h. Dynamic or variable speed limits are not yet implemented in Korea.

Intelligent Speed Adaptation (ISA) is not widespread in Korea. However, some officials recognise that it could bring important safety benefits if implemented nationwide. The introduction of ISA in Korea seems feasible considering the high penetration rate of smart phones. Most drivers use their smart phones for dynamic navigation that takes traffic conditions into account. GIS maps for roads are well developed and could easily integrate ISA functions. Intelligent Transportation System technologies are developing rapidly, and it is expected that ISA could be implemented without major obstacles.

References

Korea Institute of Autonomous Management (2008), "Optimal number of traffic police officials by analysing workload".

Korean National Police Agency(2014), "Police Statistical yearbook 2013".

Korean National Police Agency (2014), "Traffic Accident Statistics 2013".

Ministry of Land, Transport and Maritime Affairs (2011), "The 7th National Transport Safety Master Plan".

OECD/ITF (2014), *Road Safety Annual Report 2014*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/irtad-2014-en

Sul, J.H. (2013), "Promotion and application of car accident recording system", *Monthly Transport*, No. 184, July 2013.

Sul, J.H. (2014), "Korea's 95% Reduction in Child Traffic Fatalities: Policies and Achievements", Korea Transport Institute.

Sul, J.H., J.Y. Park, N. Jung (2013), "Transport Safety Policy in Korea, KOTI knowledge Sharing Report 04", Korea Transport Institute.

Traffic Accident Analysis System https://taas.koroad.or.kr/Eng/indexMain.jsp

Youm, J.H (2013), "Transport Use of Elderly People in Korea, Issue and Focus", Korea Institute for Health and Social Affairs.

Annex 2. Road crash patterns graphical analysis

Figure 2.A.1. **Fatalities by road type**

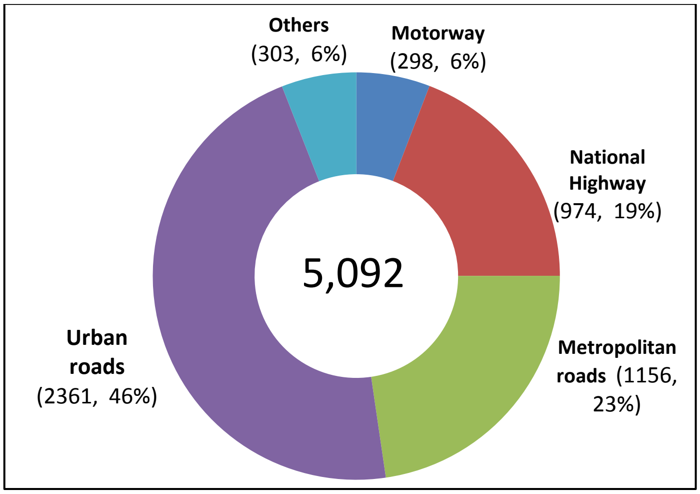


Figure 2.A.2. **Fatalities by road width**

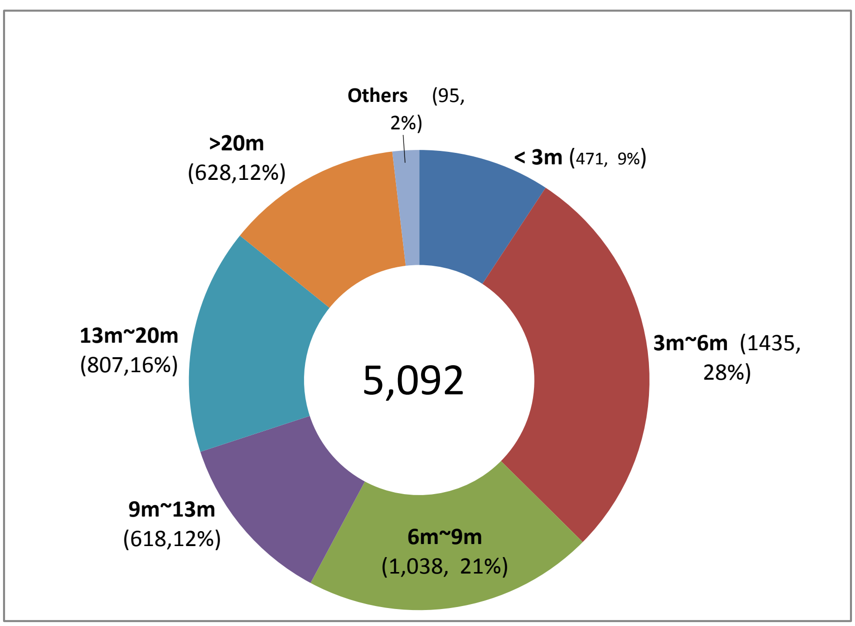


Figure 2.A.3. **Road crashes at intersections**

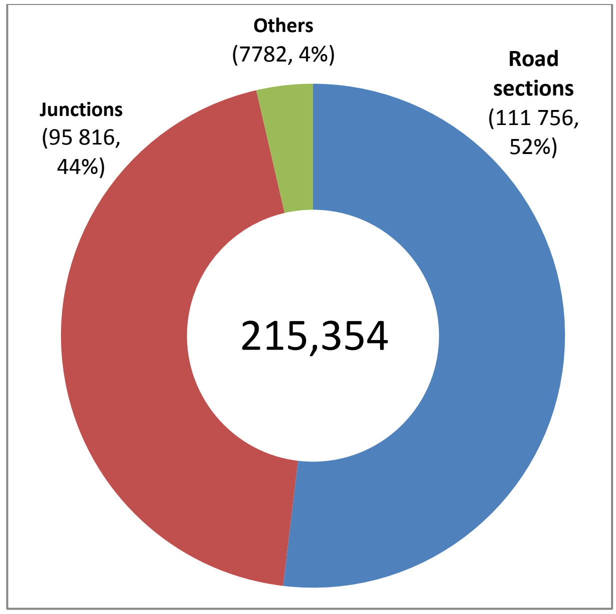


Figure 2.A.4 **Fatalities by user group**

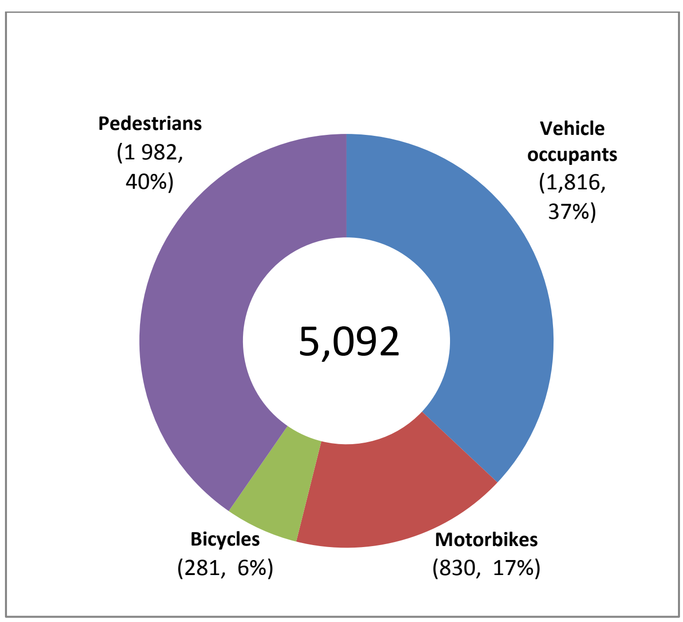


Figure 2.A.5. **Crash patterns involving the death of a pedestrian**

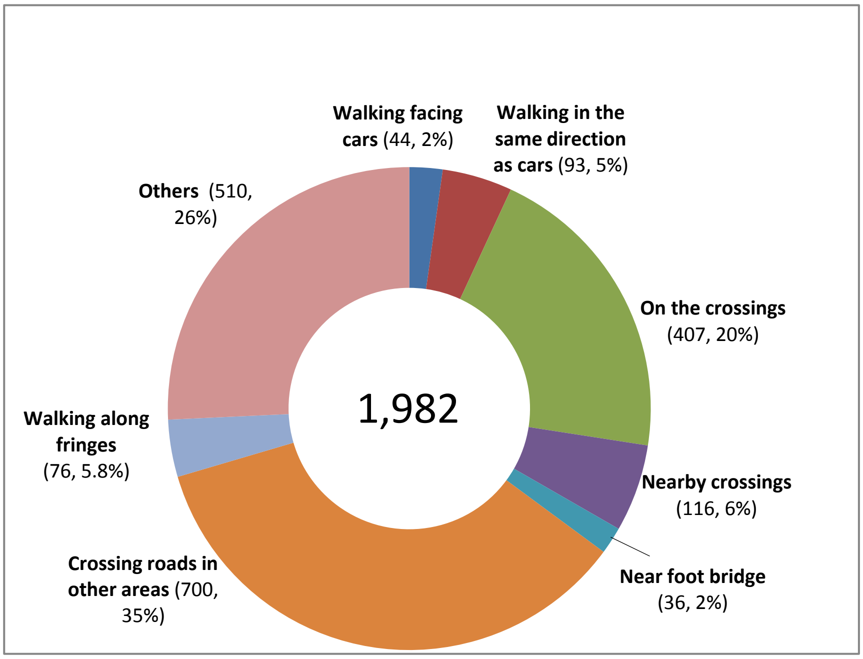


Figure 2.A.6. **Share of pedestrian fatalities as a percentage of total OECD countries, 2012**

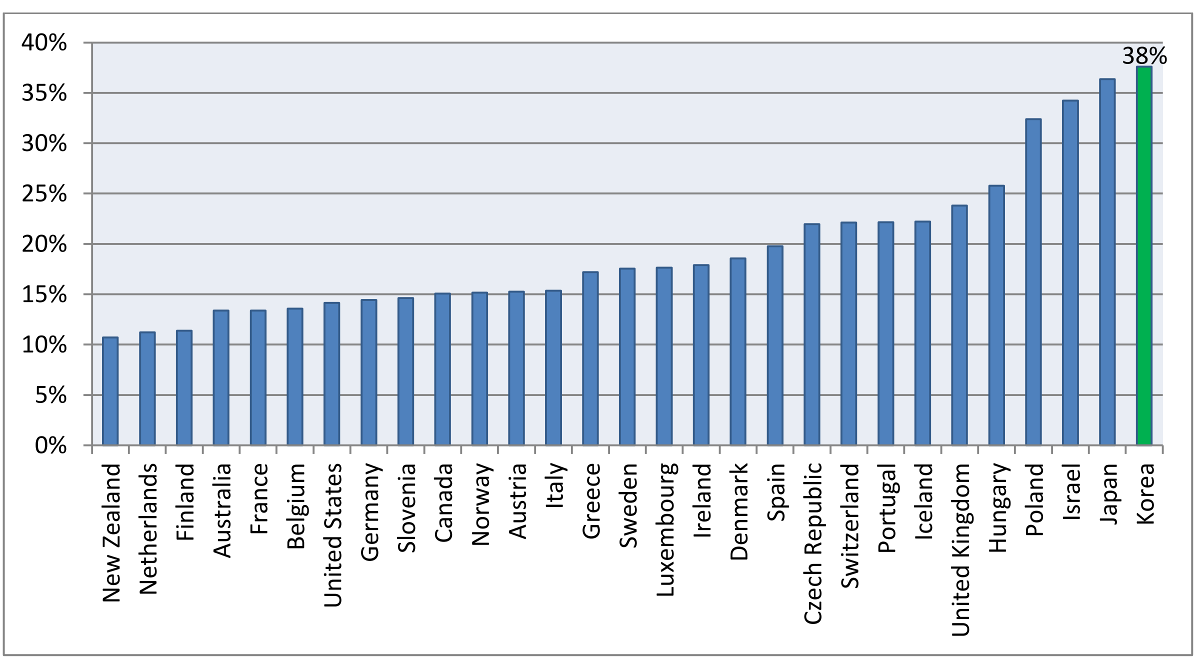


Figure 2.A.7. **Share of 65+ fatalities among all fatalities OECD countries, 2012**

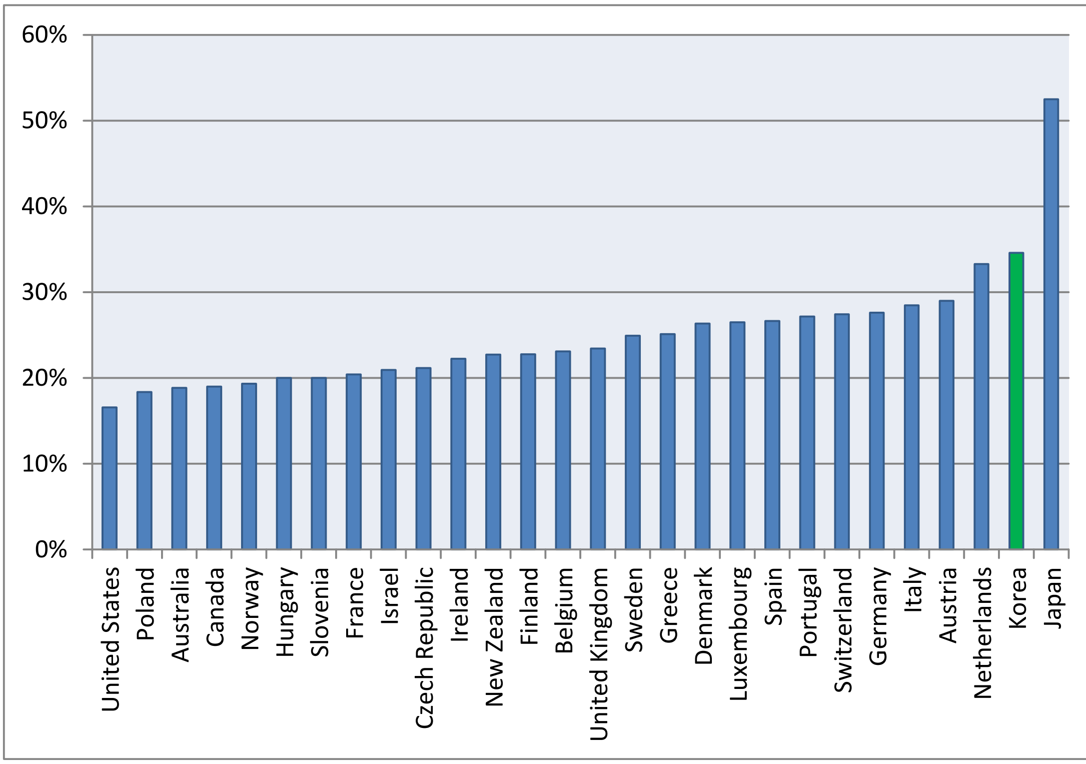
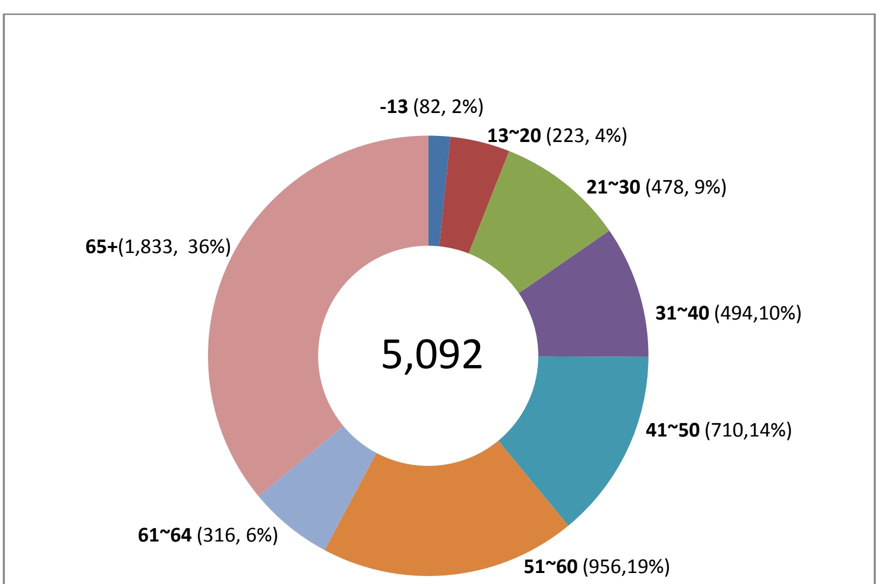


Figure 2.A.8. **Fatalities by age group, Korea**



Chapter 3. Road safety management of a Safe System for ambitious results

Iain Cameron, Office of Road Safety, Western Australia

This paper provides a summary of how the three key areas of road safety management – leadership, evidence based interventions and institutional management -- operate to enable countries to achieve ambitious levels of road safety performance.

Key messages

1. Countries achieving the best road safety results and countries striving to achieve a substantial reduction in serious road crash casualties demonstrate leading practice in:

   – the political will and leadership to achieve ambitious interim targets on the journey towards an ultimate goal of no deaths and serious injuries

   – Implementation of systematic and coordinated, evidence based interventions for improvement managed through a safe system approach; and

   – ensuring the key institutional management functions of the road safety management system are in place and operating optimally to provide the capacity or the "production line" to generate the necessary interventions.

2. Korea can achieve further substantial reductions in serious road trauma by adopting the safe system approach together with an ultimate vision of achieving no deaths and no serious injuries used in the leading countries.

3. The adoption of a bold vision with the safe system approach will enable Korea through its leading agencies and organizations, together with the community to fundamentally change the way it approaches road safety improvement. This will involve moving current thinking and practice from " decisions about the next incremental improvement " to " decisions on how to achieve the ultimate outcome of zero serious harm and then working backwards from the ultimate to the current" to determine the next steps forward along the safe system journey.

4. Korea will benefit from conducting further analysis and modeling to identify where significant gains have come from in the past improvements and to identify a package of safe system countermeasures and the recommended levels of implementation (dose response) required to achieve further ambitious improvements in results. Western Australia under took such an approach in its Towards Zero strategy development which resulted in strategic decisions about the extent to which improvements could be achieved in vehicle safety, road engineering, speed management and road user behavior.

5. The 50% reduction in road deaths by 2020 identified by Korea can be utilized as the first milestone improvement target in the safe system approach but will benefit from the addition of a target for serious injuries (as serious injuries are much more frequent and represent a significant public health burden for a country which impacts upon economic development) and further analysis to identify the range of measures and the level of implementation required to achieve this milestone improvement.

6. The adoption of a National Road Safety Performance Monitoring Framework consisting of key safety performance indicators for final outcomes, intermediate outcomes and program output measures will assist Korea as it is assisting other leading countries like Sweden to measure and assess progress and to make decisions about resources and programs, adjusting as required to maintain the desired rate of improvement and respond to emerging trends, underlying issues.

7. High level coordination and accountability involving a central unit reporting to the highest levels of government on the progress towards targets and working with the key Governmental agencies is vital to ensure a holistic and coordinated results focused management approach to approach to road safety improvement that prioritises the use of the countries resources, shares data and analysis, monitors progress and facilitates effective cross agency actions to maximize the effectiveness of responses.

8. To assist with preparation for the achievement of ambitious road safety results, Korea would benefit from the experience of other leading countries by commissioning a comprehensive external peer review through the OECD/ITF to determine the capability and readiness of Korea to set and attempt ambitious road safety improvements and what functions, management and coordination arrangements need to be put in place to manage by objectives to achieve ambitious results.

9. Leading management of safe system interventions includes:

   – Safe road and roadside Infrastructure: high-risk segments, links, intersections and areas are targeted with good practice interventions that work to assist users to stay on the road firstly and secondly to keep the impact forces of expected crash types below the human physical threshold limits to survive without serious harm. Tools and guides for good practice and training of engineering and allied professionals are vital to build the necessary capacity for change to a safe system.

   – Safe behaviours: general and specific deterrence-based traffic safety enforcement programmes, supported by intensive publicity and awareness campaigns (e.g. speed, alcohol, seatbelts and helmets, fatigue, commercial vehicles) are quick acting and effective but must be refreshed to sustain results. Reviews of policy reforms including for example novice driver licensing, alcohol interlocks, recidivist speeding are important contributors.

   – Safe speeds: managing for greater compliance with existing speed limits and managing speed limits on the network in relation to the potential crash conflicts, human frailty and the infrastructure quality for the function of the road is an essential relationship for the achievement of a safe system. The collective community harms from high and low level speeding are equivalent in the public health burden of speed related trauma and must be considered despite the harms of low level speeding being less obvious and more difficult to build support for.

   – Safe vehicles: advances in active (collision avoidance) and passive safety (protection) into the vehicle fleet using the roads is currently making a significant contribution and will continue into the future for all road users. Regulatory processes for the progressive introduction of improved safety standards for vehicles are complemented and enhanced by NCAP programs that inform consumers to purchase safer vehicles, thereby stimulating the market for safety and accelerating the rate at which vehicles with higher safety standards enter the market.

   – Improved post-crash response; reducing time to first response and emergency medical and rehabilitation services can make good contributions depending upon the starting level of emergency and health care services currently being provided.

10. The management functions suggestions are:

   – Coordination: effectively delivered coordinating arrangements allow for accountable decision making at senior levels across agencies. Coordination must be resourced and a dedicated secretariat or lead agency with funding, technical resources and authority in support is found to be effective to achieve ambitious road safety results. Accountability for results, while shared, must be clearly described in the performance agreements of Chief Executives of key agencies.

   – Legislation: specialist legislative and technical expertise is important within Government agencies to develop, consult and build support for legislation promoting enforceable standards and rules with due consideration to cost, effectiveness, practicality and public accountability.

- Funding and resource allocation: good practice countries adopt a rational framework for resource allocation based on cost-effectiveness and cost-benefit analysis using the Willingness-to-Pay methodology to establish the value of a statistical life (VOSL) to ensure lives saved and injuries avoided are properly accounted for. This allows strong and objective business cases to be put forward for road safety funding.
- Promotion: sustained promotion including advertising to support interventions such as improved road user behaviour(e.g. wearing seatbelts) and communication to engage community and stakeholders in the overall level of ambition for road safety performance and the changes required for a safe system is critical to successful change management. Promotion also provides feedback to the community on current and emerging problems, evidence based responses and provides feedback to the community on the effectiveness of interventions to help build public confidence, build demand for improved safety and build support for further safety responses.
- Monitoring and evaluation: data, monitoring and reporting systems that measure fatalities and injuries by severity using linked data bases (police, health, insurance) to provide a holistic and unbiased picture of the overall safety performance of a country’s road network are essential for managing by results. Safety performance indicators measuring outcomes, outputs and project expected performance towards the achievement of future targets contributes to effective management by results.
- Research and development and knowledge transfer: Leading countries invest in sustained and sophisticated in depth research and analysis of crashes, policy and strategy to gain new insights into less obvious and emerging issues and to inform the implementation of effective interventions. This produces a cadre of professionals who contribute to evidence based approaches and act as opinion leaders to inform the community and share knowledge across jurisdictions. Building capacity and professional knowledge to support changes in practice to the safe system approach is critically important.

11. Road safety management for Organisations; The ISO 39001 Standard: “Road Traffic Management Systems” provides a valuable framework to assist organisations to integrate road safety as a core objective in their management systems for the safety of their employees and contribute to community road safety through shared responsibility.

Introduction

Countries with different levels of road safety performance have different levels of ambition in terms of their targets for improving their results. Achieving no deaths and serious injuries represents the ultimate level of ambition and this is the vision and aspiration expressed in the road safety policies and goals of countries with the best or most ambitious desired levels of road safety performance. This vision began with Sweden and the Netherlands and has subsequently been adopted by a number of leading countries. This approach is common in other transport systems and has determined safety programs in aviation, shipping and rail for some time.

The Safe System Approach

The Safe System approach has been internationally agreed as the way to achieve the vision of zero road fatalities and serious injuries and requires that the road system be designed to expect and accommodate human error so that when crashes do occur, the impact forces do not exceed the physical tolerance levels of the human body so that serious harm does not result.

The OECD/ITF Report "Towards Zero: Ambitious Road Safety Targets and the Safe System Approach" was the first international documented agreement for the safe system approach (OECD 2008) to achieve ambitious road safety targets.

Adopting the ultimate goal of a safe system does require a transformational change in the way road safety is viewed and managed. The transformational change for a safe system involves a paradigm shift from crash prevention to the prevention of serious harm (death and serious/life changing injury). A shift from blaming the human for risk taking and mistakes in traffic and attempting to implement responses to make the human behave perfectly to acknowledging that humans will always make mistakes in traffic no matter how educated and compliant they may be.

The focus of responses becomes broader to encourage people to act responsibly and with due care and attention while also building greater forgiveness into the road transport system through the engineering of roads and roadsides, vehicles and the management of speeds so that when crashes occur as they invariably will, the resulting impacts are below the levels before serious harm occurs to the human body.

The aspirational vision and the Safe System approach to achieve it does not list the interventions required to achieve this ultimate, final goal or how long it will take to achieve. The means of achievement remain challenging, requiring practitioners to take decisions and act beyond the limits of current good practice. Leadership and a strong commitment to innovation to provide interventions to achieve the ultimate desired results, rather than only using current approaches with incremental improvements is required.

This impetus for innovation challenges road safety professionals, stakeholders and governments to develop the institutional capacity to generate and manage interventions to achieve the desired results, to form new partnerships, to seek new effective approaches and to find new ways to implement them.

The long term vision of eliminating deaths and serious injuries must be complemented with robust and challenging interim targets. This helps ensure the delivery of benefits over the shorter term, essential if the longer term vision is to remain credible.

The Safe System approach re-frames the ways in which safety is viewed and managed and encourages a fundamental shift in road safety thinking to achieve very ambitious interim on the journey to the ultimate goal.

This relies upon the implementation of a sound safety management system, focused on the achievement of ambitious results.

Achieving substantial reductions in road fatalities and serious injuries requires a systematic, comprehensive, planned and on-going response by Government led and managed for the achievement of results.

Countries with the best road safety performance and countries that are striving to achieve substantial improvements in the safety of their road network demonstrate good practice in safety management systems in three key areas:

- the political will and leadership to achieve ambitious results on the journey towards an ultimate safe system goal of no deaths and serious injuries
- a focus on adopting systematic and coordinated interventions for improvement through the build and operation of a safe system; and
- ensuring the key organisational elements for the institutional management functions of the road safety management system are in place and operating optimally to provide the capacity or the "production line" to generate the necessary interventions.

A well-operated road safety management system links these three areas to ensure a focus on management by results for improvement.

The road safety management systems of leading countries have generally evolved over time. However, all countries, however, no matter what stage of development can achieve substantial improvements by firstly assessing the current capacity of their road safety management systems, then implementing the required institutional management functions, developing and adopting an investment strategy for improvement and monitoring and reviewing progress regularly.

This chapter provides a summary of how the three key areas of road safety management operate to enable countries to achieve ambitious levels of road safety performance.

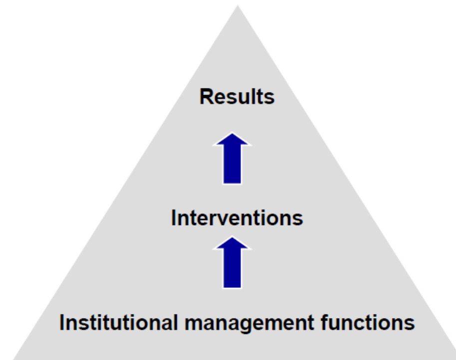
While the elements are applicable for all countries, there is no one structure or method of operations so examples of how the various elements of the road safety management system operate in different countries are provided.

A model for road safety management by results

Successful road safety management is a holistic, systematic and ongoing process where the focus is on the achievement of improved results, which is dependent upon the implementation of effective interventions which in turn are the products of management functions in institutions that support and guide the effective implementation of interventions for improved results.

The relationship between the three key areas of the road safety management system is shown below.

Figure 3.1. **Road safety management model**



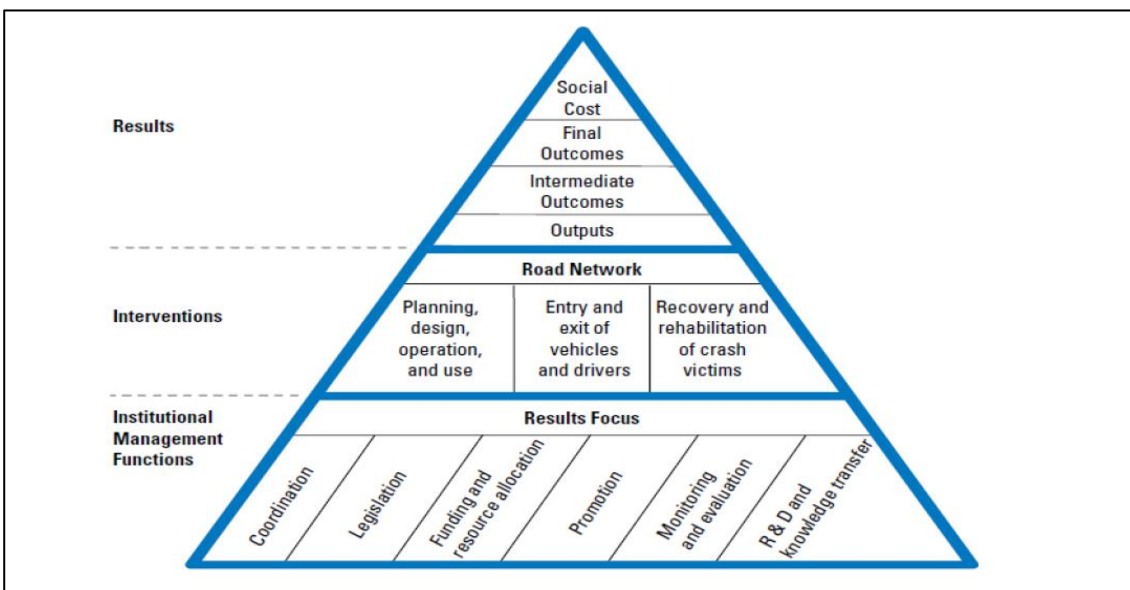
Source: Bliss and Breen 2009.

This relationship has been described and refined into a model originally developed in New Zealand as part of its target-setting model (Land Transport Safety Authority, 2000).

It was further developed by the European Sunflower Project (Koonstra et al. 2002) and then the World Bank (Bliss 2004; Bliss and Breen 2009) for use in providing guidance for countries. It is the basis for road safety capacity reviews by the World Bank preceding major investments in road improvement projects and is recommended by the OECD (2008) when planning and reviewing road safety strategies.

The model summarises the institutional management functions and elements of the road safety management system for countries seeking to achieve improved road safety results. (Figure 3.2)

Figure 3.2. **The road safety management system**



Source: Bliss and Breen (2009).

The model illustrates it is crucial to have a focus on results if improved road safety outcomes are to be achieved. The road safety management system focuses on the delivery of results by linking what we are all doing (outputs) to what we are all trying to achieve (outcomes).

The outputs and their road safety outcomes must be measurable and clearly the product of efforts by government and non-government agencies, the corporate sector and the community to implement new interventions and improve the performance of existing interventions.

Underlying the capacity to deliver better interventions are six institutional management functions which are primarily the responsibility of Government, albeit sometimes in partnership with other organisations such as in the development of infrastructure.

The institutional management functions represent the production capacity to generate road safety interventions and recognise that safety is produced in a manner similar to other goods and services. To implement successful interventions that deliver results requires underlying management systems. Each of the institutional management functions are focused on contributing to the achievement of results. In countries with the ultimate vision, the institutional management functions are important in supporting the implementation and management of the interventions necessary for a safe system.

A focus on achieving results

In managing for improved results, the foremost and pivotal institutional management function is results focus. All the other institutional management functions are subordinate to this function and contribute to its achievement.

A country's results focus can be interpreted as a pragmatic specification of its ambition to improve road safety and the means to achieve this ambition. It addresses the issues of leadership, strategy, goal and target- setting, ownership and accountability. What results are we trying to achieve for the interim and in the long-term, whether in projects or programmes? How are we going to get there? Who is accountable for these results?

In the absence of a clear and accountable focus on results all other institutional functions and related interventions lack cohesion and direction and the efficiency and effectiveness of safety initiatives can be undermined. (Bliss and Breen, 2009).

Results focus in its ultimate expression concerns a strategic orientation that links all actual and potential interventions with results, analysis what can be achieved over time and sets out a performance management framework for the delivery of interventions (outputs) and their intermediate outcomes and final outcomes. It defines the level of safety that a country wishes to achieve expressed in terms of a vision, goals, objectives and related targets. (Bliss and Breen, 2009).

Before a country can determine what results it wants to achieve, it needs to carry out a review of its current road safety performance and capacity. The aim is to develop a consensus across government around building or improving organisational capacity to manage for results. Road safety performance or road safety capacity reviews as they are known have been conducted in a number of countries. This is discussed with some examples in the "Getting Started" section at the end of this report.

Vision or Goal and target-setting: countries have become progressively more ambitious in terms of their results focus, culminating in the Safe System goal and framework for managing the safety of the road network to eliminate death and serious injury, supported by interim quantitative targets for intermediate and final outcomes.

The targets for some countries are derived from the "top down", through a political or leadership decision or from the "ground up" as a result of detailed scientific analysis and modelling to project potential results from agreed levels of intervention with the available resources. Capacity reviews are conducted in some countries to determine the capacity of the institutional management system of a country to effectively produce the required interventions and level of expected achievement.

These ambitions and targets are usually expressed through a national or regional road safety strategy developed to organise and guide implementation over five to 10 years.

Increasingly road safety strategies are using modelling and estimation based on the available evidence to estimate the projected benefits of a combination of best practice Safe System countermeasures. An example of this management by objectives approach from Sweden is included in

Box 3.1. Spain - Achieving ambitious results - road safety strategy and targets

Since 1990, the number of road fatalities in Spain has reduced by nearly 80%. Between 2000 and 2012, the number of fatalities decreased by 67%- one of the largest reductions among IRTAD countries. Since 2000, the number of injury crashes has decreased by 18%.

In 2012 Spain approved its new Road Safety Plan for 2011-2020 with its main objective to reduce the rate of people killed per million of the population to below 37. This target is aligned with the European objective of halving the number of people killed in 2020 and it will be reviewed in 2015. The safety performance indicators established by Spain are shown later in this paper under monitoring.

Priorities: The National Road Safety Action Plan focuses efforts on the following priorities:

- Improve the information systems for fatal and injury crashes
- Assessment of model drivers and intervention programs for recidivist drivers
- Alcohol, drugs and medicines; and
- Safe mobility

Target setting: The process of drawing up the Spanish strategy was based on analysis of data and information contained in official, valid and sustainable sources of information and the participation of the various public and private agents through working groups and international comparison.

Source: OECD/ITF, 2014.

Box 3.2. Japan- Achieving Continuous Improvement in Road safety

In 2012, there were 5 237 fatalities on Japanese roads, a 4.9% decrease in comparison to 2011. 2012 was the 12th consecutive year with a decrease in road fatalities, and Japan reached its lowest fatality level since record keeping began. The elderly (people aged above 65) represent more than half of total fatalities.

Since the1970’s the Government has implemented a series of five-year national road safety action plans. The 9th National Traffic Safety Programme covering the period 2011-2020 was launched by the Government of Japan in April 2001. The programme has three strategic objectives and eight pillars:

The three strategic objectives are:

- Safety for the elderly and children;
- Pedestrian and bicycle safety; and
- Ensuring safety on roads serving the community and on main roads.

The eight pillars are:

- improvement of the road traffic environment
- dissemination and reinforcement of traffic safety messages
- safe driving
- vehicle safety
- enforcement
- an improved rescue and emergency medical system
- better victim support, including and appropriate damage compensation system; and
- more research and development.

In 2010, 20% of all crashes involved a bicycle and without further intervention this share could rise given the increasing popularity of riding. The main measures to achieve the improvement in cycling safety are:

- developing a safe traffic environment for cyclists
- increasing knowledge of traffic rules
- developing safety education for cyclists; and
- strengthening enforcement aimed at cyclists.

Source: OECD/ITF (2014).

Box 3.3. Benefits of safe system interventions in the *Towards Zero* Road Safety Strategy in Western Australia

Western Australia developed a new road safety strategy "*Towards Zero*" for the period 2008-2020 within Australasia's Safe System framework, with the addition of a bold, long term level of aspiration and vision.

The Government commissioned Monash University Accident Research Centre to provide the objective research basis for the strategy and the expected benefits in trauma reductions. The process for the development of the Towards Zero road safety strategy in Western Australia included scientific analysis of the road trauma problem and modelling of benefits from various combinations of safe system organized interventions

A 40% reduction in the number of people killed and seriously injured by 2020, saving 11 000 people was projected and subsequently committed to by Government.

The projected cumulative savings in the number of people killed and seriously injured (KSI) from interventions in the safe system areas are:

- safe road user behaviour (2 200 less people KSI contributing 20% of the overall reduction)
- safe vehicles (2 900 less KSI or 26%)
- safe speeds (3 200 less KSI or 29%)
- safe roads and roadsides 2 700 less KSI or 25%).

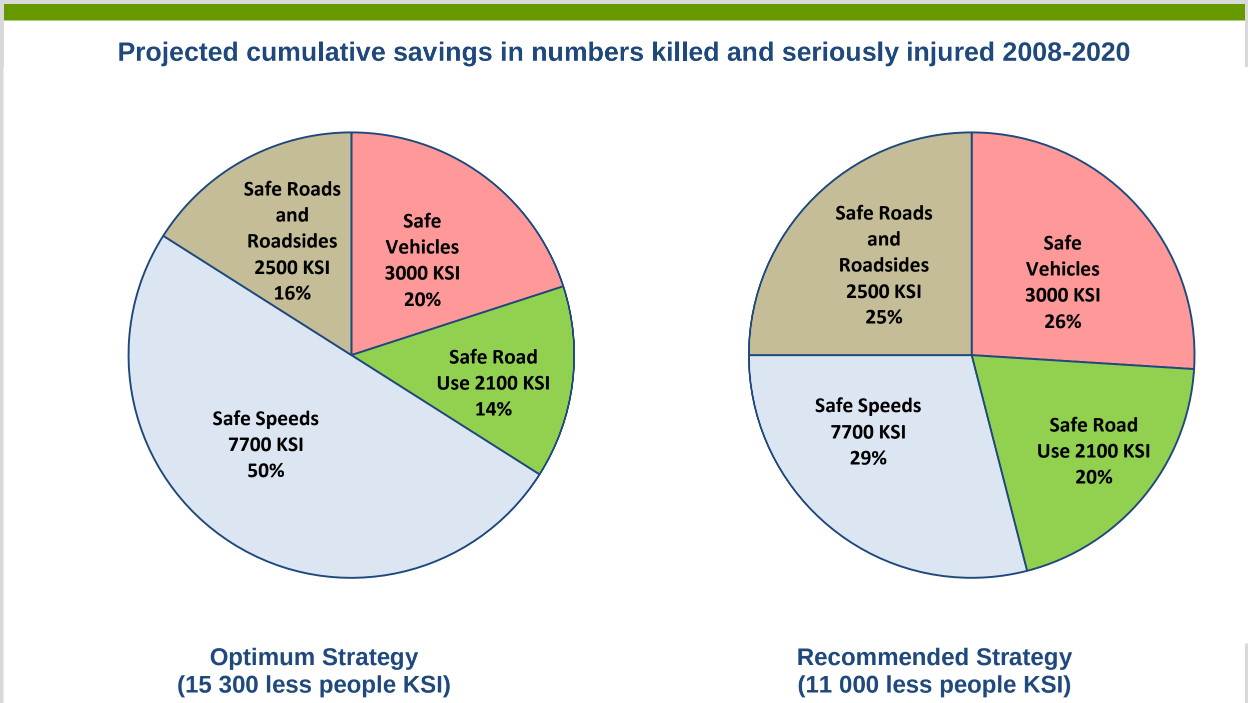
Sharing road safety science and options for improved results with the community

The development process also included a greater degree of community and stakeholder engagement than has been the case previously, based on the fundamental belief that the community should be provided with the best evidence about what works no matter how controversial, so that it can debate and consider the options available to improve road safety This also helped to build community support for the strategy under the principle of shared responsibility for safety between the Government, community and stakeholders, and business.

The community and stakeholders were invited to consider and provide feedback on the range, level, costs and benefits of different interventions identified in the scientific analysis and modelling that could be used to achieve significantly better results.

Two scenarios, an "optimum model" which included more ambitious results (15 300 less people killed and seriously injured by 2020 with bold speed management strategies included) and a "recommended model" (11 000 less people killed and seriously injured by 2020, with more targeted speed management strategies) were presented and discussed. Following community and stakeholder feedback and acting upon the advice of the legislated safety advisory body- the Road Safety Council, the Government adopted the Recommended Model". The two models with different levels of projected results and combinations of countermeasures are summarised in Figure 3.3.

Figure 3.3. **The cornerstones of the Safe System**



Source: Road Safety Council of Western Australia.

These medium to longer-term road safety strategies with higher levels of ambition and ultimate vision are increasingly including how the safe system approach will be used to manage the interaction of interventions to achieve a safe road transport system.

Shorter term "Road Safety Action Plans" for one to three years typically, may be produced to outline commitments to high priority interventions being implemented in support of the longer term strategy. These shorter terms action plans provide opportunity to adjust and refine interventions from the results of monitoring and review of performance. Some examples from different jurisdictions are shown in the boxes below.

Box 3.4. Road safety vision statements

OECD, 2008: "All countries are advised to adopt and promote a level of ambition that seeks in the long-term to eliminate death and serious injury arising from use of the road transport system." (OECD/ITF, 2008).

Sweden, 2009: "The design, function and use of the transport system will be adapted to eliminate fatal and serious accidents." Ministry of Enterprise, Energy and Communications, Stockholm, May 2009.

Western Australia, 2009: "Towards Zero means that we do not accept that any human being should die or be seriously injured on our roads. Realistically we understand that it is not practical to achieve zero serious injuries on our roads by the year 2020, but we do not accept any death or serious injury as inevitable." Towards Zero: Road Safety Strategy endorsed by the Government of WA, Perth, 2009.

EU Council of Ministers, December 2010: "Considers that the level of road fatalities and injuries remain unacceptably high and stresses the importance of adapting motorways, roads, streets and vehicles to human capacity; thereby aiming towards the long-term 'zero-vision' for European road transport safety."

New Zealand, 2010: The new Safer Journeys strategy sets out a vision for "a safe road system increasingly free of death and serious injury". Safer Journey: New Zealand's Road Safety Strategy 2010–2020.

European Commission, March 2011: "By 2050, move close to zero fatalities in road transport. In line with this goal, the EU aims at halving road casualties by 2020. Make sure that the EU is a world leader in safety and security of transport in all modes of transport." Transport White Paper.

European Road Safety Observatory, 2011: "Safe System represents the new performance frontier for road safety management embracing the long-term goal to eliminate death and serious injury to all countries necessitating challenging but achievable interim targets, exacting intervention strategies and the need for strengthened institutional management systems."

Norway, 2011: The Government has a vision of zero fatalities or serious injuries on the roads, the "Vision Zero". This is a long-term goal, and in the National Transport Plan, the aim will be to reduce by 2020 the number of fatalities or serious injuries by at least a third, compared with 2005–2008. This represents roughly the same reduction in the next ten years as in the previous twenty years. Norwegian Ministry of Transport and Communications, National Transport Plan, 2010– 2019.

Australia, 2011: "No person should be killed or seriously injured on Australia's roads." Australian Transport Council, National Road Safety Strategy 2011–2020.

The Netherlands, 2011: The three cornerstones of the new Dutch strategy 2011–2020 are cooperation, an integral approach and Sustainable Safety. The Sustainable Safety vision is for the "prevention of (serious) crashes and, where this is not possible, the almost total prevention of severe injury..." Ministry of Transport, The Netherlands; Road safety strategy 2011–2020.

Source: Bliss and Breen (2011).

Box 3.5. Goals interim targets and safe system strategies/action plans in selected jurisdictions

Australia*:* As a step towards Australia's long-term road safety vision to eliminate deaths and serious injuries, the national strategy has a target 30% reduction in the number of deaths and serious injuries by 2020. *Australian Transport Council, National Road Safety Strategy 2011–2020. National Road Safety Action Plan 2015-2017. https://www.infrastructure.gov.au/roads/safety/national_road_safety_strategy/index.aspx*

Western Australia: *Towards Zero road safety strategy 2008-2020*. To reduce the number of people killed and seriously injured by 11 000 by 2020, a reduction of 40% on 2005-207 levels. http://www.ors.wa.gov.au/Towards-Zero.aspx.

South Australia: *Towards Zero Together*. At least a 30% reduction in the number of people killed and seriously injured by 2020.

http://www.towardszerotogether.sa.gov.au/__data/assets/pdf_file/0020/82163/South_Australias_Road_Safety_Strategy_to_2020.pdf

Victoria: *Victoria's Road Safety Strategy 2013-2022, Safe Roads for all Victorians*. At least a 30% reduction in the number of people killed and seriously injured by 2022

European Union: By 2050, the EU should move 'close to zero fatalities' in road transport, with the aim of halving road casualties by 2020 to ensure that the EU is a world leader in transport safety in all modes. The long-term *Vision Zero* and need for interim targets is supported by the EU Council. *European Commission, Transport White Paper, 2011.*

Finland: To support the long-term *Vision Zero* goal, a target was set to reduce deaths from crashes by 100 fatalities per year by the year 2025. *Ministry of Transport and Communications, Finland, 2008.*

Japan: The Vision for road safety in Japan is to make Japan the safest country for road traffic.

New Zealand: Targets to reduce road deaths to no more than 200 per annum by 2040, and reduce serious injuries to no more than 1 500 per annum by 2040 were set in 2008. In support of the long-term *Safe System* goal, a range of intermediate outcome targets to 2020 are to be set that cover different elements of the traffic system and its use. *New Zealand Transport Strategy, 2008; Safer Journeys Strategy, 2011, Safer Journeys Action Plan 2013-2015. Ministry of Transport. http://www.saferjourneys.govt.nz/*

Norway: As a step towards its long-term *Vision Zero* goal, Norway has adopted a target to reduce the number of fatalities and serious injuries by at least 33% by 2020, compared with 2005–2008. Intermediate outcome targets have also been set: e.g. reductions in key safety behaviours such as excess speed and drink driving, and enhancing the safety quality of the road network and vehicle fleet. *National Transport Plan, 2010–2019, Norwegian Ministry of Transport and Communications.*

Scotland: The 2020 road safety targets to reduce deaths by 40%, serious injuries by 55%, child deaths by 50%, and child serious injuries by 65% have been set in support of Scotland's long-term vision to eliminate death and serious injury. *National Transport Policy December 2006, Scottish Executive, Edinburgh.*

Sweden: In support of the long-term *Vision Zero* goal to eliminate death and long-term injury, interim targets have been set to reduce road traffic deaths between 2007 and 2020 by 50%, and serious injuries by 25%. Thirteen intermediate outcome/safety performance targets have also been set, with speed compliance, safe passenger cars and safe state roads targets forecasted to have the greatest impact. *Swedish Road Administration, 2009.*

The Netherlands: In support of Sustainable Safety, targets have been set in the National Mobility Memorandum of 2006 to reduce the number of deaths and hospitalisations by 25%. *National Mobility Memorandum, Ministry of Transport, 2006.*

Source: Bliss and Breen (2011), OECD/ITF (2014)

Interventions in a Safe System approach

Interventions on the road network are shaped to achieve the results.Leading countries are adopting the Safe System approach as the guiding framework and philosophy for shaping and implementing interventions for the achievement of ambitious road safety targets as interim steps towards the ultimate vision or goal of a safe system.

Interventions are managed in the safe design, operation and use of the road network, the condition under which vehicles and users can safely enter, use and exit the system and the safe recovery and rehabilitation of crash victims and they set appropriate standards to achieve safety and aim to secure compliance with them.

There are different representations of the safe system but essentially the model puts the human being at the centre showing that in the event of a crash occurring there are three key elements of the safe that determine the severity of the outcomes and they are the speed at which the vehicle is travelling, the protection offered by the vehicle and the forgiveness provided by the road and roadside infrastructure.

A fourth element, safe road user behaviour is encouraged through education, enforcement, licensing and training. A fifth component is post-crash response where the time to provide a first response and emergency medical care makes an important contribution to health outcomes.

The model of the safe system from Western Australia is an example:

Figure 3.4. **Safe system model in Western Australia**

Source: Office of Road Safety, Western Australia.

Safe people (improving road user behaviour)

The principles and approach of the safe system acknowledges that humans are prone to behaviours that result in serious crashes and seeks to build forgiveness increasingly into the system through vehicles, road infrastructure and speed management so that when crashes occur they do not result in serious harms.

However, it is very difficult and very expensive to build a system that does not rely on to some extent the majority of citizens acting responsibly, safely, with due care and attention and within the road rules most of the time.

Human behaviour may be a momentary lapse of concentration or an error of judgement of it may be risk taking, which can be more common amongst younger male populations, particularly up the age of 25 when brain development matures enough for a full comprehension of behaviour, risk and consequences.

Systems of road safety education, control, regulation, traffic enforcement and sanctions are a cost effective part of the safe system. These controls also apply to the registration and operation of vehicles to ensure effective maintenance and operation of vehicles contributes to safety. Occupational health and safety controls that include the vehicle as part of the workplace and systems of controls for organisations that use the road network to transport people and goods are also important contributors.

For some countries, commencing their journey to significantly improve safety and implement the safe system can make rapid and large gains by improvements in behaviours by road users.

Important priorities are – after the prerequisite adoption of relevant regulations – to maximise compliance with speed limits, reduce impaired (drink and drug) driving, maximise the wearing of appropriate restraints (seatbelts and child car restraints) through effective enforcement programs backed with appropriate sanctions.

Education of road users, particularly used in combination with effective enforcement regimes can achieve measurable results of between 7-11% reductions in serious crashes.

However, effective as enforcement is, increasingly the safe system approach is challenging and encouraging more work to provide increasing forgiveness for human error in the road transport system. Criminal justice systems are designed to deter and punish behaviours that transgress society's norms and values as reflected in the laws to a considerable and conspicuous extent. It is not intended to respond to less than perfect behavioural transgressions to which the majority, if not all of citizenry are prone. Many of the behavioural shortcomings contributing to road trauma are of the "less than perfect" type of error and misjudgement, wandering attention of human beings.

Exciting opportunities are emerging in the use of social media and more interactive digitally based communications with the community and stakeholders. In addition to largely one way broadcast type communications a number of countries are using communications for interactive, two way conversations. These methods may be important for building understanding, capacity and in mobilising demand for safety and the safe system.

Some countries have invested in contemporary school based education programs and while the evidence of direct effect on reducing road trauma is not strong, largely due to the relative lack of valid evaluations, the potential contribution of school based education in developing the knowledge, attitudes and skills on children and young people as safe and aware road users who increasingly demand more safety in our system is a potential area for the safe system implementation.

Safe roads and roadsides

One of the most important and significant contributing components of the safe system is the design, build, and operation of road and road side infrastructure that increasingly provides real time information and guidance to the human to use the network safely but also increasingly provide forgiveness so that when crashes occur they are less likely to result in serious harms.

Major challenges for the authorities responsible for our road networks and infrastructure include the identification of risk on the network and an ability to prioritise specific locations, lengths and areas on the network that need priority attention.

The selection of the right treatments, changing practice to ensure the application of safe system principles in the design and building of roads and roadsides are significant change agendas for road authorities.

Transport agencies must be able to anticipate and manage the changing use of the network and ensure increasing safety for all as growth in more active forms of mobility such as, cycling and walking mix with vehicle traffic. Public transport remains vital to the safe system.

Existing standards, guidelines, policies and procedures must be reviewed and changed progressively to support the implementation of safe system. This can involve significant challenges but also opportunities for leadership and management as discussed earlier in this paper.

Traditional approaches involving the retrospective identification and treatment of high crash risk locations where the cumulative number of people killed and seriously injured becomes self-evident at a particular, specific location with the passage of time remain a priority. In addition, increasingly authorities are looking to identify increase risk on the network and take proactive action using the principles of the safe system to install treatments that are either full safe system forging such as flexible barriers or lay the foundations for full safe system treatments such as road shoulder sealing and tactile, audio edge lines and raised pavement markers that enable the later fitting of full safe system treatments such as flexible barriers.

Often key people in road and transport agencies have access to data and information about the inherent safety of the network that most citizens and others leaders are not aware of. This places a significant professional, moral and the ethical responsibility on leadership in transport and road agencies to advocate for and lead changes to implement the safe system. This involves examining and challenging and moving existing practice where it is not consistent with or no longer priority for implementation of the safe system.

On large road networks, there are challenges to prioritise the changes and improvements being made to maximise the safety return for the communities in terms of lives saved and serious injuries averted while seeking to maximise the effective use of available resources. On long road networks, with smaller populations, low tax payer basis for raising funds and low traffic volumes as lower speed limits can be a cost effective but controversial option.

Road infrastructure build and operation is critically dependent upon the travel speeds and the quality of the infrastructure provided. Higher speeds without compromising safety are possible depending upon the mix of traffic and the design and operation of the roads.

Leaders and staff in road and transport agencies must play a lead role in all jurisdictions to bring about the changes for the implementation of a safe system.

Beyond the traditional physical infrastructure, the use of intelligent transport systems (ITS) is increasing and is likely to offer rapid and significant improvements in the future. Cooperative ITS systems for V2V and V2I are making contributions and will make further contributions. Interactions between road and vehicle designers, builders and operators are and will realise significant safety improvements.

Road authorities have implemented many new projects and major initiatives for treatment consistent with the safe system. They have developed and trialled innovative and changing designs and engineering treatments to achieve a safe system. However, there is often a gap and a delay between emerging and innovative major new safe system road projects, their evaluation and the current, prevailing design standards and guidelines used by road authorities to design, build and operate their roads.

Some countries such as Sweden, the Netherlands, Australia and New Zealand, are developing interim resource documents or guides for practitioners that seek to achieve some consistency and share knowledge across projects for the major types of crash problems such as treating lengths of high risk road for run off and head on crashes and safe system treatments for intersections.

The International Road Assessment Program (IRAP) and its sister programs are making important contributions by assessing the safety of the road infrastructure and communicating widely through star ratings to the community and decision makers to highlight the important contribution that road engineering designs and treatments make to improved safety outcomes and advocating for further funding.

Road assessment programs will continue to make important contributions as the lengths of road assessed and the potential savings in human terms are calculated and communicated to the community and decision makers to increase demand for safer roads.

There are important collaborations between IRAP organisations and road authorities occurring to bring together the assessment and rating programs with the work of road authorities to identify risk on the road network and to prioritise the segments, lengths and types of treatments to be applied.

One such example is the collaborative development of the Australian National Risk Assessment Model (ANRAM) in Australia and New Zealand involving road authorities, motoring clubs and AUSRAP/IRAP.

Safe vehicles

Advances in vehicle safety have been one of the most significant contributors to improved road safety and will continue to provide significant opportunities for further rapid and relatively quick gains in safety as a vital contributor to the safe system.

Large gains in the crashworthiness of vehicles, the use of seatbelts and now more recently in the crash avoidance capabilities of vehicles through technology such as electronic stability control are realising large safety benefits for communities around the world.

Development in collision avoidance technology such as autonomous emergency braking to reduce impacts with other vehicles, pedestrians and cyclists will provide gains in the next decade. Lane departure warning and control technology will play major roles in reducing run off road collisions. Intelligent Speed Assistance systems will make further contributions.

Traditional regulatory approaches to improving vehicle safety such as vehicle design standards and rules will continue to make contributions by mandating minimum levels of safety across entire fleets. These regulatory approaches by their nature of operation tend to be slower to implement.

For the past 20 years, market driven approaches to vehicle safety by the manufacturers introducing new and innovative safety advances have been encouraged and stimulated further by NCAP programs now in a number of countries that stimulate consumer demand to purchase vehicles with higher levels of safety and features thereby creating a safety market that enables manufacturers to introduce changes at a more rapid rate than before.

The purchasers of vehicle fleets can have a huge influence on market demand for vehicle safety features. There are examples in the corporate and Government sectors. Therefore road safety advocacy and information should focus on informing those fleet operators. The benefits flow onto the used vehicle market at the end of the initial corporate lease period when these safer vehicles are on sold into private ownership.

Component suppliers in turn have more opportunity for research and development, often in partnership with Governments and universities to initially develop, test and then market new safety technological advances to vehicle manufacturers.

The time taken for new safety innovations to flow from high end, more expensive vehicles into the wider market and all makes and models is also increasing at a faster rate.

It is important that safety authorities continue to identify the current and emerging major crash types so the safety technology developments maintain a focus on supporting the human to anticipate and avoid the crash types that are resulting in the most serious injury and deaths on our roads.

Safe speeds

Safe speeds are achieved by ensuring that speed limits match the limits of human biomechanical tolerance to harm and the design and safety offered by the road and road side and take into account the mix and volume of traffic using the road.

Table 3.1. **Safe speed for different road configurations**

Road type and user	Safe speed (km/h)
Roads with possible conflicts between cars and unprotected users	30
Intersections with possible transverse conflicts between cars	50
Roads with possible frontal conflicts between cars	70
Roads with no possible frontal or transverse conflics between users	≥100

Source: Wegman and Aarts (2006).

Safe speeds are also dependent upon ensuring compliance with the speed limits set. In general in this increasing pace of life, many citizens desire to go faster and as discussed earlier often an individual's appreciation of the risk of speeding and crash risk is not well informed and the collective risk accumulating in society and the resulting speed related crash problems is one of the classic public health dilemmas or disconnects as described earlier by Prof. Kare Rumar.

Leaders in road and transport agencies and in law enforcement have a significant challenge and responsibility to implement safe system speed limits and ensure high compliance but this can be challenging to build community understanding and support.

It can also be a challenge within organisation so to build this support to act as staff acting as citizens also often do not understand the need for safe system speed limits and speed enforcement and this can work against progressive or fundamental changes in approaches to safe system speed limit setting and enforcement practice. For example in the enforcement of low level speeding by many more people vs a focus on catching the high end speeding motorists who are relatively few.

Emerging research in a number of countries shows that the public health burden of trauma from speed related crashes is equally derived from a larger number of citizens speeding by a little (up to 10 km/h over the limit) and a small number of individuals greatly exceeding speed limits (by over 20 km/h). This prevention paradox can be a challenging concept to communicate, especially because disbelief seems consistent with the windscreen view experience and is a convenient response to validate existing personal behaviours.

Improvements in the management of speed in most jurisdictions have and can achieve large and rapid reductions in serious crashes as well as saving fuel, reducing emissions and noise pollution.

New technology such as the introduction of intelligent speed assistance systems to advise motorists intelligently when they are speeding are important developments particularly in reducing inadvertent speeding.

This is a vital and challenging area for safe system that must be a priority as it gives potentially large and quick results for jurisdictions but can be the hardest to implement.

Institutional management functions

There are six institutional management functions, the foundations upon which the management system is built and collectively they generate the production capacity to identify, prioritise, develop and implement the interventions. All of the management functions have a results focus, i.e. they are focused on the achievement of outcomes. The six institutional management functions are:

- coordination
- legislation
- funding and resource allocation
- promotion
- monitoring and evaluation
- research and development and knowledge transfer.

These functions are primarily delivered by Government or by Government in partnership with society and business (Bliss and Breen, 2009).

Coordination

Coordination includes the arrangement and alignment of the interventions and related institutional management functions delivered by government agencies in partnership with each other and in partnerships with community and business to achieve results.

Coordination occurs across four key dimensions:

- horizontally across central government agencies
- vertically from central to regional and local levels of government
- specific partnerships for delivery of interventions between government, community and business at the central, regional and local levels; and
- parliamentary relations at central, regional and local level.

Effectively delivered coordinating arrangements allow for accountable decision making at senior levels. Coordination must be appropriately resources and may include a dedicated secretariat in the lead agency to harmonise delivery arrangements across partner organisations to achieve results (Bliss and Breen, 2009).

Leadership: The principal recommendation of the World Report on Road Traffic Injury Prevention (Peden et al., 2004) concerned the identification of a governmental lead agency to guide the national road safety effort. A lead agency should have the power and capacity to make decisions, manage resources, and coordinate the efforts of all participating sectors of government. In effective practice, this role is played by a lead governmental agency that is held publicly accountable for overall road safety performance, supported by an additional multi-sectoral coordination body (Bliss and Breen, 2009).

Managing lead agency functions: While lead agencies may not have direct responsibility for the delivery of key road safety interventions, they play the main role in most institutional management functions. In some instances, the lead agency plays more of a guiding, encouraging or catalytic role in encouraging meaningful shared responsibility. The lead agency takes responsibility within government for the development of the national road safety strategy and its results focus.

It also usually takes responsibility for horizontal inter-governmental coordination arrangements; vertical coordination of national, regional and local activity; and coordination of the necessary delivery partnerships between government stakeholders, the professional, non-governmental and business sectors, and Parliamentary groups and committees. These coordination arrangements ensure a comprehensive legislative framework to meet the road safety task; secure sustainable sources of annual road safety funding; create a rational framework for resource allocation; enable a high-level promotion of road safety strategy across government and society; allow periodic monitoring and evaluation of road safety performance; and provide the direction and support for research and development and knowledge transfer (Bliss and Breen, 2009).

Lead agency structures: Lead agencies can take on varied structural and procedural forms and there is no single recommended model. However, a central road safety organisation with adequate human, technical and financial resources is essential (Bliss and Breen, 2009).

Box 3.6. Examples of lead agencies and organisation of road safety in selected countries

Organization of road safety in Japan

During the 1950s to about 1970, Japan suffered from a significant increase in the number of serious road traffic casualties. As a result, traffic safety emerged as a highly important social issue. In June 1970, the Government of Japan, responded by enacting the Traffic Safety Policies Act (Act No.110 of 1970), with the aim of promoting traffic safety measures nationwide in a total and systematic manner. Under this act, the government has been working together with local governments and relevant private organisations to vigorously implement traffic safety measures. Since 1970, the Government sets up a National traffic Safety programme every five years (OECD/ITF, 2014)

Netherlands organisation of road safety

In the Netherlands, the Ministry of Infrastructure and the Environment is the central agency for road safety and takes responsibility for overseeing and coordinating all road safety activities. In particular, it is responsible for:

- coordination of inter-governmental process at central government level; coordination of road safety decision making across central government' coordination across different levels of government (central, regional) and coordination of mass media campaigns
- legislation: periodic review of legislation, rules and standards against best practice and recommendations for improvement; development and/or revision of legislation; monitoring and evaluation; establishing and supporting data systems that are used to monitor road safety outcomes; and
- compilation and dissemination of national statistics (in a joint role with Rijkswaterstaat WVL as a department of the central agency), Statistics Netherlands CBS and SWOV Institute for Road Safety Research. (OCED/ITF, 2014)

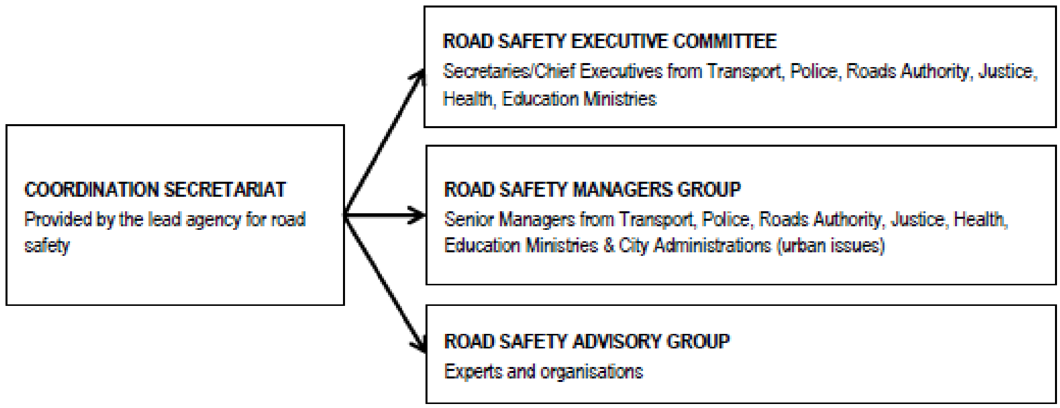
Lead, central road safety agency in Spain

The agency that centralises most of the competencies on road safety in Spain is the Directorate –General for Traffic (DGT), which belongs to the Ministry of the Interior. The core competencies of the DGT are at the national level on all inter-urban roads except for the competencies transferred to the Basque Country a, Catalonia and Navarre. The key competencies include:

- issuing and renewing driving-licences and vehicle authorizations, regulating and licensing private driving training institutes and supervision of the Roadworthiness Inspection System
- registering vehicles, drivers and traffic offences
- traffic control and traffic law enforcement on all interurban roads
- managing the traffic division of the Civil Guard (Police body in charge of traffic control and traffic law enforcement, with around 10 000 officers
- centralising road traffic statistics and coordinating crash investigations
- developing road safety plans and policies, in coordination with other relevant ministries or public bodies; and
- supervision of driving information as well as road safety education campaigns.

Source: OECD/ITF (2014).

Figure 3.5. **Model of national coordination arrangements**



National road safety coordination arrangements provide a decision-making hierarchy and partnership framework for achieving road safety results through the development and implementation of a coordinated road safety strategy and performance targets that have been agreed across government. The hierarchy consists of three main management levels:

The *Road Safety Executive Committee* comprises the Chief Executives (Secretaries/Assistant Ministers) of the key governmental stakeholders and reports to, supports, and receives direction from Ministers. Its roles are to communicate, coordinate and agree on top-level strategy between agencies on road safety issues. It monitors and reports progress to the government through its Ministers, who sign off the national road safety strategy based on detailed plans for the outputs of the key stakeholders to achieve results. The Committee meets around 4 times each year and is chaired by the lead agency for road safety.

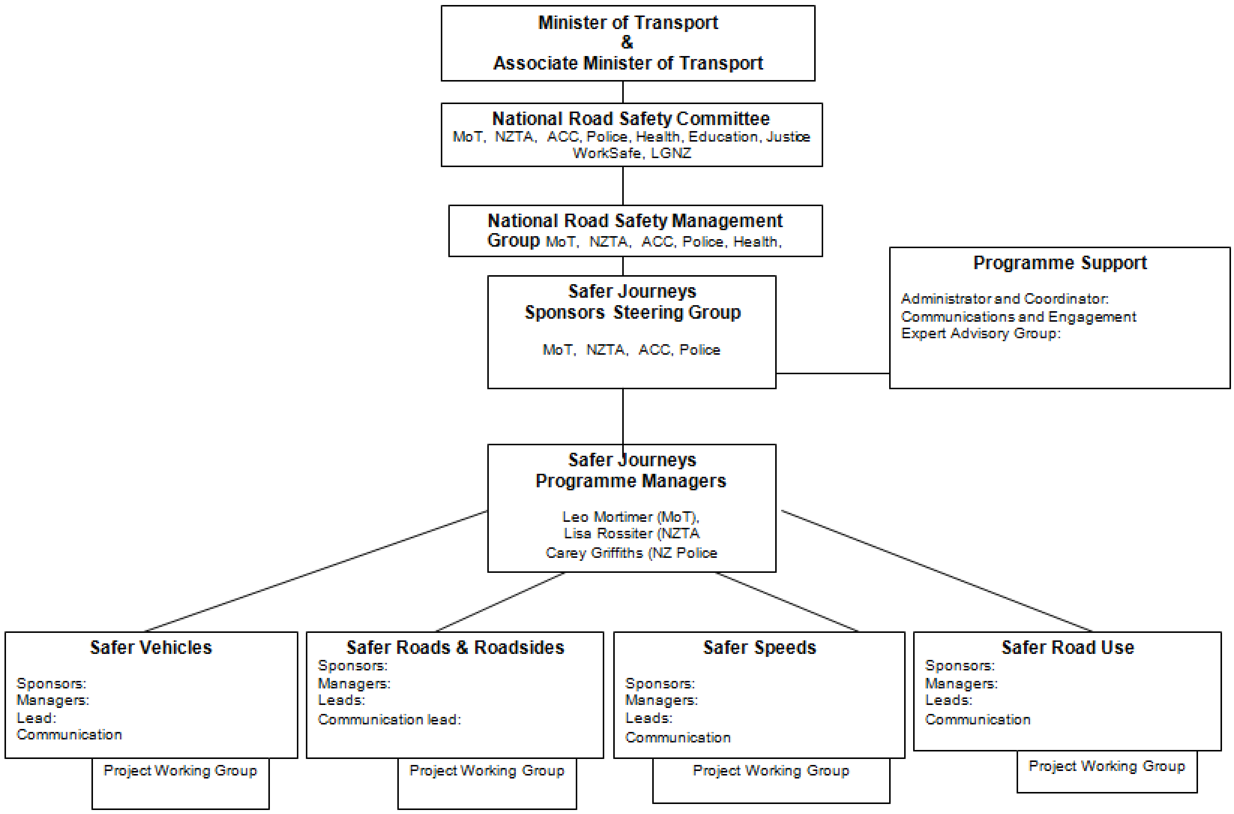
The *Road Safety Managers Group* is the hub of road safety coordination and meets monthly. It comprises senior managers from government departments who are responsible for day-to-day road safety management. The Chair is occupied by the lead agency for road safety. With the lead agency as the key link, the group coordinates implementation of the road safety strategy, develops and implements programmes and interventions, reviews identified programmes, identifies research priorities, and promotes and monitors a coordinated national programme of activities. The Group can set up *Technical Working Groups* to assist its activity.

The *Road Safety Advisory Group* is a consultative body comprising the main road safety stakeholders, including the non-governmental, business and professional sectors. The Group meets quarterly and is chaired by the lead agency for road safety.

The *Coordination Secretariat* is a dedicated, funded unit which sits within the road safety strategy departments of the lead agency. Its supports implementation of the national road safety coordination function – horizontal coordination across central government; vertical coordination from central to regional and local levels of government; specific

Source: Bliss and Breen (2009)

Figure 3.6. **New Zealand example of organisation of road safety**



Legislation

Legislation includes the legal instruments necessary for governance to provide the legitimate operation of the institutions for their responsibilities, accountabilities, interventions and management functions to achieve road safety results.

The legislative functions need to be well matched to achieve the road safety tasks.

Road safety legislation typically addresses land use, road, vehicle and user safety standards and rules, compliance and sanctions with them, as well as post-crash and medical care.

Specialist legislative and technical expertise is needed within Government agencies to develop and consult on legislation promoting enforceable standards and rules with due consideration to cost, effectiveness, practicality and public accountability. (Bliss and Breen, 2009)

Funding and resource allocation

Funding and resource allocation is the financing of interventions and related institutional management functions on a sustainable basis using a rational evaluation and programming methodology to prioritise and allocate resources to achieve the road safety results desired.

As part of the rational framework for resource prioritisation and allocation, there are robust business cases for road safety interventions developed based on cost effectiveness and cost benefit analyses. To achieve more ambitious road safety performance targets, countries may need to establish new (additional) funding sources and mechanisms and or achieve shifts in existing practice by utilizing existing resources differently. (Bliss and Breen, 2009)

Promotion

Promotion involves the sustained communication of road safety as a core business for Government and society and emphasizes the shared responsibility.

There is a shared responsibility between the users to act safely, with due care and attention and comply with traffic laws and rules when using the road network and there is a shared responsibility by those who design, build and operate the road system to achieve improved safety.

There is a shared responsibility for the delivery of interventions required to achieve the results between government, community and business.

Promotion is more than road safety advertising to support particular interventions for example to improve user behaviour to wear seatbelts, to wear helmets to comply with speed limits etc. It also includes the communication and engagement methods to include community and stakeholders in the overall level of ambition for road safety performance (Bliss and Breen, 2009).

The changes to practice for a safe system are significant and varied. The road transport system is an open network used by many individuals and organisations, all with different motivations, priorities and understating and appreciation of risk.

While the majority of people do not accept any serious harm arising from road crashes as acceptable to themselves or people they know, there is a disconnect at a community level which can work against support for safety initiatives, particularly those which may impact upon individual freedoms.

The "helicopter view" of the societal crash problem seen by a relatively few leaders and the "windscreen view" of safety based on the daily experiences of individual road users are different. The "windscreen view" can lead to a distorted perception for what constitutes the priority road safety problems as that perception is informed and shaped by what is seen frequently through the windscreen or the rear vision mirror and, this is often what causes the most annoyance to the driver.

These citizens with these views on the use of our roads and the risks, of course, are also politicians, police officers, planners, designers, engineers, technicians, public servants and community leaders who have significant leadership roles and influence in determining the funding, design, build and operation of the road transport network.

When leading and managing the change to a safe system it is vital that communication and engagement with these stakeholders and the wider community is effective to enable the changes required to implement the safe system and to achieve ambitious results.

Promoting the Safe System to stakeholders to manage changes in practice

The shift to the safe system requires not only support from Governments and the community but also those stakeholders involved in the design, build and operation of the road transport system and in the delivery of interventions. The ultimate ambition of the safe system and ambitious interim targets requires changes in existing practice for interventions to achieve ambitious results.

The change process from existing to safe system practice can be challenging due to the often deeply established and long standing policies, practices, standards and operating guidelines used by staff in road authorities, police organisations and other authorities that need to change to achieve a safe system.

Indeed there can be considerable institutional inertia particularly in large organisations and resistance to change. The new policies and practices that must be implemented to achieve a safe system must be managed or progress will be slow, stall or non-existent.

Vision and leadership in key organisations is vital to achieve effective change management across often large numbers of staff, many of whom are often quite removed from the high level policy settings for the safe system across Government and a direct focus on improving crash results and. It is desirable that most if not all staff understand and support the safe system vision of the organisation and can identify the contribution they make. This is important not only for those staff involved in direct implementation of interventions (e.g. engineers and traffic police) but also those employed in the supporting institutional management functions generating, guiding and supporting the direct interventions.

Road designers, policy officers, planners, educators, engineers must understand and be able to contribute to within their work to the safe system.

Box 3.8. Promoting the changes for the Safe System approach amongst stakeholders

Australia: The national association of the Government road authorities in Australia and New Zealand (Austroads) is developing and disseminating resources to engage and support road engineers and allied professionals to implement a safe system. Resources including guides for engineering and safe system training modules.

New Zealand: Advancing the Safe System.

By 2020 New Zealand has a goal to have made demonstrable progress to creating a safe road system. By 2016, New Zealand aims to have the Safe System approach accepted and followed as the approach for improving road safety. To achieve this New Zealand is implementing a number of promotional and other actions to shift public understanding and perception to demand a forgiving road system and reviewing organizational systems, processes, procedures and guidelines to ensure they promote the safe system approach among the implementing agencies. http://www.saferjourneys.govt.nz/action-plans/advance-the-safe-system-approach/

New Zealand's approach and activities are conceptualised and organized using the safety management systems pyramid model as the example below demonstrates where supporting functions and activities are reviewed to enable the achievement of a safe system outcome at the top of the pyramid.

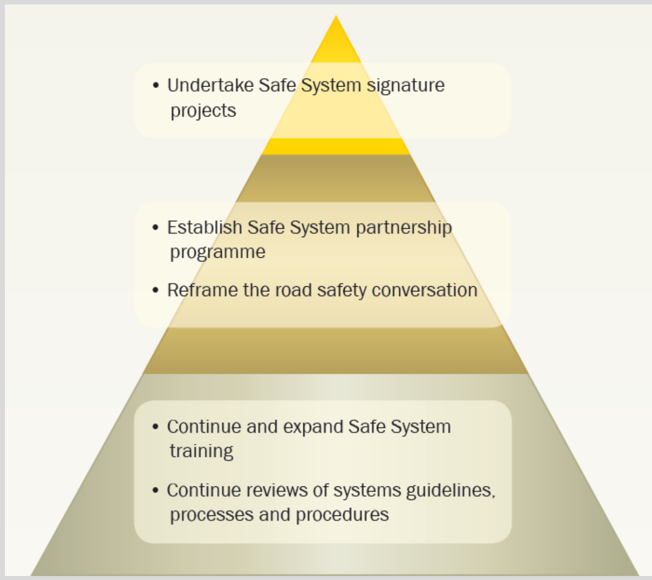
New Zealand has produced a range of supporting documents and training materials to assist those who have a shared responsibility for the achievement of a safe system to understand the shifts in practice required. This includes an excellent short video documentary produced in November 2014 called "A Matter of Life and Death" http://www.youtube.com/watch?v=mFcLUCtUAzc&feature=youtu.bewhich deconstructs a typical serious crash to apply the safe system understanding to the crash and how the outcomes can be prevented if we all work together.

There are also a series of facts sheets to explain to different stakeholders how safe system fits into their work and what contribution they can make and there is a safe systems communications toolkit to help stakeholders understand how to get safe system messages into their communications. They can be found here: http://www.saferjourneys.govt.nz/resources/

- Safe System for Road Users
- Safer Journeys for Coroners
- Safer Journeys for Engineers
- Safer Journeys for Planners
- Safe System for system designers

- Safe System in Practice training course fact sheet
- Safe systems communications toolkit.

Figure 3.7. **Safety management systems pyramid model**



Monitoring and evaluation

Monitoring and evaluation is the systematic and ongoing measurement of road safety outputs from the interventions and the outcomes (intermediate and final) and the evaluation of interventions to achieve the desired road safety results.

Regular monitoring and evaluation of performance against road safety targets is essential to assess performance and to dynamically make adjustment as required.

The establishment and operation of registries for information on drivers and vehicles, infringement data, crash injury databases and survey work to establish performance and exposure data is often the responsibility of several government departments including transport, police and health. In some countries government or private insurance departments or organisations and university departments also share responsibility. This function also includes independent inspection, audit and review.

Data, monitoring and reporting systems are vital in presenting information in key dashboard style on the outcome in terms of crash reductions, outputs in terms of implementation of the effort e.g. enforcement and road improvements.

Many countries have and continue to rely on single data sources such as police reported traffic crashes for data and analysis. Integrated, holistic and linked data bases have been established in leading countries to match the records of crashes contained in police records with data from health, insurers and other sources to form a complete picture of the road crash problem and more recently the level of severity of injury occurring. These "matched databases" involves establishing memoranda of understanding between agencies to manage issue such as privacy and, integrity and confidentiality.

Matching of police crash records with hospital data for example can help remove the traditional biases in police records of under-reporting of crashes involving cyclists and pedestrians and more minor injuries.

Box 3.9. Netherlands matching road crash reports and records

In the Netherlands, Statistics Netherlands works together with Rijkswaterstaat in matching police-reported fatalities with other records to arrive at the forma number of road traffic fatalities This comprises information from the Police, court files and death certificate records. Both the police report number and the real number are published annually since 1996.

The reporting of crashes by police does match the requirement set out by SWOV and the Ministry of Infrastructure and the Environment. The implementation, in 2009, of one overall national information system (BVH) for the Police lead to lower data quality and a smaller number of reported crashes. Renewed agreements with the Police and the Ministry of safety and Justice will lead to a to a gradual improvement in the reporting rate and data quality once implemented during 2013 and 2014. Results in terms of more and better reports are not expected before 2015, a full year of operation under the new arrangements.

Source: OECD/ITF (2104).

Traditional reactive approaches to monitoring based on crash history trends are increasingly being complimented by analyses to project forward for emerging trends in crashes and to identify which serious crash types are being treated and being progressively reduced and which ones are not.

These analyses which project results to the end of the life of the current road safety strategy such as the year 2020 are in some countries identifying that good reductions are being achieved for occupants of vehicles but that increasingly the proportion of serious crashes made up of vulnerable road users such as motorcyclists, cyclists and pedestrians is increasing with increasing exposure or increasing as a proportion remaining residual as larger gains are made in safety for vehicle occupants.

For the safe system this indicates that integrated, holistic approaches to improving urban safety for vulnerable road users through enhanced planning, speed management, road and vehicle operations becomes increasingly significant for some countries by 2020. These forward looking analyses suggest that new approaches may be needed to improve safety for all road users.

Box 3.10. Road safety performance indicators, targets and potential in Sweden

Sweden has a long tradition in monitoring and evaluation of road safety carried out by the lead agency (at national and regional level), the Swedish Institute for Transport and Communications Analysis (SIKA), the Road Traffic Inspectorate (since 2003), research organisations, the municipalities, and independent national and international experts. The SRA and its partners have established databases to identify and monitor final and intermediate outcomes against targets and the results are published annually. The SRA uses the Euro NCAP and European Road Assessment Programme for monitoring the safety quality of vehicle fleet and aspects of road network safety. The SRA established the Road Traffic Inspectorate to help monitor road safety performance and stakeholder activity.

The performance indicators for road safety in Sweden have been developed in a wide ranging dialogue with the stakeholders in the road transport sector. A review by the Swedish Road Administration estimated that the performance indicators suggested the potential for a total reduction of more than 250 in the number of road fatalities by 2002.

The performance indicators used in management by objectives for road safety in Sweden including the targets for each indicator until 2020, and the estimated potential for reducing the number of fatalities are given in Table 3.2.

Table 3.2. **Road safety performance indicators and targets for 2020 in Sweden**

Performance Indicator	Target for 2020	Road Safety Potential fatalities
Compliance of speed limits, state owned road network	80%	88
Compliance of speed limits, municipal road network	80%	29
Sober road users	99.90%	30
Use of Seatbelts	99%	40
Use of helmets (bicyclists)	70%	10
Safe Vehicles	100%	90
Safe Heavy Vehicles	100%	25
Safe state-owned roads	75%	50 (62)
Safe crossing for pedestrian, bicycle and moped	-	15
Safe intersections	-	15
Safe and satisfactory rescue	-	
Rested drivers	6%	
High valuation of road safety	80	

The safety indicators have been developed further and are used annually to review progress and identify budgetary priorities for actions to achieve the 2020 performance targets. The 2012 summary appears in Table 3.3.

Table 3.3. **Progress in 2012 on the road safety performance target in Sweden**

Indicator	Starting point	2012	Target year 2020	Trend
No. of fatalities on the roads	440	286	220	In line with required trend
No. of seriously injured on the roads	5500	4400	4100	In line with required trend
Percentage of traffic within speed limits, national road network	43%	46%	80%	Not In line with required trend
Percentage of traffic volume within speed limits< municipal road network (2012: starting year for index)	63%	63%	80%	Staring year for the measurement- the trend cannot be assessed
Percentage of traffic volume with sober drivers	99.71%	99.77%	99.9%	In line with required trend
Percentage of those wearing a seatbelt in the front seat of passenger cars	96%	98%	99%	In line with required trend
Percentage of cyclists wearing a helmet	27%	33%	70%	Not In line with required trend
Percentage of moped riders wearing a correct helmet	96%	96%	99%	Staring year for the measurement- the trend cannot be assessed
Percentage of passenger cars with the highest Euro NCAP score	20%	46%	80%	In line with required trend
Percentage of safe motorcycles (ABS)	9%	28%	70%	In line with required trend
Percentage of traffic volume on roads with speed limits above 80km/h with median barriers	Approx. 50%	71%	75%	In line with required trend
Percentage of safe pedestrian, cycle and moped passages in urban areas	Approx. 25%	_	Not defined	Not measured, no target
Percentage of municipalities with a good quality of maintenance of pedestrian and cycle paths	_	_	Not defined	Not measured, no target

Box 3.11. Spain- Road safety strategy for 2011-2020 and safety performance indicators

The Spanish Road Safety Plan 2011-2020 contains a number of safety performance indicators including:

- Lower the fatality rate to 3.7 deaths per 100,000 population
- Reduce the number of serious injuries by 35%
- Zero children killed without a child-restraint system
- 25% less drivers between the age of 18 and 24 killed or seriously injured at the weekend.
- 10% less drivers killed above the age of 64
- 30% less deaths due vehicle collision with a pedestrian
- 1 million more cyclists without their death rate rising
- zero deaths in cars in urban areas
- 20% less deaths and serious injuries among motorcyclists
- 30% less deaths due to having come off a singly carriageway
- 30% less deaths in crashes driving to and from work
- 1% reduction in those testing positive for alcohol in the blood in random preventative tests
- 50% reduction in the percentage of light vehicles which exceed the speed limit by more than 20 km/h

Source: OECD/ITF- IRTAD (2014).

Table 3.4. **Western Australia "Towards Zero" road safety key performance indicators**

Road safety strategy performance area	Indicators
Persons Killed and Seriously Injured (KSI) against targets	Monthly counts of people KSI compared to targets. Cumulative counts of people KSI compared to targets
Fatality rate comparisons with other jurisdictions	fatality rates per 100 000 population, Western Australia and Australia- moving 12 monthly data Fatality rates per 100 000 population selected Australian states and territories- moving 12 monthly data.
Metropolitan intersections	Outcome Indicators: People KSI in crashes at intersections People KSI in crashes at the top 200 highest risk intersections
Run off road crashes on regional roads	Outcome Indicators: People KSI in regional run off the road crashes by road class (state/local) Proportion of people KSI on highest risk regional road sections
Impaired driving crashes	Outcome indicators: Persons KSI in alcohol related crashes Intermediate Outcome Indicators: charges laid from breath testing by Police Output Indicators: preliminary breath test conducted by Police operational hours of breath testing conducted by Police
Excess and inappropriate speed (data for metropolitan and regional)	Outcome Indicators: persons KSI in crashes where inappropriate/excess speed was a contributing factor. Intermediate Outcome Indicators: speed limit compliance (from annual free speed surveys) Vehicles exceeding the speed limit by 10km/h or greater infringements arising from speed checks by Police Outputs: number of vehicle speed checks conducted by Police number of operational hours of speed checks
Vehicle safety and occupant protection	Outcome Indicators: vehicle occupants KSI not wearing a restraint Intermediate Outcome Indicators: Percentage of vehicles purchased with a 5 star ANCAP safety rating Output Indicators: Police traffic contacts for restraints, motorcycle, bicycle helmet wearing

Research and development and knowledge transfer

Research and development and knowledge transfer involves the systematic and ongoing creation, codification, transfer and application of knowledge that contributes to the improved efficiency and effectiveness of the road safety management system to achieve the desired improvements in road safety results.

This function guides the design and implementation of national and regional road safety strategies that have sustained reductions in road deaths and serious injuries in the face of growing mobility and exposure to risk.

It also produces a cadre of professionals who contribute research based approaches and knowledge to road safety policy, programs and public debate as informed opinion leaders and key influencers who see and understand the road safety problems and solutions through a different lens to the average road user and therefore can contribute different perspectives based on data and evidence of the problem at a local, regional or international level.

Knowledge transfer is grounded in practice by learning by doing process backed with investment to overcome barriers at local, regional and international level.

Co-operation at local, regional and international level is vital to mobilise knowledge transfer across jurisdictions and countries to reduce the burden of road trauma as part of sustainable development. (Bliss and Breen, 2009)

In the safe system approach, research and development is making important contributions to develop our understanding of the nature of crashes, the errors that people make and the forgiving systems and effective treatments that will reduce serious crash outcomes.

Road safety management for organisations (ISO 39001)

Motor vehicle crashes are a leading cause of death and long-term injury at work and in driving associated with work. It has been estimated that between 40–60% of all work accidents resulting in death are because of road crashes and the costs of work-related crashes are large, both for the community and employers.

In 2012, to help improve road safety in workplaces the International Standards Organisation (ISO) published ISO 39001, a management system standard for road safety.

The standard is a practical tool for governments, vehicle fleet operators and all public and private sector organizations, large and small, worldwide who want to reduce death and serious injury due to road accidents. ISO 39001 provides state-of-the-art requirements for safety aspects including speed, vehicle condition and driver awareness.

ISO 39001:2012*, Road traffic safety (RTS) management systems – Requirements with guidance for use*, is widely regarded as a major contribution to the United Nations' Decade of Action for Road Safety 2011-2020. ISO 39001 assists governmental and private sector organizations by providing a structured, holistic approach to road-traffic safety as a complement to existing programmes and regulations. It is based on the process approach, proven by successful ISO standards such as ISO 9001 for quality management, including the plan-do-check-act cycle, and a requirement for continual improvement.

The new standard lays down harmonized requirements, based on international expertise and applicable to all countries, to support all public or private sector organizations involved in regulating, designing or operating road transport. It will also help by providing a framework for contracts and communication between regulators, vehicle manufacturers and their suppliers.

ISO 39001 is useful for organizations involved in road-safety related activities as varied as auditing the effectiveness of road safety programs, such as for analysing "black spots", or providing funding or awarding prizes for road safety.

The standard was developed with the support of experts from 40 countries and 16 liaison organizations, including the World Health Organization, the World Bank, and the International Road Federation.

Getting started

The OECD and other international organisations have recommended that countries and organisations adopt the Safe System approach to achieve ambitious road safety results.

While different countries will be at different stages in their development with road safety management and achieving results a number of leading countries have benefited from conducting independent reviews of their past road safety results, strategy directions and management before deciding upon a road safety investment strategy. The reviews usually include senior road safety practitioners who have experience in other countries who bring an understanding of the challenges and the opportunities for change to the Safe System approach to achieve ambitious road safety results.

It is recommended that reviews examine past performance to identify what has worked and the levels of implementation (or dose) that have been applied to proven interventions to the get the results achieved in the past.

The Safe System approach to road safety improvement is holistic and relies very much on the management and coordination of a holistic set of interacting components in the safe system to achieve ambitious results.

It is suggested that countries seeking to embark upon achieving ambitious results in the future use a review to examine the capacity and capability that exists within the country, within its key agencies to adopt and implement the changes necessary to transform thinking and practice to the safe system approach.

A review that includes future modelling can also assist a country to determine ambitious/stretch targets and interim targets for improvement going forward and the range of interventions and the level of intensity of implementation that may be required.

It is important to engage and seek the support of the Government political and agency leadership, community opinion leaders and the wider community as the changes require significant support. Understanding the road safety problem and the effective solutions are keys to building the support necessary for significant change.

Box 3.12. Sweden 2008: An independent review of road safety in Sweden

The first international review of a country using the Word Bank Safety Management Systems framework was conducted by an International review team and published in 2008 (Breen, J., E. Howard and T. Bliss, 2008).

Sweden is a world leader in road safety performance, having achieved continuous improvement towards one of the lowest international fatality rates globally Sweden works to a bold vision and ambitious targets, innovating constantly in new solutions and approaches which has inspired and engaged national stakeholders as well as road safety leaders world-wide.

The reviewers concluded that Sweden is in the “establishment” phase of its journey towards Vision Zero. The next challenge, in view of Sweden’s highly ambitious goal, is to achieve rapid growth” in the delivery of accountable well-orchestrated and effective Vision zero activity across and by different organisations.

This is expected to include the continuation of and deepening of essential long term work either underway or envisaged, as well as sharper multi-sectoral focus on interim goals to prevent death and disability in the shorter ter. Short term gains can be expected from conventional interventions derived from best practice, while improvement of the protective features of the network and the vehicle fleet will bring big benefits in the longer term. The new interim targets to 2020 and the related strategy and programmes will establish the next phase of “growth for Vision Zero.

Western Australia 2010: Road Safety Management Review

Western Australia was the first regional jurisdiction toundertakek a road safety management review using the World Bank Road Safety Management Framework. The same international review team as that used in Sweden conducted the review. Western Australia with fatality rate of 11.7 deaths/100 000 population in 2007 had experienced a 40% increase in road fatalities during 2006 and 2007, in part influenced by very robust economic conditions based on a large expansion of mining activity for world markets.

The Government had developed a bold and visionary Towards Zero road safety strategy for 2008-2020 based on the safe system approach and wanted to determine the capacity that existed to effectively implement the Towards Zero strategy. The recommendations of the review were grouped into 8 priority areas:

- provide a road safety booster package with additional, resources to kick start a step down reduction in road trauma
- formally adopt a 40% trauma reduction target for 2020
- provide sustained investment funding to fully implement the strategy
- encourage and support the changes in thinking and practice required to create the safe system through demonstration projects, best practice interventions, policy, standards, auditing, data, research and training across all road safety professionals
- ensure high priority implementation of key legislation
- enhance coordination and partnerships among government agencies, professional bodies and other stakeholders for the safe system
- review the role, function and capacity of the Lead Agency to ensure its ability to support implementation of Towards Zero.

While work to progress the changes towards the safe system approach is still very much in progress, the majority of the recommendations have been implemented. Western Australia has achieved a 30% reduction in the rate of fatalities and a 20% reduction in the number of people killed and seriously injured at the half way point of the Towards Zero strategy. While this in encouraging, further work is being conducted as WA seeks to increase its rate of improvement to match and catch up to the performance of leading jurisdictions in Australia and overseas.

In 2010 the Government gained Parliamentary approval to hypothecate 100% of all speed and red light camera, photographic infringements to a fund dedicated for road safety interventions which has resulted in a significant increase in funding available for road safety interventions. A further Government review of road safety governance and management was conducted to ensure that the administration and management of road safety in Western Australia is optimal to help achieve better performance and implementation with a focus on management by results and accountability for performance. At the time of writing the Government was finalising its decisions.

References

Bliss, T. (2004), "Implementing the recommendations of the World Report on Road Traffic Injury Prevention", Transport Note No. TN-1, World Bank, Washington, DC.

Bliss, T. and J. Breen (2009), "Implementing the Recommendations of the World Bank Report on Road traffic Injury Prevention. Country guidelines for the Conduct of Road Safety Management capacity reviews and the Specification of Lead Agency Reforms, Investment Strategies and Safe System Projects". Global Road Safety Facility World Bank, Washington, DC.

Breen, J., E. Howard, and T. Bliss (2008), "An Independent Review of Road Safety in Sweden", *Swedish Road Administration*, Vol. 2008/109.

Corben, B.F. et al. (2010), "Strengthening road safety strategy development Towards Zero 2008-2020: Western Australia's experience", scientific research on road safety management SWOV workshop 16-17 November 2009. *Safety Science* Vol. 48/2010, pp. 1085-1097. Elsevier.

Howard, E., J. Breen, and T. Bliss. (2010), "Road Safety Management capacity Review: Western Australia." Final report. Accessible at: https://rsc.wa.gov.au/Documents/RSC/ors-rsc-research-capacity-review.aspx

Koonstra, M et al. (2002),"SUNFlower: A comparative study of the development of road safety in Sweden, the United Kingdom and the Netherlands". SWOV, Dutch Institute for Road Safety Research, Leidschendam.

Land Transport Safety Authority (2000), "Road Safety 2010: A Consultation Document". National Road Safety Committee, Land Transport Safety Authority, Wellington.

OECD/ITF (2008), *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789282101964-en

OECD/ITF (2014), *Road Safety Annual Report 2014*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/irtad-2014-en

Road Safety Council of Western Australia (2011), "Building capacity to deliver a Safe Road Transport System in Western Australia: Road Safety Council Recommendations to Ensure Capacity to Implement Towards Zero". Accessible at: https://rsc.wa.gov.au/Documents/RSC/ors-rsc-research-capacity-review-response.aspx

Trafikverket, Swedish Transport Administration (2012), "Analytic report Review of Interim Targets and Indicators for Road Safety in 2010-2020". Vol. 2012/162. Accessible at: https://www2.unece.org/wiki/download/attachments/15237246/LKAS-01-09e.pdf?api=v2

Trafikverket, Swedish Transport Administration (2013), "Analysis of Road Safety Trends 2012: Management by Objectives for Road Safety Work, towards the 2020 Interim targets". Vol. 2013/1178. Accessible at: https://www.unece.org/fileadmin/DAM/trans/doc/2013/wp1/Nat_Dev-2013-Sweden.pdf

Chapter 4. Road safety data collection, analysis, indicators and targets

Fred Wegman

Delft University of Technology, the Netherlands, Chairman of the IRTAD Group: International Traffic Safety Data and Analysis Group

This chapter was written to provide inspiration and good points of departure that may lead to improvements of the Korean road safety data system, the analysis of data and its use in policymaking and research.

Introduction

Designing an effective road safety strategy and conducting good quality road safety studies are impossible without good data. These data are necessary to get an accurate picture of road safety problems. Good data can tell the right story and can convince politicians, governments, social organisations and the general public of the social relevance of the issue. Good data are also required to be able to design a policy to reduce the consequences of crashes. Data are subsequently analysed in more detail to determine why crashes take place and how they can best be prevented. These analyses lead to the identification of the main problems or sub-problems, provide an understanding of the causes of crashes and their outcome, and enable the identification of risk factors. Once this understanding exists, specific interventions may be considered. All these steps require the availability of good data as well as the know-how to analyse the data correctly.

Insights gained in this way can be brought together in a policy document defining a road safety strategy. A strategy will set out objectives, such as fewer casualties, and programmes to achieve these objectives. Good data are indispensable to underpin these decisions. Once it is decided to execute action plans based on a strategy, progress should be monitored to establish whether the progress is adequate or additional interventions are needed.

Likewise, road safety studies often cannot be conducted without fundamental information on road safety. Some analyses use information about real crashes. This makes it possible to examine the influence of certain risk factors. It is evident that good data are indispensable for this. In addition, research carried out in a driving simulator or by means of computer simulations must be validated with information from real crashes.

Information on road crashes

Information about real crashes is collected by the police and saved in a computer database in many countries. An important question is whether this information is of a good quality and provides a fair view of reality. In order to understand why crashes happen and how they can be prevented effectively, crash data are perhaps the most important source of information, but they are not sufficient. This becomes clear if we take a more detailed look at the crash process. Sustaining injuries (fatal, major or minor) in a crash is influenced by three factors: exposure to risk (indicated by exposure E), the chance of a crash taking place given the exposure (C/E) and the chance that one suffers injuries given a collision (I/C). The number of casualties can then understood to be the product of the three factors (I = E times C/E times I/C). In order to understand clearly why someone is injured in case of a crash, information is required about all three factors.

Information about exposure means information about traffic participation. The more someone takes part in traffic, the greater his exposure to risk and the bigger the chance of a crash. Crash risks (C/E) information is about risk factors in traffic, such as driving while intoxicated, which is known to be a factor that increases risk. Information about injury risks means information about injuries suffered in a crash and about the factors that affect the risk of injury given the collision, such as the use of safety belts or crash helmets for motorized two-wheelers (known to decrease injury chances).

Road safety data systems

Data systems for road safety are compound by nature and many subjects are involved. Data can be categorized into five groups:

- information about all crashes that occurred and their consequences
- data about exposure to risk

- Safety Performance Indicator data
- background data such as population and age composition, road network broken down by type of road, weather conditions, norms and values in a society, etc
- data on crash costs.

Safety Performance Indicators (SPIs) are measures reflecting those operational conditions of the road traffic system that influence the system's safety performance

For example, the safety quality of the vehicle fleet can be measured by New Car Assessment Program (NCAP) scores. SafetyNet suggests using SPIs for road user behaviour, passive vehicle safety, roads and trauma management.

The section "Road safety data" discusses the quality of data systems and the section "Causes of road crashes" goes more deeply into the causes of crashes. The following sections have a more policy-oriented perspective and describe how the various steps in a policy process make use of data and how choices depend on good data.

All sections, therefore, make clear that good data are essential, and good analysts are required to ensure that good data lead to correct conclusions. In virtually all cases, a crash is preceded by a chain of poorly attuned events, several of which may have a major influence on the outcome of a crash. As influencing factors often occur in combination, it is always important to determine to what extent which factors influence the crash and its outcome. A good analyst requires a great deal of professional skill: knowledge about database structures, road safety, research methods and statistical techniques. Every country needs a pool of good analysts who are able to do their jobs independent of policy making.

Concluding remarks

More and more frequently, research is carried out in an international setting. In the case of international research, it is essential that data are comparable or are made comparable. This leads to the conclusion that it is advisable to pursue harmonization of road safety data. This starts with definitions to be used (e.g. the 30-day definition of a road death) and also involves the harmonisation of methodologies for data collection (e.g. when collecting data about Safety Performance Indicators). In every case of international comparisons, comparability of data has to be ascertained.

This chapter was written as a discussion paper for the workshop "Halving the number of road deaths in Korea" but it does not specifically discuss the situation in Korea and is not based on a thorough analysis of the data system in Korea. It was written to provide inspiration and good points of departure that may lead to improvements of the Korean road safety data system, the analysis of data and its use in policymaking and research.

The motto of 1913 Dutch winner of the Nobel Prize in physics, Heike Kamerlingh Onnes, was: "*Measuring the way to knowledge"*. One hundred years later, this is still true. Another phrase very relevant for this research is: "*You can't manage what you can't measure"*.

Road safety data

Various authorities, mostly governmental, are responsible for collecting, managing and supplying the diverse data that usually make up a data system for road safety. It is advisable to consider these different sources as part of one road safety whole and clearly agree on who collects which data, with what frequency, and how data is managed and made available to users.

Crash data

Basic information about crashes is supplied by the police. If a police official visits a crash site, as a rule it is his or her task to report on the crash and fill out a registration form. Sometimes an official report is made. The goal is to obtain a complete overview of all crashes and their characteristics.

In several countries police registration is unable to achieve this goal. Police are not informed about every crash, and if they are informed they do not always fill out a crash form or make a report. This phenomenon is called "underreporting" and from a data perspective, this is a widespread problem (Derriks and Mak, 2007). The problem is not only that a certain percentage of the crashes eventually does not end up in the statistics, but also that the statistics are biased. For example, registration for major crashes is higher than for less severe crashes, and registration of crashes involving single vehicles or vulnerable traffic participants is relatively low. In other words: the bias leads to a distorted picture. Obviously, it is a matter of great importance to maximize the quality of police registrations, and it is advisable to check the quality of registrations periodically and make adjustments if required. To eliminate underreporting, it is recommended to keep working on an excellent registration by the police and to enable the police to carry out this task with the proper manpower, facilities and budget.

One way to improve the quality of crash data is to make comparisons with other databases. With respect to road deaths, for example, the results of the police registration can be compared with data from vital statistics offices and statements provided by coroners.. Another possibility is to compare road casualty data as recorded in police registrations with hospital data. In a 2001 report, the International Road Traffic and Accident Database (IRTAD) indicated how linking of databases can be done. Results from various countries (e.g. the Netherlands, Spain and Sweden) show that linking data from the police to the data of hospitals is absolutely necessary to get a good picture of all major road injuries. Partly on the basis of this IRTAD-report, the European Commission has invited all member states of the European Union to improve registration of serious injuries and include these consequences of road crashes in policymaking. In order to get an idea of the minor injuries, one might make inquiries at emergency services departments and at GPs. Whether this is a realistic option primarily depends on which data bases related to public health are available in a country.

A second concern of data quality that is often noted in addition to 'underreporting' is the poor location coding of crashes. This issue could be resolved by investment in technology if police organizations would fill out Geographic Information System location data electronically from their vehicles or computers and stop filling out their registration forms by hand.

There is no right or wrong answer to the question of the minimum information that needs to be registered by the police. It has to do with finding a good balance between what would ideally be required and practical limitations. The Model Minimum Uniform Crash Criteria (MMUCC) developed in the United States the European Union's Common Accident Data Set (CaDaS) may serve as guidelines for other countries such as Korea. More information can be found on the websites of the United States (National Highway Traffic Safety Administration) and the European Commission. See also a manual on data systems published by the World Health Organisation (WHO, 2010)

Exposure data

Many countries do not collect exposure data in a qualitatively adequate manner. International databases, such as those of IRTAD, show many empty cells in this area. Given the fact that methods of data collection seem to differ in those countries that do provide exposure data, the data may not be comparable internationally. Detail is important, as this type of information is not only collected for purposes of road safety, but also can be used for traffic management purposes or investments in road infrastructure. Many countries provide useful examples. It is to be hoped that modern technology will help us in the future to make data collection more efficient and cheaper.

Safety Performance Indicators

Safety Performance Indicators are a relatively new and relevant source of data. This concept was introduced at the start of the 21st Century (ETSC, 2001). These indicators essentially concern the safety quality of characteristics of the road traffic system: the road user, the road, the vehicle and the trauma management system. This concept is also found in the literature under different terms, such as intermediate variable, and throughput variable between policy and the effects of policy. Safety Performance Indicators, such as the safety quality of the vehicle fleet as measured by NCAP scores, are supposed to have a causal relation with outcome indicators: killed and injured.

Data on costs of crashes

There is no agreement on how to estimate the cost of crashes, although some elements are widely included: medical costs, property-related costs, settlement costs and loss of production. Other costs are under discussion. Should the costs of a traffic jam resulting from a crash be included. Should the costs of pain, grief, suffering and reduced quality of life be included? Calculation methods have been developed both for road deaths and injuries. The Value of a Statistical Life can be calculated with the so-called willingness-to-pay method, and the cost of injuries can use the Disability Adjusted Life Years calculation (DALY times the costs per DALY). These methods are used more and more.

A rule of thumb for the costs of crashes used to be 1%-1.5% of the Gross Domestic Product for developing countries and 2% for developed countries (WHO, 2004). However, recent calculations suggest that these estimates are generally on the low side. In its annual report for 2014 (OECD/ITF, 2014), the International Transport Forum (ITF) presents a survey of estimates from various IRTAD countries. Estimates range from 0.4% to 3.4%. Korea estimated costs at just over 1% and finds itself on the low side of the spectrum (KoROAD, 2012). It does not seem conceivable that differences in economic development (GPD/capita) or the level of unsafety (casualties/capita) form a complete explanation for these large differences. Unfortunately, no generally accepted method yet exists for the making cost estimates. This is very likely a major explanation for the reported differences. It is advisable to develop and apply a generally accepted method for making road crash costs estimates.

Quality of a data system

The quality of a data system can be described from an input perspective but also from the perspective of output and the use of the data. As to output, this concerns, for instance, the way in which the data are made available for further processing and analysis. As to the use of the data, this refers to the actual use by road safety stakeholders and researchers. The possible and actual use of data by road safety stakeholders and researchers can be considered as a main indicator of the quality of a data system. The more possibilities there are to analyse the data, the better the quality of data systems. The internet permits analysis to take place in a decentralized way, no longer limited by fixed tables and printed charts. This democratization of road safety data is a good development. Data use is more attractive if no costs are charged. Occasionally, a helpdesk facility can be a useful addition in case of a more complex query. Obviously, when data are used, attention must be paid to privacy issues.

Use of road safety data

Road safety data can be used by a number of user groups, such as:

- Governments such as the ministries of transport and justice, road safety agencies, national road authorities, police, public health authorities, etc.
- Local and regional authorities such as provinces and municipalities.
- Research institutes.
- Private sector elements such as the automotive industry, insurance companies.
- NGOs such as organisations that represent road victims, consumer organisations, interest groups.
- International organizations such as WHO, ITF, the Organization for Economic Co-operation and Development (OECD), development banks.

To make roads safer, road authorities require a good understanding of the risks on their roads and knowledge about the locations where crashes take place. Police will be able to improve traffic enforcement if they know where traffic violations lead to crashes. These are just two illustrations to show how good road safety data are relevant for day-to-day operations and for policy making.

Road safety data ought to be available for free to all road safety stakeholders through the internet without any restrictions. The only critical restriction will deal with privacy issues, and legal arrangements may have to be made to secure privacy integrity. Charging for using road safety data will limit usage, and is not recommended. If data structures are complicated, it is advisable to organise training sessions for proper usage and install a helpdesk. For reasons of efficiency it could be considered to bring all road safety data behind one portal. In that case a central coordination is required and a lead road safety agency is an obvious candidate for this role.

Box 4.1. Road safety data system in the United States of America

Various sections of the US Federal Department of Transportation are engaged in road safety. The National Highway Traffic Safety Administration (NHTSA) is responsible for road safety data, and for this purpose, the National Center for Statistics and Analysis (NCSA) was set up. NCSA is responsible for providing a wide range of analytical and statistical support to NHTSA and the highway safety community at large. Information here is derived from www.nhtsa.gov/NCSA (approached 19/01/2015). The databases include:

- Fatality Analysis Reporting System is a nationwide census providing yearly data regarding fatal injuries suffered in motor vehicle traffic crashes.
- NASS is composed of two systems – the Crashworthiness Data System and the General Estimates System. These are based on cases selected from a sample of police crashes.
- Special Crash Investigations (SCI) provides in-depth and detailed information. Hundreds of data elements relevant to the vehicle, occupants, injury mechanisms, roadway and safety systems are collected for each of the over 100 crashes designated for study annually.
- State Data System (SDS) is a computerized state crash data file. Thirty-four states currently participate in this system and the system is maintained by NHTSA.
- Crash Outcome Data Evaluation System (CODES) provides a comprehensive understanding of motor vehicle crash outcomes including medical and financial consequences.
- Model Minimum Uniform Crash Criteria (MMUCC) consists of a recommended minimum set of data elements for States to include in crash forms and databases.

Box 4.2. South Australia Road Safety Progress report

This report provides a quarterly snapshot of crash and injury statistics and factors that influence road safety including numbers of insurance claims, levels of enforcement and the numbers of new cars sold with safety technologies. It provides an indication of how South Australia is progressing toward targets outlined in Towards Zero Together, South Australia's Road Safety Strategy 2020. The report also compares South Australia to other jurisdictions.

This quarterly progress report includes information on:

- a summary of progress towards 2020 road safety targets
- managing for results
- overview of casualties and crashes
- enforcement activity
- road safety management practices and other measures
- measures of exposure to the road system.

Source: www.dpti.sa.gov.au

Causes of road crashes

Over the years, there have been different perceptions of the causes of crashes (and the same holds for the ways to remove these causes). Consultation of The *Compact Oxford English Dictionary* (they claim this to be 'the world's most trusted dictionary') does not help us when trying to find causes of accidents. The dictionary defines an accident as 1) an unexpected and unpleasant event; 2) an event that is unforeseen or has no apparent cause. In the early years of crash studies, about a hundred years ago, crashes were thought to be a chance phenomenon (OECD, 1997): sometimes a crash occurred and sometimes a crash happened to people. Over the years, research has taught us much more about the causes of crashes and factors that affect the chance that a crash takes place and those that influence its outcome. Our knowledge has increased to such an extent that "no apparent cause" for road accidents is no longer correct.

There were times when the idea existed that certain people were accident-prone persons, suggesting that some individuals caused crashes due to their own behaviour and while others were invulnerable and would never be in a crash. Over the years, much effort has been put into finding the relationship between (major) traffic violations and the chance of a crash. And although the relationships vary between crash rates and various types of violations like speeding, driving while intoxicated, ignoring red traffic lights, etc., generally speaking we can say that intentional violations increase the chance of a crash (for example, Chapter 8 in Wegman and Aarts, 2006). In order to prove that violations have contributed to crashes, it should be established that those violations have contributed to the occurrence of crashes (causal relation).

The conclusion of the accident-proneness theory was that the road safety problem was related only to this select group of drivers and not to anyone else. Reality is different, as turns out to be more wilful and many crashes are impossible to explain by this theory. In the course of time research has shown that many crashes are not the result of intentional dangerous behaviour, but they more or less happen, we might say, to road users. Road crashes also occur due to a small inattention, a slightly late reaction to an unexpected situation, a small moment of distraction or being deep in thought, being surprised by an unexpected manoeuvre of another road user, etc.

What then makes traffic risky? The first reason is the vulnerability of the human body in combination with the high kinetic energy released in a crash (Wegman and Aarts, 2006). Kinetic energy is the mass of the vehicle multiplied by the square of the speed. There are all sorts of ways to protect the human body (cage constructions in cars, crash helmets for motorcyclists, etc.) but the collision energy can lead to serious and even fatal injuries. We refer to this as the basic risk factors (speed, mass, protection) and vulnerability of the human body. On top of these, there are the risk-increasing circumstances. Research has provided us with much knowledge about these factors: lack of driving experience, psycho-active substances like alcohol and drugs, fatigue, distraction of the driving task. The description in the Oxford dictionary ("has no apparent cause") is correct, however, only if this intends to mean that crashes can seldom be attributed to a simple cause. Studies have provided much insight into risk factors and causes and the fact that a combination of factors is often involved.

When establishing the cause of a crash, the registration form filled out by the police in the event of a crash is considered an important source of information. However, it is a mistake and it is advisable to exercise restraint in doing so. It is the task of the police to ascertain whether rules or regulations have been violated by road users and this knowledge can be used to establish the penalty, for instance in a court of law. As a rule, the police might not pay much attention to circumstances related to the road or the vehicle. It will not be a surprise that police often consider human errors in general and violations of the law more specifically to be the cause of a crash. Practice also teaches us that the police often sticks to one cause while in many cases a combination of circumstances is involved; considering only one single cause is a simplification of reality. In this context, it is interesting to consider the case of a crash (Table 4.1) that frequently occurs in the Netherlands.

Table 4.1. **Crash description vs. causes from a safe system perspective**

Crash description	Causes from a safe system perspective
18 years old **Just passed his driving test**	A young, inexperienced driver
Saturday night **Driving his friends home** **…from a party**	Peer-pressure from his friends Driving at night
Windy and winding dyke **It's raining**	In the rain
Misjudges a bend	An unexpected sharp bend
Driving too fast	With inappropriate speed Bald tyres
Hits trees alongside the road	Trees in a bend

Considering all the elements of an accident leads to the conclusion that it is better not to use one single cause indicated by the police on the registration form, which usually involves a violation of the law or regulations.

In the past and at present, quite a few (large) studies were and are conducted into causes of crashes (Shinar, 2007 in the chapter called "Accident/crash causation an analysis"). Two types of studies are worthwhile in this context: in-depth research and studies using naturalistic driving methodologies.

Human error as cause of a crash: extreme behaviour or system failure?

Much research tells us that in almost all crashes, human error can be seen as a prevalent factor in up to 95% of crashes. Sometimes human error is intentional: an "unwilling" human being is violating a law or decides not to adapt enough to prevailing conditions. We also have the “incapable” human being making unintentional errors, sometimes resulting in a crash. Both intentional and unintentional errors occur, and both deserve our attention. Unfortunately, researchers do not yet have a full picture of the relative contribution of intentional errors and unintentional errors. However, recent studies indicate that quite a proportion of crashes involve unintentional errors.

A study was carried out by two researchers of the University of Adelaide (Wundersitz and Baldock, 2011). They used a data set from coroners’ reports of fatal crashes and also information from their own in-depth investigations of non-fatal crashes. They categorized road crashes into three groups. One group involved drivers with extreme behaviour such as high level speeding and drink driving. A second group involved drivers with illegal activity that was less than extreme. Drivers in the third group were compliant road users whose errors lead to a crash. Wundersitz and Baldock describe crashes caused by less than extreme behaviour as “system failure”, that could be addressed by road system improvements such as better infrastructure, speed limits or vehicle design In this latter case, we are speaking about ordinary road users, having more or less ordinary behaviour. Sometimes we speak about system failures, in which well-intentioned road users have a crash because of some sort of 'human error'. Wundersitz and Baldock distinguished furthermore between fatal and injury crashes and between rural and urban crashes. The results are presented in Figure 4.1.

Figure 4.1. **Proportion of crashes based on extreme behaviour or systems failures**

Data source	Extreme behaviour (%)	Illegal system failure (%)	System failure (%)
Fatal crashes 2008	43.4%	22.9	33.7
Non-fatal metropolitan injuries 2002-2005	3.3	9.9	86.8
Non-fatal rural crashes 1998-2000	9.4	16.6	74.0

Source: Wundersitz and Baldock, 2011.

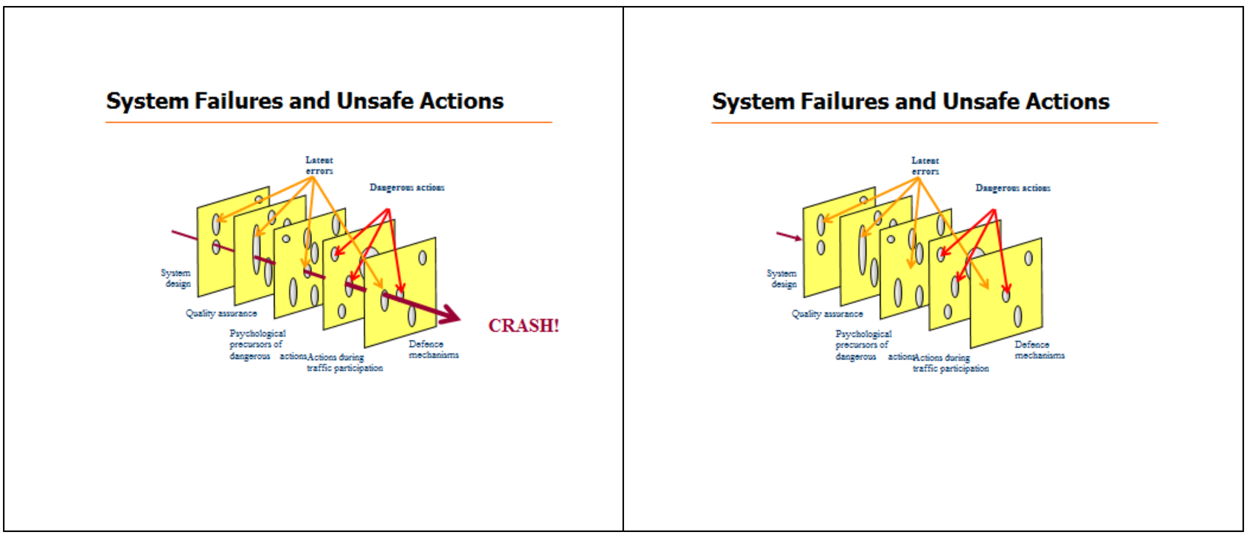
The South Australian data and other studies reject the idea that crashes are only, or mainly, caused by extreme behaviour (antisocial road users who grossly disregard all rules). Comparing fatal crashes (first row) with injury crashes (second and third row), Figure 4.1 illustrates how they are quite different, with extreme behaviour very important in fatal accidents, but accounting for less than 10% of rural non-fatal crashes.

In other words, data on fatal crashes and injury crashes are different type of crashes and are not telling the same story, meaning that fatal crashes will not be good predictors for injury crashes. This has important implications: first of all, we may not expect that a reduction in the number of fatalities will necessarily result in a similar reduction of the number of injuries. And secondly, we cannot rely only on fatal crash data when formulating road safety strategies, we have to include injury crash analysis as well.

Human error from a wider perspective

Going back to the question “why do crashes still occur?”, it might be interesting to take a small diversion and learn from other human activities to understand why crashes occur and how best to prevent them. James Reason from the United Kingdom wrote an influential book “Human Error” (Reason, 1990). The findings of his book came from cognitive ergonomics, based in industrial safety and aviation, but can certainly be applied to road traffic crashes. The model developed by Reason, sometimes referred to as the "Swiss Cheese Model", has been adapted to road safety (Wegman and Aarts, 2005). His "slices of cheese" have different hiatuses, or holes in the cheese. A hole is also called a latent error, and in isolation they are not necessarily a problem. They start to become a problem the moment they allow for a chain of events, depicted by an arrow in Figure 4.2. Latent errors in the last two screens are dangerous actions by road users. We could say that holes in the psychological precursor screen can be considered as dangerous actions, such as being intoxicated or fatigued. The arrow in the diagram is a good illustration of a chain of events leading to a crash.

Figure 4.2. **Reason's "Swiss Cheese Model" as applied to road safety, indicating how crashes can occur and may be prevented**



Source: Wegman and Aarts, 2005.

Our basic assumption is that human beings make errors, no matter how well they are educated and motivated. Sometimes people do not abide by the rules. In order to prevent crashes, society is now almost completely dependent on the extent to which individuals are capable (and sometimes willing to) correcting their own errors. Road users are sometimes distracted (in the car and outside the car), fail to observe other road users or sharp bends and don't pay enough attention to the driving task. Drivers don't always anticipate and respond well to static and dynamic elements in road traffic. Even when trying to prevent a crash, they make errors.

If we want to eliminate risky traffic conditions and eliminate holes in the first few screens in order to make road safety less dependent on how well the road user performs' (holes in the last two screens), we drift away from the traditional approach of blaming the driver. In the case of a crash, we don't ask who is to blame, but instead we ask "how could this crash have occurred?"

Sometimes this new approach is called a paradigm shift. This new approach fits better with our understanding of the majority of crashes, in which the ordinary behaviour of ordinary people is involved, rather than criminal behaviour by a small number of offenders. We expect designers and operators to provide a road traffic system in which conditions are created in such a way that ordinary road users, who unintentionally commit errors, will not be punished for those errors with serious injury or death. Trying to create safe conditions is a proactive approach aimed at eliminating so-called latent errors in traffic. This is a key element of the Safe System approach.

Safe System approach to eliminate serious crashes

The OECD report "Towards Zero: Ambitious road safety targets and the Safe System approach" (OECD/ITF, 2008) can be considered as a major step forward in getting the Safe System approach well understood and also accepted. It makes the bold statement that a Safe System approach is the only way to achieve the vision of zero fatalities and serious injuries and that the road system can be designed to expect and accommodate human error.

A few observations can be made that are relevant for road safety data systems:

- A Safe System approach is a pro-active approach and is based on our general understanding of risks in road traffic. As a result, we consider making interventions although we cannot defend them with specific data. For example, it is not necessary to wait for a crash to occur to decide that a traffic calmed street is safer than a street with a speed limit of 50 or 60 km/h. We know that already, so there is no need to prove that once more.
- We have to escape from the traditional road safety playground of the three Es: Engineering, Education and Enforcement, with their only goal to improve road safety. We certainly should not miss opportunities to make progress among them. However, we should explore a wider range of opportunities and enter arenas in which road safety is not yet present, such as planning, public health and environmental policies. From a road safety perspective, we should try to liaise between these different areas. Road safety policymakers and professionals will probably have to start building bridges to these other arenas and try to explain how to create win-win solutions developed with their experts. This will result in more integrated decisions in which reaching more goals should be considered. It is good to understand that society should meet goals other than road safety as well.
- As a consequence of this wider perspective, we have to include more stakeholders to improve road safety from all levels of government, from peer/lobby/interest groups, from the private sector, from the community and road users. Real leadership is needed for this challenging task and leaders such as the premier, the minister for road safety, the cabinet, industry chief executives and the chair of a road safety advisory council all needed to achieve a successful result.

These three points illustrate that we have to prepare for this Safe System approach before policy actually implements measures derived from, and fitting into, this approach. Moreover, policy makers and road safety experts have to understand that they have great opportunities to win when they operate together with other important areas such as traffic management and environmental policy.

Monitoring progress

Periodically monitoring road safety developments of road safety is highly recommendable as part of an effective road safety policy and should be considered as a core element in every road safety policy. Measuring progress can be done by means of information that is collected every day, every week, every month, every quarter, every year or at a longer interval. Monitoring can establish whether developments are still on track compared to a policy goal, and monitoring can establish whether new and undesirable developments have surfaced. The sooner we are aware of such developments, the better we can prepare suitable countermeasures.

Figure 4.3. **Evolution of road fatalities in countries of the European Union compared with a trend line resulting in halving the numbers between 2000-2010**

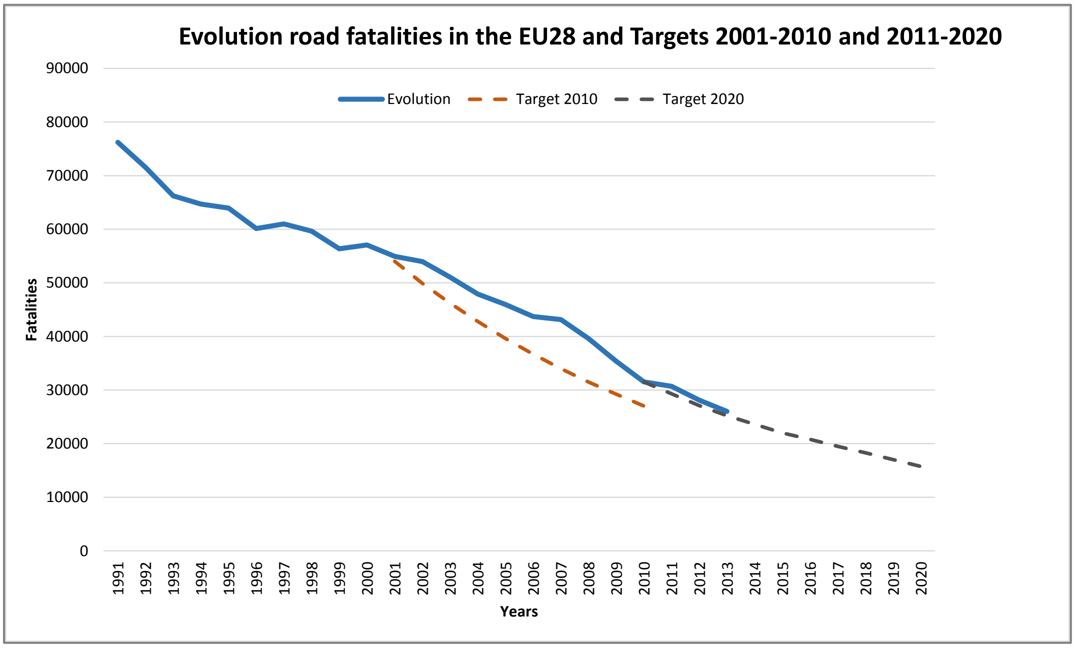


Figure 4.3 is an example of monitoring. It records changes in the number of road deaths in the European Union, which had decided to strive for a halving of the number of road deaths between 2001 and 2010. Figure 4.3 shows a substantial drop in the annual number of road deaths, although it fell short of the target. Actual fatalities are closer to the predicted path for the 2020 target. Monitoring between 2001 and 2010 showed that this is a politically relevant observation, since in order to reach this target, additional interventions are necessary, but monitoring cannot specify what these should or could be. Explaining developments uncovered by monitoring requires further analyses.

Some countries keep track of how many fatal crashes happen every day and compare this to the numbers on the same day of the previous year. These comparisons are sometimes published. However, some caution is needed as crash numbers are subject to random fluctuations. In order to reduce the influence of randomness, numbers are sometimes not only compared on a year-to-date basis, or to those of the previous year but also to the average of a period of previous years, for instance over a five-year period, or to a trend line over a period of years. It is advisable to consider longer periods and not to focus on the “rate of the day”.

Publishing progress reports

Every year, IRTAD publishes its annual report (for instance, OECD/ITF, 2014). In this report, the most recent data of IRTAD member states are put into the context of earlier developments.

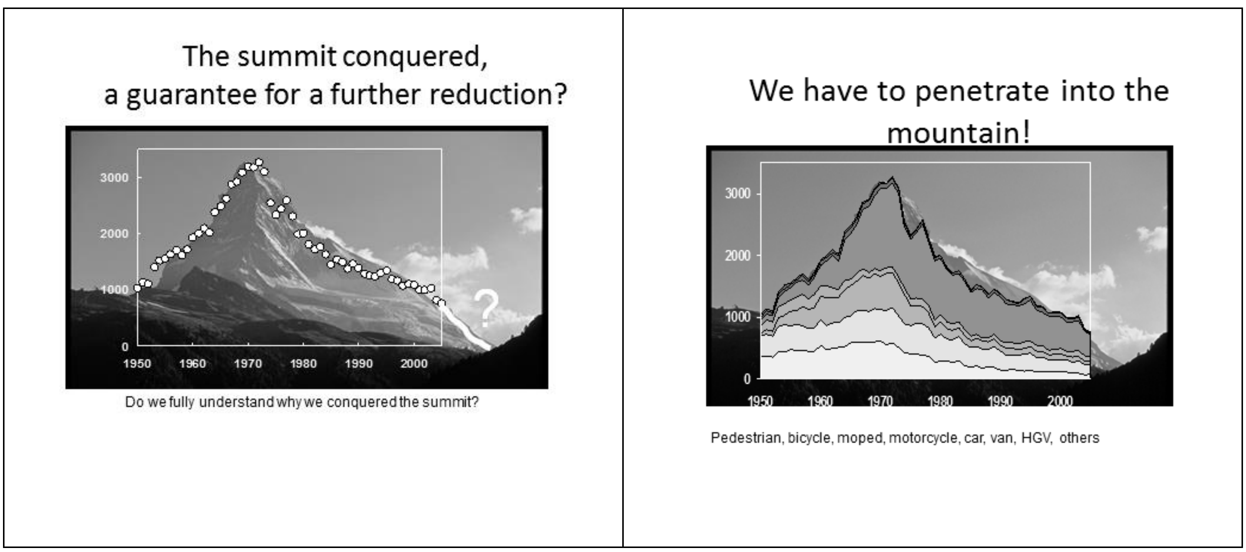
When drawing up progress reports, the choice of outcome indicators should be established. Output indicators serve as a measure for the level of road (un)safety. Traditionally, data about the number of road deaths are used. In addition to absolute numbers, these data are put into context. For example population in a jurisdiction, leading to the number of road deaths per 100 000 inhabitants, also referred to as mortality. This measure indicates the consequences of crashes to society and can then be compared to other threats to public health such as cardiovascular disease, AIDS/HIV, tuberculosis, etc. The number of road deaths may also be related to the number of kilometres travelled. The lower this ratio is, safer is the traffic. Both ratios are used side by side and they definitely are not interchangeable.

In more and more countries, the number of seriously injured persons is used as an outcome indicator in policy making and monitoring. The OECD/ITF report entitled "Reporting on serious road traffic casualties" (2011) advocates considering injury consequences as a relevant outcome indicator of road crashes, next to fatal injuries. Sometimes, the (economic) costs of crashes and injuries resulting from crashes are also considered to be outcome indicators.

Understanding progress

Choosing outcome indicators is a first step. The second step is to understand why developments occur. This understanding arises not only by considering the total number of road casualties, but also by looking at various components. For instance, data can be subdivided by criteria such as transport mode or age group, or a combination of the two. In this way, a more exact picture of the developments is formed and the search for explanations is more focused.

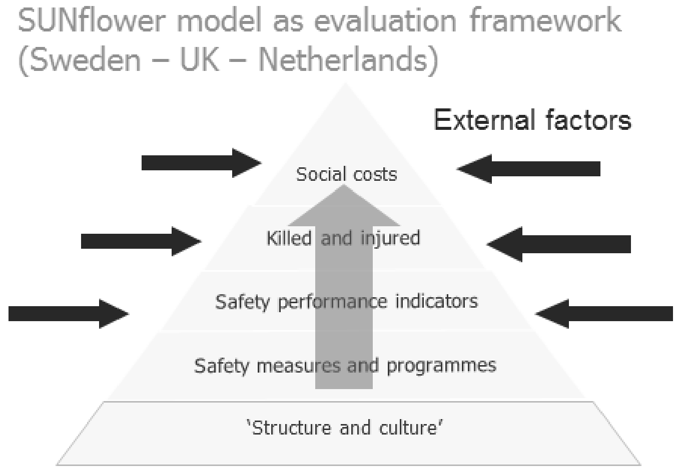
Figure 4.4. **A description of the number of fatalities in the Netherlands (with the Eiger Mountain as a reference) and a breakdown by different transport modes**



This step is also referred to as a stratified approach (Stipdonk, 2013). A past decrease in crashes is no guarantee that crashes will decrease in the future. Only if there is a better understanding of the reasons for the decrease will it be possible to formulate expectations about future developments.

Another step is to analyse not only outcome indicators such as the numbers of killed and injured but also to include Safety Performance Indicators (SPIs) in the analyses. SPIs describe the safety quality of parts of the road traffic system (for instance, SafetyNet, 2006). There are indicators for (unsafe) traffic behaviour (e.g. speeding, driving while intoxicated), the safety quality of vehicles (e.g. NCAP stars), the safety of roads (e.g. International Road Assessment Program [IRAP] stars) and the quality of the trauma system (e.g. arrival times of ambulances). Analysts can consider to what extent the execution of policies has influenced the SPIs and to what extent a change in SPI has led to a change in the number of casualties. This idea can be found in the so-called SUNflower approach.

Figure 4.5. **A target hierarchy for road safety as used in SUNflower studies**



*Source***:** Koornstra et al., 2002

The SUNflower approach is to determine underlying elements of current policies and programmes that make them particularly effective. Such understanding will identify policy improvements that are most likely to reduce road casualties. The SUNflower approach started with comparing three countries with the lowest accident levels in the world: Sweden, United Kingdom, and the Netherlands (Koornstra et al., 2002). Analyses included national road safety strategies, changes in overall risks and fatality risks of comparable road types, road user modes and collisions between modes. A case study approach on specific topics has been added to the more general picture. This 2002 study covered drinking and driving, seat belt and child restraint use, local infrastructure improvements on urban and minor rural roads, and safety on main interurban roads.

The SUNflower study uses a kind of benchmarking approach. The thinking is based on a road safety target hierarchy of the final outcomes (the number killed and injured), intermediate outcomes (Safety Performance Indicators), safety programmes and measures, and "structure and culture" as shown in Figure 4.5. This approach is adapted from a consultation document on a road safety strategy in New Zealand (LTSA, 2000). The methodology tries to link, in a causal way, indicators at the different layers as indicated by the vertical arrow. Each layer in this hierarchy may be influenced by external factors.

Priority setting

Road safety problems are huge and the possible solutions and necessary resources within a short timeframe are too limited to expect that all problems can be resolved immediately. For this reason, setting priorities is inevitable: what should be done first, what at a later stage and what not at all? Priority setting can be done in several ways. Policy priorities can be based on the possibilities of finding solutions for identified problems. This is a matter of balancing the costs involved in solving the problems and the benefits of the solutions. For this purpose, cost-benefit or cost-effectiveness considerations will make clear where the largest benefits can be gained at the lowest costs. This paper will not go into the cost-benefit approach, but instead will rank the problems and identify those that should be the first to qualify for a solution. Before introducing ways in which to set priorities on the basis of road safety data, a few observations can be made.

First, in addition to analysis of objective data, political views often will play a role. We can take the view, for instance, that vulnerable road users deserve a high priority even though objective data do not support this view.

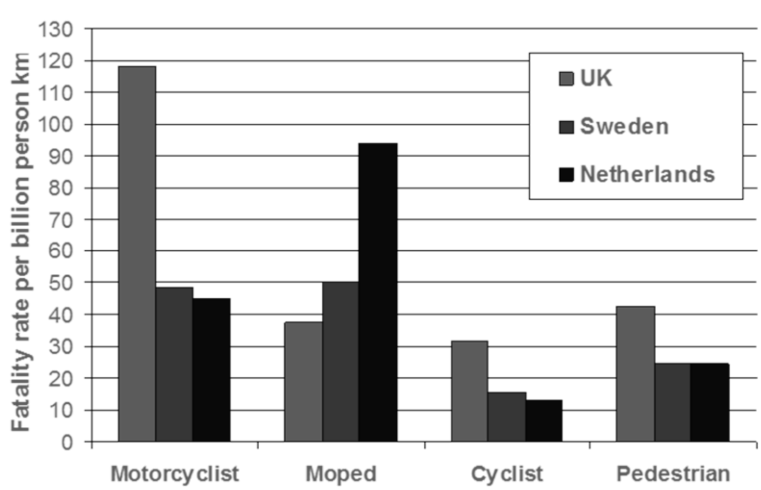
A second observation is that priority setting based on data from the past is basically a reactive form of policy making. The section on causes of road crashes suggests that choosing a proactive form in terms of a Safe System is also possible and an option to be preferred. This forms part of the thinking in terms of Safe System. This approach is even preferable if enough knowledge is available. Of course the Safe System approach also requires that priorities must be set, for which cost-benefit considerations will be of great help.

A third observation is that we assume that safety problems that emerge from the statistics and other data will continue to manifest themselves in the future all things being equal. However, if we are aware of major relevant changes to the road transport system, it is not justified to extrapolate trends from the past. For example, at a certain time it was decided in the Netherlands to make it financially very attractive for students to use public transport. This changed the mobility of this group completely.

The ranking of road safety problems is sometimes described as "going fishing where the fish are". This method focuses on identifying the biggest problems or the most negative developments. The assumption is that addressing the biggest problems will lead to the highest benefits or benefits at the lowest costs. To establish the biggest problems we analyse existing databases with crash data and establish which problems occur most frequently. For example, it could be the many casualties among car occupants or among pedestrians in case of truck collisions. However, we might decide not to consider absolute casualty numbers but to compare the number of casualties to the distance travelled by specific groups, to establish the traffic risk. Then it may turn out, for instance, that young and novice drivers run a relatively high risk. We might also decide not to analyse a specific period but to consider trends over time.

The SUNflower study (Koornstra et al., 2002) contains a number of interesting comparisons between Sweden, United Kingdom and the Netherlands.

Figure 4.6. **Comparing fatality risks for different transport modes in SUNflower countries**



Source: Koornstra et al., 2002

In Figure 4.6, a comparison is made in these three countries between the risks (fatalities per kilometres travelled) of four groups of road users: motorcyclists, moped riders, cyclists and pedestrians. Displayed this way, we see that the risks for motorcyclists are somewhat higher than for moped riders, and for pedestrians are somewhat higher than for cyclists, and we notice that the risks for various modes in the three countries (where on average the risks do not differ) are not the same. The risks for motorcyclists, cyclists and pedestrians in the UK are much higher than in both other countries. Moped riders in the Netherlands have relatively unfavourable scores. These comparisons suggest that further investigation is required to find explanations for the relatively high risks. Are they related to the age distribution of the casualties? Do laws involving minimum age for certain modes of transport differ? Are there differences in the quality of driving lessons or the way vehicles are used? Are results related to urban density? Detailed analysis demands much knowledge of subject matter, analytical skill and creativity. Understanding why risks are higher or lower is a basis to attach priorities to problems.

Target setting

The title of the workshop and the present report is "Halving the number of road deaths in Korea", with a subtitle: "Lessons learned from other countries". The title clearly reflects Korea's ambition to reduce the number of road deaths. This means there is a target. Deciding on a realistic and ambitious timeframe within which this halving should be realized is a key component of target setting. Experiences in other countries teach us that a halving within 10 years is possible but may also be ambitious. Halving the deaths with a 30 year target cannot be considered ambitious.

Another striking element is that the target only refers to road deaths and not to the number of seriously injured. An increasing number of countries, including those of the European Union, formulate targets for reducing serious injuries. Korea might consider this.

Targets: absolute numbers, no rates

The best targets are phrased in terms of the number of casualties to be saved, rather than by a ratio such as the number of casualties per kilometre travelled. First, an absolute number is easier to communicate and will be clear to everyone: 1 000 road deaths less per year. A target expressed in terms of ratio is more difficult to explain (Box 4.3). For example, deaths per kilometre travelled may drop while the overall number of road deaths increases. If the target was a decrease of the ratio, then we met the target despite more casualties, and we should never be pleased with that.

Box 4.3. **Target setting with absolute numbers or rates?**

Suppose 1 000 people were killed in road crashes in a certain country in a certain year. The next year, 1 100 people were killed, a 10% increase. But the fatality rate (fatalities per billion kilometres travelled) initially was 20 and the next year was 19, meaning a 5% reduction, because mobility had increased from 50 billion kilometres to 58 billion kilometres. But, if a target was set in rates, one has to conclude: we are on the right track, because we accomplished a 5% reduction, but the 10% increase in deaths is unacceptable. This confusing result is realistic in case of a higher increase (in percentage points) in mobility (in this case from 50 billion kilometres to 58 billion kilometres, meaning plus 16%) than a fatality rate reduction (in this case from 20 to 19, meaning minus 5%).

Data quality is crucial when working with quantitative targets. More particularly: the quality of the crash registration should remain unchanged during the period under review, so that a change in the numbers will reflect changes in the reality. Suppose a country had 5 000 road deaths and the degree of registration is 100%. If the degree of registration dropped to 90%, only 4 500 instead of 5 000 casualties would be registered whereas the actual number would remain 5 000. The same line of reasoning holds for other relevant data: percentage of people wearing safety belts, percentage of intoxicated drivers, etc. The method of observation and registration should warrant comparability of the results over the years. Should methods of observation change, the effects for the resulting data should be understood and, if needed, corrected.

There are valid reasons to formulate a quantitative target. The report entitled “Towards Zero: Ambitious road safety targets and the Safe System approach” (OECD/ITF, 2008) sends out a strong signal that reduction of road deaths is important both from a political and a social perspective. Such a target motivates politicians as well as the professional community. A clear target increases the chance that stakeholders consider themselves to be co-owners of safety policy and therefore behave more accountable. Finally, such transparency will simplify the possibilities for the media to monitor whether targets are actually realized and if not, to exercise pressure on politicians. The extent to which a quantitative target is truly effective is connected to a country’s culture and to the benefits experienced once the target has been reached, or the disadvantages should this not be the case. Especially to politicians in a democratic society, not reaching a target may imply political risks.

Hardly any research has been done into the effectiveness of quantitative task setting. One of the studies that analysed this association between setting targets and the performance of policies is a study reported by Allsop et al. (2011). Based on a comparison of the performances of countries with and without a road safety target, the authors conclude that countries working with a target perform better, with an estimate of about 10% greater road fatality reduction.

Targets: top-down or bottom-up?

Basically, there are two ways to set targets. The first method is to formulate a target without being exactly clear beforehand what measures need to be taken to realize that target. This is also referred to as a top-down target. An example is the manner in which targets are formulated by the European Union: a halving of road deaths in 10 years. Since the largest contributions will have to come from the member states of the EU themselves, the European Union hardly has any influence on this. The Commission’s own contribution to policy is limited, and the European Commission is not accountable for reaching or not reaching the target. But the target sent out a political signal felt particularly in countries that have a relatively unfavourable road safety record. To what extent this target has contributed to the downward trend in Europe is not clear. It is interesting, however, that for the period 2010/2011-2020, the European Commission has once more chosen a 50% reduction. It is said that the European Commission did not dare to choose a target other than a halving in 10 years, as it did not want to send out a signal of giving either more or less political priority to road safety.

The second method is a bottom-up approach. This involves deriving a target from the anticipated benefits of a road safety measure. As a rule, this approach is based on extrapolation of past trends to which the safety effects of the policy interventions under consideration are added. If analysis leads to a satisfactory result, it is formulated in terms of a target. If results are unsatisfactory, the package of measures can be adjusted and results recalculated.

This second procedure depends on the quality of the data, of forecasts and of the tools used to model future developments. Road safety knowledge must be of high quality to make sound ex-ante estimates. Bottom-up procedures have been developed in a number of countries, and much work was summarized in a special issue of “Safety Science” (Editorial of “Scientific Research on Road Safety Management”, Wegman and Hagenzieker, 2010). This special issue contains contributions of the approach used in Western Australia (Corben et al., 2010), the Netherlands (Wesemann et al., 2010), Switzerland (Siegrist, 2010), and the United Kingdom (Broughton and Knowles, 2010). The various approaches show a great deal of similarity as well as differences. Basically, practical choices need to be made:

- How are time series from the past extrapolated?
- Are absolute casualty numbers used, or of ratios such as casualties per kilometre travelled, casualties per capita or casualties per crash?

- Is an aggregated approach adopted or a stratified approach in which results of different sections are added later stage to come to a total result?
- Which extrapolation method is used (linear, exponential, log-linear, or structural time series analysis)?

For this bottom-up approach, it is of great importance to make a selection of possible interventions and estimate their safety effects. For this, knowledge is required of the safety effects /casualty reduction per intervention unit, such as the effect of building one roundabout, or one hour spent on police enforcement. Assumptions have to be made regarding the number of units: How many roundabouts will be constructed, how many hours of police enforcement will be added. Once these estimates have been made for individual interventions, the effect of the combinations of interventions can be estimated. The total is not the sum of the effects of each measure, as there will be an overlap of effects. All of the methods described above take this into account.

It is advisable to opt for a bottom-up method. Even though this is more complex than the top-down approach, it provides a much better insight into how realistic a particular target is and how this can be achieved. For Korea it is recommended to explore this approach in more detail.

Conclusions and recommendations

This chapter includes a survey of good practices in relation to data collection and data analysis in the area of road safety. Before data collection and analysis can start, it is necessary to consider the question of which road safety indicators are considered relevant. Indicators can be used in policy making, for progress monitoring and for explaining developments, particularly in relation to the policy conducted. Good data are indispensable for this. When data are not good, erroneous decisions are possible. Improving road safety is a social issue, and *society cannot afford to let dilettantes take erroneous decisions based on false data leading to unnecessary road casualties*. In addition to their use in road safety policies, good data are of extreme importance for research.

This report suggests several best practices for Korea to consider carefully and conclude whether or not their application is desirable. The Safe System ideas come to mind as well as the SUNflower approach. Specifically, Korea may want to examine what this means for Korean data systems. Korea may want to consider:

- Putting more emphasis on the serious injuries and translate this into a policy objective in addition to halving the number of road fatalities.
- Introducing explicit and realistic, short-term and long-term timeframes to achieve road safety targets, using the bottom-up approach when formulating targets.
- Introducing Safety Performance Indicators, defining a data collection programme for this purpose and making SPIs part of a periodical monitoring activity.
- Making road safety data, where possible, available widely, such as by publishing them on the internet, and not limiting them to published statistics.
- Having well-trained analysts with knowledge of databases, road safety and analysing techniques perform analyses on a periodic basis and publishing the results.

References

Allsop, R.E., Sze, N.N. and Wong, S.C. (2011), “An update on the association between setting quantified road safety targets and road fatality reduction”, *Accident Analysis and Prevention*, Vol. 43/3, pp. 1279-1283.

Broughton, J. and Knowles, J. (2010), “Providing the numerical context for British casualty reduction targets”, *Safety Science* Vol. 48/9, pp. 1134-1141.

Corben, B.F., Logan, D.B., Fanciulli, L., Farley, R. and Cameron, I. (2010), “Strengthening road safety strategy development ‘Towards Zero’ 2008-2020 – Western Australia’s experiences”, *Safety Science* Vol. 48/9, pp. 1085-1097.

Derriks, H. and Mak, P. (2007), *Underreporting of Road Traffic Casualties*, IRTAD Special Report.

ETSC (2001), Transport safety performance indicators, ETSC, Brussels.

Koornstra, M., Lynam, D., Nilsson, G., Noordzij, P., Petterson, H., Wegman, F and Wouters, P. (2002), *SUNflower: a comparative study of the development of road safety in Sweden, The United Kingdom, and the Netherlands*, SWOV, Leidschendam.

KoROAD (2012), The estimation and evaluation of road accident costs, KoROAD, Seoul.

LTSA (2000), *Road safety strategy 2010. A consultation document*, National Road Safety Committee. Land Transport Safety Authority, Wellington.

OECD/ITF (2014), *Road Safety Annual Report 2014*, IRTAD, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/irtad-2014-en

OECD/ITF (2011), *Reporting on Serious Road Traffic Casualties*. IRTAD, Paris. http://internationaltransportforum.org/irtadpublic/pdf/Road-Casualties-Web.pdf

OECD/ITF (2008), *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789282101964-en

OECD (1997), Road safety principles and models. OECD, Paris.

Reason, J. (1990), *Human error*, Cambridge University Press.

SafetyNet (2006), *Road safety performance indicators. Theory*. Deliverable D3.6 of the EU FP6 project SafetyNet. https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/4952/1/AR2590%20Deliverable%20D3%206%20Road%20safety%20performance%20indicators%20theory.pdf

Shinar, D. (2007), *Traffic safety and human behaviour*, Emerald Group Publishing Limited.

Siegrist, S. (2010), “Towards a method to forecast the effectiveness of national road safety programmes”, *Safety Science* Vol. 48/9, pp. 1106-1110.

Stipdonk, H. (2013), *Road Safety in bits and pieces: For a better understanding of the development of the number of road fatalities*, SWOV, Leidschendam. https://www.swov.nl/rapport/Proefschriften/Henk_Stipdonk.pdf

Wegman, F. and Aarts, L (eds.) (2005), *Advancing Sustainable Safety: National road safety outlook for 2005-2020*, SWOV, Leidschendam. http://www.swov.nl/rapport/dmdv/Advancing_sustainable_safety.pdf

Wegman, F. and Hagenzieker, M. (2010), "Editorial" in *Safety Science*, Special issue, Scientific research on road safety management, *Safety Science* Vol. 48 /9, pp. 1081-1084. DOI:10.1016/j.ssci.2010.07.004

Wegman, F. (2012), "Driving down the road toll by building a Safe System", Adelaide Thinker in Residence 2011-2012. Government of South Australia, Adelaide.

Wesemann, P., Norden van Y. and Stipdonk, H. (2010), "An outlook on Dutch road safety in 2020: future developments of exposure, crashes and policy", *Safety Science* Vol. 48/9, pp. 1098-1105.

WHO (2010), Data systems: a road safety manual for decision-makers and practitioners, WHO, Geneva.

WHO (2004), World report on road traffic injury prevention, WHO, Geneva.

Wundersitz, L.N. and Baldock, M.R.J. (2011), "The relative contribution of system failures and extreme behaviour in South Australian crashes (CASR092)", Centre for Automotive Safety Research, Adelaide.

Chapter 5. Road policing in New Zealand

David Cliff, New Zealand Police

This chapter provides a summary of the key elements of an effective road policing programme. It highlights that in order to develop a successful programme, understanding primary crash patterns and causes allows enforcement to be targeted to proven crash risk and hence maximise its impact.

Introduction

Road policing can significantly improve road safety outcomes, but it must be applied consistently and it must be based upon sound research. Key considerations include solid legislation that supports the sanctions imposed upon offending drivers, sound intelligence, and well trained, educated and committed police officers. This paper sets out New Zealand Police's Road Policing foundational principles and looks at a selection of international traffic enforcement examples. A well designed road policing programme is one part of a comprehensive road safety strategy that supports the 'Safe System' approach, whereby all components of a strategy operate in unison to generate greater levels of safety and hence reduce road trauma[1]. The Safe System approach aims for a more forgiving road system that takes human fallibility and vulnerability into account. Under a Safe System the whole transport system is designed to protect people from death and serious injury.

New Zealand's success in implementing an effective road policing operation can be attributed to the trust and confidence of the New Zealand public. In part, this stems from the international ranking, as not corrupt, of New Zealand institutions. The international measure of corruption consistently ranks New Zealand as either the least, or the second least corrupt nation in the world (see Corruption Perception Index 2013, http://www.transparency.org/cpi2013/results). New Zealand has held this ranking for many years, and New Zealand Police, as the nation's single police service, is a cornerstone New Zealand institution. New Zealand Police enjoy high levels of trust and confidence, measured through an ongoing independent survey.[2] This shows that 78% of the New Zealand public have 'full or quite a lot' of trust and confidence in Police, and this level of confidence has been steadily increasing.

Public confidence enables New Zealand Police to adopt a strong stance in the prevention of road trauma by applying enforcement counter measures across the New Zealand population. New Zealand's Ministry of Transport conducts an annual survey on 'Public Perceptions on Road Safety' (Ministry of Transport, New Zealand, 2012). It shows that 93% of New Zealand adults said they would like Police efforts to enforce road safety laws increased (41%) or maintained at the current level (52%). New Zealand Police believe part of the reason for this support of their road safety programme is the pace of implementation, which is determined largely by the public appetite to accept successive layers of countermeasures. Secondly, the enforcement programme is well supported by a public advertising campaign that, using focus groups, exhaustively tests road safety messages with the target audience and ensures the most effective methods of delivery to achieve both behaviour change and public acceptance. The campaign supports police enforcement and essentially explains 'why' to the general populace through a range of innovative techniques and media. Road Policing enforcement effort is greatly enhanced when supported by a coordinated, systematic, well researched, tested and funded on-going public awareness programme. In spite of high levels of support, there remains a vocal minority who endeavour to undermine the programme by dismissing road policing as having a 'revenue raising' motive. While the claims are groundless, as fines imposed do not return to police, these claims do arise from time to time in the media with diminishing frequency. Regardless of this opposition, New Zealand Police believe that the success of New Zealand's road policing programme is linked in part to the credibility and status of the enforcement agency.

Terminology

There are two terms that will be used within this chapter that require explanation. Firstly, historically, vehicle collisions were referred to as 'accidents'. This implies no responsibility by community or government and gives the impression that road trauma is inevitable. The implication in the use of the word 'accident' is that road trauma is an 'act of God' and outside our control. New Zealand Police prefer the term crash or collision to ensure that these events are not regarded as inevitable, as most road incidents are preventable.

Secondly, the term 'road trauma' is used to describe the nature of the serious harm that occurs in the violence of a collision. The forces encountered by a vehicle occupant, motorcyclist, pedestrian or cyclist in a collision are such that only the term ‘road trauma’ can encapsulate the harm done. The forces involved in these events are severe and currently result in more than 1.24 million deaths worldwide annually, and for every death at least 20 people sustain non fatal injuries (WHO, 2013).

Public health paradox

According to Professor Ian Johnston, road policing should be regarded as similar to a disease inoculation programme for a population – rather than a punishment. He sees commonalities between ‘the public health paradox’, and issues in road safety.[3] Johnston explains that in preventive medicine, in order to eradicate a given disease, the entire population – as far as is possible – is immunised to prevent a disease occurring in only a few. We are not able to predict exactly who will contract a disease, but we are able to predict, across a population, the broad numbers. Similarly, in road safety, we are not able to predict who will be killed or seriously injured in a road crash, but we are able, with a reasonable degree of certainty, to predict the numbers. We are also able, through crash reporting analysis, to predict with accuracy the proportions of deaths or serious injuries that will be attributed to alcohol impaired driving, speeding, failure to wear safety belts and other causes. Therefore, in the same way that we inoculate a population against a disease, we can immunise a whole population against road trauma by reducing rates of drink-driving and speeding, and increasing the rates of safety belt and motor cycle helmet wearing.

Furthermore, Johnston and his colleagues urge society to not be misled by ‘averages’ and to consider the overall impact of risk-taking behaviour that is practiced at a personal level. For many individual drivers or passengers, the risks of a collision and death or serious injury are low, and they will choose to drive drunk (or ride with a drunk driver), exceed the speed limit routinely, or not wear a safety belt, without ever being involved in a collision. Their individual experience convinces them that their behaviours are harmless or at least very low risk. However, road trauma is the consequence of illegal behaviours being replicated across millions of drivers, and a proportion of these behaviours will inevitably result in serious collisions. Road safety practitioners must appreciate that the aggregate result of high numbers of low-risk trips is ‘a large absolute number of disabling injuries and deaths’ on our roads (Johnston, 2013).

Any road policing programme should be designed to reduce overall rates of illegal behaviour that when repeated across the whole population result in high levels of road trauma. The intention of the programme is to drive up the perception that offending has a high likelihood of resulting in apprehension, and to follow up with swift and certain sanctions for those who choose not to modify their behaviour and continue to offend.

Aims of a road policing programme

New Zealand Road Policing operates a deterrence or prevention strategy whereby the guiding principle is the prevention of road trauma. Particular attention is paid to drunk driving, safety belt wearing and speed. It is not intended to maximise the detection of offences and is not focused on attendance at road crashes or responding to reported traffic incidents – although both are important aspects that must be addressed. Many police jurisdictions have an historic culture focused on emergency response rather than prevention. Reorienting agencies to crash prevention, rather than crash or crime attendance is necessary to change a population’s behaviour. The programme aims are to deter drivers from committing offences that either cause, or worsen, crash outcomes. For example, a driver under the influence of alcohol is at a much greater risk of a collision, as judgement and reaction times degrade as blood alcohol levels rise. When occupants fail to wear safety belts or riders motorcycle helmets, they greatly increase their risk of suffering serious injury or death if they do crash. Excessive speed can cause a road crash or worsen the outcome if it is not the primary cause; the higher the speed, the longer a vehicle will travel before it can be brought to a stop, the more likely a driver negotiating a bend will lose control, the less time a driver has to react to an unanticipated event, and as forces applied to a human body in a crash increase as speeds rise, the trauma that results also increases. Excessive speed therefore acts to both increase the risk of a crash occurring and then worsens the outcome by increasing the resulting level of trauma (Zaal, 1994).

The effects of speed are supported by research. Studies from the Monash University Accident Research Centre (MUARC) show that a small rise in speed substantially increases the risk of death or serious injury. A person hit by a car travelling at 30 km/h will be severely injured and have a 10% likelihood of death. If the speed increases to 55 km/h, the likelihood of death is about 85%, and at 60 km/h the person is unlikely to survive.[4] Therefore one important aim of any road policing programme is to strictly enforce speed limits, drive down average speeds across the driving population and reduce overall levels of road trauma.

Deterrence theory

The prevention strategies for various road safety offending types differ depending on the types of offending.

General deterrence and Homel's theory

General deterrence is the process whereby drivers are deterred from offending by the perceived risk of detection without the actual experience of that detection. Behaviours that are highly susceptible to general deterrence are simple behaviours, such as an alcohol impaired driver makes a single decision at the beginning of their journey to drive, and once the single decision is made, they continue to offend for the duration of the journey. Similarly, an unlicensed, suspended or disqualified driver, or someone driving an un-roadworthy vehicle, fits into the same simple behaviour category with a single decision made at the start of the journey. Simple behaviours are easily affected by general deterrence.

The 'General Deterrence' theory, developed by Doctor Ross Homel in the late 1970s, posits that many road crashes can be prevented through the wholehearted implementation of Random Breath Testing (RBT). Homel argued that an enforcement programme that is well publicised, rigorously enforced, sustained over a long period, and highly visible would be highly effective in deterring impaired driving (Homel, 1993).

RBT was applied in the state of Victoria, Australia and then introduced to many Australian states with spectacular results. In New Zealand it was introduced as Compulsory Breath Testing (CBT). The New Zealand programme involves alcohol testing by means of a Passive Breath Testing device, and every driver is stopped. This process of mass screening is not designed to catch impaired drivers, but to deter them from considering driving because of the perceived risk of detection. The important components to this programme are the volume of drivers tested, that the programme is sustained so that testing occurs constantly throughout the year and a clear focus on high alcohol hours. High alcohol hours are the times and days of the week when alcohol related crashes peak.

When general deterrence is sufficiently visible and regular – to create a perception that a driver will be detected – it is highly effective in deterring 'simple' offending behaviour types such as alcohol impaired driving or breaches of driver licensing. The level of deterrence is directly proportional to the perceived likelihood of detection and the severity and speed of sanctions. Furthermore, it is essential that road police calculate the volumes required to generate high levels of deterrence. For example, in New Zealand, police currently carry out approximately 3 million compulsory breath tests annually for a population of 4.4 million people and 3.2 million licensed drivers. The New Zealand dosage has proven to be highly effective in reducing alcohol related deaths and injuries on the roads from 227 deaths and 3 042 injuries in 1993 to 102 deaths and 1 815 injuries in 2012 (Ministry of Transport, 2013a).

Specific deterrence

Speeding is a complex driver behaviour, as speed will, over the course of a driver's journey, increase and decrease as a driver adjusts to traffic flows, negotiates corners and intersections, and responds to events that occur while travelling, including their perceived risk of detection. Complex driver behaviours respond most effectively to specific deterrence. Specific deterrence is the actual experience of being sanctioned for the speeding behaviour. This may be an immediate sanction in the form of being stopped by a police officer and issued an infringement notice, or receiving an infringement later if detected by a speed camera. Research suggests that complex behaviours are not deterred by highly visible enforcement, but through the actual experience of detection. Other complex behaviours include unsafe overtaking or lane changes, which are driver behaviours that are momentary and involve complicated thought processes and may be performed during a journey.

In order for police to respond effectively to complex behaviours, high levels of detection are required to sanction a significant proportion of the offending population, whereby drivers come to believe that continued offending has a high likelihood of both detection and sanction (effective sanctions and detection volume will be explained in detail later).

Deterrent penalties

In New Zealand, in order to deal effectively and efficiently with high volumes of offending, an infringement notice system operates where police officers issue instant fines of a prescribed value for the offence detected. In respect to exceeding speed limits, fines increase as the detected speed increases. This system was designed to avoid large numbers of offences being dealt with in a Court environment – the Courts would struggle to deal effectively with the volume of offences detected. It is important to note that although penalties are set at deterrent levels, they cannot be so high as to be oppressive and unreasonable. Secondly, a review system is necessary to monitor prescribed penalties to ensure they keep pace with the cost of living.

New Zealand legislation prescribes a complex set of penalties for various classes of offences, some of which are laid out below.[5] Serious offending – for example, high level drink driving, dangerous and reckless driving, extreme speeds, and offences such as dangerous or careless driving causing death or injury, are dealt with by the Courts.

Highly effective penalties include:

- **Fines**: Infringement fees range from NZD 12 for parking offences to NZD 10 000 for overloading offences. The infringement fees for not wearing a seat belt or not wearing a motor cycle helmet are NZD 150. Court imposed maximum fines for general driving offences range from NZD 2 000 for driving an unsafe vehicle to up to NZD 20 000 for reckless or dangerous driving causing injury or death to another person, or for failing to stop after a crash where someone is killed. In New Zealand, the median weekly income from all sources, for all people in the June 2014 quarter was NZD 60 000.
- **28-day roadside licence suspension**: If caught committing a serious driving offence, such as speeds of more than 40 km/hour over a speed limit or certain illegal street racing offences, police can suspend a driver licence, on the spot, for 28 days. This is called roadside licence suspension, but can happen anywhere.

- **28-day roadside vehicle impoundment***:* A vehicle will be impounded by police for 28 days where a driver is caught driving while disqualified from holding a driver licence or where the driver licence has been suspended. At the end of the 28-day impoundment period, a driver must to pay the towing and storage fees before getting the vehicle back.
- **Alcohol interlock disqualifications:** A driver convicted by the courts for certain driving offences involving alcohol may receive an alcohol interlock disqualification. At the end of the disqualification, a driver must not drive until they have obtained an alcohol interlock licence. A driver may then only drive vehicles fitted with an approved alcohol interlock. An alcohol interlock is a device fitted to a vehicle that requires a driver to provide an alcohol free breath sample before the vehicle will start. The device also requires breath samples to be provided at random intervals to ensure that the driver has not consumed alcohol. Such devices have proven to be highly effective (Terer K.; and R.Brown, 2014).
- **Demerit points:** Demerit points are given for all speeding infringements and some traffic offences, including breaching licence conditions. Points can also be allocated in conjunction with a court disqualification where the court chooses to disqualify a person for less than six months. Demerit points remain active on a licence record for a period of two years from the date of the offence. If 100 or more demerit points are accumulated within any two year period, a licence will be suspended for a period of three months. The suspension period begins as soon as the demerit suspension notice is served on the driver by the Transport Agency or the Police. At the end of the demerit suspension, a driver is unlicensed and not entitled to drive until the licence is reinstated. Demerit point systems are proven to be highly effective at deterring offending, particularly at the point where continued offending will result in licence suspension (Van Schagen and Machata, 2012; Basili and Nicita, 2005; Chandler, 2012; SWOV, 2012).
- **International perspective on Demerit Points:** Many jurisdictions have complimented their traditional police enforcement systems with some type of Demerit Point System (DPS). These systems assign a defined number of points to specific traffic offences. The systems are designed to address drivers who repeatedly commit offences by invoking a process whereby continued offending will result in additional punishment (driver licence suspension for typically 3 to 6 months).

The key features of a Demerit Point System (DPS) are:

- It is complementary to traditional police enforcement (additional to fines).
- Focuses on repeat offenders by presenting an increasing likelihood that an offender's driver licence will be suspended if offending continues.
- Assigns penalty points to offenders. Specific offences attract a defined number of points (the more serious the offence, the more points).
- Results in additional punishment when the level of repeat offending has resulted in a set number of penalty points being accumulated.
- If within a certain period (typically two to three years), a defined number of points have been collected, the driver licence is suspended.
- After the suspension period, the driver licence is regained; however, in some cases a rehabilitation course/new driving test is required.

As examples, 21 of the 27 European Union member states have some kind of DPS in operation. These systems generally apply to all drivers although the Netherlands and Malta DPS apply only to novice drivers (Van Schagen and Machata, 2012).

Both communication and enforcement are critical to success. People must be aware that a DPS is in place and understand how it works. Secondly, the public must believe there is a sufficient level of enforcement to make detection for repeated offending likely and the threat of licence loss credible.

In order to administer a DPS, a centralised administration for managing offences/points and driver licence suspension documentation is required. These processes must be largely automated, clear, and promptly applied. Offenders should be able to quickly access up to date information about their points accumulation.

- **Collection system:** The volume of offending and the need to achieve mass deterrence necessitates three things: sanctions must be applied at pace, be set at deterrent levels, and be supported by a streamlined and robust collection regime. Offenders must not be able to avoid payment by exploiting loopholes or taking advantage of weak systems that delay payment or avoid it altogether. In a number of jurisdictions, while penalties are theoretically imposed, inadequate support systems allow offenders to avoid payment and sanctions.
- **Compliance:** Police operate a compliance scheme for certain offence types. For example, when police detect a vehicle that is not roadworthy – e.g. a tyre with insufficient tread – an infringement notice for NZD 150 is issued. The driver is given a defined period to fix the fault, forward evidence that the fault is corrected within 14 days, and the police will waive the fine. Similarly, an unlicensed driver who is issued a NZD 400 instant fine and is forbidden to drive is given the opportunity to commence the driving licence testing process. When evidence is presented to police, the fine is waived. New Zealand Police believe that a compliance scheme incentivises drivers to fix faults in order to avoid fines and provides a powerful incentive to comply.
- **Imprisonment:** Serious offences may also result in periods of imprisonment ranging from 3 months for offences such as dangerous or impaired driving to up to ten years for certain offences causing death.
- **Driver rehabilitation programmes:** A number of rehabilitation courses are in place across Europe which educate deviant drivers. Participation may be voluntary or mandatory and is generally administered in groups by a trainer or psychologist trained for this purpose. The effectiveness of these courses, however, has not been established unequivocally. Some studies show impacts upon attitude, behaviour, crash rate and recidivism, yet other research shows no effect (SWOV, 2010). A dated review of the literature from 1985 evaluating Defensive Driving Courses (DDC) concluded, after assessing 14 evaluations, that about a third was methodologically sound, but the remainder had design flaws. The best available evidence did not support the hypothesis that DDC decrease the likelihood of motor vehicle crashes (Lund and Williams, 1985). A study is soon to be published in the UK assessing the impacts of a programme targeting speeding drivers which may shed more light on opportunities in this area. However, at present it is far from certain that there are positive impacts upon road trauma as a result of offender attendance at rehabilitative courses.

Crash reporting

Under-reporting of road crashes is a significant issue worldwide, and numerous studies have highlighted that high percentages of road crashes that result in serious injury are not reported.[6] A meta-analysis of road crash reporting – based on 49 studies in 13 countries – concluded that, regardless of the severity of the injury, reporting in official statistics was incomplete. In rounded values, the mean reporting level in the countries included was found to be 95% for fatal injuries according to the 30-day rule,[7] 70% for serious injuries (admitted to hospital), 25% for slight injuries (treated as outpatients), and 10% for very slight injuries (treated outside hospitals).[8] Reporting levels vary substantially among countries, ranging from 21% to 88% for hospital-treated injuries.

Previously, New Zealand was guilty of under-reporting. In 2000 a comparison between serious crash injuries reported by police and hospital admission data indicated that the ratio of reported serious injuries to hospital admissions was 56% and 55% in two regions, Otago and Southland respectively. This meant that for every 100 crash casualties admitted to a hospital, Police reported just over half. Nationally, the figure was lower, the reporting ratio had been steadily falling. In 2000 reporting reached a low of 36%.

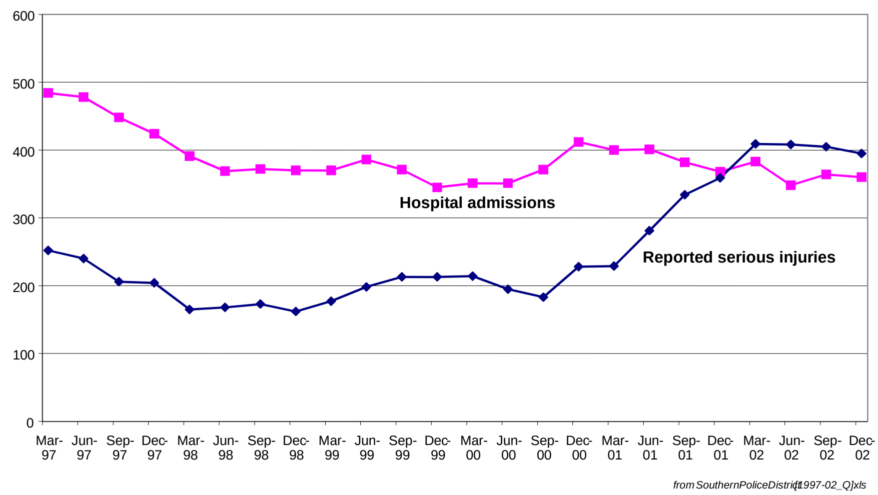
In addition to the obvious under-reporting, there were other problems with the quality and accuracy of Traffic Crash Reports (TCRs). The reports were sometimes incomplete, or had not been sent to the Land Transport Safety Authority (LTSA), which was at that time responsible for the data entry, coding and analysis of crash reports. Injuries were often inaccurately recorded, if at all. Crash locations were often imprecise and Blood/Breath Alcohol levels, and pre-crash speeds, were not recorded in all cases. This combination of under-reporting of casualties and missing data resulted in important crash data not being captured, understating both the actual levels of road trauma and crash contributing factors.

In response, the police and the LTSA set about jointly to improve crash reporting. Accurate crash data is used as a source of intelligence. The first step towards improving the data was to run a series of training sessions to provide police officers with an understanding of the importance of accurate data, the common faults with Traffic Crash Reports (TCR), and the ways in which reporting could be improved. The next step was to develop a crash file audit system for each Police District. Every crash file was centrally checked to ensure accuracy and confirm that all the required information had been forwarded to the LTSA.

This audit process improved reporting rates and report quality. For example, it ensured that every blood or breath alcohol level (including those under the legal limit) was recorded, thus significantly improving data on the involvement of alcohol in collisions. Furthermore, crash victims were also contacted by the police a week to ten days after the crash to update the details of their injuries, as victims are often unaware of the full extent of their injuries at the time of the crash.

As a result of training and the new audit process, the reporting ratio for the Southern District rose from 55% in 2000 to 115% by 2002. For every 100 hospitalised casualties, police reported 115 serious injuries – serious injuries do not always result in hospitalisation. The reporting ratio that was achieved is a more accurate reflection of the true level of serious road trauma. Over the same period, the number of crash casualty hospital admissions was stable, indicating that the actual level of road trauma had not risen, and the significant increase in reported injuries was attributable to improved reporting. Figure 5.1 shows how Otago and Southland police reporting of serious injuries improved between 1997 and 2002.

Figure 5.1. **MVC hospitalisations in Otago and Southland, 1997-2002**



New Zealand police and LTSA demonstrated that robust crash reporting systems can significantly improve crash reporting rates. Improved crash reporting allows important information to be gathered that forms the basis for road safety intelligence that can be utilised by an effective road policing programme.

Improving crash reporting accuracy

In order to improve crash reporting rates and accuracy, the following approach is recommended for police officers attending collisions to allow this information to be recorded in crash reports:

- Every driver involved in a crash is required to undergo a breath test and the result recorded on the crash report. Where a driver cannot be tested for reason of injury or death, a blood sample must be taken at the hospital or place of treatment and provided to police to allow blood alcohol analysis with results recorded on crash reports.
- Whether a vehicle occupant was wearing a safety belt to be recorded for all vehicle occupants involved in a collision.
- Basic crash investigation is undertaken to allow pre-crash speed estimates to be recorded within crash reports. In the case of serious collisions, a serious crash unit with high levels of training should attend.
- In the case of commercial drivers, a standard set of questions designed to identify whether driver fatigue was involved should be developed.
- For all intersection collisions, collisions in 70 km/hr or higher speed zones, involving vulnerable road users (pedestrians and cyclists), vehicle rollover, side impacts or other crashes where injury appears likely, a process of contacting vehicle occupants to validate and confirm injuries (whether they are initially indicated or not) should be developed to increase injury recording accuracy.

A system to collect anonymous[9] health data in order for it to be matched and compared with police reported injuries should be developed. This allows the true level of crash injury to be determined. A useful measure of casualty severity is to record the number of hospitalisations of more than one day (e.g.

those who are hospitalised after a road crash for longer than 24 hours) as a means of monitoring serious road trauma at a national or regional level.

Intelligence

Accurate crash reporting is one important source of road safety intelligence. It informs areas such as:

- Road engineering initiatives by identifying high crash rate locations.
- Public awareness campaigns by identifying the demographics of those involved in crashes.
- Policy initiatives targeting prevalent crash causes.
- Future road safety investment decisions by recording the true cost of road trauma.
- Police deployment decisions based on identified high risk times and locations.

Analysing crashes generally allows police to target resources effectively. It pinpoints when and where police will be deployed, and the offence types police will focus on – giving priority to the offence types that contribute to the highest levels of road trauma. For example, in New Zealand over the years 2010-2012, alcohol/drugs were a factor in 33% of fatal crashes, 21% of serious injury crashes and 12% of minor injury crashes (Ministry of Transport, New Zealand 2013b).

Table 5.1 below demonstrates that alcohol related road crashes occur at all times of the day and night with no day of the week immune from offending. However, offending rates during day time hours and early in a week are low, while offending rates in the early hours of Saturday and Sunday mornings are dramatically higher. Therefore, police compulsory breath testing operations must, in order to be effective and credible, focus immediately before and during hours of greatest risk (high alcohol hours). A programme focused on low risk times is ineffective and jeopardises public confidence.

Table 5.1. **Alcohol related fatal/injury crashes by hour band**

2008-2012	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12:00-1:59 am	64	48	80	124	161	319	327
2:00-3:59 am	31	32	54	68	130	256	295
4:00 -5:59 am	22	15	34	48	62	180	215
6:00-7:59 am	19	15	22	35	45	104	132
8:00-9:59 am	15	17	12	22	26	45	51
10:00-11:59 am	10	12	22	23	20	41	37
12:00-1:59 pm	21	19	25	28	30	50	55
2:00-3:59 pm	33	47	43	46	57	80	66
4:00 -5:59 pm	38	76	84	94	104	108	103
6:00-7:59 pm	73	86	108	101	182	183	135
8:00-9:59 pm	69	103	134	161	229	256	131
10:00-11:59 pm	65	121	158	200	291	299	96
Total	460	591	776	950	1337	1921	1643

Source: New Zealand Crash Data

Table 5.1 shows the number of fatal and injury alcohol related crashes that occurred in each 2 hour time band across the week for the years from 2008 to 2012 inclusive. The yellow shaded periods, represent the times when alcohol related crashes peak (>90 crashes). These time period are defined as 'High Alcohol Hours'

Table 5.2. **Speed related fatal/injury crashes by hour band**

2009-2013	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
00:00-01:59	56	38	58	**86**	**97**	**216**	**175**	726
02:00-03:59	24	29	46	44	63	116	**137**	459
04:00-05:59	26	20	26	**40**	41	91	**91**	335
06:00-07:59	51	54	55	70	83	77	55	445
08:00-09:59	72	88	90	73	71	84	71	549
10:00-11:59	85	82	61	71	63	**98**	**97**	557
12:00-13:59	**75**	76	75	**98**	77	138	**123**	662
14:00-15:59	95	80	101	107	134	**148**	**137**	802
16:00-17:59	116	137	**134**	**129**	**136**	**136**	**149**	937
18:00-19:59	72	96	100	**102**	**135**	**136**	**107**	748
20:00-21:59	**69**	**79**	108	112	**172**	**174**	**80**	794
22:00-23:59	56	66	**86**	99	**152**	**167**	65	691
Total	797	845	940	1031	1224	1581	1287	7705

Source: New Zealand Crash Data

Table 5.2 shows the number of fatal and injury speed related crashes that occurred in each 2 hour time band across the week for the years from 2009 to 2013 inclusive. The yellow shaded periods, represent the times when speed related crashes peak (>91 crashes). These time periods are defined as 'High Speed Hours'. Values in **bold** indicate hour bands with higher than average fatal crashes.

Similarly, speed in New Zealand contributes to 20% of the social cost associated with all injury crashes. The more serious the crash the more likely it is that speed was a contributing factor. For the years 2010-2012 driver speed was a factor in 29% of fatal crashes, 19% of serious injury crashes and 14% of minor injury crashes (Ministry of Transport, New Zealand, 2013a). The distribution of 'high speed hours' is similar to 'high alcohol hours' crashes. However, unlike alcohol, which has a marked decrease in crashes during daylight hours, speed crashes are much more evenly distributed over the whole day. Table 5.2 indicates that speed enforcement will have more impact if it is concentrated in the high risk periods of evenings and weekends.

Key enforcement priorities, principles and lessons

Investment logic mapping

New Zealand Police recently conducted an investment logic mapping process. Its purpose was to deliver an improvement programme to ensure that its road policing delivery is doing the right things as cost effectively as possible. The objectives of the process were to:

- improve transparency and consistency of police investment decision making for road policing activities
- identify activities that evidence shows will be effective
- identify the most efficient and effective methods of delivering enforcement activities, and
- support the continuous review of road policing activities.

Road policing support staff assessed the research that relates to a particular road policing activity and then assessed the effectiveness of an activity according to that research. This resulted in a clearer understanding of the most effective road policing activities. The process allowed police to place various classes of activity into the categories of 'high', 'medium' or 'low' effectiveness. In cases where the research on a particular activity was simply not available or inconclusive, an activity was placed in the 'low' category. The points below sets out the findings from this process.

The most effective road policing activities are:

- directed patrols using laser / radar speed detection devices
- mobile speed camera deployments
- fixed speed cameras
- compulsory breath tests at small and large checkpoints
- mobile breath tests
- hand held mobile phone enforcement for distracted driving
- directed patrols for restraint compliance.

Activities with medium effectiveness are:

- drug testing using compulsory impairment tests
- high risk targeted enforcement
- commercial vehicle inspections
- enforcement of shift regulations for Commercial Motor Vehicles (CMV) drivers for driver fatigue
- intersection enforcement for red light, stop and give way violations
- school road safety education
- targeted information on illegal street racing
- enforcement of the illegal street racing laws
- enforcement of lane compliance.

Activities with unknown effectiveness or with limited police impact are:

- patrols for distracted driving (excluding hand held mobile phone behaviour)
- directed patrols for fatigued driving (non-commercial drivers)
- community engagement programmes
- drink and drug driving education programmes
- alternative sentencing
- promoting child restraint use.

These findings are important as they clearly define activities that have a clear and proven impact upon road trauma reduction and those which do not. Restricted resources make it essential that police agencies focus upon activities that maximise impact and minimise or stop ineffective or unproven activities.

Principles of enforcement

In June 2003, Professor Max Cameron presented research from the Accident Research Centre at Monash University. A series of principles were presented to police from across Australasia that explained the most effective delivery of drink-driving and speed camera enforcement and the associated publicity campaigns.

The principles are as follows:

- There is a minimum level of urban CBT (Compulsory Breath Test) activity that must be reached before it is certain that crash reduction will result. The threshold is about 20 hours per 100 square kilometres per week.
- CBT in urban areas will have an ongoing effect on crashes in the area that checkpoints are held in for at least two weeks after the operation.
- CBT carried out during high alcohol hours is highly likely to produce crash reduction; however, it is not certain that there is any positive impact when CBT is carried out at other times.
- The visibility of CBT operations, and the capacity of the staff at checkpoints to test high proportions of passing motorists, are important factors in increasing the general deterrence effects of CBT.
- The effectiveness of patrol car based CBT in rural areas is similar to that achieved by CBT (both car and booze-bus based) in urban areas. This may relate to the ability of patrol cars to cover broad areas and to raise the perceived risk of detection in the minds of rural drivers.
- In rural areas, CBT operations should be conducted on minor and major roads. Furthermore, greater emphasis is required on the use of patrol cars to conduct CBT in rural areas, particularly near hotels and clubs and on minor roads with a booze bus operating in a nearby town.
- Visible speed cameras only reduce speed near the camera site.
- Conversely, covert speed cameras, when used intensely and alongside high-profile mass media publicity, will have a ‘general effect’ – widespread and long term reductions in crashes and their severity.

- A speed camera programme is effective because it achieves specific deterrence – speeding drivers are detected and issued infringement notices.
- A speed camera programme also achieves general deterrence when publicity is included.
- The deterrent effects of police enforcement of speed and drink driving are increased by publicity of that enforcement.
- Effective publicity campaigns alongside enforcement that targets speed and drink driving are highly cost beneficial (Cameron, 2003).

When these principles are considered, alongside the findings of the investment logic mapping process, it is possible to develop a road policing programme that is efficient, based upon sound researches and of proven impact.

Lessons learnt: speed enforcement

Before road police can enforce speed limits in an urban environment, road controlling authorities should ensure that speed limits take account of the presence of vulnerable road users – for example pedestrians and cyclists. Injury severity increases exponentially as impact speeds rise above 30 km/hour. Police enforcement in urban environments must focus on reducing speeds to levels that minimise road trauma for vulnerable road users.

Police must enforce at a level sufficient to ensure that offending drivers perceive there is a high likelihood that detection is inevitable. Without this perception, high numbers of drivers will continue to speed increasing the likelihood of crashes.

Hand held laser or radar based devices are highly effective at deterring speed in urban areas. Speeding drivers are stopped immediately and issued an infringement notice. The added value of officer based enforcement is that it gives the officer an opportunity to explain the reason for the enforcement and the risks speeding poses to the community. It also gives the driver an opportunity to offer an explanation which may be regarded as procedurally more fair. Professor Lorraine Mazerolle and her colleagues have demonstrated that when a procedurally just approach is applied, offending motorists are more likely to comply and accept the consequences (Mazerolle et al., 2013). Another advantage is an opportunity for other offences to be detected and dealt with – for example vehicle safety or driver licence offences, which are undetectable by automated enforcement.

One fundamental aspect to the effectiveness of speed enforcement programmes is enforcement tolerance. Most drivers and police officers have no difficultly in understanding the risks of travelling at speeds well in excess of the speed limits; however, many do not understand the risks associated with low level speeding. In fact, the prevalence of low level speeding presents a significant road safety risk and has to be addressed by applying strict enforcement thresholds. The New Zealand experience is that most drivers will travel at speeds below the level at which they *perceive* police will stop them. Therefore, New Zealand Police set clear standards of enforcement tolerance. Although automated enforcement – speed cameras – can be set to capture offences at defined speeds, police officers must be educated on the value of lower level speed enforcement and its role in driving down overall crash risk. Mechanisms to monitor officer discretion are also necessary.

Figure 5.2. **Safer Summer' road safety campaign – roadside billboard**

Source: New Zealand Police

Previously, New Zealand Police has operated a policy whereby most speed enforcement did not occur until drivers were travelling at more than 10 km/hour over a speed limit. However, over New Zealand's last summer, December 2013 to January 2014, police launched a road safety campaign and reduced the enforcement threshold to four km/hour. Road policing support staff evaluated the campaign afterwards and concluded that it resulted in:

- a 36% decrease in exceeding the speed limit by 1-10 km/h
- a 45% decrease for speeding in excess of 10 km/h.

In terms of road trauma, the evaluation (Van Lamoen, 2014) showed that:

- fatal crashes decreased by 22%
- serious injury crashes decreased by 8%
- minor injury crashes decreased by 16%.

Speed enforcement – international perspective

Speed enforcement requires on-going significant attention and the international experience is that high volumes of detection do result in significant reductions in road trauma. The European Traffic Safety Council (ETSC) reported that excessive and inappropriate speed is the number one road safety problem in Europe (European Transport Safety Council, 2011a). The report highlighted the high rate of speed involvement in fatal collisions and the fact that speeding is a widespread problem. Furthermore, the level of enforcement was assessed by looking at the number of speeding tickets issued per 1 000 population. Offence detection rates are highest in the Netherlands, Austria and Switzerland where safety cameras are used extensively.

Table 5.3. **Number of speed tickets per 1 000 inhabitants**

(both police roadside checks and from speed cameras)

Country	2006 (Number of Speed Tickets Issued)	2007 (Number of Speed Tickets Issued)	2008 (Number of Speed Tickets Issued)
The Netherlands	543	595	558
Austria	327	458	456
Switzerland	350	335	n/a
France	114	127	138
Cyprus	87	165	137
Norway	52	52	51
Spain	17	27	44
Sweden	21	24	25
Italy	23	25	24
Lithuania	18	20	10
Portugal	9	n/a	n/a

Source: European Transport Safety Council

According to the Korea Transport Institute (KOTI), the annual number of speed tickets issued equates to 158 tickets per 1 000 population in 2013 – approximately 30% of the average rate of the three countries with the highest enforcement rates in Europe during 2007. In New Zealand over the twelve months between July 2013 and June 2014, 254 speed infringements per 1 000 population were issued. In recognition of New Zealand's current enforcement rate New Zealand has recently invested in an additional 56 fixed speed cameras.

Studies (Erke et al., 2009a) indicate that speed enforcement is effective when:

- it explicitly concentrates on locations with a speed related safety problem
- it focuses more on average speed checks (the most effective type of check over longer distances)
- the enforcement activities are clearly visible along the roadside (e.g. by warning signs) and the purpose – road safety – is clear.

For example, a hidden speed camera trial was conducted on 100 km/hr roads in a region of New Zealand between July 1998 and June 1997. The study into the trial results showed speeds fell by 3.2 km/h at speed camera sites and by 1.6 km/h on all roads and 85th percentile speeds fell by 3 km/hr at speed camera sites and 4 km/hr on all roads. The crash rate fell by 11% and casualties fell by 19% (Land Transport Safety Authority, 1999).

Extensive worldwide researches on the impact of various forms of speed enforcement all demonstrate its effectiveness; however, particular speed enforcement types are more suitable to different road environments as follows:

Fixed speed camera and point to point (time over distance) cameras	Treatment for speed related crash prone areas and to moderate speeds on divided motorways and highways
Mobile speed camera (unmarked or covert)	Effective at reducing speeds generally across a road network to reduce overall levels of trauma
Mobile mode radar (operated from a mobile marked or unmarked patrol car)	Effective for enforcement on rural non divided highways with low to moderate traffic flows
Stationary laser	Effective particularly on divided highways and in urban higher volume arterial roads

The European Road Safety Observatory notes that the effects of speed enforcement are limited to both time and place, and when enforcement stops the effects will disappear in a few weeks (European

Road Safety Observatory (2007). There is clear value to both automated enforcement utilising both fixed and mobile speed cameras. While fixed cameras are effective at specific locations, the uncertainty of location in the deployment of mobile speed cameras creates a general effect across the road network that creates generalised compliance. While these devices are labour intensive, as they require staff to operate them, they are highly effective.

There are at least three advantages with non-automated enforcement:

- The violator is stopped and receives immediate feedback.
- The police officer has an opportunity to explain why they are enforcing speed.
- If violators are stopped at a clearly visible location, other drivers can see that police are active, which increases the subjective chance of apprehension.

It is significant that the European Road Safety Observatory highlights the important role of publicity and notes the effects of speed enforcement are substantially increased through targeted media campaigns.

Lessons learnt: drink-drive enforcement

In New Zealand, Police conduct 3.1 million compulsory breath tests each year – approximately one test per year for every licensed driver. In order to create general deterrence, testing volumes that generate the belief that detection is inevitable must be achieved. Drivers detected with excess breath alcohol are a by-product of the deterrence strategy – their apprehension is not its aim.

Testing sites must be set up and managed to ensure both staff and public safety. Strict safety guidelines must be applied.

Effective urban and metropolitan based CBT style operations are typically conducted by teams of Police, operating from a checkpoint and utilising a 'Booze Bus' (a Police vehicle used to carry out evidential breath testing of impaired drivers). These testing sites are highly visible and set up in such a way that drivers cannot avoid testing.

Figure 5.3. **Compulsory breath testing checkpoint**

Source: New Zealand Police

New Zealand Police engage three essential aspects to ensure checkpoint operations are effective. Firstly, every driver who approaches a checkpoint should pass through that checkpoint, regardless of their identity or occupation. Any driver who attempts to evade the testing site is apprehended by a patrol that is specifically tasked with observing traffic flows and stopping any driver who attempts to evade testing. Similarly, every driver who is stopped should be tested – without fear or favour. Finally, Police should note that, contrary to prevailing views, it can be difficult to identify an impaired driver visually; police should not rely on personal judgement. The only effective mechanism to detect alcohol is a correctly administered breath test, and police officers should be trained to administer the test correctly, and not to rely on personal judgement. It is less effective to prove visual impairment before a breath test can be administered.

New Zealand Police find highly visible mass testing most effective in urban areas; it is not as effective in rural areas. In country environments, elaborate word of mouth networks operate that warn potential drunk drivers of Police enforcement. Impaired drivers simply wait out police and drive after the enforcement operation has finished or drive on back roads to avoid testing. Researchers in Victoria found that alcohol related crash rates increased when highly visible testing was conducted in rural areas as drivers travelled on less safe back roads (Harrison, 1996). Consequently, New Zealand Police use unmarked cars, mobile random stopping of vehicles and covert surveillance of licensed premises as effective countermeasures for rural based operations. These tactics drive up rural paranoia, as it not possible to predict where testing will occur, forcing potential drink drivers to cease the practice. This example is a useful illustration of how operational tactics need to be adjusted to meet the particular circumstances of particular communities.

Policies require officers to breathe test every driver stopped, regardless of the reason for the stop or the time of day. This provides valuable consistent messaging to the public that they can be breath tested at any time.

International perspective – drink driving

In the United States, constitutional arrangements preclude conducting compulsory breath testing as carried out across Australasia. Most states carry out ‘sobriety checkpoints’, which require police to advertise the intention to carry out the activity and then put in place roadside signage to warn motorists of their presence. Breath testing is not legal unless a police officer is satisfied there is evidence of impairment. A police officer typically requires that a suspected drunk driver undergo a field sobriety test to confirm impairment before a breath test can be administered. The permissible drink drive limit across the United States is high - 80 milligrams of alcohol per 100 millilitres of blood - and well above the 50 milligram limit prescribed in most countries. The legal constraints applicable in the United States do not allow best practice enforcement to be carried out, and high rates of alcohol related road trauma continue. In 2013, 32 719 people were killed in traffic crashes across the United States, including an estimated 10 076 in drink drive crashes accounting for 31% of traffic deaths. This represents just over 3 alcohol related traffic crash deaths per 100 000 people, which by international standards is a particularly high rate (National Highway Transport Safety Administration, 2014).

The European Traffic Safety Council (ETSC) identifies alcohol impaired driving as one of the three main killers on Europe’s roads (European Traffic Safety Council, 2011b). The Council’s advice is that maximum permissible breath alcohol concentration (BAC) limits should be 50 milligrams of alcohol for general drivers and 20 milligrams for novice drivers and drivers of heavy goods vehicles.

The ETSC identifies monetary fines, demerit points, licence suspension, alcohol interlocks, vehicle confiscation and imprisonment as possible sanctions for drink drive offending.

The ETSC reports that the most efficient form of breath testing is a systematic testing of all drivers stopped by police regardless of the reason for the stop. The World Health Organisation reported in a study carried out in 2004 that for each euro spent on random breath testing a saving of EUR 19 resulted (Peden, 2011). In New Zealand, a benefit-cost of between NZD 14 and NZD 26 saved for each dollar spent was found, with the highest ratio for random breath testing with both a media campaign and ‘booze buses’ (Miller et al., 2006).

The relative rates of breath tests conducted across Europe are highest in Finland, Norway and Sweden at 385, 338 and 287 drivers tested annually per 1 000 population.[10] In New Zealand, breath testing rates of 600 drivers per 1 000 population are carried out, which is similar to testing rates in the Australian state of Queensland.

The most effective random breath testing programme, as evidenced by alcohol related crash reduction, has been achieved in Australia. The key features have involved mass alcohol screening that is highly visible and utilises ‘booze buses’ to allow large numbers of offenders to be processed on the roadside. Australian enforcement is more intense and regular than other countries. The Australian programmes are well publicised and police typically carry out between 500 and 1 000 breath tests per 1 000 licensed drivers annually (there are variations between states in the number of breath tests conducted). The RBT approach is more effective than only testing those that arouse suspicion (Erke et al., 2009b).

KOTI report that 269 836 ‘alcohol driving’ offences were recorded in Korea during 2013. The number of breath tests conducted was reported to be the same number. It is not certain what the current breath test numbers are in Korea.

Lessons learnt – safety belt enforcement

During the 1999-2000 period, New Zealand Police issued 32 373 infringement notices for seat belt offences, and the annual national seat belt survey showed that wearing rates for front seat passengers was 87%. A doubling of enforcement notices over the following two years resulted in a significant increase in wearing rates (Table 5.4).

Table 5.4. **Seat belt wearing rates and restraint offence infringement notices issued**

	1999-2000	2002-04	2004-05	2013-14
Seat belt enforcement - Notices issued	32,373	76,182	73,508	62,983
Seat belt wearing rate (front seat)	87%	92%	95%	97%
Seat belt wearing rate (rear seat)	58%	70%	86%	90%
Children restrained	88%	89%	94%	96%

Source: Ministry of Transport, New Zealand 2014

Overall, safety belt wearing rates in New Zealand are now high, with 97% of front seat vehicle occupants wearing them (Ministry of Transport, New Zealand, 2014). However, around 60 people who were not restrained were killed in crashes in each of the last three years – although many of these collisions also involved speed and alcohol. Police have found that rigorous enforcement of seat belt compliance dramatically increases wearing rates. When local enforcement declines, wearing rates also decline. Although robust local research is required, New Zealand Police believe that a 2014 internal report entitled "New Zealand Police Management Report, July 2014" indicates that increasing the ratio of seat belt infringements continues to improve seat belt wearing rates. International studies show that ongoing Police enforcement is one of the most effective means of achieving and maintaining high levels of seat belt wearing (Wundersitz et al., 2010; Kallberg et al., 2008).

International perspective – safety belts (including rear seats)

Safety belt enforcement in the United States has been an ongoing area of effort. Over half of the nation's states have 'primary' safety belt laws which allow for a citation to be issued if a police officer simply observes an unbelted driver or passenger. However, the other states have in place 'secondary' safety belt laws, which require a police officer to stop or cite an offender for another infraction before being able to issue a citation for not buckling up. There is strong advocacy for states to upgrade their state law. Those states with primary legislation have wearing rates that are on average 10% higher than states with only secondary legislation. Two major national campaigns have been run titled 'Click it or Ticket' and 'Buckle up America' which couples high visibility enforcement with accompanying mass media campaigns that have achieved improvements in wearing rates. In 1996, national wearing rates were 61%. By 2005, these had improved to 82%. Rates across the states range from a low of 73% in Massachusetts to a high of 97% in Washington.[11]

The European Transport Safety Council identifies the failure to wear safety belts as one of the three main killers on Europe's roads. Despite legal requirements, wearing rates are reported to be unsatisfactorily low with 12% failing to wear them in the front seat and 28% failing to wear them in the rear. Despite the general picture, high wearing rates have been achieved in France, Germany, Sweden, the UK and the Netherlands. The best performing nations have put in place substantial penalties for offences (EUR 150 in Sweden) as well as demerit points for drivers who fail to ensure passengers are restrained. In France, drivers lose three points on their driver licence if passengers are not restrained. It is repeatedly highlighted that strict, regular, intensive enforcement linked to highly visible and well publicised mass media campaigns are crucial to optimising the effects of enforcement which must be regularly conducted. Education and information campaigns improve wearing rates provided they are accompanied by active enforcement.[12]

Every vehicle being driven on a road has a driver, but fewer will have passengers, and when they do, passengers will tend to occupy front seats before sitting in the rear. Therefore, enforcement will tend to focus on front seat wearing, which is easier to detect and provides the greatest number of opportunities to check compliance. However, enforcement of safety belt use by all vehicle occupants is important, as unrestrained rear occupants in a collision are often thrown forward, striking front seat passengers. In Korea, laws do require front seat occupants to wear safety belts at all times. However, rear passenger safety belts are only required to be worn on motorways.

Lessons learnt: 'regular-irregularity'

Road policing must operate on an 'anywhere, anytime' model so that offending drivers cannot predict where or when enforcement will occur. Most people are creatures of habit and, depending on their activities, will generally take the same route at a similar time – to work, schools or shopping centres. Drivers also tend to drive in similar ways – they will have habits in respect to their speed, their manner of driving and their use of seat belts. The role of police is to increase the perception amongst the non-compliant portion of the population that somewhere on their route it is likely they will encounter police carrying out enforcement. The concept of 'regular-irregularity' and random patrol is foundational and must be actively managed.

In New Zealand, police officers often fall into a predictable enforcement cycle – going to the same locations at similar times. The impact of enforcement is less when these practices are predictable, making them avoidable. Police must carry out enforcement in a way which does not develop into predictable patterns. For example, when police set up compulsory breath testing checkpoints or speed cameras in the same locations, and at the same times and days of the week, that enforcement becomes predictable and can be avoided, which makes it less effective.

Lessons learnt: commercial vehicle enforcement

In New Zealand, comprehensive systems of regulation, licensing and enforcement are in place to monitor our commercial vehicles. The regulation of commercial vehicles, particularly heavy vehicles, buses and taxis is important. Heavy vehicles present significant risk to other road users because of their mass. A light vehicle or vulnerable road user is at great risk when involved in a collision with a vehicle of greater mass, particularly when the vehicle is overloaded or poorly maintained. Secondly, drivers who carry passengers for reward have a responsibility for passenger safety and tight regulation to ensure commercial drivers are 'fit and proper' to meet their responsibilities is required. In addition, drivers transporting children are subjected to added layers of scrutiny.

Commercial vehicles by their nature and use typically travel long distances under load. Without well-established maintenance programmes, these vehicles will quickly develop safety faults. Compulsory roadside inspections that are routinely carried out in safe off road locations ensure commercial operators maintain fleets to acceptable safety standards. New Zealand Police have a team of police officers (Commercial Vehicle Investigation Unit) consisting of 110 dedicated staff, including vehicle mechanics, who are fully committed to commercial vehicle enforcement. When these operations are carried out in a similar way to drink drive checkpoints – targeted, utilising mass checking, and sufficiently regular – they too are highly effective as a prevention strategy. Also, similarly to drink drive enforcement, penalties should be sufficiently severe to provide deterrence. The added risk that commercial vehicles present necessitates stringent penalties and enforcement regimes to ensure those involved in this industry are held accountable for the management of their fleet and drivers. Owners that put in place work schedules that demand a driver exceed speed limits and/or drive excessive hours are heavily penalised for unsafe management practices. Driver fatigue is a particular risk that must be managed, as employers can in some cases insist on drivers working unreasonably long hours, and drivers may feel compelled to comply. For this reason, strong processes to regulate commercial vehicle owners and their drivers, vehicles and driver safety standards and fatigue management are required.

Systems to record and report on offending across fleets, identifying drivers, owners and offending patterns are required. The New Zealand Transport Agency has developed a risk profile for commercial vehicles entitled the ‘Operator Rating System’, which collects data on offending and safety issues from commercial vehicles fleets. The data is then used to decide which operators should be the subject of higher levels of scrutiny because of their offending and compliance patterns. Using Automated Number Plate Recognition (ANPR) and ‘weigh in motion’ systems, the commercial fleet can be screened so that enforcement focuses upon the non-complaint operators.

Commercial driver fatigue management

Considerable research has been undertaken to identify the extent of fatigue involvement in commercial vehicle road crashes. Estimates vary greatly and are likely to under-represent the real extent of the problem (Gander et al., 2006). Drivers involved in crashes may fail to recognise or acknowledge the effects of fatigue and the symptoms of fatigue may not be evident to police or witnesses at a crash scene. Additionally, crash investigators often do not have a sufficient understanding of fatigue and do not collect the information needed to investigate its possible role.

In the USA, the National Transportation Safety Management Board reports that driver fatigue is the most common cause of fatal-to-the-driver truck cashes (31%), and it is implicated in 30-40% of all truck crashes (National Transportation Safety Board, 1990). In New Zealand between 2002 and 2004, driver fatigue was identified as a contributing factor in approximately 11% of fatal and 6% of injury crashes, and Australian estimates indicate that fatigue accounts for up to 30% of single-vehicle crashes in rural areas.[13]

In Europe, fatigue is reported to be a significant factor in approximately 20% of commercial road transport crashes, with surveys showing over 50% of long haul drivers having fallen asleep at the wheel (European Transport Safety Council, 2001). Studies have shown that people are likely to be sleepiest at around 3:00 to 5:00 am and then again at around mid-afternoon.[14]

In response, many jurisdictions have in place commercial driver regulations that provide maximum driving and work time rules. These regulations specify maximum driving hours, work hours, minimum rest periods within a working shift, minimum rest breaks between shifts and maximum hours of work over a week. The requirements vary, but they are consistently designed to limit the number of driving hours per day, the number of driving and working hours per week and specify daily minimum periods of rest. They also ensure that longer ‘weekend’ rest periods are codified to combat cumulative fatigue effects that accrue on a weekly basis.

A selection of jurisdictional requirements has been provided to illustrate a range of approaches. These rules typically apply to commercial drivers and operators using heavy transport (over 3 500 kg vehicles) as well as drivers of taxis and buses.

– **European driving hours rules**[15]

The main European Union rules on driving hours are that a commercial driver must not drive more than:

- 9 hours in a day (this can be extended to 10 hours twice a week)
- 56 hours in a week

- 90 hours in any 2 consecutive weeks
- with respect to breaks and rest that must be taken
- at least 11 hours rest every day, which can reduce to 9 hours in some circumstances
- a break or breaks totalling at least 45 minutes after no more than 4.5 driving hours.

– **New Zealand driving hours rules**

The main NZ rules are that a driver must drive for:

- no longer than 5.5 hours before taking a half hour break
- in any cumulative day (defined as no more than 24 hours), drivers can work a maximum of 13 hours and must take a break of at least 10 hours (as well as the standard half hour breaks every 5.5 hours)
- after 70 hours, drivers must take a break of at least 24 hours
- chain of responsibility requirements mean that an employer must ensure that work schedules do not require drivers to breach work time rules.

– **British Columbia (Canada) driving hours rules**

The main British Columbian rules require:

- maximum of 13 hours driving in a day (day defined as a 24 hour period)
- minimum of 10 hours off duty in a day
- no driving after 14 hours on duty in a day.

– **United States driving hours rules**

The main rules across the United States require:

- maximum consecutive driving of 11 hours
- maximum on-duty 14 hours
- minimum off-duty 10 hours
- maximum of 8 hours on-duty before a 30 minute break.

Typically, 'driving' time includes 'on-duty' time and both are counted when calculating maximum driving time requirements. While 'driving' time is self-explanatory, 'on duty' time is all time from when a driver begins work or is required to be in readiness for work until a driver is relived from all responsibilities for performing work. As examples, it includes time such as loading and unloading, completing paperwork, picking up and dropping off or attending to needs of passengers etc.

The enforcement of these requirements is often a specialist function assigned to dedicated staff within a police agency. Regulation typically requires commercial drivers to maintain log books that record their driving and on-duty time with strict penalties for failure to accurately complete these requirements. Manual recording systems are known to be easily manipulated (e.g. drivers may operate more than one logbook to mask excessive driving hours) and electronic log books that make inaccurate recording difficult to disguise are increasingly being utilised to ensure driver compliance.

Vehicles and equipment

Equipment and calibration

Enforcement credibility demands that equipment used to detect offending – typically speed detection, breath screening and evidential breath testing devices – is maintained, calibrated and operated to the highest standards. To achieve this, police must have in place robust testing and operating practices that ensure instruments operate accurately. The integrity of an enforcement programme rests upon demonstrated device accuracy. New Zealand Police operate an International Organization for Standardization (ISO) approved laboratory that tests and calibrates (or in some cases coordinates such testing) existing speed, breath testing and weighing devices to ensure the highest standards of accuracy are maintained.

Marked and unmarked vehicles

The use of a mix of marked and covert vehicles is associated with proven crash reduction benefits (Diamantopoulou and Cameron, 2002). Highly visible patrol cars (including the use of multiple base colours) and a distinctively visible livery are a successful feature of the New Zealand road policing programme (see Figure 5.4). The battenburg livery style has been tested and found to be more easily recognised by the public and adds to policing visibility Harrison, 2004). The use of a mix of marked and unmarked police vehicles using mobile mode radar has also been effective. Unmarked cars drive up the belief by offending drivers that a vehicle travelling toward them or parked on the roadside may be a police officer using a mobile or stationary mode radar. Any roadside vehicle, or a vehicle travelling behind or in front could be an unmarked patrol. In New Zealand, approximately 10% of the police highway patrol fleet is unmarked sedans and station wagons without any overt equipment that identifies them as police cars.

Figure 5.4. **New Zealand Police – Vehicle livery**

Source: New Zealand Police

Speed cameras (mobile, fixed and section control)

Effective enforcement strategies depend on the environment where the offending occurs. Speed cameras work effectively in many locations and can be operated at fixed locations, often known speed related crash risk sites, or through mobile vehicle mounted cameras. Mobile speed cameras are intended to have a general impact upon speed offending across the network. Mobile speed cameras are most effective when they are operated in a non-overt manner utilising unmarked vehicles (Cameron, 2009). This ensures that offending drivers are not able to predict where cameras will be operating and thereby are forced to slow down in order to avoid detection. Overt speed cameras have been shown to be less effective at reducing speeds generally, but are effective at reducing speeds at their deployment location, as offending drivers tend to slow only when they are aware of the camera and tend to speed up after passing it.

The effectiveness of the speed camera programme relies upon a sound vehicle registration system. The registered owner of an offending vehicle is liable for the sanction unless liability is formally transferred to a driver. It is critical to the success of the programme that offenders cannot avoid the penalty and that it is swiftly applied and strictly enforced. A weak system that allows an offender to frustrate the process significantly weakens the deterrence value.

Section Control (Time over distance speed cameras)

Section Control utilises a form of speed camera technology to measure the average speed of vehicles travelling on a given stretch of highway by recording the time taken to travel a measured distance. Automatic Number Plate Recognition (ANPR) cameras record every vehicle entering the 'section' of highway and a second camera records the vehicle leaving the 'section'. The entry and exit times, distance travelled and vehicle data are used to calculate the average speed of every passing vehicle and where speed limits are exceeded, speed infringements are issued.

These devices have proven to be effective in achieving mean speed reductions and crash casualty reduction on stretches of highway where they operate in a number of European countries and in Australia.[16] Additional uses and effects include congestion management, environmental benefits related to vehicle emissions and weigh in motion to detect overweight speeding commercial vehicles causing infrastructure damage (e.g. speeding overweight vehicles can cause bridge structure damage).

The critical features of these programmes typically involve:

- stretches of highway ranging from 2-10 kilometres in length where crash rates and levels of speeding are high
- sections do not have entry or exit points across the measured portion
- the same speed limit for the entire control section
- the section must have a design that does not place limitations on driving faster than the speed limit on any portion of the relevant section (e.g. tight corners and or slopes that prevent travelling at or above the speed limit)
- high traffic volumes
- operating in more urban environments were device security and power sources can be provided
- legislative support framework that assigns responsibility for speeding violations to the registered vehicle owner
- frequently sign posted to alert drivers to the fact they are entering the area with a reminder sign within the section.

Because these devices record the registration number of every vehicle entering and leaving a road section, regardless of whether an offence is detected, jurisdictional privacy legislation may impact on the acceptability of the technology. Systems that ensure the deletion of all identity data relating to compliant vehicles can mitigate privacy concerns. These systems have also been found useful to detect vehicles that are 'wanted' (e.g. stolen vehicles) by checking the registration number against a vehicle of interest database.

As these devices measure average speed across a measured distance, they are considered to be a fair enforcement technology and have, when utilised, achieved high levels of public acceptance. They do not sanction momentary speeding at a single point in a journey (e.g. an overtaking manoeuvre) which some claim is unfair. A driver must be exceeding a speed limit for a sustained period in order to receive a sanction.

The purpose of these devices is to drive down speeds across a significant portion of a road network which has substantial impacts on reducing fatal and injury crash rates. There are several studies (European Transport Safety Council, 2009) that highlight positive impacts through the utilisation of this technology including a 65% reduction on deaths and serious injuries at eleven sites in the United Kingdom to a 47% reduction in collisions at treated sites in the Netherlands.

Red light/speed cameras

New Zealand has a small number of red light cameras operating at high volume intersections where red light running offences are a proven problem. Research has shown that the most effective technology is combined red light and speed cameras. Drivers who either fail to stop for red lights or who speed up to beat red traffic signals are sanctioned (Budd et al., 2011).

Road safety advertising

New Zealand’s national road safety advertising and enforcement campaign began in its current form in 1995. The campaign aimed to reduce the number of people dying or suffering on New Zealand roads. By 1995, New Zealand's annual road toll neared 600 people. These deaths mainly resulted from people drink-driving, driving at excessive speed and not wearing their safety belts. Other driving errors such as not giving way, not stopping and not keeping left were also a contributing factor.

International comparisons of road deaths per 10 000 vehicles ranked New Zealand's driving record 14th out of 24 Organisation for Economic Co-operation and Development (OECD) countries in 1995. Estimates of the total cost of the road death tragedy to New Zealand society was around NZD 3.6 billion (Ministry of Transport, New Zealand, 2006). This figure was reached by measuring the cost of all damages resulting from road crashes.

In 1995, the National Road Safety Plan set an ambitious goal to reduce the annual road toll to no more than 420 deaths by the year 2001. As this and the other targets of the plan were not likely to be met without additional efforts and initiatives, a new approach was required.

As part of this approach, a new road safety package to improve driver behaviour in New Zealand was endorsed by government. The package was based on the world's best practice Transport Accident Commission (TAC) programme that was successfully developed in Victoria, Australia. Between 1990 and 1993 the TAC strategy helped prevent an estimated 10 800 serious casualty crashes and halved the state's road toll over the five years from December 1989 (Cameron et al., 1993).

Key priorities for New Zealand roads were identified through research and crash statistics. The initial priorities were drink driving and driving at excessive speed. The strategy of the campaign was to have an increased law enforcement presence on the roads supported by hard-hitting, high-profile advertising. A blueprint developed from the Victorian experience specified the style, media mix and weight for the advertising component of the programme. From this, vivid, realistic road safety advertisements that specifically targeted offenders were produced to great success.

Between 1995 and 1997, changes to the road toll were dramatic. There were substantial reductions in serious road crashes, deaths (111 less), police-reported injuries (19% less) and hospitalisations (12% less).

The campaign's strategy has seen little change since 1995 because the strategy is proven best practice and is very effective. Campaign priorities are determined by government transport strategies. While individual campaigns – drink-driving, speed, failure to give way, safety belt use, drug affected driving, young drivers, fatigue, vehicle safety, rail safety – have evolved since 1995, the basic formula adopted from Victoria remains the same.

This campaign is one of the most effective ever seen in New Zealand, as it has raised public awareness and changed driver behaviour. Independent evaluations show it has helped save more than 300 lives since it began in 1995.[17]

A comprehensive review by Monash University of mass media campaigns in road safety (Delaney et al., 2004) identified a number of key findings. When evaluating the effects of such campaigns, using all available measures of effect, it was estimated that on average a campaign will generate a 7.5 percent reduction in the outcome measure of effect. Cited is a 1999 review of evaluations of mass media campaigns and their impact on crashes. It was estimated that on average a road safety mass media campaign will result in an 8.5 percent reduction in crashes during the campaign. Following the campaign's completion, the crash reduction is expected to increase on average to 14.8 percent. A number of individual campaign evaluations conducted since 1997 also support this conclusion. In particular, the evaluations of mass media campaigns in Australia and New Zealand indicate that when coupled with enforcement and legislation, they lead to significant reductions in the severity and frequency of casualty crashes. These results were also supported by research from North America and Europe.

The Monash review identifies the following campaign characteristics of particular importance. Campaigns with a persuasive orientation and those that use emotional rather than rational appeals tend to have a greater impact. By contrast, information and educative campaigns have been shown to be less effective. The underlying themes that they identified were:

- Public education campaigns should play an important role in targeting younger drivers, particularly when accompanied by significant increases in speed enforcement during evenings and late at night.
- Targeting drivers who drive as part of their occupation and possess other specific characteristics (males living in metropolitan areas) should involve radio advertising.
- Targeted enforcement programmes aimed at the identified groups of drivers who are either exposed to lower enforcement or believe enforcement can be avoided must involve an increase in actual detection of offences.
- The use of enforcement related advertising in enforcement programmes should increase the effectiveness of such programmes and will contribute to the cost benefit of those programmes.
- In the 'short-term', high profile publicity can be used as an effective short term measure to reduce crash frequency when enforcement levels are low.

The important point identified in the MUARC research was that in all instances they examined, publicity supporting enforcement programmes has apparently been effective in magnifying the effects of the enforcement programme. These magnified effects have been evident over a range of road types. Also, the combined effect of speed enforcement programmes and publicity is highly cost beneficial.

The use of social media

Police agencies now have the ability to connect via social media with target groups to provide innovative educational material and stimulate public debate on road safety issues. The use of Facebook and YouTube in particular allow for road safety messages to be provided to large proportions of the public, be age and audience specific and also avoid having the message filtered and edited by the media.

Annex 5 provides a selection of links to innovative social media campaigns that serve as examples of the variety of initiatives that can be initiated to support police road safety campaigns. As an example, New Zealand Police have a dedicated ‘media team’ who are involved in developing road safety campaigns with partner agencies.

Education and training of police

New Zealand Police have developed a strong focus on the education of police officers in road safety research, outcomes measures, tactical excellence and programme integrity. The 'hearts and minds' approach ensures that road policing is regarded as a mechanism to increase community safety and prevent road trauma. Issuing an infringement notice or prosecuting an impaired driver should not be regarded as punishing the citizen but protecting the community. It is important for police officers to understand the risks associated with speeding – the impact of low end speeding and the obvious risks of high end speeding – so they can actively enforce speed limits. Understanding when and where crash risk is occurring allows officers to target areas of greatest risk and maximise impact. Furthermore, understanding the rationale behind a mass breath testing campaign and the components that add to its effectiveness coincide to ensure that individual officers are knowledgeable and focused on achieving crash reduction by applying the most effective operational tactics. It also ensures that officers spend their time targeting the highest risk offending types to avoid focusing on less important regulatory offences.

New Zealand Police are currently providing peer to peer police officer support in Uttar Pradesh, Republic of India, as that state embarks on an ambitious programme to reduce road trauma in conjunction with the World Bank. New Zealand Police executive see this as an excellent example of early recognition of the importance of educating local officers at the outset so that they are well educated on their role, road policing research and sound operational tactics.

Performance monitoring

Although police are not solely responsible for a reduction in road trauma, a comprehensive performance monitoring system, as described below, allows high standards of enforcement to be monitored. In New Zealand, performance monitoring and accountabilities are arranged in a hierarchy (Table 5.5).

Table 5.5. **New Zealand performance monitoring system**

Final outcomes	**Reductions in road fatalities** **Reduction in hospitalisations** **Reduced Accident Compensation Corporation (ACC) road crash entitlement claims**
Intermediate outcomes	Reductions in urban and rural mean traffic speeds Increases in front seat, rear seat and child restraint wearing rates Increased use of cycle helmets Decreased rates of drink-driving (annual survey) Improved public attitudes (measured by annual survey)
Outputs	Number of compulsory breath tests conducted Hours of speed camera deployment Offence detection compared to compliance rates Commercial vehicle inspections Means speed of officer detected offences

The ultimate aim of the programme is to reduce road trauma with the 'Final outcomes' measured by reductions in those killed and seriously injured (hospitalised) in road crashes and those with injury claims.

"Intermediate outcomes" provide important regular information about the actual levels of road safety risk. Surveys of behaviours that have a direct correlation with crash injury rates such as mean speeds, restraint and helmet wearing rates, and drink-drive rates are regularly conducted at a wide number of geographic locations to allow objective measures of public compliance. These measures are also used as a proxy for determining the effectiveness, volume and application of police enforcement. For example, if police in a particular location are rigorously enforcing the use of restraints, restraint wearing rates will rise. Conversely, a lack of enforcement will typically see poor wearing rates. Also included in the intermediate outcome measures are independently conducted public surveys that will test the perceived likelihood of being caught speeding, belief that an individual can predict where a compulsory breath testing checkpoint will be and admissions of drink-driving. These survey measures also provide valuable feedback to police on how effective their operations are in changing public attitudes and behaviours that cause or worsen road trauma.

Output measures include such activities as: the number of breath tests conducted, hours of operation of speed cameras, commercial vehicle safety inspections and assessments of the number of fatal five offences detected given objective known levels of offending (refer intermediate outcome measures). It is important to compare offence detection rates with known offending rates. As enforcement of given offence types rise, actual offending rates will fall. Therefore, high levels of offence detection are important precursors for observed reductions in offending.

Obstacles to effective road policing

In New Zealand the tension between the emergency response dimension to policing and road policing is always present and must be carefully managed. The emergency response dimension to policing remains a priority. Police officers are routinely required to deal with public calls for service – attending crimes, mental health and other service types that demand an immediate police response. The risk is that road policing patrols – focused upon crash prevention – may be seen as involved in work that is not an immediate priority. While emergency response by road policing staff will always be required, minimising it and ensuring road policing staff return as quickly as possible to their prevention role has to be monitored on an on-going basis.

Typically, much of policing is driven by crime patterns generated by prolific offenders. For example, a spate of house burglaries or car thefts attributable to an organised group or individual will prompt police to target the offender(s), locations and commodities to reduce the offending and apprehend the perpetrators. In road policing, Police target population based behaviours that are not by their nature criminal, but when repeated across the population, cause high levels of road trauma. These behaviour patterns, when observed across a population, are relatively consistent over time. Typically, this results in similar numbers of alcohol related crashes, speed related crashes and a predictable range of crashes occurring. The long term reduction in these trends relies upon a relentless enforcement programme and supporting publicity over many years in order to change engrained behaviours. From time to time, anomalies in these crash patterns will occur and can give rise to public, media or political speculation that a particular crash type, because of its profile, is occurring at a much higher rate and should be addressed as a priority. A high profile event can generate calls for a major emphasis on a particular issue that is not consistent with its relative importance when considering long term crash tends. An over emphasis of enforcement effort on issues that are not significant contributors to road trauma must be resisted by always looking at long term trends.

The success of any road policing programme relies upon a committed application of proven tactics focussed on priority areas over a long period and not the watering down of the effort to address perceived, but statistically irrelevant anomalies.

Maintaining public support for enforcement

It is apparent that there exists worldwide a vociferous minority who consistently attempt to undermine police enforcement of road safety laws. This approach tends to focus mostly upon speed enforcement, tends to be cyclic, and usually associated with the launch of a new countermeasure, a new enforcement campaign, or an increase in penalties. Johnston et al. (2013) argue that this phenomenon is worldwide and cite numerous examples of efforts to discredit road safety research and enforcement relating to speed. They have coined the term 'anecdata' to describe the modern ability to post information onto social media that supports an individual's worldview – often with opinions and anecdote that are not supported by fact. They argue that in a complete absence of quality control, anecdata has adversely affected the level of debate and not just in the road safety sphere.

Significantly raising the levels of enforcement is likely to attract substantial criticism, as that has been the experience in other countries. These will include allegations that enforcement has a 'revenue raising' motivation, that Police should only focus on extreme behaviours and leave 'good citizens' alone, that police should use their scarce resources on 'crime fighting', and not on minor traffic offending to list but a few typical claims. Historically, police agencies have also tended to avoid traffic enforcement for fear of alienating the public.

The essential issue is that many people think of themselves as law abiding, yet believe that traffic violations do not count. This thinking has long history. Motoring journalist L.J.K. Setright took the view that widespread car ownership changed the relationship between the British middle classes and the Police. Until the 1920s or 1930s, they assumed the police were there to protect them and their property from the 'riff-raff' and became angered when the police treated them as perpetrators when it came to traffic offences (Setright , 2003). He argues that the relationship never quite recovered and the vociferous attacks on speed cameras in the United Kingdom and the constraints on their use suggest there is merit in this argument.

The most effective way of countering these attacks is to ensure that a proactive programme exists to educate the public by explaining the issue and the rationale for the action taken. Having high profile, educated, supportive spokespeople available that are independent of police to support the rationale for the enforcement is particularly helpful. Essentially, it is important to anticipate and prepare for the criticism before it occurs.

Partner agencies can publicly support police enforcement and explain that it is one part of the 'Safe System'. One useful approach is to enlist the support of trauma surgeons who have an ability to speak with compelling authority on the levels of road trauma being treated. They are able to speak with a rare authority about their observations of the role of alcohol, speed and the failure to wear safety belts play in the injuries they are forced to treat. This approach was highly successful in Melbourne, Victoria when a trauma surgeon and an editor combined to arouse public condemnation of the level of road trauma and seek public support for it be addressed.

To minimise the likely criticism that police will face and in order to maintain public trust and confidence, Johnston et al. (2013) argue that:

- publicly explaining the rationale for all speed enforcement locations and linking it to crash risk and crash risk data
- the punishment should be set at the right level for the level of the offending

- all fines revenue must be publicly and transparently allocated to traffic safety measures with regular publication of fund allocation and outcomes
- an independent audit should be appointed to act as a community representative Io hear complaints and act as a 'speed' ombudsman'.

It is a given that increased enforcement activity will attract criticism, and proactively planning the enforcement strategy, public education and setting up of an enforcement programme that includes the elements advocated is the best method of preparing for, responding to and minimising the attacks as they arise.

Conclusion

This chapter provides a summary of the important aspects to developing an effective road policing programme. It highlights that in order to develop a successful programme, understanding primary crash patterns and causes allows enforcement to be targeted to proven crash risk and hence maximise its impact.

Enforcement is most effective when it is accompanied by a well-resourced public awareness campaign that highlights the areas being targeted by police.

Ensuring that police officers understand relevant road safety research allows them to develop 'general' and 'specific' deterrence operational tactics, with sufficient intensity and focus on times and locations that maximise effectiveness.

Lastly, how effective is road policing at saving lives? One of the largest and most compelling pieces of research to address this question was conducted in Ontario, Canada and published in the Lancet, a renowned medical publication. It concluded that: 'Traffic-law enforcement effectively reduces the frequency of fatal motor-vehicle crashes in countries with high rates of motor-vehicle use. Inconsistent enforcement, therefore, may contribute to thousands of deaths each year worldwide.' (Redelmeier et al., 2003).

Recommendations

The following recommendations are made for the government of Korea to consider:

Capacity review - road policing delivery

Commission an independent capacity review of road policing within Korea to benchmark the methods and volume of enforcement against best international practice and current research in the areas of:

- alcohol impaired driving enforcement
- speed enforcement
- restraint enforcement
- commercial vehicle enforcement (focusing on maximum permissible driving hours)
- road policing training
- road safety intelligence.

Capacity review – crash investigation and reporting

Commission an independent capacity review of crash investigation and reporting practices and standards and benchmark these against best international practice.

Development of intermediate outcome measures

Develop intermediate outcome measures and arrange on-going independent surveys to monitor over time and by geographic areas the following behaviours:

- mean and 85^{th} percentile free traffic speeds in urban and highway environments
- restraint wearing rates in the front and rear of vehicles
- alcohol impaired driving rates
- commercial vehicle safety compliance.

Capacity review – public awareness campaigns

Review current public awareness campaigns and assess:

- effectiveness measures
- audience reach (Target Audience Rating Points)
- target audience impacts
- alignment with police enforcement priorities, crash risk, crash casualty demographics and best international practice.

Review of legislation and Penalties

Commission an independent review of current road safety legislation and benchmark it against best international practice. The review should focus upon legislation and penalties relating to:

- alcohol impaired driving
- speed offending
- failure to wear safety belts/utilise child restraints
- commercial vehicle safety standards and permissible maximum driving hours
- driver demerit schemes.

References

Basili M. and A. Nicita (2005), "Compliance and deterrence in demerit point systems", *American Law & Economics Association Annual Meetings,* pp.1-24.

Budd L., J. Scully and S. Newstead (2011), "Evaluation of the crash effects of Victoria's fixed digital speed and red light cameras", Report No. 307, Monash University Accident Research Centre.

Cameron M. (2009), "Safety benefits of speed cameras", Fact Sheet No. 5, Curtin-Monash Accident Research Centre, accessible at: http://c-marc.curtin.edu.au/local/docs/CMARC%20Fact%20Sheet%205%20Speed%20Cameras.pdf

Cameron M. (2003), "Evaluation of random breath testing and speed cameras in Victoria and some principles learnt", presented at Monash University Accident Research Centre, Melbourne.

Cameron M., N. Haworth, J. Oxley, S. Newstead and T. Le (1993), "Evaluation of Transport Accident Commission Road Safety Television Advertising", Report No. 52? Monash University Accident Research Centre, accessible at http://www.monash.edu.au/miri/research/reports/muarc052.pdf

Chandler V. (2012), "Assessing the Impact of Deterrence on Road Safety due to the Demerit Point System", MPRA Paper No. 39439, accessed at http://mpra.ub.uni-muenchen.de/39439/

Delaney A., B. Lough, M. Whelan and M. Cameron (2004), "A Review of Mass Media Campaigns in Road Safety", Monash University Accident Research Centre, accessible at: https://www.monash.edu/__data/assets/pdf_file/0012/217200/muarc220.pdf

Diamantopoulou K. and M. Cameron (2002), "An evaluation of the effectiveness of overt and covert speed enforcement achieved through mobile radar operations", Report No. 187, Monash University, accessible at; http://www.monash.edu.au/miri/research/reports/muarc187.pdf

Erke A., C. Goldenbald and T. Vaa (2009a), "Good practice in the selected key areas: Speeding, drink driving and seat belt wearing: Results from meta-analysis", European Commissioner, Brussels.

Erke A., C. Goldenbelde and T. Vaa (2009b), "The effect of drink drive checkpoints on crashes – A meta-analysis", *Accident Analysis and Prevention,* Vol. 41(5), pp. 914-923.

European Road Safety Observatory (2007), "Speed Enforcement", accessed at www.ec.europa.eu/transport

European Transport Safety Council (2011a), *Traffic Law Enforcement across the EU – Tackling the Three Main Killers on Europe's Roads*, p.19, Brussels, accessible at http://etsc.eu/wp-content/uploads/Traffic_Law_Enforcement_in_the_EU.pdf

European Traffic Safety Council (2011b), "Traffic Law Enforcement across the EU", accessible at http://archive.etsc.eu/documents/Final_Traffic_Law_Enforcement_in_the_EU.pdf

European Transport Safety Council (2009), "Section Control: towards a more efficient and better accepted enforcement of speed limits?" Brussels, accessed at www.etsc.eu

European Transport Safety Council (2001), "The role of driver fatigue in commercial road transport crashes", Brussels, accessible at http://etsc.eu/wp-content/uploads/The-role-of-driver-fatigue-in-commercial-road-transport-crashes.pdf

Gander P. H., N. S. Marshall, I. James and L. Le Quesne (2006), "Investigating driver fatigue in truck crashes: Trial of a systematic methodology", *Transportation Research Part F: Traffic Psychology and Behaviour,* Vol. 9 pp.-65-76 accessible at http://www.sciencedirect.com/science/article/pii/S1369847805000720

Harrison W. and N. Pronk (1998), “Investigation of the relationship between traffic enforcement and the perceived risk of detection for driving offences”, Monash University Accident Research Centre, Report No.134 accessible at: http://www.monash.edu/__data/assets/pdf_file/0005/216887/muarc134.pdf

Harrison P. (2004), *High Conspicuity Livery for Police Vehicles*, Home Office Police Scientific Development Branch, No. 47/06, Hertfordshire, U.K

Harrison W. (1996), “Exploratory Investigation of Aspects of Drink-driving and Enforcement in Rural Areas of Victoria”, Monash Injury Research Institute, accessible at http://www.monash.edu.au/miri/research/reports/muarc093.html

Homel R. (1993), “Random breath testing in Australia: getting it to work according to specification”, *Addiction* Vol.88, pp.27S-33S http://onlinelibrary.wiley.com/doi/10.1111/j.1360-0443.1993.tb02159.x/pdf

Johnston I., C. Muir and E. W. Howard (2013), *Eliminating Serious Injury and Deaths by Road Transport: A Crisis of Complacency*, pp. 55, 56, 140, 141

Kallberg V. P., D. Zaidel, T. Vaa, J. Malenstein, A. Siren and E. Gaitanidou (2008), “Police Enforcement Policy and Programmes on European Roads”, p.91, accessed at vtt.fi/files/sites/pepper/pepper_d17_finalrep.pdf

Land Transport Safety Authority (1999), ‘Hidden Speed Camera Trial Evaluation Report’, Wellington New Zealand. https://trid.trb.org/view.aspx?id=648207

Lund, A. K., and Williams, A. F. (1985), “A review of the literature evaluating the defensive driving course”, *Accident Analysis and Prevention*, 17 No.6, pp. 449-460. http://www.sciencedirect.com/science/article/pii/0001457585900405

Mazerolle, L., Antrobus E., Bennett S. and Tyler T. R. (2013), “Shaping Citizen Perceptions of Police Legitimacy: A Randomized Field Trial of Procedural Justice”, *Criminology*, Vol. 51 no. 1, pp.33–63. http://onlinelibrary.wiley.com/doi/10.1111/j.1745-9125.2012.00289.x/pdf

Miller T, M. Blewden and J. Zhang (2004), “Cost savings from a sustained compulsory breath testing and media campaign in New Zealand”, Vol. 36 *Accident Analisys and Prevention*. https://www.researchgate.net/publication/8505119_Cost_savings_from_a_sustained_compulsory_breath_testing_an_media_campaign_in_New_Zealand

Ministry of Transport, New Zealand (2014), “Front seat safety belt use by adults: Results of a national survey 2014” http://www.transport.govt.nz/assets/Uploads/Research/Documents/Front-seatbelt-survey-results-2014.pdf

Ministry of Transport, New Zealand (2013a), “Speeding, crash statistics for the year ending 31 December 2012”, *Crash Factsheet November 2013,* accessible at: transport.govt.nz/assets/Uploads/Research/Documents/speed-crashfacts-2013.pdf

Ministry of Transport, New Zealand (2013b), “Alcohol/Drugs, crash statistics for the year ended 31 December 2012”, *Crash Fact Sheet November 2013,* accessible at: transport.govt.nz/assets/Uploads/Research/Documents/alcohol-drugs-crashfacts-2013.pdf

Ministry of Transport, New Zealand (2012), “Public attitudes to road safety 2012: Results of the 2012 survey”, prepared by the Financial, Economic and Statistical Analysis Team of the Ministry of Transport, New Zealand. http://www.transport.govt.nz/assets/Import/Documents/Public-Attitudes-to-Road-Safety-survey-2012-summary-report-final.pdf

Ministry of Transport, New Zealand (2006), "The social cost of road crashes and injuries" June 2006 update, accessible at: http://www.transport.govt.nz/assets/Uploads/Research/Documents/Social-cost-June-2006-update.pdf

National Highway Transport Safety Administration (2014), "Traffic Safety Facts Research Note – 2013 Motor Vehicle Crashes: Overview", December 2014, accessible at http://www-nrd.nhtsa.dot.gov/Pubs/812101.pdf

National Transportation Safety Board (1990), "Fatigue, alcohol, other drugs and medical factors in fatal-to-the-driver heavy truck crashes", Safety Study Vol. 1, Washington DC.

Peden M. (2011), "World Report on Road Traffic Injury Prevention", *World Health Organisation*. http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/summary_en_rev.pdf

Redelmeier D. A., R. J. Tibshirani, L. Evans (2003), 'Traffic Law enforcement and risk of death from motor-vehicle crashes: case-crossover study', *The Lancet*, Vol.361, No.9376, pp.2177-2182, accessible at: http://ac.els-cdn.com/S0140673603137701/1-s2.0-S0140673603137701-main.pdf?_tid=fe01f82a-fffa-11e5-82c4-00000aab0f6c&acdnat=1460389097_d98da53987a71431236821d88d80790a

Setright L.J.K. (2003), *Drive On! A Social History of the Motor Car;* Granta Books, London.

SWOV (2012), "Demerit points systems", *Leidschendam, the Netherlands: SWOV Institute for Road Safety Research*, factsheet. https://www.swov.nl/rapport/Factsheets/UK/FS_Demerit_points.pdf

SWOV (2010), "Rehabilitation courses for road users", *SWOV Institute for Road Safety Research*, factsheet. https://www.swov.nl/rapport/Factsheets/UK/FS_Rehabilitation_courses.pdf.

Terer K.; and R.Brown (2014), "Effective drink drive prevention and enforcement strategies: Approaches to improving practice", *Trends and issues in crime and criminal justice*, No. 472. http://www.aic.gov.au/media_library/publications/tandi_pdf/tandi472.pdf

Van Lamoen N. (2014), *Evaluation of the Safer Summer road safety campaign*, Road Policing Support, Police National Headquarters, accessible at: http://www.police.govt.nz/sites/default/files/publications/safer-summer-campaign-evaluation-report.pdf

Van Schagen, I. and Machata, K. (2012), "The BestPoint Handbook: Getting the best out of a Demerit Point System". Deliverable 3 of the EC project BESTPOINT, Criteria for BEST Practice Demerit POINT Systems.

WHO (2013), "Executive Summary", *Global Status Report on Road Safety 2013; Supporting a Decade of Action*, World Health Organisation, Luxembourg, p. 7. accessed at http://www.who.int/violence_injury_prevention/road_safety_status/2013/report/executive_summary.pdf

Wundersitz L.N., S.D.Doecke and M.R.J. Baldock (2010), "Annual performance indicators of enforced driver behaviours in South Australia, 2008". Centre for Automotive Safety Research, University of Adelaide, p.46, accessed at casr.adelaide.edu.au/publications/researchreports/CASR073.pdf;

Zaal D. (1994), "Traffic Law Enforcement: A Review of the Literature", SWOV (Institute for Road Safety Research) Monash University, report No. 43, p. 71, accessible at: http://www.monash.edu.au/miri/research/reports/muarc053.pdf

Johnston I., C. Muir and E. Howard (2013), *Eliminating Serious Injury and Death from Road transport: A Crisis of Complacency*, CRC Press Taylor & Francis Group, pp.49-51

Annex 5. Examples of the use of social media to support road safety campaigns

- Anything over the limit is speeding video:

https://www.facebook.com/video.php?v=792256854157189&set=vb.116383195077895&type=2&theater

- Reach the Beach Campaign (1):

https://www.facebook.com/NZPoliceRecruitment/photos/a.140780399304841.27672.116383195077895/786437538072454/?type=1&theater

- Reach the Beach Campaign (2):

https://www.facebook.com/NZPoliceRecruitment/photos/a.140780399304841.27672.116383195077895/799003816815826/?type=1&theater

- Make it to Monday – Children's video:

https://www.facebook.com/video.php?v=768575843191957&set=vb.116383195077895&type=2&theater

- Driving tired – Fatigue video:

https://www.facebook.com/video.php?v=619400224776187&set=vb.116383195077895&type=2&theater

- Driver Distraction - Pay attention video:

https://www.facebook.com/video.php?v=620672831315593&set=vb.116383195077895&type=2&theater

- Safer Summer - What police are doing to stop speeders:

https://www.youtube.com/watch?v=UJvrbzAOwP0

- Jamie's world collaboration with Bay of Plenty Police:

https://www.youtube.com/watch?v=KvGuURYKpFQ&feature=youtu.be

Notes

1. http://www.saferjourneys.govt.nz/about-safer-journeys/the-safe-system-approach

2. See *Police Citizens' Satisfaction Survey 2013 – 2014,* http://www.police.govt.nz/sites/default/files/publications/citizen-satisfaction-survey-2013-full.pdf

3. Ian Johnston, 'Public Health Paradox', presented to New Zealand Police at Dunedin June 2006.

4. http://www.camerassavelives.vic.gov.au/home/road+trauma/speed+and+road+safety/

5. http://www.nzta.govt.nz/resources/factsheets/55/docs/55-driving-offences-and-penalties.pdf

6. http://ec.europa.eu/transport/wcm/road_safety/erso/data/Content/studies_about_underreporting.htm

7. Many of the jurisdictions that New Zealand Police have a working relationship with apply the 30 day rule – if a person dies within 30 days of sustaining injuries in a crash a fatality is counted.

8. http://ec.europa.eu/transport/wcm/road_safety/erso/data/Content/studies_about_underreporting.htm

9. Anonymous health casualty data typically records age (and or day and month of birth), gender, date of admission and location. This is compared with the same anonymous police recorded casualty data in order to establish matches. Once a match is established, it is possible to determine crash reporting rates which can be monitored over time. This process protects individual privacy and ensures the integrity and confidentiality of health information of crash victims.

10. European Traffic Safety Council.

11. National Highway Traffic Safety Administration, "Primary Enforcement Saves Lives – The Case for Upgrading Safety Belt Laws"

12. European Traffic Safety Council

13. New Zealand Transport Agency, 'Fatigue, Staying awake when you're driving, Fact Sheet 25', June 2004, accessed at www.nzta.govt.nz

14. Accessed at www.massey.ac.nz/massey/learnings/department/centres-research

15. Accessed at www.gov.uk/drivers-hours/eu-rules

16. SafetyNet (2009) Speed-Enforcement; accessed at http://ec.europa.eu/transport/road_safety/specialist/knowledge/pdf/speed_enforcement.pdf

17. New Zealand Transport Agency, 'A history of the road safety campaign (N.Z. Transport Agency, 2013) accessed at http://www.nzta.govt.nz/about/advertising/campaign/history.html

Annex 5. Examples of the use of social media to support road safety campaigns

- Anything over the limit is speeding video:

https://www.facebook.com/video.php?v=792256854157189&set=vb.116383195077895&type=2&theater

- Reach the Beach Campaign (1):

https://www.facebook.com/NZPoliceRecruitment/photos/a.140780399304841.27672.116383195077895/786437538072454/?type=1&theater

- Reach the Beach Campaign (2):

https://www.facebook.com/NZPoliceRecruitment/photos/a.140780399304841.27672.116383195077895/799003816815826/?type=1&theater

- Make it to Monday – Children's video:

https://www.facebook.com/video.php?v=768575843191957&set=vb.116383195077895&type=2&theater

- Driving tired – Fatigue video:

https://www.facebook.com/video.php?v=619400224776187&set=vb.116383195077895&type=2&theater

- Driver Distraction - Pay attention video:

https://www.facebook.com/video.php?v=620672831315593&set=vb.116383195077895&type=2&theater

- Safer Summer - What police are doing to stop speeders:

https://www.youtube.com/watch?v=UJvrbzAOwP0

- Jamie's world collaboration with Bay of Plenty Police:

https://www.youtube.com/watch?v=KvGuURYKpFQ&feature=youtu.be

Chapter 6. Review speed management policies

Oliver Carsten

University of Leeds, United Kingdom

Speed management is a critical element in a national safety strategy. It encompasses far more than speed enforcement. It involves creating an overall policy for setting appropriate speed limits, based on expected crash types on various road categories and on human tolerance for injury in those crashes. Countries such as the UK, France, Denmark, New Zealand and the various states of Australia have placed speed management at the core of their road safety strategies and have demonstrated the effectiveness of pursuing speed management as a major contributor to casualty reduction. Tools for speed management include creating a functional hierarchy of roads, self-explaining road designs so that drivers understand road function, enforcement (including camera enforcement), dynamic speed control for adverse conditions and Intelligent Speed Assistance, which has been shown to be a highly effective too for encouraging speed compliance.

The role of speed in crashes (why speed?)

Speed and injuries

Speed is a factor in virtually all injury crashes and the more severe the crash, the more it is a factor. This may be obvious, but it is often forgotten. It is a factor in injury crashes because had the participants been travelling more slowly, the outcome would have been a damage only accident. And because energy in a crash goes up with the square of a collision speed, crash forces go up exponentially with speed, leading to a much higher probability of a serious injury or fatality at higher speeds.

Of course with modern road design it is possible to provide safe travel at relatively high speeds. That is what motorways do. But motorways are unique: there is a very low probability of encountering opposing traffic, side collisions are unlikely, flows are generally smooth and homogeneous, and vulnerable road users such as pedestrians and cyclists are prohibited. Thus impacts tend to be relatively rare and impact speeds tend to be quite low, so that they can be managed by occupant protection systems. And high-speed motorways become unsafe under certain conditions: when visibility is impaired, when the surface becomes slippery, in high winds and with high traffic flows. All these lead to crashes and to the risk of secondary crashes when fast-moving vehicles collide with stopped or slowly moving vehicles. So speed management is relevant to motorways also.

Even with modern vehicle design it is not really possible to reliably protect belted occupants at very high impact speeds. The probability of a driver sustaining fatal injuries is 80% in a frontal collision, for which occupants are relatively well protected, at 90 km/h. For a side collision, it is 80% at 55 km/h (Richards, 2010).

Pedestrians have a higher risk of fatality in low-speed crashes. A pedestrian struck at 50 km/h has 7% chance of a fatality (this compares with 3% for a car driver in frontal collision), whereas one struck at 64 km/h has a 31% chance of incurring a fatality (Richards, 2010). That is the essence of "vulnerability" and is one of the major justifications for having low speed limits on urban roads in general and for 30 km/h (and even lower) speed limits on residential roads. An analysis of Korean data makes the risk at 50 km/h substantially higher: 34% (Oh et al., 2008). The explanation for this higher risk in Korea is not clear, but may be connected to a different vehicle mix.

Traffic speed and accident numbers

An overall model, known as the "Power Model", originally proposed by Anderson and Nilsson (1997) and by Nilsson (2004), presents a useful summary of the relationship between traffic speed and accidents of various severities. The initial modelled relationship is that changes in all injury accidents are proportionate to a change in mean speed for a length of road squared, serious injuries change with speed cubed and fatalities with speed to the fourth power. This means that, in general, a 10% reduction in mean speed will translate into a 34% reduction in fatalities. So, quite small changes in speed have a dramatic effect on serious injuries and fatalities.

Since that initial work, the Power Model has been further refined both in theoretical terms and by being calibrated to more extensive data. Elvik et al. (2004) pointed out that the injury categories in the first version of the Power Model overlapped, and recalculated the model based on studies from across the world. The best estimates of the model from that calculation are shown in Table 6.1. It can be seen that the exponent for fatalities is even larger than in the original formulation.

Table 6.1. **Exponents of the Power Model**

Injuries		**Accidents**	
Severity	Exponent	Severity	Exponent
Fatalities	4.5	Fatal	3.6
Serious injuries	3.0	Serious	2.4
Slight injuries	1.5	Slight	1.2

Source: Elvik et al, 2004.

Five years later, Elvik recalculated the exponents in the Power Model using an updated set of studies (Elvik, 2009). Table 6.2 shows the new set of exponents. It can be seen that the exponents have fallen somewhat, perhaps because of improved vehicle design which provides better protection to occupants and vulnerable road users.

Table 6.2**. Exponents of the Power Model**

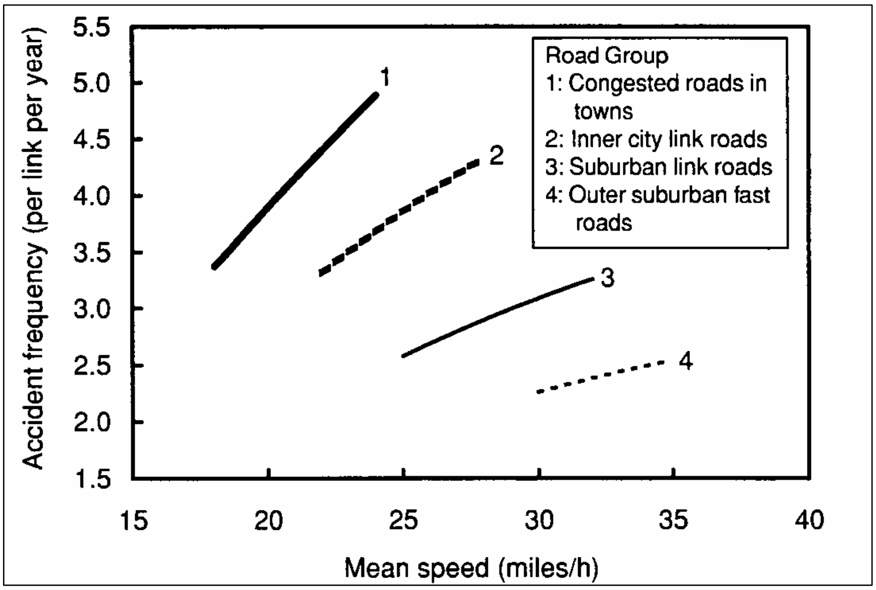
Injuries		**Accidents**	
Severity	Exponent	Severity	Exponent
Fatalities	4.3	Fatal	3.5
Serious injuries	3.0	Serious	2.0
Slight injuries	1.3	Slight	1.0

Source: Elvik, 2009.

Most recently, Elvik (2013) reanalysed the previous data set and compared exponential models with the Power Model. He found that exponential models better fitted the relationship between speed changes and overall injury accident numbers. He found that the Power Model provided a better fit with fatal accidents. He also pointed out that the exponential model was more plausible, in that changes of speed at the high end had a greater impact on accident number than changes in speed at the low end. However, the differences in predictions from the two formulations were not very large. It can thus be argued that the Power Model remains a reasonable predictor, and provides a useful shorthand for the fundamental rule that changes in traffic speed will have a far greater proportional effect on the numbers of severe accidents than on the numbers of slight accidents. Thus speed management is a very effective tool for reducing fatal and serious accidents.

Road quality also affects the relationship between traffic speed and accidents involving injuries. Increases or decreases in traffic speed have a greater impact on lower quality roads than on higher quality roads. Models developed with UK data have shown that not only do better-quality urban roads have lower accident rates, but also that on better quality roads changes in the mean speed of traffic have a smaller impact on accidents than is the case on lower-quality roads. This can be seen in Figure 6.1.

Figure 6.1. **Relationship between mean speed and accident frequency for urban roads**



Source: Taylor, Lynam and Baruya, 2000.

Another UK study looked at rural single carriageway roads and again found differences by road quality (see Figure 6.2). The categories established by the analysis were as follows:

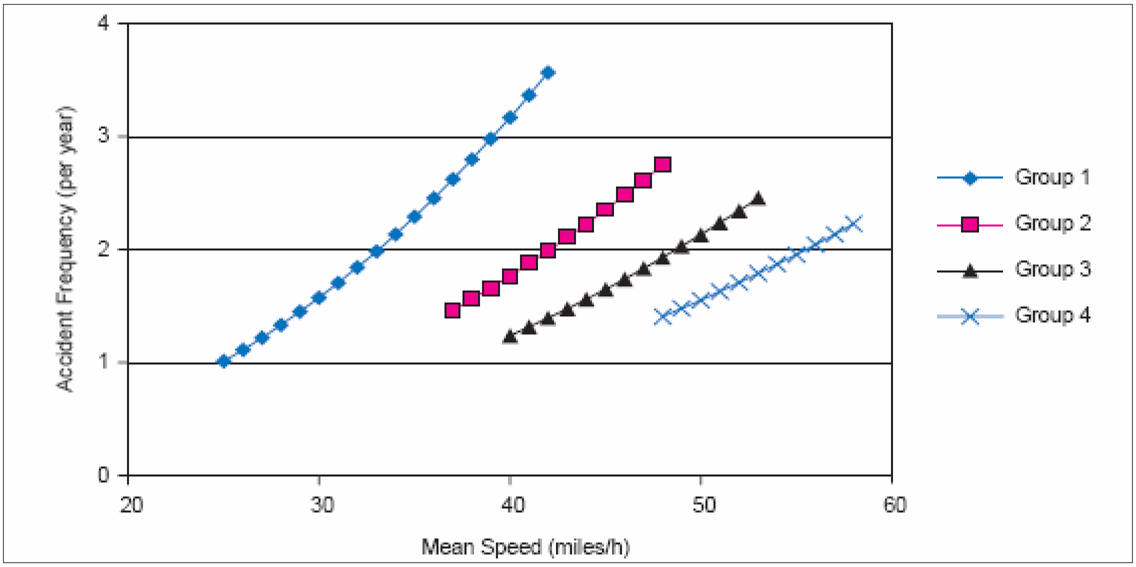
Group 1: Roads which are very hilly, with a high bend density and low traffic speed. These are *low quality* roads.

Group 2: Roads with a high access density, above average bend density and below average traffic speed. These are *lower than average quality* roads.

Group 3: Roads with a high junction density, but below average bend density and hilliness, and above average traffic speed. These are *higher than average quality* roads.

Group 4: Roads with a low density of bends, junctions and accesses and a high traffic speed. These are *high quality* roads.

Figure 6.2. **Relationship between mean speed and accident frequency for rural roads**



Source: Taylor, Baruya and Kennedy, 2002.

The same study concluded that, at junctions on single-carriageway roads, accident risk goes up with the mean speed of the main-road traffic to the fifth power. Here, the crashes tend to be high-speed side impacts, which result in intrusion into the vehicle with a high probability of serious injury or fatality to the occupants. Measures to slow main-road traffic at rural intersections will have a dramatic effect on accident numbers.

Individual vehicle speed and accident risk

Fewer studies have examined individual risk. Theoretically it can be argued that accident risk is related to the variability of traffic speed on a road. Higher speed variance leads to less smooth road operation and a greater chance of shock waves resulting from sudden changes in speed. High speed variance can result from:

- Large differences in speed between different categories of road user or vehicle (e.g. slow HGVs and fast cars, or slow elderly drivers and fast young drivers).
- Very high flows along a road (at saturation level), producing the phenomenon of sudden accelerations and decelerations in the traffic stream. This often occurs on crowded motorways.

Based on this, it can be argued that both slow moving vehicles in a faster traffic stream and faster vehicles in a slower traffic stream are incurring added risk. Such a relationship was in the form of a U-shaped curve, with vehicles going slower than the mean and vehicles going faster than the mean both at elevated risk, was found by West and Dunn (1971). The formula calculated in this study was as follows:

$y = 0.0139x^2 + 0.0140x$

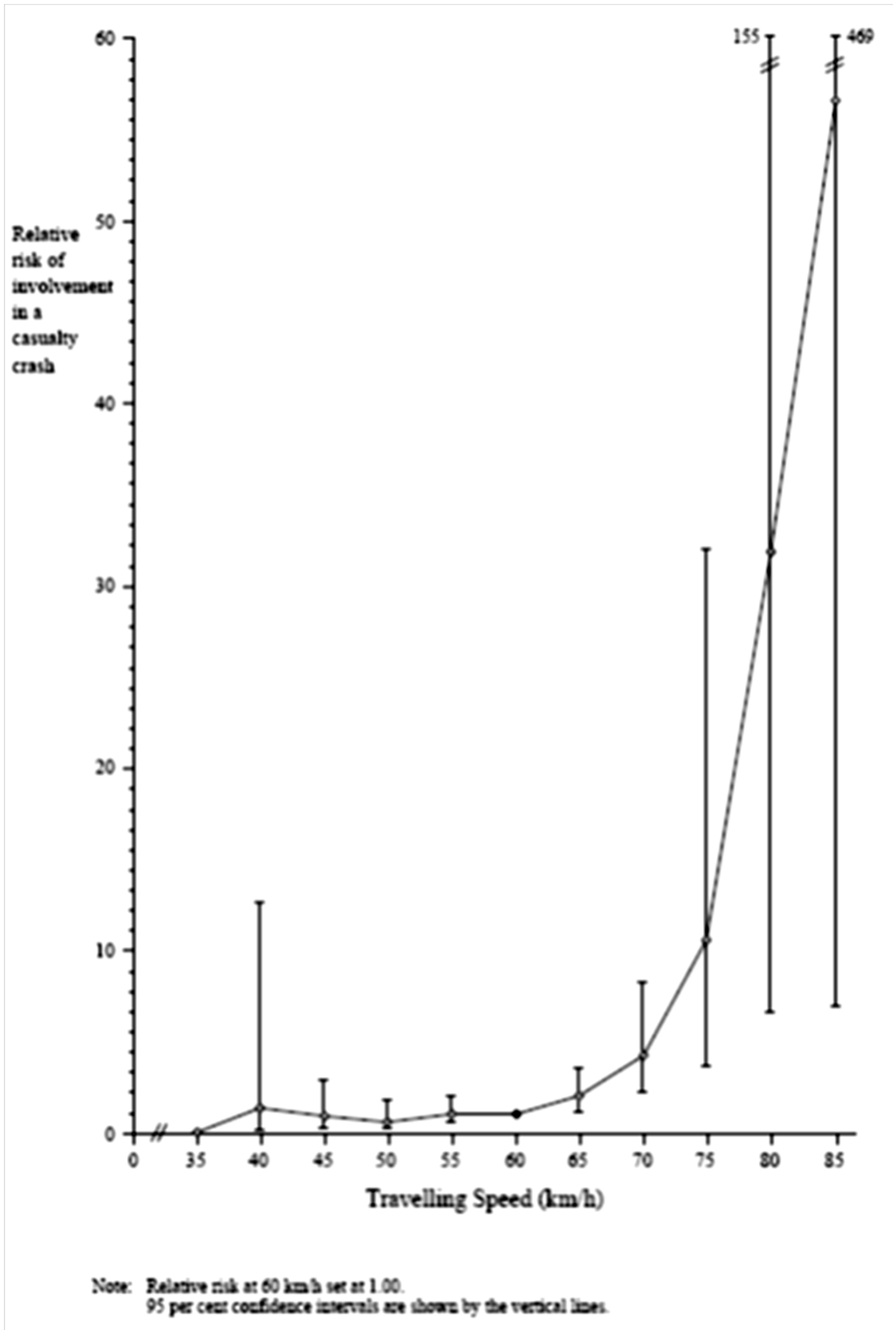
where y is relative risk

and x is speed difference of a vehicle from mean speed in mph

More recent studies have tended to find that risk only increases with travelling speeds *above* the mean speed of traffic or above the speed limit. Kloeden et al. (1997) investigated the relationship between speed compliance on urban roads and the risk of a vehicle being involved in a crash on 60 km/h road in the Adelaide metropolitan area. The study used a case-control methodology, in which case-vehicles were involved in accident crashes (speed before crashing was calculated by accident reconstruction) and control vehicles were matched vehicles observed in the traffic stream. The case-vehicles selected in this study were vehicles involved in crashes where at least one person was transported to hospital by ambulance, i.e. accidents involving a serious injury. The resulting prediction of risk by travelling speed is shown in Figure 6.3.

A subsequent reanalysis of the same data, using a logistic regression modelling technique, came to much the same conclusion about risk above the speed limit as shown in Figure 6.3 but concluded that vehicles travelling *below* the speed limit in free-flow conditions had a reduced risk (Kloeden et al., 2002).

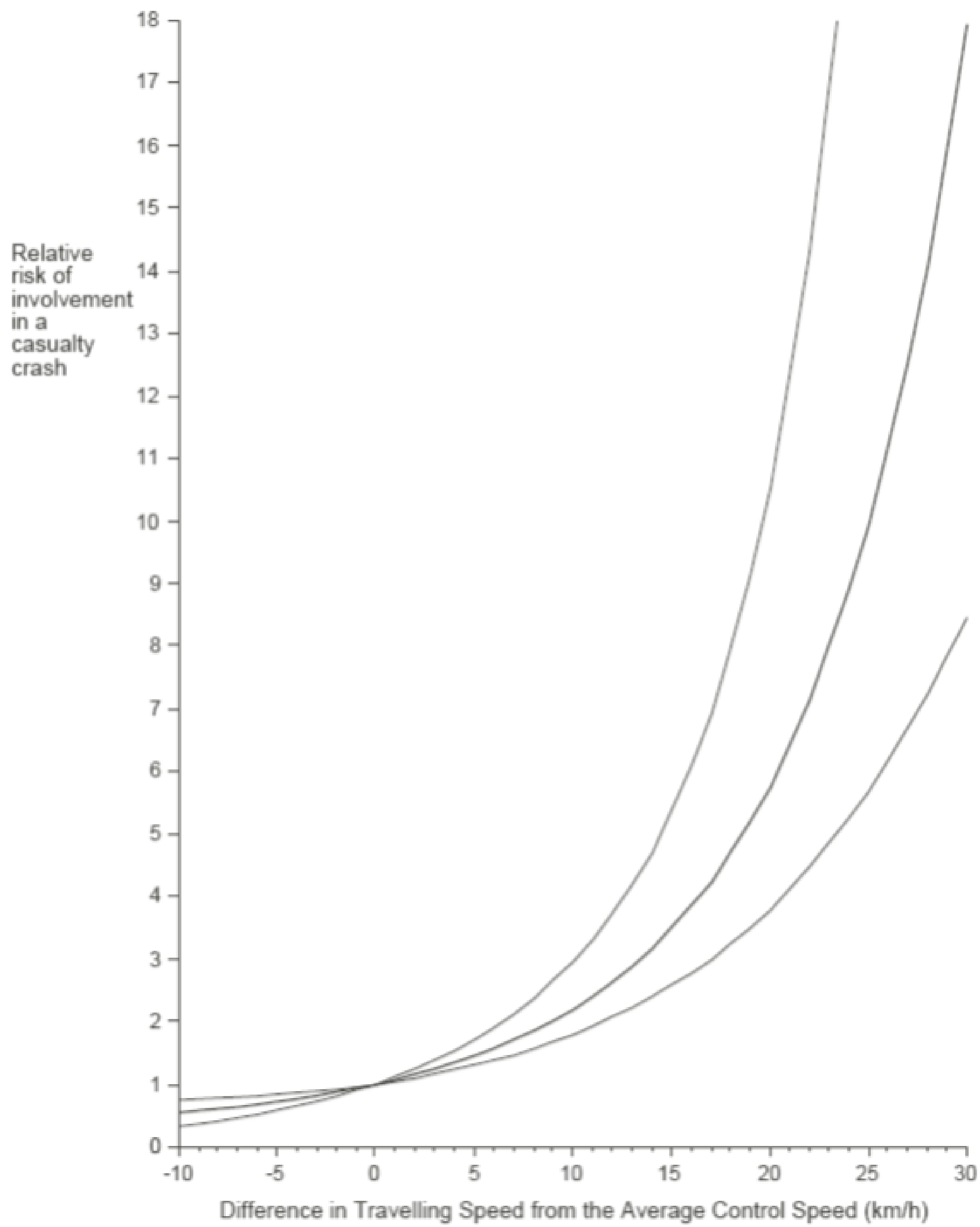
Figure 6.3. **Travelling speed and the risk of being involved in a serious injury crash relative to travelling at 60 km/h in a 60 km/h speed limit zone**



Source: Kloeden et al., 1997.

A study using the same methodology was carried out on rural roads with a speed limit greater than 80 km/h. Because of the variety of mean speeds observed in the traffic, it was decide to calculate relative risk for the crash-involved vehicles as compared to mean traffic speed. A logistic regression procedure was used and the results are shown in Figure 6.4. Once again, risk was reduced at relatively slow speeds.

Figure 6.4. **Relative risk of involvement in a serious crash compared to a driver travelling at mean traffic speed on rural roads**



Note: 95 per cent confidence intervals are shown by the thin lines

Source: Kloeden et al, 2001.

Unfortunately, similar models do not exist for other vehicle types, such as motorcycles and large trucks. However, since crashes involving both these types of vehicle tend to be more severe than crashes involving one or two cars, one can surmise that the risk curves of harm for both large trucks and motorcycles would be steeper than for passenger cars.

What is speed management?

Speed management is the application of a strategic approach to managing speeds on all road categories. It is an essential part of an overall road safety strategy, but other considerations, such as emissions management to improve air quality and curbing high speeds in order to maintain smooth traffic flows and thereby reduce incidents, may also be incorporated. Speed management is a vital element in an overall safety strategy and countries and territories that have been successful in their strategic approach to road safety have also invariably incorporated speed management as a major element in strategy.

Regime – how to identify appropriate speed limits

One question that immediately arises in creating a speed management strategy is what speed limits are appropriate. Here Sweden's Vision Zero philosophy that no traffic participant should suffer a fatality or serious injury can provide guidance. Speed limits should be set so that crashes, if they occur, will not result in a death or serious injury. So, human tolerance for injury and the potential for protecting humans in different circumstances can be used to establish speed limits on different kinds of roads. The assumption can be made that car occupants will use their seatbelts (of course, encouragement and enforcement will be needed to achieve this). Tingvall and Haworth (1999) propose that appropriate limits are:

- 30 km/h on urban roads where there is a potential for conflicts between pedestrians and cars
- 50 km/h on roads with intersections and hence the possibility of side collisions (this is because vehicle occupants are not so well protected in side collisions)
- 70 km/h where there is no possibility of a side collision median barrier and there is a risk of head-on collisions
- 100 km/h or even more where there is a median barrier and hence virtually no risk of a head-on collision.

It can be seen from this that urban speed limits on roads which pedestrians need to cross should be set at 30 km/h. In many cities in Europe it is now the norm to have 30 km/h speed limits on residential roads, but it is still common to have the speed limit on urban arterials set to 50 km/h. Serious and fatal accidents with pedestrians tend to occur precisely on those urban arterials.

Similarly, rural single-carriageway roads across Europe often have speed limits of 80 km/h or 90 km/h (96 km/h in the UK). Yet these roads also have intersections where serious and fatal crashes are often concentrated. It can be concluded that either the intersections need to be re-engineered to eliminate the potential for side collisions, or speed should be lowered. Sweden has been implementing the dynamic reduction of main road speed on rural roads around intersections: when a vehicle is detected wishing to enter from a side road, the limit is reduced from 90 km/h to 70 km/h (Lind, 2006).

Implication for South Korea

Serious consideration should be given to lower speed limits on urban roads. A limit of 30 km/h is a sensible default for residential streets. The current limit of 60 km/h on many urban roads is too high.

30 km/h zones and streets

The adoption of 30 km/h speed limits on residential roads is a well-proven means to reduce harm to vulnerable road users and improve the environment, particularly in residential areas. Lower speed limits are typically made self-enforcing by means of a variety of traffic calming measures. Those road engineering measures, involving vertical and/or horizontal deflection, can be designed so as to keep overall speeds within the desired range. The measures used often provide informal crossing points for pedestrians, e.g. with pinch points (sidewalk extensions) at intersections. Such zones are highly successful in reducing injury crashes. Evaluations indicate that reductions in the range of 40–60% in injury accidents and 50–70% in fatal and serious accidents can be achieved (Webster and Mackie, 1999; Webster and Layfield, 2003; Elvik et al., 2009).

Moving on from limited areas with 30 km/h zones that are reinforced with traffic calming, many cities have now moved to a policy of having 30 km/h as the default speed limit across the whole urban area, typically with some arterial roads still having a speed limit of 50 km/h. Graz in Austria is perhaps the most famous example (http://www.eltis.org/discover/case-studies/citywide-30-kmh-speed-limit-city-graz-austria), starting implementation in 1992. In Graz, overall reductions in serious accidents of 25% were achieved initially, although subsequently there was an upwards reversion in accident numbers, in part because of low levels of enforcement. It should, however, be noted that in Graz (as elsewhere) 80% of injury accidents occur on arterial roads.

So it is sensible also to focus on such arterial roads. Recently the principle that most urban roads have mixed uses (vehicle traffic, cyclists, motorcyclists, pedestrian activities) has been used to apply traffic calming measures on arterial roads in urban areas. Perhaps the best-know example of a city that has used a variety of calming techniques on urban arterials is Portland, Oregon. Schemes implemented in a variety of towns in the UK were generally successful in reducing injury accidents and also had a number of other benefits — increased walking and cycling, benefits to businesses along the routes and increased patronage of buses. Expected reductions in casualties are of the order of 30% (Department for Transport, 2011).

Seasonal and weather-related speed limits

Weather and road surface conditions may require lower limits. Slippery road surfaces from rain, ice or snow can require lower limits, while reduced visibility from fog is particularly hazardous, especially on motorways *where* drivers may think it appropriate to follow a fast-moving lead vehicle, unaware that a traffic queue ahead may be invisible.

French motorways have a speed limit of 130 km/h in dry conditions, but this is reduced to 110 km/h when the surface is wet. In Finland, the speed limit on motorways is reduced from 120 km/ to 100 km/h in winter and from 100 km/h to 80 km/h on most rural two-lane roads. It should be noted that in Finland, as in other Nordic countries, vehicles are required to have winter tyres in the winter months.

There have also been trials in Finland of dynamic systems to further lower the winter speed limit in adverse conditions — when the weather indicated that the road surface was slippery, in poor visibility and in high winds (Rama, 1999). Slippery conditions were the most common. In adverse conditions, the limit was reduced from 100 km/h to 80 km/h. Drivers were in some cases informed of the lower speed limit by means of VMS signs which also conveyed the reason for the lower limit. The evaluation indicated that there was an additional effect of the lower limit and signs on free-flow speeds. Without the lower limit, mean traffic speeds reduced by 6.3 km/h. With the dynamic limit of 80 km/h, there was a further reduction of 3.4 km/h. In those situations when the lower limit was accompanied by the slippery road warning sign, the prevailing weather and road surface conditions reduced traffic speeds by 9.3 km/h with the combination of lower limit and slippery road warning bringing about a further reduction of 1.8 km/h. There was also an effect that the signs reduced speeds on adjacent road sections.

Automatic fog-warning systems on motorways are another means to curtail inappropriate speeds in bad conditions. The evaluation of the system installed on the M25 orbital motorway around London found that the effect of the signs being active was to reduce mean speed by approximately 3 km/h (Cooper and Sawyer, 1993) which is meaningful in safety terms. A Dutch fog warning system installed on the A16 motorway, that varied maximum speed limit depending on the detected visibility, was evaluated by Hogema and van der Horst (1997). The evaluation found that the system reduced mean speed in fog by 8 to 10 km/h. The standard deviation of speed was also slightly reduced. There was an indication of somewhat higher speeds with system activation in conditions of very low (less than 35 m) visibility, indicating perhaps that the lower speed limit of 60 km/h was not low enough.

Encouraging drivers to comply with appropriate speeds

Self-Explaining Roads (SER)

The concept of SER is that drivers and riders should be able to understand road function and what kinds of traffic mix to expect from the design and layout of a road. Thus road design should indicate road function, appropriate speed, permitted manoeuvres and the presence or absence of animals, moped riders, cyclists and pedestrians. The argument is that, apart from motorways, which have a fairly universal and well-understood layout, drivers are often confused about road function. We design wide, multilane urban arterials, post 50 km/h speed limits on them and expect drivers to comply with that limit although all the road features indicate that the road is safe at considerably higher speeds. Similarly, we have rural roads of low quality (narrow with sharp horizontal and vertical curvature), where the posted limit is 80 or 90 km/h.

One of the problems is that there are often too many functional categories of roads. For urban roads, we can have through roads, district distributors, local distributors and access roads (local streets). Even the traffic engineers might get confused, let alone road users. So a fundamental aspect of designing a road network that is understandable to road users is to reduce the number of road categories. The Dutch

Sustainable Safety approach proposes six categories overall: the three major road functions of flow (through traffic), distributor and access with the two land-use categories of urban and rural.

The SER concept originated in the Netherlands (Theeuwes, 1994; Theeuwes and Godthelp, 1995). A comprehensive literature review has been carried out by the SPACE project (Charman et al., 2010). The link to the SER concept to driver behaviour and speed choice has been stated by Martens et al. (1997): "The traffic environment should provoke the right expectations concerning the presence and behaviour of other road users as well as the demands with regard to their own behaviour. In order to reach this goal, clearly distinct road categories must be used, each requiring their own specific driving behaviour."

In this context, Hakkert (2011) has drawn an interesting contrast between "roads" and "streets". Roads have the primary function of serving traffic, whereas streets serve multiple functions — shopping, entertainment, eating and drinking, meeting, etc. As a result, for streets in particular, there needs to be appropriate consideration of the needs of multiple users.

In the Netherlands, there has been a comprehensive programme to redesign roads to the categories of the Sustainable Safety strategy. Of course, this is a long-drawn-out process and one that has by no means been completed as yet. There is a lack of solid evidence on the overall real-world impact of redesigning roads according to the SER concept (Charman et al., 2010), although there is evidence for success of particular redesigns of road layout, such as the Swedish 2+1 rural road, which uses a median barrier to prevent head-on collisions and prohibit overtaking into the opposing traffic stream; or the 2-1 road design which has been applied in Denmark, Sweden and the Netherlands to reduce speed and discourage overtaking on relatively narrow rural roads (Trafitec, 2007; Erke and Sorensen, 2008). However, the lack of evidence on the overall rollout of the SER concept, e.g. in the Netherlands, is not very surprising: the concept is so wrapped up in the overall Dutch safety strategy (which has been a general success story) that it is hard to single out the effect of this particular element.

Dealing with speed transitions: "psychological traffic calming"

It is well known that, following a prolonged period of high-speed driving, drivers may have difficulty in perceiving their true speed when they have to reduce their speed. They tend to overestimate their speed reduction. This creates a need to reinforce the perception of driving speed, particularly at transitions to lower speed limits, on the entry to towns and villages, on the approach to intersections and on the approach to sharp curves. One method to induce a sensation of travelling at high speed is through the use of so called "psychological traffic calming" where road features and markings are used to create a heightened awareness of the need to slow down and/or of entry into a lower speed zone. An example of an entry treatment is the now widely used installation of a "gateway" at village or town entry as shown in Figure 6.5.

Figure 6.5. **Example of a village entry gateway treatment**

Source: Oliver Carsten

Systematic development and testing of these techniques for encouraging drivers to slow down at speed transitions and on the approach to dangerous locations has been mainly down in driving simulator studies. One example is the study of Jamson et al. (2008). This investigated treatment for a number of situations:

- the approach to urban junctions
- the approach to rural junctions
- the approach to rural bends
- village entry.

It also examined psychological calming measures for urban and rural straight road sections, where it might be desirable to slow drivers down by creating a feeling of high speed. A major criterion used in the testing was the durability of the effect, i.e. a demonstration that it would work on repeated experience rather than wearing off after the initial encounter. The most successful treatment for a rural bend is shown in Figure 6.6; it produced a reduction in mean speed at curve entry of 3.4 km/h as compared with no treatment. The countdown signs that were the most effective treatment for the approach to village entry, with a speed reduction of 4.7 km/h as compared with no treatment, are shown in Figure 6.7. The most effective solution for rural straight sections was very similar to the 2–1 concept. These speed reductions are highly significant in safety terms. However, a real-world evaluation to substantiate that the selected treatments worked in the real word has not so far been carried out.

Figure 6.6. **Recommended treatment for approach to rural bend**

Note: Note that this is for the UK with speed signs in miles per hour and driving on the left.

Source: Jamson et al, 2008

Figure 6.7. **Recommended treatment for approach to village**

Source: Jamson et al, 2008.

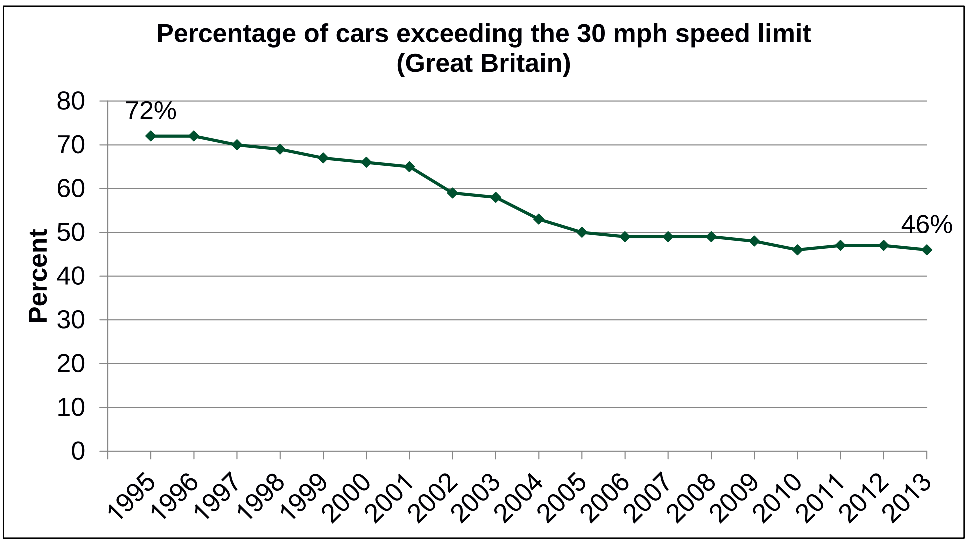
Enforcement

Speed cameras have been shown to be one of the most effective tools for increasing compliance with speed limits and reducing injury crashes associated with excess speed. The UK now has some 3 500 fixed speed cameras, though not all are active at any one time. There is also a regime such that drivers earn points on their licences for speed violations and typically lose the licence after four speeding offences within a period of three years. In fact, rather few drivers actually get to four speeding tickets in three years, indicating the strong deterrence effect of the potential loss of licence.

Speed cameras do bring about a localised improvement in safety (Mountain et al., 2005; Hirst et al., 2005; Allsop, 2010), but more important is their general effect on compliance with speed limits and hence on safety performance.

There has been a steady improvement in compliance with the standard urban speed limit of 30 mph (50 km/h) in the UK over the years since 1995 as shown in Figure 6.8 (the same improvement has not taken place in terms of compliance with the speed limit on motorways). It used to be the case that only 38% of car drivers complied with the limit in free-flow conditions; now 54% do so. This constitutes a very substantial improvement and can be linked to the overall national improvement in safety performance as well as the reduction in injuries to pedestrians, e.g. a reduction of 62% in pedestrian fatalities between 1995 and 2013.

Figure 6.8. **Compliance with 30 mph urban speed limit in Great Britain**



Average speed cameras, also known as "time over distance" cameras, are increasingly replacing single speed cameras. They use number-plate matching to measure speed over a section. They induce more steady traffic flows, whereas in the case of stand-alone speed cameras there is a tendency for some drivers to brake just before a camera and to accelerate after passing the camera. In London, such cameras are now being used to enforce 20 mph (30 km/h) zones.

Campaigns and acceptance

Accompanying the increased enforcement in the UK, there has also been a very effective campaign of persuasion, particularly focused on urban speeds (DfT, 2009). So drivers have not just been scared into compliance, they have been persuaded to do so. That, no doubt, helps to explain the general improvement in compliance which extends far beyond the well-publicised sites of speed cameras.

Public acceptance of speed management, and in particular of the lowering of speed limits, has been reviewed by Turner et al. (2014). On the basis of their literature review, they concluded that it was important to accompany any reduction of speed limits with information to the public about the justification for the change, covering the areas of safety, mobility and the environment. Predictions of the effects on safety will help to secure support. After the change, there needed to be feedback to politicians and the public about the impacts on safety. In addition, while there might be significant advance opposition to lower speed limits, once the reductions were implemented, drivers did tend to respond that they were travelling at lower speeds, i.e. complying, and only a small minority believed that lowering the speed limit of a road had impeded accessibility. Their review of the literature ends with the following summary:

Overall, it could be concluded that while the driving public might not yet be ready to accept lower travelling speeds without question, the compelling arguments for their implementation are likely to help drivers rationalise the changes and justify their acceptance, backed up – as with practically all road safety messages – by levels of enforcement to ensure compliance in the short to medium term until such time as the majority of road users accept the new regime as the norm.

Turner et al. (2014) carried out their own survey of public attitudes in New Zealand. They found that there was greater support for lowering speeds on shopping streets than on residential streets and that a majority were opposed to reducing the speed limit on 100 km/h single-carriageway rural roads by 10 km/h. On the other hand, they found that, overall, there was a good understanding of the link between speed choice and road trauma. They suggest that road authorities should anticipate some public opposition to lowering limits and encourage those in the community who support such changes to be more vocal.

ITS solutions

Smart motorways

"Smart" or "Managed" motorways are becoming a standard way of managing high traffic flows on motorways (http://www.highways.gov.uk/our-road-network/managing-our-roads/improving-our-network/smart-motorways/). Typically speed limits are reduced when traffic builds up towards the critical 2000 vehicle per lane per hour. The aim of the speed limit reduction is to reduce speed variance and the propensity for shock waves to cause incidents and accidents. The overall aim is to maintain throughput, but the schemes typically bring about a reduction in crashes and secondary crashes. Speeds are enforced with automatic enforcement (video-based time over distance cameras in the more recent schemes). The use of the hard shoulder for through traffic at times of high congestion is a common feature.

Intelligent Speed Assistance (ISA)

Intelligent Speed Assistance, also known as Intelligent Speed Adaptation, is the driver assistance system that brings speed management into the vehicle. The aim of ISA is to discourage or even prevent speeding, by informing drivers about the speed limit for a road, warning them about excess speed and in the most sophisticated systems preventing speeding by use of an electronic speed limiter. The fundamental distinction in ISA is between *advisory* (warning) systems, which typically beep at the driver when speeding over a certain threshold is detected, and intervening systems, which typically limit speed at, or just over, the speed limit. Intervening ISA systems can be further separated into *overridable* systems, where the driver has the possibility of disengagement of the limiter, and *mandatory* systems with no override possibility. Mandatory ISA is not currently being considered for real-world deployment, although it has been implemented on research vehicles.

Advisory ISA is already on the market — it is a feature in many commercial satellite navigation systems, although it is normally up to the end-user to implement the function. For many countries, including most of Europe and North America, the maps in commercial Satnav systems have quite accurate speed limit information — the map-makers claim well over 95% coverage — but changes to speed limits tend not to come through very fast. Collaboration between highway authorities and map-makers to provide a fast-responding map update service is therefore needed. A European platform for voluntary collaboration has been established.

Manually set speed limiters are available in many vehicle models. However, no vehicle manufacturer currently offers a full intervening ISA.

ISA has been trialled extensively in real-world driving (so-called Field Operational Tests). Thus there have been trials of advisory and intervening ISA in Sweden and France, of advisory ISA in Denmark, the United States (Michigan), Australia (New South Wales) and the UK, of intervening ISA in the UK and Belgium and of non-overridable intervening ISA in the Netherlands. Most of those studied ISA in isolation, sometimes with additional financial incentives to encourage compliance, but in a few countries trials were conducted examining ISA in comparison to, and in conjunction with, other systems. Examples here are the Belonitor trial in the Netherlands, which looked at an informative ISA combined with headway information and with incentives to comply, and the TAC SafeCar project in Australia which investigated intervening ISA in conjunction with headway warning and seatbelt reminder. References to most of these trials can be found in Carsten (2012).

These trials have generally produced rather positive results in terms of behaviour, showing that the use of ISA in all its forms brings about a significant reduction in speeding. Figure 6.9 shows the speed distribution on urban 30 mph (50 km/h) roads for the 79 car drivers who participated in the ISA-UK trials in the period 2004 through 2006. They were using an overridable ISA. They drove one month in the "before" period without ISA, four months in the "during" period with ISA active and a further one month in the "after" period with ISA again deactivated. It can be seen that the ISA system had a substantial impact in curtailing speeding, although in the "during" period there was still some speeding because of the ability to override. The amount of driving in the speed range just over the limit is explained by the design of the ISA system, which gave the drivers some margin before cutting in. A similar pattern can be seen in Figure 6.10, which shows the speed distribution on the 70 mph (112 km/h) roads which are mainly motorways.

Figure 6.9. **Speed distribution on 30 mph roads from ISA-UK trials**

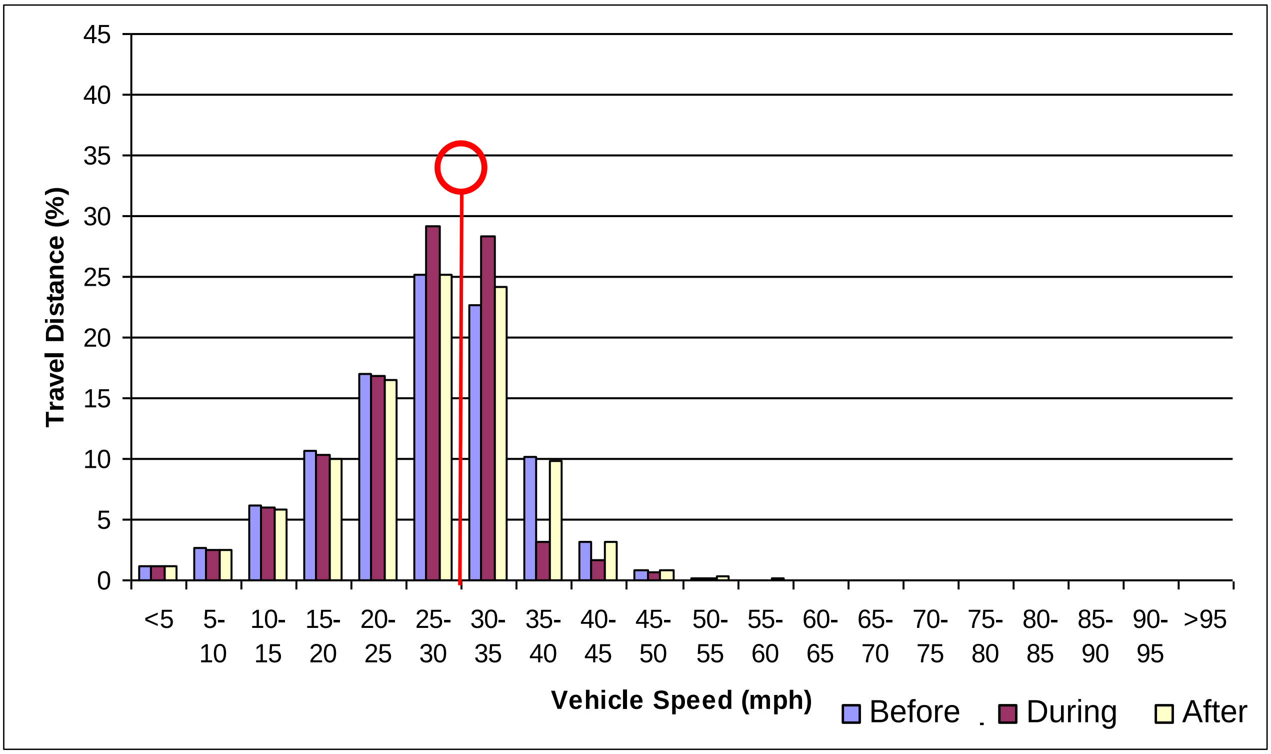
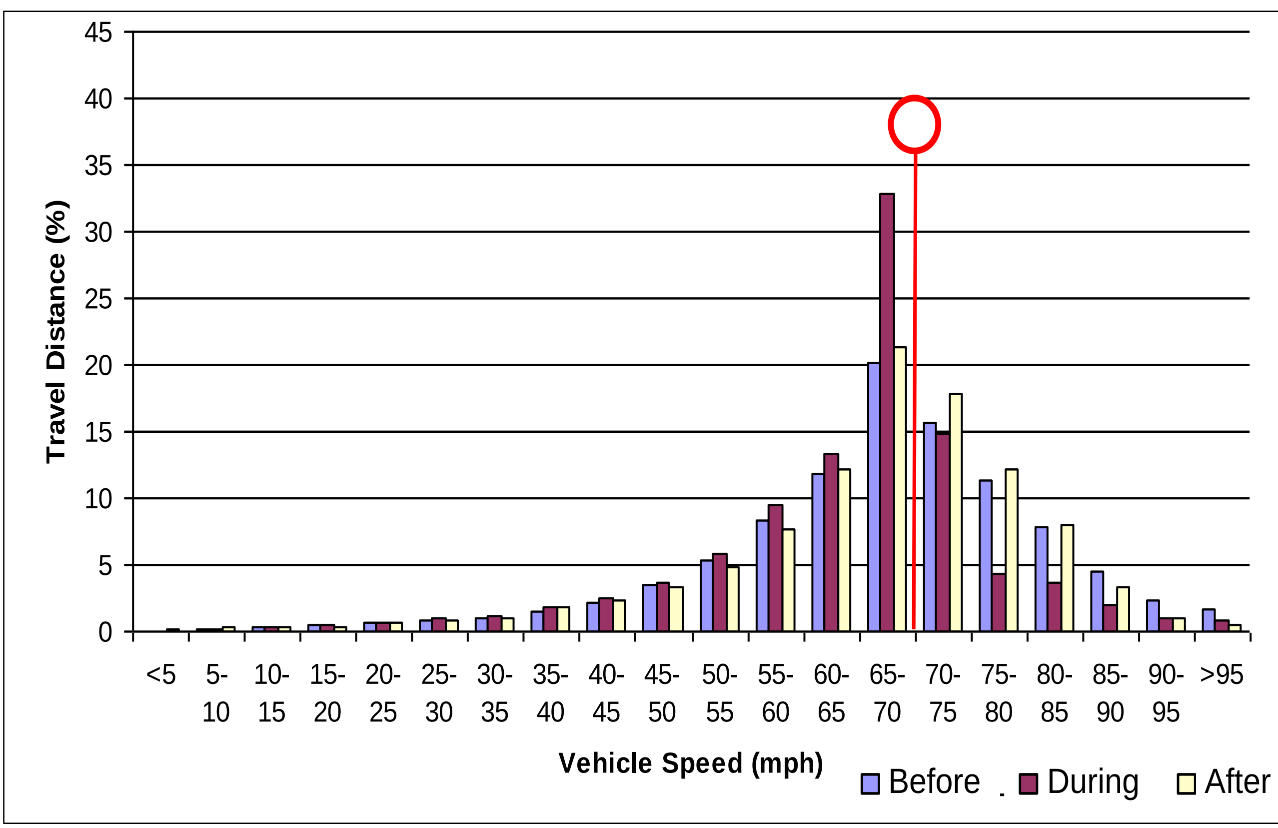


Figure 6.10. **Speed distribution on 70 mph roads from ISA-UK trials**



The various trial results also indicate a reasonable level of acceptance by users, even though users might feel somewhat disadvantaged by having ISA in that they can see other drivers travelling faster than they are.

Using well-validated models of the relationship between driving speeds and risk, calculations of the impact of ISA on accidents have been made. Probably the most comprehensive set of calculations is that from the trials conducted in the ISA-UK project. The prediction is that an advisory ISA in general use would save 3% of injury accidents and an intervening ISA would save 12% of injury accidents and 20% of fatal accidents. In its strongest variant (i.e. in a non-overridable version), the predictions is that ISA would deliver a 29% reduction in injury accidents (Lai et al., 2012). Applying the power model of Elvik et al. (2009), this translates into a 45% reduction in fatal accidents. In other words, shifting drivers from their current state of compliance with speed limits to virtually full compliance can cut the number of fatal accidents almost in half in a country that has quite good current compliance in international terms. For countries with poorer performance, the impact would almost certainly be substantially greater. The estimated benefit-to-cost ratio (BCR) from ISA-UK is 7.4 for a scenario in which the authorities actively promote ISA deployment through regulation (Lai et al., 2012).

Based on the evidence for the very large safety potential of ISA, new cars fitted with ISA systems are now given extra points on the overall safety ratings of Euro NCAP as part of the "Safety Assist" protocol which rates various assistance systems as well as seatbelt reminders. Cars with intervening ISA score more highly than cars with an advisory ISA. Extra points are also given for vehicles that combine map-based ISA with a camera-based sign recognition system.

Two recent European studies have highlighted the very large safety potential of ISA. Vaa et al. (2014) examined the safety potential for Norway of a number of driver assistance systems, including Adaptive Cruise Control, alcolocks, seatbelt reminders, Electronic Stability Control and fatigue warning. The conclusion was: "The most effective driver support system is ISA" (page 50). Similar conclusions are being reached by the current review of the General Safety Regulation of motor vehicles for the European Commission (Hynd et al., 2014). That report confirms the benefits and also states that, since the costs of ISA equipment has reduced over time, previous estimates of the benefit-to-cost ratios (BCR) for ISA may have over-estimated the costs. The BCR is therefore likely to be higher than previously suggested.

The future – cooperative ITS

Cooperative Intelligent Transport Systems (C-ITS) systems are based on vehicle-to-vehicle (V2V) and infrastructure to vehicle (I2V) communication. They are the focus of increasing attention by road authorities because of their potential to improve management of the roads and improve safety. In the United States, NHTSA is considering a requirement for new vehicles to be equipped with V2V capability. In Europe, the transport directorate of the European Commission has established the C-ITS Platform of experts to advise on deployment of Cooperative ITS.

ISA is one of the systems that could take advantage of I2V communications. Maps could be updated over the air, and C-ITS could enable dynamic ISA systems in which the speed limits were adjusted according to the prevailing conditions, just as they currently are in Smart Motorway management. So dynamic speed management could be extended to all roads, without any need for the expensive installation of variable message signs. The communications technology for this could be based on existing mobile phone networks. The European DRIVE C2X project has recently evaluated a range of C-ITS functions. A version of ISA, i.e. in-vehicle signage particularly for speed signs, was the top-ranked system for safety potential with a predicted reduction of approximately 22% in fatalities with full introduction (DRIVE C2X Final Report, forthcoming). Thus a dynamic capability in ISA can add considerably to its overall safety impact (see also Carsten and Tate, 2005).

Success stories

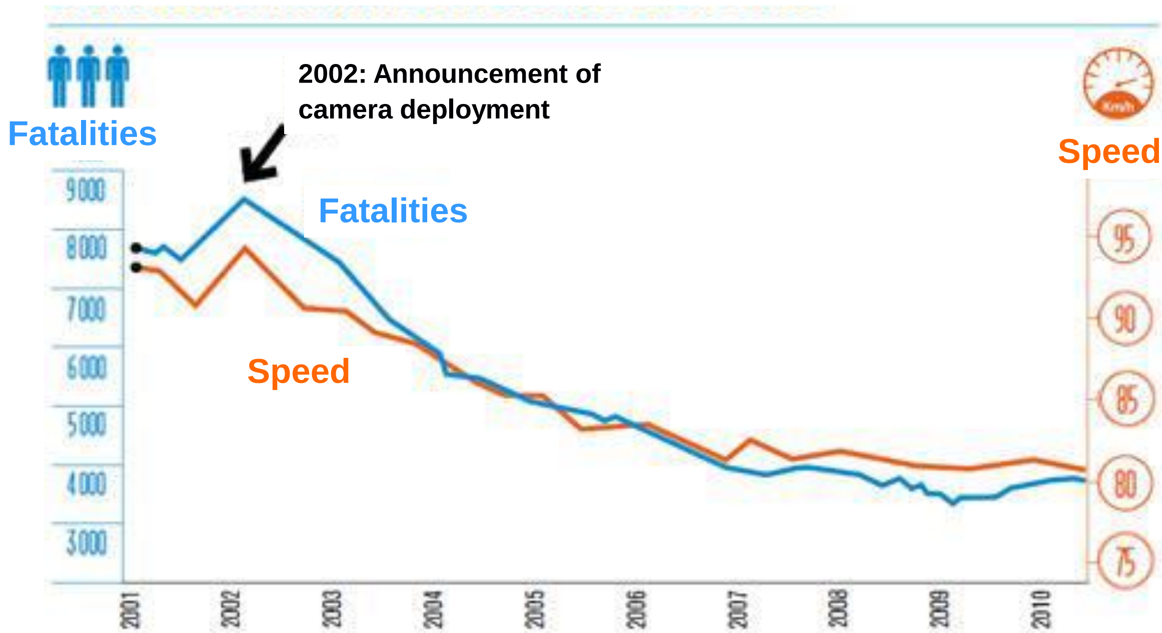
Perhaps the most striking success story on speed management has been France. Aware that France's overall safety performance was twice as bad as that of the UK, President Jacques Chirac implemented in 2003 a highly publicised programme of speed and alcohol enforcement (Figure 6.11). The main tool for speed enforcement was the deployment of speed cameras accompanied by strict penalties. As in the UK, speeding tickets incurred points and the potential for loss of licence. Fatalities in France fell very rapidly from around 8 500 per year to around 4 000 over a period of five years (Source: Oliver Carsten

Figure 6.12). This shows what can be achieved with determination in a short period.

Figure 6.11. **French warning sign — "Automatic control for your safety"**

Source: Oliver Carsten

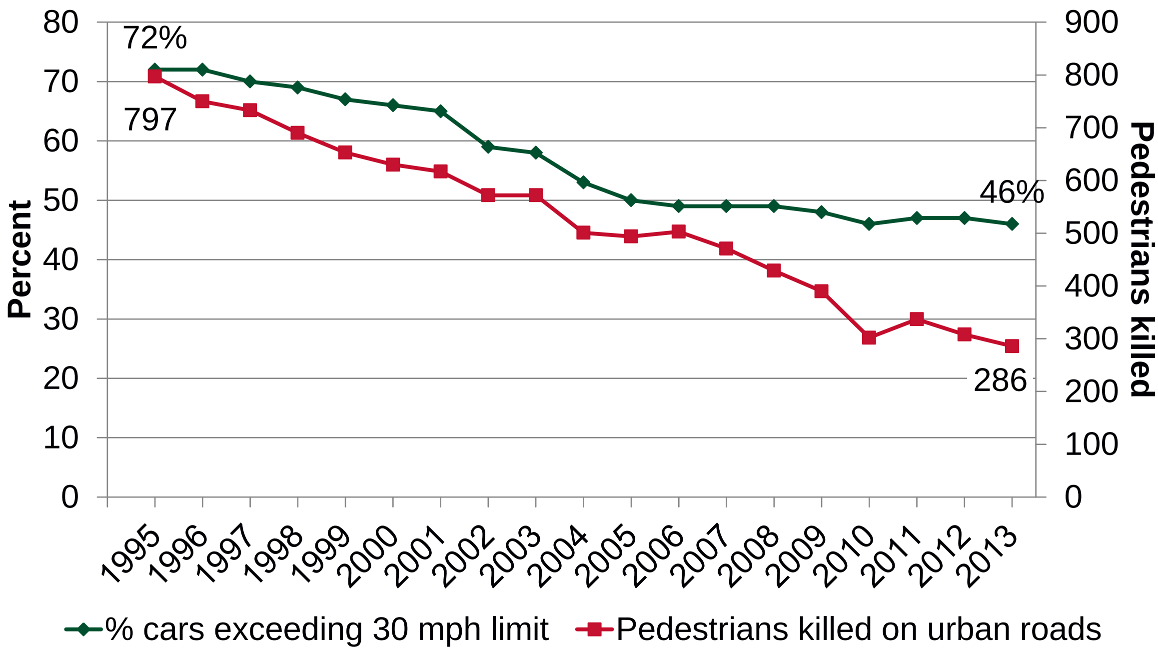
Figure 6.12. **France — the decline in fatalities matches the decline in speed**



Source: Canel, 2013.

The UK constitutes another success story. Figure 6.13 shows the proportion of cars exceeding the 30 mph urban speed limit in free-flow traffic conditions and the number of pedestrians killed on roads with a speed limit lower than 50 mph (80 km/h). It can be seen that there has been a very steady improvement in compliance with the standard urban speed limit of 30 mph, and that this has been accompanied by a steady decline in pedestrian fatalities, which (as predicted by the Power Model) has fallen at an even faster rate than the proportion of car traffic exceeding the limit. It can also be seen that there is very close correspondence between the shape of the two trend lines.

Figure 6.13. **Compliance with the 30 mph (50 km/h) speed limit and pedestrian fatalities, Great Britain 1995-2013**



Denmark, too, constitutes a success story. Like the UK and France, Denmark has experienced a year-on-year improvement in speed compliance (ETSC, 2014). Mean speeds have declined steadily: by an average of 2 km/h on rural roads and 1 km/h on urban roads since 2009. There, too, there has been a strong correlation between the trend in mean speeds and the number of persons killed in accidents.

What are the wider social implications of speed management?

It is often argued that lower speed limits impose unacceptable social costs, resulting in particular from increased travel times for private cars, buses and freight operations. The MASTER project created a framework for evaluating the various costs and benefits associated with speed management implementations, including changes in speed limits. This framework considers travel time, casualties from traffic accidents, environmental aspects (noise and emissions) and vehicle operating costs. Cameron (2000) applied this framework to establish the optimum speed limit for urban residential roads and concluded that an overall speed limit of 50 km/h was optimal. Cameron (2003) applied the same framework to assess the social costs and benefits of speed limit changes on rural roads in Australia. Road categories considered were motorways, dual carriageways and single-carriageway roads. He concluded that increases in speed limits were extremely hard to justify. Raising the speed limit for light vehicles from 110 to 130 km/h on rural motorways would have substantial social costs. A dynamic system with speed limits for light vehicles increased to 120 km/h in good conditions only would result in an overall reduction in social cost, but would also increase road trauma. Any higher speed limits on non-motorway dual carriageways, including dynamic regimes that operated only in good conditions, would result in increased overall social costs. For rural single carriageway roads, even those of high quality, any increase in speed limit would inevitably raise social costs. On roads with poorer alignment, i.e. curvy roads, Cameron concluded that limits should be substantially reduced from the then prevailing 100 km/h. The implications are that lower limits are almost always justifiable on lower quality in rural roads. It can also be noted that higher speed limits are associated with high vehicle operating costs and increased environmental damage.

Korea

Korea has an urgent need for a serious speed management programme. Overall safety performance does not match that of many industrial countries, far too many pedestrians are killed (OECD, 2012), speed limits in urban areas are too high (roads typically have a 60 km/h limit which, although lower than the previous limit of 80 km/h is incompatible with human tolerance for injury in pedestrian crashes), and there does not appear to be a programme of systematically reviewing the appropriateness of speed limits on rural roads. New technologies in the form of ISA provide an opportunity for Korea to take advantage of innovative tools for speed management and could deliver substantial improvement in safety performance in a short time.

References

Allsop, R. (2010), “The effectiveness of speed cameras: a review of evidence”, RAC Foundation, London.

Andersson, G. and Nilsson, G. (1997), “Speed management in Sweden”, Swedish National Road and Transport Research Institute (VTI), Linköping.

Cameron, M.H. (2000), “Estimation of the optimum speed on urban residential streets”, Monash University Accident Research Centre, Monash, Australia.

Cameron, M. (2003), “Potential benefits and costs of speed changes on rural roads”, *Road Safety Research Report CR216,* Australian Transport Safety Bureau, Canberra.

Canel, A. (2013), “Speed management and enforcement as life-saving tools”. ETSC Road Safety PIN Talk, Vilnius, Lithuania, 13 November. European Transport Safety Council, Brussels.

Carsten, O. (2012), “Is Intelligent Speed Adaptation ready for deployment?”, *Accident Analysis and Prevention*, 48: 1-3.

Carsten, O.M.J. and Tate, F.N. (2005), “Intelligent Speed Adaptation: accident savings and cost–benefit analysis”, *Accident Analysis and Prevention*, 37(3): pp.407-416.

Charman, S., Grayson, G., Helman, S., Kennedy, J., de Smidt, O., Lawton, B., Nossek, G., Wiesauer, L., Fürdös, A., Pelikan, V., Skládaný, P., Pokorný, P., Matějka, M. and Tučka, P. (2010), “Self-explaining roads literature review and treatment information”, Deliverable 1 of SPACE (Speed Adaptation Control by Self-Explaining Roads), TRL, Crowthorne, UK.

Cooper, B.R. and Sawyer, H.E. (1993), “Assessment of M25 automatic fog-warning system: final report”, Project Report 16, Transport Research Laboratory, Crowthorne, UK.

Department for Transport (2011), “Mixed priority routes: results update and cost review”, Department for Transport, London.

Elvik, R. (2013), “A re-parameterisation of the Power Model of the relationship between the speed of traffic and the number of accidents and accident victims”, *Accident Analysis and Prevention*, Vol. 50 pp.854-860.

Elvik, R. (2009), “The Power Model of the relationship between speed and road safety: update and new analyses,” *TØI report 1034/2009,* Institute of Transport Economics, Oslo, Norway.

Elvik, R., Hoye, A., Vaa, T. and Sorensen, M. (2009), *The handbook of road safety measures,*second edition, Emerald Group Publishing Limited, Bingley.

Elvik, R., Christensen, P. and Amundsen, A. (2004), “Speed and road accidents: an evaluation of the Power Model”, *TOI Research Report 740/2004*, Institute of Transport Economics, Oslo, Norway.

Erke, A. and Sorensen, M. (2008), “Extended road shoulders on rural roads: a measure for cyclists and pedestrians?”, English summary of TØI-report 961/2008, Institute for Transport Economics, Oslo, Norway.

ETSC (2014), Report of Danish Road Safety Council to Main Council Meeting, 28 November, European Transport Safety Council, Brussels.

Hirst, W.M., Mountain, L.J. and Maher, M.J. (2005), “Are speed enforcement cameras more effective than other speed management measures? An evaluation of the relationship between speed and accident reductions”, *Accident Analysis and Prevention*, 37 (4) pp.731-741.

Hynd, D., McCarthy, M., Carroll, J.A., Seidl, M., Edwards, M., Visvikis, C., Reed, N. and Stevens, A. (2014), "Benefit and feasibility of a range of new technologies and unregulated measures in the fields of vehicle occupant safety and protection of vulnerable road users", Draft Project Report, Annex 1. TRL, Crowthorne, UK.

Jamson, S., Lai, F., Jamson, H., Horrobin, A. and Carsten, O. (2008), "Interaction between speed choice and road environment", *Road Safety Research Report 100*, Department for Transport, London.

Kallberg, V-P. and Toivanen, S. (1998), "Framework for assessing the impacts of speed in road transport". Deliverable D8 of MASTER (Managing Speeds of Traffic on European Roads), VTT Communities and Infrastructure, Helsinki, Finland.

Kloeden, C.N., McLean, A.J. and Glonek, G. (2002), "Reanalysis of travelling speed and the risk of crash involvement in Adelaide South Australia", CR 207, Road Accident Research Unit, University of Adelaide, Australia.

Kloeden, C.N., Ponte, G. and McLean, A.J. (2001), "Travelling speed and the risk of crash involvement on rural roads", CR 204, Road Accident Research Unit, University of Adelaide, Australia.

Kloeden, C.N., McLean, A.J., Moore, V.M. and Ponte, G. (1997), "Travelling speed and the risk of crash involvement", NHMRC Road Accident Research Unit, The University of Adelaide, Australia.

Lai, F., Carsten, O. and Tate, F. (2012), "How much benefit does Intelligent Speed Adaptation deliver: an analysis of its potential contribution to safety and environment", *Accident Analysis and Prevention*, Vol. 48, pp.63-72.

Lind, G. (2006), "Effects of variable speed limits at intersections". Proceedings of the 13th World Congress on Intelligent Transport Systems, 9-12 October, London.

Martens, M., Comte, S. and Kaptein, N. (1997), "The effects of road design on speed behaviour: a literature review". Deliverable D1 of MASTER (Managing Speeds of Traffic on European Roads), VTT Communities and Infrastructure, Helsinki, Finland.

Mountain, L.J., Hirst, W.M. and Maher, M.J. (2005), "Are speed enforcement cameras more effective than other speed management measures? The impact of speed management schemes on 30 mph roads", *Accident Analysis and Prevention*, 37(4), pp.742-754.

Nilsson, G. (2004), "Traffic safety dimensions and the power model to describe the effect of speed on safety", Bulletin 221, Department of Technology and Society, Lund University, Sweden.

OECD/ITF (2012), *Pedestrian Safety, Urban Space and Health*. OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789282103654-en

Oh, C., Kang, Y. and Kim, W. (2008), "Assessing the safety benefits of an advanced vehicular technology for protecting pedestrians", *Accident Analysis and Prevention*, 40(3), pp.935–942.

Rama, P. (1999), "Effects of weather-controlled variable speed limits and warning signs on driver behaviour", *Transportation Research Record*, 1689, pp.53-59.

Richards, D.C. (2010), "Relationship between speed and risk of fatal injury: pedestrians and car occupants", *Road Safety Web Publication No. 16*, Department for Transport, London.

Taylor, M.C., Baruya, A. and Kennedy, J.V. (2002), "The relationship between speed and accidents on rural single-carriageway roads", *TRL Report 511*, TRL Limited, Crowthorne.

Taylor, M.C., Lynam, D.A. and Baruya, A. (2000), "The effect of drivers' speed on the frequency of road accidents", *TRL Report 421*, TRL Limited, Crowthorne, UK.

Theeuwes, J and Godthelp, H. (1995), "Self-explaining roads", *Safety Science* 19(2,3), pp.217-225.

Theeuwes, J. (1994), “Self-explaining roads: an exploratory study”. Report TM 1994 B-18, TNO Human Factors Research Institute, Soesterberg, The Netherlands.

Tingvall C. and N. Haworth (1999), “Vision Zero - An ethical approach to safety and mobility”, Monash University Accident Research Centre; Paper presented to the 6th ITE International Conference Road Safety & Traffic Enforcement: Beyond 2000, Melbourne, 6-7 September 1999. http://www.monash.edu.au/miri/research/reports/papers/visionzero.html

Trafitec, (2007), “Narrow cross sections without centre line markings — “2 minus 1” rural road: road user behaviour study”. Trafitec, Lyngby, Denmark.

Turner, S., Bosher, S., Logan, D., Khoo., J. and Trumper, H. (2014), “Safer speeds: public acceptance and compliance”, Research Report 563, NZ Transport Agency, Wellington, New Zealand.

Vaa, T., Assum, T. and Elvik, R. (2014), “Driver support systems: estimating road safety effects at varying levels of implementation”, *TØI report 1304/2014*, Institute of Transport Economics, Oslo, Norway.

Webster, D.C. and Layfield, R.E. (2003), “Review of 20 mph zones in London Boroughs”, Report PPR243, Transport Research Laboratory, Crowthorne, UK.

Webster, D.C. and Mackie, A.M. (1999), “Review of traffic calming schemes in 20 mph zones”, *TRL Report 215*, Transport Research Laboratory, Crowthorne, UK.

West, L.B. Jr. and Dunn, J.W. (1971), “Accidents, speed deviation and speed limits”. Traffic Engineering, 11 (41).

Chapter 7. Traffic safety of an ageing population

Ralf Risser, Factum, Austria

The safety of senior citizens is a key issue in Korea. This paper reviews mobility and safety challenges of an ageing population and describes and describes measures that can contribute to keep up or to enhance the safe mobility of older citizens.

Introduction

According to official information the proportion of elderly fatalities from road crashes in Korea has increased rapidly over the last few decades. It was 24% in 2001 and this rose to 36% in 2013. This is more than the OECD average (22.6%). The number of elderly fatalities per 100 000 people has been reported at 30.5, and this is more than 3 times compared to the OECD average of 10.0.

What are we talking about when we refer to "ageing" or to "the old"? In literature 65 years or older is often chosen to be the age limit for being an "older citizen", or "senior citizen" or "old", or "elderly" (Amann et al. 2007 etc.). For this group independent travel and mobility is important for autonomous living (Schwanen et al., 2012). It is also assumed that active older people stay healthier than others. Frequency of out-of-home activities is positively correlated to wellbeing in old age (Mollenkopf et al. 2005; Spinney et al. 2009). Supporting independent travel in old age is important for any society from an ethical point of view, but it is also beneficial from an economic perspective. If the necessary daily trips cannot be carried out autonomously then service and assistance from the side of society are needed, which is connected to (high) costs (Guralnik et al. 2002). Many different types of daily trips are needed for autonomous living (Bell et al.2010). In literature, trip purposes such as visiting family and friends (as the need for social contact and visits remains more or less constant throughout the ageing process); cultural activities; grocery shopping; and travelling to and from work (frequently voluntary activities) are mostly mentioned. However, the risk gets higher the older one gets until such autonomous mobility is no longer possible. Table 7.1 sets an overview of these ideas.

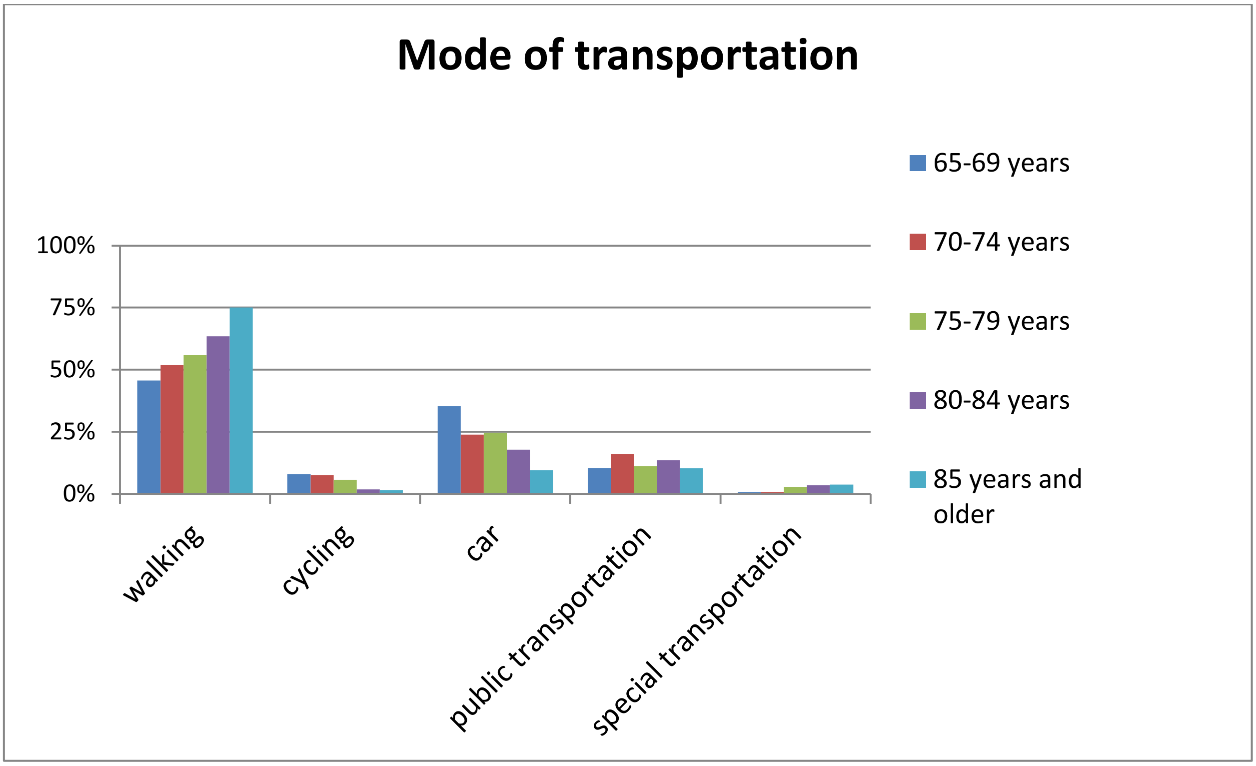
Table 7.1. **There is a need for autonomous and safe mobility for older citizens**

Many different types of daily trips are needed for autonomous living. If these trips cannot be carried out autonomously then service and assistance is needed, which among other things is connected to societal costs.					
What modes do senior citizens use to carry out their daily trips?	Walking	Bicycling	Car as drivers or passengers	Public transport	**Scooters, micro mobility, others**
Safety and comfort	**Transport with these means has to be possible under safe and comfortable conditions, with view on health and quality of life**				
Data and state of the art	**What is known concerning safety of these modes? It is important to know facts concerning this question in detail. For instance, a policy that implies to take away the driver's license could mean that one forces the individual into situations of higher risk.**				

Mode choice

What modes of transport do senior citizens use to carry out their daily trips? This has to be known, together with objective and subjective safety conditions of these modes, in order to give a structure to one's traffic safety work and to set priorities. The goal is to sustain autonomous mobility, under conditions of good traffic safety. But there is insufficient data available on the mobility behaviour of older road users in Europe, and the existing data is usually only collected on national, or even regional levels, with high variance in sample sizes, used concepts and periodicity. Figure 7.1 shows one example from one Federal State of Austria, the Burgenland (Answers to the question: "What is your main mode of transportation nowadays?").

Figure 7.1. **Modes of transportation, Austria**



Source: Bell et al, 2010.

As can be seen, walking and travelling as car occupants are referred to as the most frequent transport modes by older old people. According to this survey the proportion of car users decreases as age increases while walking steadily increases in importance.

According to expert information from Korea, recent studies show that the age group between 65 and 69 uses private cars more often than the older age groups. The reason is that they are healthier and have a higher income than the other groups of older citizens. But for older citizens in total buses show the highest modal share (48.9%) followed by subway at 19.3%. One may assume that all of these trips start and end with a – longer or shorter – walk. The portion of car trips is reported to be 18.4%.

Existing literature suggests that generally – and internationally speaking - mobility in old age is constrained the older one gets. Siren and Hakamies-Blomqvist (2004) and Marottoli et al. (2000) have shown that holding a driving licence is of major significance for mobility in old age (see also Box et al. 2010). This suggests that policies should be developed and implemented to maintain older people's ability to drive, such as refresher courses and other encouragements for continued driving. But this is also affected by income: keeping a car in old age might be difficult in many cases as income decreases after retirement or the loss of a spouse. This calls for policies that help older people to keep a car in the household, or to have access to a car.

Generally, expectations are that tomorrow's older people will continue to drive longer and for larger distances than earlier cohorts, partly because they have better access to cars. In England, Sweden and Norway, the number of trips taken daily by older people remained more or less constant between 1985 and 2000, but the daily distance travelled increased (OECD 2001). In the United States, the number and length of trips have increased for people over 65 years of age, with a faster growth than that for younger age-groups (Rosenbloom 2000). Much of the increase in travel distance among older groups can be attributed to better access to cars. There is also greater need to travel larger distances, because society and spatial distribution of (service) functions has changed. For example, retail and banking have up-scaled their facilities, closing down neighbourhood establishments. New residential developments have a larger scale than 50 years ago. On average shops, banks and medical facilities are farther away from their customers, exceeding walking and cycling distances. The car is becoming more dominant as a transport mode for older people, but there are differences among countries, especially between Europe and the United States. In Europe, walking is still an important transport mode for older people, with 30-50% of older people's trips made on foot (~80% of trips of persons over 80 in the Austrian study are made on foot, see Bell et al. 2010; OECD 2001). There are differences even within countries; town planning and access to public transport have the potential to influence mode choice in the direction of less dependence on the car (Mollenkopf et al. 2004; Bell et al. 2010). Differences are also observed between the young old and older old age-groups, with the younger age-groups using cars more frequently (Bell et al. 2010). Since there will be more older females with driving licences in the future, gender differences in car use among older people today may be reduced by 2030 (OECD 2001).

Public transport will have to considerably improve the quality of its services. Previous research has shown that older people experience a range of barriers to using public transport (Gilhooly 2002; Nordbakke 2013; Risser et al. 2010; Rosenkvist et al. 2009; Wretstrand et al. 2009) such as long distances to stops, problems entering and leaving public transport vehicles, lack of seating and handles, but also fear of crime during evening travel. Poor provision of services at night and on the weekends have been found in other studies to considerably constrain mobility in old age (Hjorthol and Nordbakke 2008; Schwanen et al. 2012).

In the Netherlands the portion of older cyclists is rather high. As car trips shorter than 5 km make up about 50% of all car trips in Europe, there is some potential for cycling also in other European countries. Is it reasonable to expect that the distribution of lengths of car trips will be much different in Korea? Probably not, and therefore cycling as a mode for senior citizens should also be considered, particularly now that the electrical bicycle has come about to cover greater distances.

In the project CONSOL (partner countries: Austria, Czech Republic, Denmark, France, Ireland, Spain, Sweden and the UK; Bell et al. 2013) special attention was directed to the increasingly heterogeneous nature of the ageing populations[1]– the older the groups, the more heterogeneous they are. Certain subgroups need special attention, namely subgroups which are growing (oldest old, older women and persons living in single-households), those which appear especially disadvantaged and at risk of social exclusion (e.g. low income groups, rural residents), and those for which both criteria apply (e.g. ethnical minorities). Heterogeneity is reflected by the different types of needs of different groups:

Older *women* tend to give up driving earlier, because they lack confidence or are discouraged by others. Increasing women's confidence and experience in driving in order to keep them safe and mobile implies a strong need for future research. Especially *rural residents* suffer from public transport deficits and often highly depend on others' assistance regarding their mobility needs. High-density urban areas provide better conditions to maintain mobility in older life, but there perceived danger – due to the complexity of the traffic environment - is a major concern often underestimated by experts. Better design and maintenance of the physical environment as well as better infrastructure conditions and safe alternatives to the car need to be provided.

Studies on mobility and *ethnicity* are limited, but the existing ones show that immigrants have to face more transport deficits; e.g. they have less access to cars, especially immigrant women. Differences can partly be explained with differences in income, residential location, etc., but some differences still remain. Ethnicity should be integrated in national travel surveys in order to gain more knowledge in this regard. More in-depth research on cultural effects on mobility behaviour is needed to explain possible differences.

Older women especially tend to live in single households and have limited car access, show lower life satisfaction and a generally lower level of mobility. However, older people’s leisure activities or general mobility increase with decreasing household size when age is controlled for, i.e. the consequences are more negative for older people. There is a noticeable decrease in out of house mobility around 75 years (age group 75–79), with a strong decline above 85 years and onwards. Living alone also has different consequences for older men and women; older women seem to cope better with being single. Men show higher car dependence and suffer more from ceasing to drive than women. Women are more strongly relying on walking and more often use public transport compared to men.

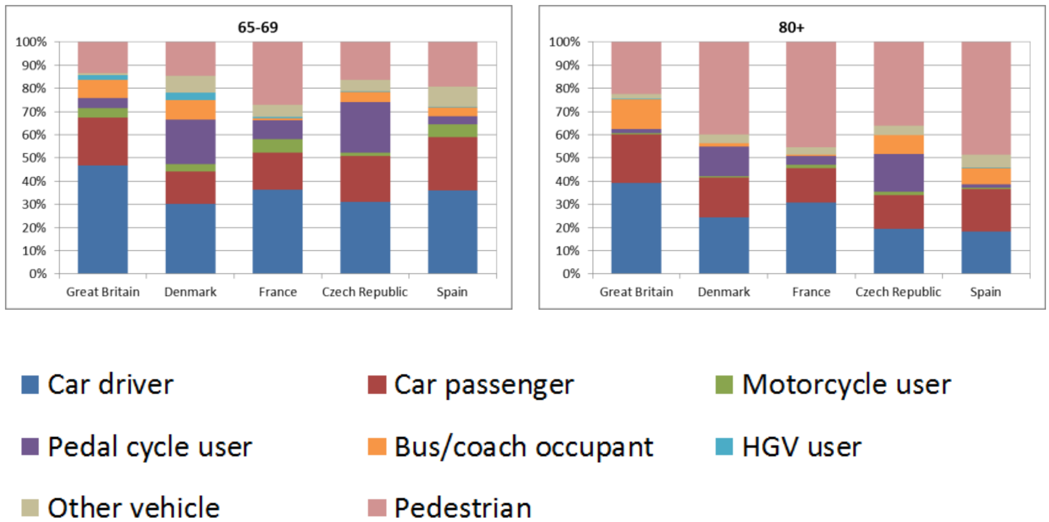
Overall the car is the dominant mode of transportation, closely followed by walking (with the above mentioned gender differences). With rising age the car is losing importance for older road users, while walking, travelling as a car passenger and the use of public transport become more prominent. Except for the Netherlands, cycling is only of minor importance in this comparison. There are not many newer studies about mobility scooters around, yet. In a study from from Australia (May et al. 2010) the authors could show that older persons who used such scooters could cover their daily mobility quite well with the help of such scooters. They would travel up to 5 km several times a week with them, which corresponds quite well to an earlier figure given by the OECD (2001; see further below)[2].

There is also a clear decline from 80 years onwards regarding the physical health with a high share of motor impairments (50 to 60 %). Poor health viz. the general subjective assessment of health as being poor has a strong negative effect on mobility, with even stronger effects in the older age groups (Rosenkvist et al. 2009). The actual effects of impairments are independent of age, with physical impairments having a more detrimental effect on mobility than sensory impairments. Age is a strong predictor of immobility only after 80 years. However, above this age also the level of heterogeneity among persons and their mobility patterns is strongest. But it has to be repeated: walking will still be the most important mode above this age.

Safety related to different modes

Accident data for assessing critical scenarios and incidents in traffic are available for most European countries, with varying data quality concerning validity, consistency and representativeness. Some cross-country comparisons are possible based on the European CARE database. However, older road users are confronted with a variety of very specific traffic safety problems which cannot be assessed appropriately based on available macro data[3]. For instance, falls in public space or in public transport vehicles are hardly ever addressed thoroughly and are usually not defined as traffic accidents, and hence not registered. Also, the age group of 80+ is the fastest growing population group and at the same time has the highest KSI (killed and seriously injured) rate leading to a strong need to focus on improving safety measures especially for this group.

Figure 7.2. **Proportion of casualties by transport mode**



Source: Reeves et al., 2013

As previously mentioned, walking and travelling as car users are the major transport modes for older people in the countries represented in the figures above. In each of them over 40% of casualties aged 65-69 were car drivers or passengers, but the proportion of car users decreases as age increases (Figure7.2). Thus, a much larger proportion of casualties in the 80+ age group were pedestrians. Future travel surveys should allow for better differentiation in travel patterns beyond the age of 65. There is a need to better understand the transport modes used by these individuals in order to assess safety problems appropriately and to develop measures apt for the identified sub-groups. For instance, when compared to younger age groups, the older old have the lowest mileage per year concerning 'walking' and 'bicycle' in absolute numbers; but these individuals have the highest KSI rate for these two transport modes.

Older drivers are over-represented in side-impact accidents at intersections, most often in situations where they turn left (in right hand traffic) or right (in left hand traffic) against oncoming traffic, or when entering priority roads on side roads. Countermeasures need to target this crash type which will become increasingly common as the population ages, while older drivers are under-represented in crashes involving loss of control or collisions due to speeding, risky overtaking or driving under the influence of alcohol.

Non-collision injuries in public transport systems and single pedestrian accidents represent a significant risk to the health and well-being of older Europeans. Traffic injury recording systems should be broadened to include both types of accidents as these are often not included in the official road accident statistics. According to the results of the CONSOL-project, risks of falls are mainly linked to the characteristics of the pavement: Uneven pavements are a major factor causing falls on streets, followed by slippery pavements (with external contributors like rain or ice). Non-detection of stairs and kerbs is a frequent cause in cases of visual impairment (O'Neill 2013). Falls in public transport (PT) vehicles (O'Neill 2013) often also have to do with irregular flooring. Such falls may be frequent but the severity of the resulting injuries is assessed as only minor. The main risks in public-transport systems are falls on stairs, often as a negative effect of crowds. The consequences are frequently rather serious. Escalators are also presenting a risk. Risks of collisions with vehicles in the PT system mainly arise in spaces shared by PT users and PT vehicles, e.g. at bus stations. The low noise level of modern vehicles (e.g. electric or hybrid buses) may add to this problem.

For older pedestrians, when walking along the street, the probability for collisions with obstacles is low. However, mixed traffic could lead to problems, especially with vehicles with a low noise level (e.g.: scooters, bicycles, etc.). But the real risk arises when crossing streets, where collisions usually have critical severity levels when cars or public transport vehicles are involved. The issue of low noise vehicles (i.e.: electric/hybrid cars) needs to be investigated further, not least as the use of electric scooters or electric vehicles for mobility impaired persons increases. It has to be decided how to adapt infrastructure so that these vehicles can be used under conditions of appropriate safety, both for the users, if they have to share space with cars, and for pedestrians and/or bicyclists, when they have to share the space with them.

Pedal cyclists account for only a low proportion of casualties as the numbers of older cyclists are rather small, with the exception of Denmark, the Czech Republic (Figure 7.2) and the Netherlands (Table 7.2).

Table 7.2. **Traffic fatalities per billion kilometres by age and mode (Netherlands 2005-2009)**

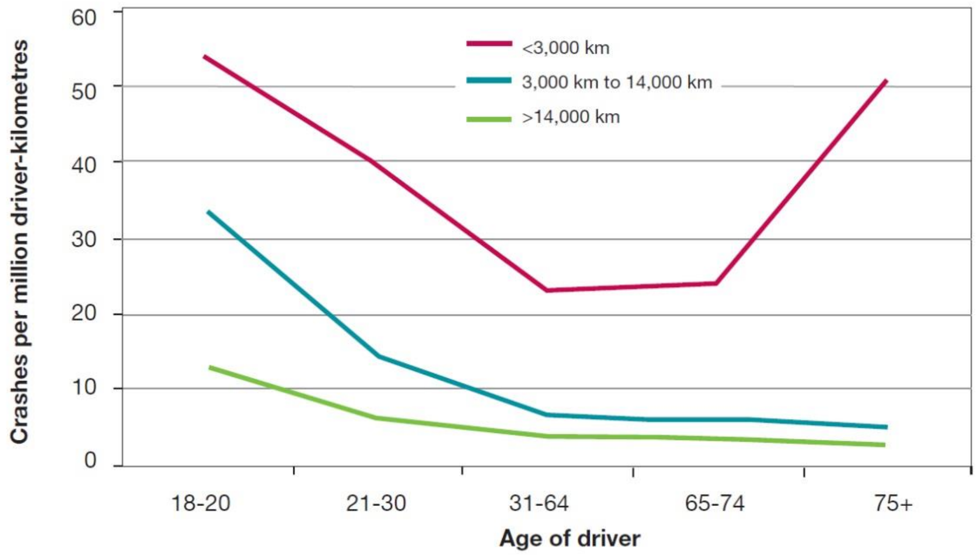
	Pedestrians	Cyclists	Car drivers	Car passenger.
18 - 24	21	6	11	6
30 - 49	11	4	2	1
60 - 64	10	12	1	1
65 - 74	22	28	3	3
75+	97	124	14	9

Source: Ministry of Infrastructure and the Environment, Statistics Netherlands (2011).

Cross-national comparisons at the level of detail as in Table 7.2 (fatality rate by age and mode of transport) are not possible. The international databases that contain crash data of several European countries do usually not include data on fatalities per means of transport per age-group. Cross-national comparisons of the number of fatalities and of fatality rates for all road users aged 65 years and above (regardless of means of transport) can however be found in the European Road Safety Observatory (ERSO) statistics (Traffic Safety Basic Facts 2011: The Elderly (Aged >64)).

Generally, research has shown that a number of policies are based on biased assumptions on the safety issues associated with older road users (Hakamies-Blomqvist 1996). These erroneous assumptions can be summarised as media bias, low mileage bias and frailty bias. The *media bias* is connected to the fact that the representation of topics related to older car drivers' behaviour and their involvement in accidents in the news is often exaggerating both accident numbers and the role of older drivers. But they steer public discourse of these issues. The consequences can be policies that are not based on scientific data but rather on public demand. The *low mileage bias* is based on the lower mileage of many older car drivers; research has shown that the lower the mileage of a group the higher the per-capita probability to be involved in accidents. This increases many older drivers’ potential to get involved in an accident due to their lower average mileage (Figure.7.3).

Figure 7.3. **Mileage per year, per age group (young/old)**



Source: Langford et al., 2006.

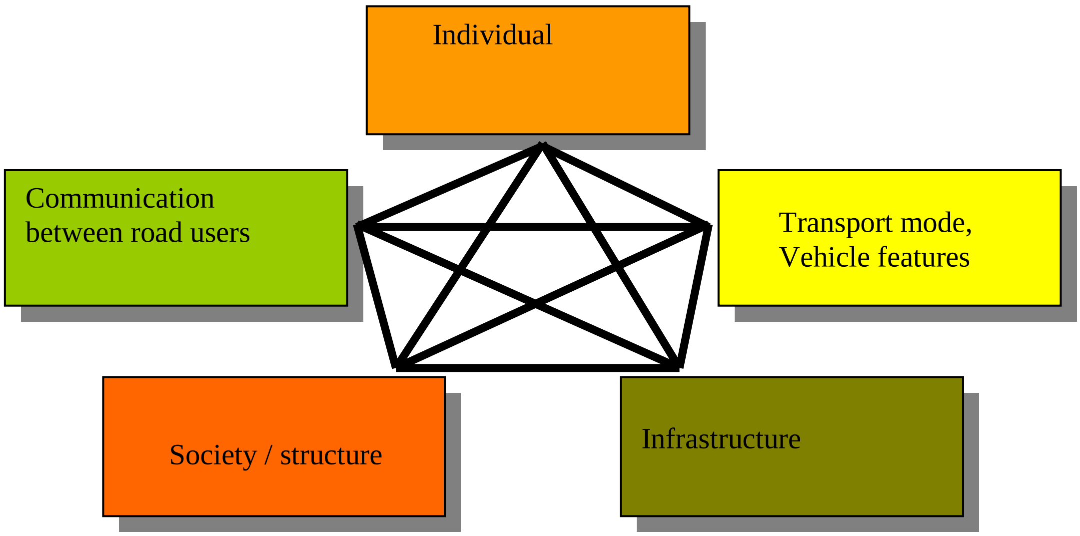
In addition to this, older road users have a higher risk of being injured due to their increased physical *frailty*, leading to an overrepresentation in fatal accidents and accidents with severe injuries. Therefore consequent evaluation of both the societal discourse of older road users' safety issues and available accident and mobility data is crucial.

The conclusion that can be drawn from all known data and facts is that older people who still drive do not pose a disproportional danger to other road users. They are more often severely injured themselves (killed or hospitalised) in collisions with younger motorists as opposed to them, as a motorists, causing severe injury to the younger road users (SWOV 2012).

Recommended measures

In order to describe and structure the types of measures to keep up or to enhance the safe mobility of older citizens, the model displayed in Figure 7.4 – the "Diamond" – is followed[4]

Figure 7.4. **Traffic system – Diamond**



Source: Risser 2004.

Society/structures

Societal actors and practices in the area of senior road user safety play an important role. In the interplay of societal actors there certainly are forces facilitating and those hindering implementation of safety policies. In any country that wants to deal systematically with older road users the mapping of societal actors - relevant stakeholders and decision makers - is an important step to take. Such an approach can be taken with the help of expert interviews and available documents from the policy and planning areas, and from online information about different institutions that are involved in the topic, like national transportation authorities and national senior organisations relevant for the areas of mobility and road safety. The list of experts to be involved in the process will thereby grow step by step, and end with a comprehensive overview of those persons and institutions that can actively contribute to both understanding the current situation and improving it by a variety of measures on different levels. Questions of what the main problems are with regard to senior road users, how the stakeholders work with issues of senior mobility or why they do not work with those issues, previous and ongoing collaborations etc. need to be in focus. Literature (Haustein et al. 2013) shows that generally older road users and the issue of ageing are mentioned and recognised as being of importance in the transportation policies of most European countries. However, seniors often seem to be treated as a sub-group of the disabled or vulnerable road users in safety and accessibility policies but hardly ever as an issue that is highly important per se; there is a lack of policies focusing specifically on senior road users (Heikkinen et al. 2013). For instance, senior citizens' transportation issues have difficulties to compete with issues on health and pensions within senior organisations.

Driver license policies

Between OECD countries, there are major differences, not least in connection with the driving license policies, indicating a need for further research. For instance, in the EU various procedures still exist in the re-licensing process for older drivers and little knowledge is available about their traffic safety and mobility impacts, and the ethical aspects of such measures. In general, data collection shows that policies which are currently in place regarding the assessment of older people's ability to drive are not evidence-based: there is no evidence supporting the assumption that general age-based assessments have any safety benefits (see "Assessing fitness to drive" section below). Only few safety benefits were found in the analysis such as in-person renewal (as opposed to renewal by mail) and restricted driving (see Fastenmeier et al. 2015). A shift from driving a car to unprotected modes of transport can – and probably will - be the effect of these measures which might be detrimental for older persons, as using these modes tends to be far more dangerous for them than driving a car (Hakamies-Blomqvist et al. 2003; see also Table 7.2).

Assessing fitness to drive

The assessment of an older person's fitness to drive can take place both as part of renewal of the driving license at a specified age and when a health problem has been identified. Practice in European countries on the licensing of older drivers varies greatly. Some countries require renewal of the driving license at a certain age, whereas others do not. Those countries that do often require some sort of medical examination (Table 7.3). However, as already mentioned above, there is no evidence that age-based screening or assessment programmes produce any safety benefits. Hakamies-Blomqvist et al. (1996) compared Finnish and Swedish licensing practices; in Finland regular medical check-ups are obligatory starting at 70, while in Sweden there is no age-related control at all. They found no reduction in crashes among car drivers in Finland, but there was a higher rate of fatalities among unprotected older road users than in Sweden. In a similar study in Australia, Torpey (1986) compared the state of Victoria that has no age-related licensing controls with other states with established testing programmes and found no differences in crash rates. The main outcome of age-based population screenings or age-related testing seems to be an adverse one: many drivers, especially women, stop driving without necessity (Hakamies-Blomqvist and Wahlström 1998).

Rather, a focus on prolonging older persons' safe driving would be important. Older persons should be encouraged to keep their licence, e.g. by applying technological support (ADAS and IVIS, see below), by voluntary driving training, etc. Such measures are certainly better solutions than taking away the driver's license and making people cease driving without necessity (OECD 2001), thus deteriorating preconditions for their own outdoor mobility and possibly reducing their overall safety by being forced to use modes that are more dangerous for them than driving a car.

However, it has been stated that older groups or cohorts are very heterogeneous and that the probability of incidence of health problems that might be prohibitive for driving a car is higher than for the general population. In this context, physicians working in primary care represent an important first contact and information source and are in a position to give advice to the patient about fitness to drive. But if they take on this role they need to know about the functional consequences of an illness and how it may affect an individual's fitness to drive (OECD 2001). Physicians also need to provide advice concerning prescribed drugs. But then of course knowledge of the relationship between the effects of the drug and traffic safety is needed, as well. In any case, medical care (e.g. by family physicians) plays an important role when there are genuine reasons to question older drivers' functional capabilities.

Table 7.3. **Driving license renewal requirements in Europe**

Country	Procedure?	Renewal interval	Medical requirements for renewal
Belgium	No	No renewal required	**None**
Denmark	Yes	At 70, issued for four years; at 71, issued for three years; at 72-79, issued for two years; at 80+, issued for one year; If ill, shorter terms possible.	**Doctor´s certificate required**
Finland	Yes	At age 45, renewal every five years; as of age 70, renewal period depends on the physician.	**After 45, medical review every five years (general health status and vision). Renewal requires medical examination and verification of ability by two people.**
France	No	No renewal required	**None**
Germany	No	Renewal not determined by age	**None**
Ireland	Yes	Annual renewal regardless of age	**At 70, a certificate of medical fitness is required**
Italy	Yes	Ten-year renewal up to 50; five-year renewal after 50; three-year renewal at age 70.	**Medical test required with renewal**
Netherlands	Yes	At 70, medical review required every five years	**Depending on physical condition, medical review may be more frequent, vision test required**
Portugal	Yes	At age 70, renewed every two years	**At 70, a medical exam is required every two years**
Sweden	No	No renewal required	**None**
United Kingdom	Yes	From age 70, mandatory renewal for three-year periods	**Self-declaration of ability to meet vision standard required. Any medical condition that could affect driving must be reported to the Licensing Agency**

Source: OECD (2001).

Preparation for "life after the drivers' licence"

When safe mobility as a car driver is no longer experienced as being possible, alternative means of transport should be available. Generally, overall societal and infrastructure circumstances need to be provided for the time when older people finally cease driving. Literature stresses the importance of fostering more independence from the car in daily mobility already at a younger age; people who have been used to walking and using public transport at a younger age run into fewer problems when they (are forced to) cease driving a car (Ahern and Hine 2012, Mollenkopf et al. 2005). The better the provision of alternative means of mobility, the more likely a person is to start using them for journeys long before ceasing to drive, while the lack of attractive and feasible transport alternatives to the private automobile, coupled with land-use patterns that make walking difficult or impossible, contributes to the problems experienced by people who have to stop driving.

The preparation for "after ceasing driving a car" causes some problems, though. Firstly, the fatality rate for older cyclists and pedestrians is higher than for older drivers. In addition, older people will often have already stopped cycling, partly because of loss of balance. Saying farewell to their car often is also a farewell to part of their social lives. This can have negative consequences for the well-being of the individual, but also for society as a whole (e.g. the extra costs of door-to-door community transport). Especially in sparsely populated areas, without a car it becomes very difficult to carry out longer trips due to a lack of good-quality public transport. Thus, for older people in areas with poor public transport coverage, who in addition have difficulties with walking to the bus stop and cycling, driving is often the only acceptable option for independent mobility (Jansen et al. 2001). Thus, the availability of means of transport other than the car is one of the most important ways to maintain older people's mobility. Not least, services should be provided for those who have to cease driving and have no access to public transport (e.g. taxi vouchers). Such options allow older people to travel but they need to ensure that the entire travel chain is suitable, taking account of older people's capabilities and limitations and being affordable and accessible (OECD 2001). Alternatives to the car are often provided by community transport and para-transit (Dial-a-Ride) services. These can be useful, although a drawback of these services is that they often require advance booking. They rarely permit spontaneous travel of the kind that is possible by car or on foot. Powered wheelchairs, scooters and golf carts constitute another class of modes that do not require a driving licence. These vehicles allow for spontaneous travel and are being used for journeys of up to about 4 km which are made under favourable weather conditions (OECD, 2001). The question is, however, whether given infrastructure is suitable for the safe use of such modes of transport, how given infrastructure should be used by these vehicles and how it should, or could, be adapted.

No single form of transport provides mobility for all people under all circumstances. A family of services which enables travellers to select the one that best suits their requirements for a particular journey is needed. These services include: conventional public transport services, which are accessible to passengers in wheelchairs, wherever possible; bus service routes using small vehicles that pick up and discharge passengers close to origin and destination. This service is particularly appropriate for areas where demand is low (e.g. in rural areas); conventional taxis, often subsidised in order to reduce the fare; dial-a-ride services for door-to-door travel for passengers who require assistance and/or who use a wheelchair that cannot be accommodated by a conventional taxi or bus.

In addition to all provisions listed above, accessible pedestrian infrastructure is generally a necessary prerequisite in order to allow access to all transport services and to make journeys wholly on foot, by bicycle, or by (powered) wheelchair or scooter (see chapter about infrastructure, below).

Mobility as a health issue

From the point of view of the national economy it may be worth noting that giving up driving has negative health effects, statistically speaking; stopping driving is likely to reduce mobility and thus to negatively affect quality of life (Harrisson and Ragland 2003; Hakamies-Blomqvist et al. 2003). It reduces the number of outdoor activities and social contacts (Marottoli et al., 2000) and is related to increased depression (Fonda et al. 2001). At the same time, a lot of programmes and initiatives focusing on the issue of health in older people have been launched in EU countries, focusing on walking and cycling. An active life style, which means being mobile, has been shown to be positive for the health of older people. Going for a walk is still possible for many people at advanced age, while other kinds of personal exercises become difficult or impossible. Walking has sociological and psychological benefits; it is stimulating, reduces stress and helps to train psycho-physical resources (Marin-Lamellet et al. 2012).

What can be done to support walking (and cycling)? General ideas and recommendations that would reflect all areas displayed in Figure 7.4 above are summarised in the OECD/ITF report from 2011 and in the final report of the COST project 358 (called Pedestrian Quality Needs PQN) by Methorst et al. (2010).

An example of good practice stems from the Municipality of Donostia (San Sebastián). During 2009 and 2010 they developed up to 20 walking tours with the aim of promoting walking among older people, not only for leisure and social activity, but also as a means of transport inside the city, to promote the idea that walking for older people is a source of health, and to develop the use of new pedestrian routes. The target group was people over 60, with no major mobility disabilities and who were ready and able to make excursions of nearly two hours. Almost 1 000 people, most of them between 60 and 70 years old, took part in the activity. 80% were female and more than 90% of the participants already walked almost every day and used public transport even if they had a car. One result was that they felt confirmed in their motivation to walk and to reduce car use even more, maintaining their health and capabilities.

Another example is from the city of Odense in Denmark. With more than 550 km of walking and cycling paths and lanes and hundreds of speed bumps that keep car speeds low, Odense provides a unique infrastructure for walking and cycling. In 2008, cycling covered 25% of all trips in the municipality and in central areas it exceeded 50%. In June 2009, a traffic and mobility plan for the city of Odense was enacted that gives priority to cycle and footpath connections and routes as well as the quality of the surroundings and green areas, ensures that public areas, squares and streets are accessible to senior citizens, and ensures that cycle and footpaths are safe and well-lit 24 hours a day. The goal was to increase the number of citizens who are physically active and to ensure that the opportunities for physical activity are easily accessible for everyone, regardless of age and physical capability. However, it is known from research that older cyclists are at particularly high risk of being injured in accidents because they lose balance and fall. Therefore, the objective was to raise awareness of safety issues for older cyclists and to teach them to cycle safely. Training courses were offered. Teaching was carried out by experienced cyclists over 55 years. 65% of participants taking part in such training courses (n=250) stated that they felt safer on a bike after taking part in the course.

Measures addressed to planners and transport operators

A good example is the training of bus drivers in Salzburg (www-aeneas-project.eu). Bus drivers were made aware of the needs of older passengers and should train driving skills such as driving smoothly and stopping close enough so that (low-floor) buses could be easily entered and alighted. The training underlined the following points:

- Style of driving: older people generally have difficulties to keep their balance and have less handgrip strength, making it harder to hold on in a moving vehicle. Quick acceleration from a bus stop and abrupt braking can make older passengers anxious. Non-aggressive and smooth driving can help prevent accidents.
- Vehicle condition: older people are particularly aware of dirt in the vehicles, and rubbish left lying on the floor can cause them to trip and fall.
- Getting on and off the vehicle: when boarding or alighting a bus, older passengers are at the greatest risk of falling. However, if drivers are attentive and considerate, accidents can be prevented.
- Friendliness and courtesy: older people value personal contact and enjoy exchanging a few words with the driver. They appreciate friendliness and are particularly sensitive to rudeness and lack of respect (they in fact "prefer people to machines").
- Respect and consideration: about 60 new drivers were trained with this training scheme and the movie about the needs of older passengers was shown to the whole driving staff (approximately 250) at the beginning of 2011.

Infrastructure

An infrastructure for car traffic that takes into account the functional limitations that accompany ageing can contribute to a reduction of the crash involvement of older people. Intersection accidents and especially left-turning vs. oncoming traffic accidents (in right hand traffic) are over-represented among crashes involving drivers of 75 years and older (Hakamies-Blomqvist, 1993, 1994b, Davidse, 2000, 2007). The explanation is that older drivers have problems with making complex judgements of speed and distance under time pressure, due to increased perception and reaction time and problems with discriminating between relevant and irrelevant information. A decrease in visual acuity and peripheral vision plays an important role, as well. Peripheral vision is important to allow the sighting of pedestrians who, e.g., want to cross the street, or cars approaching the intersection from side roads. Therefore, providing a good and early view on the intersection and assistance in making left turns should be seen to. Moreover, a reduction of vehicle speeds at intersections is helpful. This can be achieved by, for example, raising the intersection – thus producing a hump-like effect – or replacing an intersection with a roundabout. In sum, providing enough time to observe, to decide and to act/react in those situations and to make the tasks in those situations easier is necessary.

Infrastructure measures should focus on: intersection design; signs and markings; traffic lights and lighting; exits and entries of motorways. Examples are long acceleration lanes on motorways and large stopping sight distances at intersections, increased letter-height and retro-reflectivity of street name signs, etc. For intersections with traffic lights, errors in giving way and any resulting crashes can be prevented by a regulation that does not allow traffic that can collide to have green light simultaneously. Roundabouts have the required qualities for older drivers: e.g., left turns are eliminated, fewer decisions have to be made because of one-way traffic and yield-at-enter, lower speeds allow for more time to decide and act (Staplin et al., 2001; Davidse, 2000). They reduce crash numbers and, as a result of lower speeds, crash severity. This is especially beneficial to older drivers. But roundabouts can also be perceived as being complicated: there is a difference between single-lane and multi-lane roundabouts (Mesken 2000); single-lane roundabouts are much easier to tackle. Right-angle connections are more effective in reducing driving speed and provide a better view of roundabout traffic for drivers that are about to enter the roundabout than tangential connections (Brouwer et al. 2000).

Road design elements can support one in finding their way and to avoid situations where drivers' attention is away from traffic for longer periods, by providing appropriate placement and legibility of traffic signs (such as street name signs), conspicuousness of obstacles (e.g. kerbs, medians and traffic islands) and recognisable intersection control (who has right-of-way) and lane assignment (Taoka 1991). Older adult drivers are over-represented in wrong-way movements (Blokpoel and De Niet, 2000), not least due to decreased selective attention. To compensate for this, relevant information needs to be signalled well visibly, e.g. by placing signs in the drivers' field of vision, and with some redundancy.

Road markings help the driver to maintain the correct lane position and provide a preview of the course of the road ahead. Older drivers need a higher contrast between pavement markings and carriageway to be able to see the markings and to have enough time to act accordingly. Therefore the brightness contrast between pavement markings and the carriageway should be adjusted: pavement markings where there is no street lighting need to be at least three times as bright as the carriageway (Staplin 1998). However, the older driver's need for increased levels of luminance and contrast should be weighed against their sensitivity to glare (CROW 1996). For instance, glare can be reduced by reducing the intensity of traffic signals during darkness. In addition to the recommendations described above, good lighting is of advantage for the total driver population and thus for traffic safety, but good lighting is especially important for older drivers.

It has been stated above that many older people may (have to) recur to walking and cycling in order to remain mobile. This could have a negative effect on safety if the environment is not inclusive for older people. Older pedestrians and cyclists are at higher risk of being injured than young and middle-aged people and the promotion of walking and cycling for them should be performed only in parallel to the promotion of the design of a safe environment for older people. Therefore, designing a safe and inclusive urban environment should be the goal (OECD/ITF 2012, Methorst et al. 2010). As a practical example, guidelines were established in Finland in 2004, involving the cities of Helsinki, Espoo, Joensuu, Tampere, Turku and Vantaa (Project "Helsinki for All"). The guidelines form the basis for the City of Helsinki Accessibility Plan and are freely available for use by other municipalities, corporations and planners. The guidelines contain criteria for evaluating the accessibility of outdoor locations: pedestrian crossings and pavements; pedestrian streets and squares; public courtyards; park paths and resting places; public bus stop areas etc. Elements to be considered at all those places are appropriate kerbs at pedestrian crossings, outdoor staircases, ramps, demarcation strips, smooth walking surfaces, pedestrian crossing markings, handrails and railings, pedestrian push-button posts, pedestrian crossing signs, seating opportunities, bollards in pedestrian zones, pedestrian refuge islands, tactile maps and information signboards etc. (Marin-Lamellet et al. 2013). In the frame of the EU project SIZE, public toilets are added to the list of important elements to equip the public space with (Amann et al. 2007).

In the Highway Design Handbook for Older Drivers and Pedestrians published by the Federal Highway Administration (FHWA, USA) in 2001 there is a section related to the design of intersections from a pedestrian perspective. Analyses by Council and Zegeer (1992) and by Blomberg and Edwards (1990) showed older pedestrians to be overrepresented in both right- and left-turn crashes – i.e. they were knocked over by vehicles turning left or right while crossing the road which car drivers turned into. Other accident types were so-called “intersection dash” where a pedestrian “appears suddenly" in front of an oncoming vehicle at an intersection; situations in which one or more vehicles stop in one through lane and the pedestrian steps in front of the stopped vehicle(s) and into the path of a through vehicle in the adjacent lane which do not stop; bus stop related accidents when the pedestrian steps out from in front of a stopped bus and is struck by a vehicle moving in the same direction as the bus in an adjacent lane; where pedestrians are hit in the middle of the road when a traffic signal turns red and cross-traffic vehicles start moving; finally night time accidents where pedestrians are struck when crossing at an intersection. The handbook recommends, among other things, protected left turn traffic signs and island protection places for pedestrians, as well as better lighting at pedestrian crossings in order to avoid night time accidents.

Integrated accessibility planning

Mobility is a global task, which includes not only the vehicle but also the infrastructure and the management and operating process. The design of an efficient transport service needs to be thought of as a whole issue, particularly when dealing with people with reduced mobility or older people. This needs a lot of discussion between the different players, along with efficient cooperation. The two following practices are good illustrations of this process. In the city of Gothenburg (Sweden) a detailed working plan was finalised in 2010 and adopted as the regular system, with the goal to encourage more use of public transport and so-called flex-lines[5] and bicycles, and to decrease the use of the expensive – municipality-paid - Special Transport Services (STS)[6] and taxis. To achieve this, the number of flex-lines in Gothenburg was expanded and stops were adapted to travellers’ needs; other measures that were implemented were travel training and trip accompaniment; one bus line and one tramline were made fully accessible (vehicle and stops); a map for accessible journeys was created; personal assistance was introduced at major interchanges; since December 2005 there is a training of public transport company staff on the needs of disabled people; and the disabled-transportation-system principles were adopted by the public transport authority. The project succeeded in that many STS passengers switched to using buses and trams (again). From 2008 to 2009, the number of STS trips decreased by 32 000 (5%) while the journeys with flex-lines increased from 132 000 to 137 000. The project also resulted in the introduction of free public transport for passengers over the age of 65 at certain times of the day which also affected travel habits of older people. However, particularly the “older” old people still need individual transport solutions such as STS.

Another example stems from Nürnberg which was the first city in Germany to commit to making its public transport accessible to all in 1972. From this date, several improvements to the public transport network and urban environment have been made: trams and buses are low floor, with kneeling and ramps for the buses and with adapted platforms, metro stations are barrier-free and the safety of the 2 automated lines has been addressed with extensive discussions with representatives of older and disabled passengers. Since 1980, an Accessibility Commissioner has been appointed to liaise with representative organisations of older and disabled passengers. A study in 1986 compared the costs of a barrier-free public transport system to providing a separate door-to-door transport service for disabled people. The cost estimates for the two were quite close and a political decision was made to pursue the barrier-free route. The same study had also surveyed all the different disability groups within the city in order to obtain a clear understanding of their needs. The success of the commitment to accessibility is the continuing close relationship between the public transport providers and disability organisations, and the large and growing number of disabled and older people who use public transport.

Personal transport services for people without a car

One interesting example comes from the US where the Independent Transportation Network (ITN) addresses the issue of transportation for older people. Members of ITN America pay dues to a non-profit organisation committed to their independence and mobility. They call in to schedule a ride and are provided with a transportation alternative that keeps them in control. Volunteer drivers provide rides for older users a few hours during the month. Volunteers receive training, and ITN arranges driving assignments and routes around volunteer schedules. ITN fares are typically lower than a comparable taxi ride, they are available 7 days a week, 24 hours a day for any purpose, and door-to-door service is provided by volunteer drivers. No money is exchanged, the riders pre-fund a personal transportation account and a monthly statement details all payments and charges. Automobiles are used rather than vans or buses. Rides may be booked at any time, with discounts for advance notice. There are discounts for shared rides.

Another type of service - les Compagnons du Voyage - is provided by the French Railway Company SNCF (Société Nationale des Chemins de fer Français) and the RATP (Régie Autonome des Transports Parisiens). It is a service in Paris involving personal escort for individuals as well as for communities and companies for different types of trips. The service is offered in the city and for trips to surrounding districts and even abroad. It is available every weekday, 24 hours a day. The main target groups are older people, those with disabilities and children. This door-to-door accompanying service provides older people with access to medical services, banks, post offices and other day-to-day destinations (public parks, senior centres, and cultural activities). The service can be booked by telephone, fax, post and email. This service is not free of charge (EUR 20/hour for older people), but half of the cost can be deducted from annual income tax. Persons who are accompanying older people are also required to show them how to travel safely, to guide them in the city and to explain the basics of public transport and networks. Les Compagnons du Voyage employs about 100 people and since its inception in 1993, more than 1 million accompanied trips have been undertaken.

Measures on the mode and/or vehicle side

Advanced Driver Assistance Systems (ADAS) and In-Vehicle Information Systems IVIS

Advanced Driver Assistance Systems (ADAS) provide personal assistance in a road environment that does not always take into account the possibilities and limitations of the older driver (Haddad and Musslewhite 2007). Lees and Lee (2009) and Yound and Bunce (2011) suggest that emerging vehicle technologies can be exploited to enhance the safety of older drivers. Older drivers need support when they have to: judge whether other road users are approaching the same intersection and at what speed; notice other road users while merging and changing lanes; notice traffic signs and signals; react quickly in a complex traffic situation (Davidse, 2006, 2007). ADAS can therefore contribute to a reduction of crashes of older drivers if they have at least one of the following functions: draw attention to approaching traffic; signal road users located in the driver's blind spot; and provide prior information on the next traffic situation viz. on how to proceed. Examples are collision warning systems, pedestrian detection systems, vision enhancement systems, and a navigation system is an example for a typical IVIS etc. (Mitchell and Suen 1997; Färber 2000).

During the past five years the development of ADAS for older drivers receives growing attention from both car industry and research (Davidse et al. 2009; Pereira et al. 2010; Gelau et al. 2011). Systems like night-vision enhancement systems; navigation systems, and mayday systems are helpful for drivers who have difficulties driving in the dark or driving in an unfamiliar area viz. for those who have feelings of insecurity (Fildes and Charlton 2005). Hence, these systems are particularly suitable to enhance the mobility of older people. Mayday systems can reduce the time to medical treatment, thereby reducing injury severity. Several studies have shown that older drivers are to a large extent willing to consider using and buying ADAS such as reversing aids and collision warning systems that are aimed at the prevention of crashes on intersections (Oxley and Mitchell 1995; Viborg 1999). Furthermore, older drivers are also willing to accept systems that give feedback messages or that (partly) take over vehicle control, like automatic speed or distance adjustment (Viborg 1999).

Design principles for the human machine interface

Knowing which types of ADAS and IVIS have the highest potential to improve the safety of older drivers is not enough to actually improve their safety. The drivers should also be able to understand the information the ADAS sends, via a display, by sound, or haptic. Older drivers are also more susceptible to poorly defined ADAS than younger drivers. Caird et al. (1998) have summarised design guidelines for older drivers (Table 7.4).

Table 7.4. **Functional limitations and relevant design principles**

Functional limitations	Relevant design principles
General sensory deficits	Use redundant cues, like auditory, visual and tactile feedback
Visual acuity	Increase character size of textual labels
Colour vision	Use white colours on a black background
Diminished low-light vision	Use supplemental illumination for devices used in low-light conditions
Sensitivity to glare	Use matt finishes for control panels and antiglare coating on displays
Hearing	Use auditory signals in the range of 1500-2500 Hz range
Depth perception	Where depth perception is important, provide non-physical cues, such as relative size, interposition, linear position and texture gradient
Selective attention	Enhance the conspicuity of critical stimuli through changes of size, contrast, colour or motion
Perception-reaction time	Give the user sufficient time to respond to a request by the system and provide advanced warnings to provide the driver with enough time to react to the on-coming traffic situation
Hand dexterity and strength	Use large diameter knobs, textured knob surfaces and controls with low resistance

Source: Davidse 2007, adapted from Caird et al.

ADAS design should make use of familiar features that are common to other products that are used by them (Gardner-Bonneau and Gosbee 1997). Older drivers should also be involved when ADAS are evaluated, and not only younger ones or the "average" drivers. Older persons experience more difficulties with tasks connected to new technologies and it is therefore important to involve them in usability evaluations.

Information given simultaneously from different ADAS increases the pressure on the driver, the presence of several, independently functioning systems increases the work load. Especially older persons will "suffer" from this. Co-ordination between the installed ADAS may overcome these difficulties (ETSC 1999). Especially, conflicting instructions have to be avoided. Heijer et al. (2001) suggested that one ADAS should be able to support the driver in a set of problematic situations instead of separate ADAS each supporting the driver in a different situation. Another solution would be a system that decides which system is allowed to pass what kind of information, when and in what kind of way (e.g. Green 2004, Vonk et al. 2002; Piechulla, 2003).

What also has to be considered is the phenomenon of behavioural adaptation. It implies that people in many cases adapt behaviour to some of the improvements of a system by taking more chances (Wilde 1982, Evans 1991). A form of behavioural adaptation that could arise among older drivers is the withdrawal of compensatory behaviour. For instance, older drivers generally compensate for their impaired night-time vision and sensitivity to glare by avoiding driving at night. As a result, the number of crashes involving older drivers at night is relatively low (Hakamies-Blomqvist 1994, McGwin and Brown 1999). The large-scale introduction of night vision enhancement systems may allow older persons to drive at night again. This will on the one hand increase mobility, but the use of such systems may on the other hand make drivers give up their compensatory behaviour. An eye should be kept on such developments.

Vehicle design and vehicle safety

Age-related muscular-skeletal impairments like arthritis and decreasing strength may make it more difficult to enter and exit vehicles, to reach driving controls or to handle the steering wheel. Door frame height, width of door opening, doorsill height and seat height should have the right dimensions (e.g. Petzäll 1991). Special equipment makes it easier to operate the vehicle, like handles at the right places, power steering, automatic transmission, appropriate rear-view mirrors to support drivers with an impaired field of vision or restricted head movements, etc. (OECD, 2001). Systems like night-vision enhancement can also compensate for functional limitations (with the necessary precaution, see above). Older adults are more vulnerable than younger adults: their injuries will be more severe given an identical collision impact. Therefore, apart from the usual test dummies also ones capable of modelling the effects on older occupants are needed when testing and improving vehicle safety (OECD, 2001). Moreover, occupant protection can be enhanced by the further development of seat belts and airbags, e.g. through force-limiting features which control the maximum restraining force exerted by the shoulder belt. Other technological advances that are likely to be relevant for older occupants are: Intelligent restraint systems that adjust for lighter, older occupants; dual-stage airbags to minimise airbag impact in moderate crashes; head restraints to minimise soft tissue injury and whiplash injuries to the neck; side airbags to protect head and chest in side collisions, such as crashes when turning left (in right-hand traffic) or right (in left-hand traffic; DfT, 2009).

Measures directed to the individual

In order to encourage older people to use buses, to give them recommendations on how to prevent accidents and to familiarise them with new or less well-known functionalities, the Salzburg bus operator has developed a training scheme for passengers. The concept targets older people in Salzburg (60 to 100 years old) who represent approximately 33% of the city's bus users. They often face problems when using public transport: two thirds of all accidents in public transport occur with persons over 65. During the training sessions people learn in small groups how to board the bus, how to stand safely inside the vehicle or how to get a seat. Afterwards, a trip is organised, where the newly acquired knowledge can be put into practice. The training sessions also address people who recently had an accident and are at risk of seeing their mobility significantly reduced. The participants of the training are invited in small groups (maximum 6 people) to the bus depot, where a bus is made available for the training session. 3 coaches and 1 driver run the training. The trainees have the opportunity to practice on the bus. Evaluation reports showed that these training courses attract more women than men. The courses can be booked individually or for whole groups. Since the beginning of this training programme in 2010, more than 150 people have been trained. Evaluation showed that the training helps to reduce fears and to teach safe behaviour. Along with the training there is a safety brochure, which contains all the topics of the training and defines safe behaviour on public transport. The success of this training lies in the equal cooperation between the NGO Centre for Generations and Accessibility and the StadtBus (CityBus) Salzburg.

The objectives of a similar training in Munich, Germany, were also to enable older people to use public transport in a safe and comfortable way and to respond to the needs and requirements of older passengers in public transport. The main target group was people between 60 and 90 who want to be safer in their use of public transport and need certain information about safety and security. Such people could be partly disabled (in wheelchairs or requiring a mobility stick), but they were required to be mobile in order to participate in the practical training sessions. The project was initiated by MVG (Munich Public Transport Cooperation) and Green City e.V. (an environmental organisation from Munich). MVG was responsible for providing the buses, infrastructure and the more technical aspects of the training. Green City took care of the educational component, the organisation of the training and general preparations in collaboration with older people service centres. Ten training sessions were held during October and November 2010 with a total of 77 participants. The average age of participants was 78, with the oldest person being 94. The majority (83%) were women. Evaluation showed that people felt that they had improved their skills in getting on and off the vehicles (which is considered as one most critical issue) and were more confident in using public transport.

An important issue is information, mainly of two types: pre-trip information and on trip information. A good practice example for dealing with information in a sound way is a traveller information system on barrier-free travelling in Frankfurt and Berlin (Germany), the BAIM system: "Barrierefreie ÖV-Information für mobilitätseingeschränkte Menschen“ (barrier-free information for persons with mobility impairments). It was developed in order to supply people with reduced mobility with detailed information on the accessibility of public transportation facilities. It informs about transportation chains from any given starting point to any destination, according to the user's personal requirements profile and should be applicable to all similar regions. The implementation and practical testing of BAIM and the follow-up-project BAIMplus are conducted in the federal capital Berlin, the surrounding federal state Brandenburg and the Rhein-Main-Verkehrsverbund, which is the public transport provider for the Rhine-Main region, with several cities (Frankfurt, Offenbach, Wiesbaden, Darmstadt, etc.) and an extended rural surrounding. The challenge is to inform all user target groups appropriately about the present opportunities of barrier-free travel and to present this information through integrated and barrier-free information paths. Services include real-time information, tour escort services, barrier-free routing around stations and stops, accessibility search functions and a voice-operated dialogue system with target group-oriented information before and during the journey concerning suitable travelling opportunities or potential barriers. Target groups are people with reduced mobility (e.g. due to disabilities, luggage or other circumstances), and more generally citizens from 55 to 64 and over 65. Key aspects are consideration of user needs and requirements and evaluation in the field. One important conclusion so far is that thorough information making use of real-time data, presented in an appropriate way, has a great potential to enhance confidence in the public transport system.

Another good example stems from Sofia, Bulgaria, where audio announcement at public transport stops is provided as a result of cooperation between the Sofia Urban Mobility Centre and the Sofia Regional Department of the Union of Blind People in Bulgaria. Electronic boards giving real time visual information about vehicle movements had already been fitted at city centre stops. Later, audio announcement modules were added to make the real-time information available to blind and partially sighted people. The same kinds of announcements are in the process of being deployed inside vehicles.

Also ticketing and pricing are important issues for the promotion of public transport use by older citizens. In the UK, those who have reached pensionable age (then 65 for men and 60 for women, now 61 for women, increasing gradually to 65 by 2020) have free bus travel England-wide since April 1st 2008 with the so-called concessionary travel passes (CTPs). About 19 million people are eligible for a CTP due to age or disability (or both), which is about 30% of the population of Great

Britain. The highest rate is in London, which has had the Freedom Pass offering free travel to older people since 1984 (free travel both on buses and the London Underground at all times). According to the British National Travel Survey, most people have used the bus more since obtaining their passes. There is an inverse relationship between age and bus use increase, with the younger group 55 to 64 increasing their bus use most and the oldest increasing it least. Several studies have found evidence of respondents stating that holding a CTP had improved their quality of life in general: better access to health facilities, more exercise by increased walking and better mental health by more social interaction.

In Germany, in the frame of the VIVALDI-Project, the city of Bremen and the public transport operators in the area designed the BOB-ticket. This is a special chip card focussing on non-frequent passengers. Based on smartcard-technology, this ticket allows the customer access to public transport without the need for prepaid tickets or cash. The customer registers once at one of the participating public transport operators for a BOB-ticket. When entering a bus or a tram, he/she registers the stop of destination and number of passengers for his journey. The information is stored on the registered smartcard and also transferred to a main database for the monthly bill. Customers making single trips are charged as if they were using "one of ten" prepaid tickets; multiple journeys per day are billed for the cheaper one day ticket only. The BOB-ticket was introduced in May 2005 in the transport region of Bremen and surroundings. By the end of 2010 there were about 77 000 ticket holders registered. No data is available regarding the age of the users, but it seems that this kind of practice can be relevant for older people who are in the process of reducing their use of their cars for urban trips. These people are not familiar with the pricing schemes and ticketing systems. Many also want to avoid handling money in public.

Support to car drivers

Measures for older drivers are, among others, refresher courses and activities to support, increase, or even re-install self-awareness. Very few structured and evaluated refresher courses were identified in Europe. One of them is from Norway. The Bilforer 65+ (Driver 65+) refresher course system was introduced in the Norwegian Road and Traffic Plan 1998-2007, and was implemented in the 2006 National Plan of Action for Traffic Safety on the Road. Courses are open for all Norwegians from 60 years on and are run by the Norwegian Public Roads Administration in collaboration with authorised driving schools. A course invitation is sent to all drivers aged 65 or more holding a licence and is repeated for those reaching 70. The courses are based on voluntary participation and contain both theory and practice. Drivers have to pay a fee of about EUR 60 to participate in the course. The topics addressed are: right of way; roundabouts; road markings; traffic signs; traffic light crossings; highways; light usage; overtaking; parking regulations. The course was evaluated in 2011 on the basis of a sample of 2 100 drivers from 70 years on who had reported an accident to their insurance company during a two-year period. About 24% of the sample had completed the course prior to the accident. Drivers who had taken the refresher course before turning 75 years old were found to be at a 35% lower risk of being involved in multiple vehicle crashes compared to older drivers who had not taken the course (Ulleberg et al. 2011). This was statistically significant both before and after adjusting for various confounding variables (age, number of miles driven annually, etc.). However, drivers of 75 and more who had taken the refresher course were at the same risk as drivers who had not. The same tendency, although weaker and non-significant, was found for single-vehicle accidents. It seems that the refresher course has a beneficial effect on safe mobility only if the driver completes the course before 75.

Regarding self-awareness assessment tools, a report was recently issued by Lang et al. (2013). One practice used in Switzerland is described as a representative example, there. A brochure „Älter – Aber Sicher! Wissenswertes für Senioren am Steuer" ["Older – but safe! Useful facts for seniors behind the steering wheel] was published by the Touring Club of Switzerland in 1996. Its aim was to support older drivers' mobility by providing information on age-related changes in performance and medical conditions, and on legal processes in relation to driving licences and fitness-to-drive assessments. It gives recommendations for the maintenance of safe autonomous mobility. Ten questions allow the reader to self-assess driving performance in difficult situations (intersections, dense traffic and reversing), incidents of failing to see other road users, experience of fatigue and vision problems when driving, slowing of reactions in critical situations, and negative feedback from the driver's friends and family, or from other road users. Respondents are recommended to see a doctor if they experience any of the listed problems, and to undergo a detailed assessment of their fitness to drive. As for most self-assessment tools, no scientific evaluation is available.

Measures to improve interaction between road users

It is difficult to find literature or practice cases concerning the communication between road users. However, one main result of the EU-Project SIZE was that a most important barrier for agreeable out-door mobility of older persons stems from difficult interaction with (other) car drivers. Older car drivers complain about other road users "pressing" them by keeping short distances behind them, by showing impatience etc. (Kaiser and Kraus 2006, Amann et al. 2007). Older people who do not sit in a car, mostly pedestrians, perceive car drivers as ruthless, ignoring pedestrians' right of way, obstructing pedestrians' paths by parking on their areas, passing by with too high speeds etc. (Kaiser and Kraus 2006). These results are interesting, as they stem from a large sample of older persons in 8 EU countries – 1 184 males and 2 024 females, all of them 65 and older (except for the Czech Republic with 60 and older) - but the complaints are rather similar to those of road-side surveys with 600 people of all ages in Vienna who declare themselves as "pedestrians" (i.e. persons whose daily mobility mostly consist of walking; Ausserer et al. 2013). This result underlines the frequently expressed assumption that improving the public space and surface-traffic preconditions to the advantage of senior citizens would improve safety and comfort of all road users, especially the unprotected ones. It is obvious that measures to mitigate problems connected to road user communication are: limiting and control of speeds, and especially so where older car drivers have to communicate with other road users and where they generally have difficulties (intersections); and protecting older pedestrians by precisely the same measures, namely by clearly limiting car speeds at those places where they interact with pedestrians (and cyclists), i.e. pedestrians crossings and intersections. These measures have been discussed under the headline of Infrastructure above. In Chapter 6, the importance of appropriate speed management for traffic safety is discussed extensively. Here, it can be added that appropriate speed management is *especially* advantageous for senior citizens and their safety on the road, no matter whether they are car drivers, pedestrians or users of other modes.

Conclusion

This chapter deals with mobility as much as it does with traffic safety. It is in fact necessary to combine these two issues. If one were to only look at the safety of car drivers, it could well happen that many people would be forced to give up their car driving *without necessity*. The consequence could either be a deterioration of autonomous mobility – with the described negative consequences for the individual and for society – or a deterioration of traffic safety because people change to modes that under the present preconditions are more dangerous for them, or both. Thus, it is the firm opinion of the author that, if efforts are to be made to improve senior citizens' safety in traffic and transportation, mobility and safety have to be addressed in combination. Measures have to be taken on this basis. Promising measures are summarised in Table 7.5 below, following the system of the diamond model (Figure 7.4).

Table 7.5. **General overview of measures in relevant areas**

Mode Area	Pedestrians	Cyclists	Car drivers and passengers	Public transport users (PT)	Other modes (scooters, "micro mobility")
Social and cultural issues	Consider senior road user matters as an important area per se; treat those issues in a holistic way, look at mobility and traffic safety as combined matters; start from the daily necessities of senior citizens and hence from the need of autonomous mobility. Lower car speeds will make life of older road users easier and safer no matter which mode they use. Pedestrian accidents when crossing roads, both at intersections and mid-block (= between intersections), are very frequent. Lower car speeds will have an overall positive affect, there, especially concerning mid-block-crossing accidents (which otherwise are very hard to tackle)				
	Public campaigns with health arguments (active ageing) BUT NOT without taking precautions: infrastructure, speed management etc.	Public campaigns with health arguments (active ageing) BUT NOT without taking precautions: infrastructure, speed management, vehicles etc.	Support NGOs and self-efficacy Avoid age based screenings but involve medical doctors, to recognise possible problems and to tell about effects of drugs and for general consulting	Use of PT before getting old fewer driving cessation problems Training of staff: driving style: smooth driving, use of information systems, kneeling mechanism, drive near to kerbs at stops, etc.	Regulations for areas to be used, quality control of vehicles Licensing procedures for use in the public space
Infrastructure	Provide sufficient walkways with smooth surface and appropriate design (kerbs etc.) Adapt waiting times (shorter) and crossing times (longer) at signalised intersections Infrastructure measures to reduce car speeds at intersections	Provide areas for cycling Provide know-how about design of bicycle lanes and bicycle paths and especially of intersections Consider demands if multiple use is planned (bicycles, scooters and micro mobility vehicles)	Appropriate road design for safe use by senior citizens → probably to the advantage of traffic safety in general (handbooks exist)	Smooth surfaces in PT stations, design of stops; places to seat; safe accessibility of stops; adapt stairs and escalators Sufficient number and good placement and hygiene check of toilets Easy to use ticketing systems and time tables	When decision is taken where scooters etc. should be used (Bicycle lanes and paths? Pedestrian paths? On the road with cars?): adjust infrastructure to provide appropriate room and preconditions
Vehicle/Mode	Shoes, Shopping equipment	Bicycles that are appropriate for older users (research ongoing in the Netherlands); equipment (carts, bags, lights, locks, etc.)	Advanced driver assistance systems ADAS, In-vehicle information systems IVIS for older drivers; Vehicle design to support older drivers and passengers	Bus design for easy entering and alighting, well placed seats and handles, good on-trip information (dual mode), easy way to announce wish for stop	Provide vehicles for safe and easy use (see also regulations above)
Directed to the Individual	Information for walkers about walkways in the surroundings, distances and time ways take; short cuts, danger spots	Info for bicyclists about cycle paths and cycle lanes, short cuts, dangerous spots and risky situations	Driver training and refresher courses, information about typical problems of seniors Information and consulting by medical doctors	Info to households about services, lines, schedules, ticketing, easy to get pre-trip info (internet, on paper); Training courses for PT use	Especially information about how and where to use scooters etc. Info about danger spots and risky situations
Communication between road users	Include info about communication with motor vehicle drivers in all info packages (see above); Lower car speeds are best precondition to improve communication between walkers and car drivers	The same as for pedestrians; but cyclists also have to take care of pedestrians: if there is enough space for both modes this is easier	Communication with other road users as a part of all training courses and info packages Lower car speeds will help improve communication with all other road users:best safety measure	Communication utterly relevant for the way to PT: this is probably a walk and often roads have to be crossed on this walk, on intersections or mid-block	The same as for pedestrians and cyclists; users have to train their communication depending on where, viz. in which traffic streams they will travel

Senior citizens should get support for driving a/their car as long as possible in a safe way, especially as driving cessation among older road users in Korea sets in relatively early, after the age of 69. Korean car drivers from 70 years onwards are currently expected to take a driving ability test on a five year basis. However it is suggested that mandatory age based screenings are avoided and the emphasis placed on personal consultation of medical doctors to support individual decisions of older road users. Older car drivers need support in relation to their abilities and deficiencies in certain situations and information on how to compensate for cognitive and sensory limitations and this can be provided at regular medical check-ups.

As public transport accounts for 68% of trips for Korean seniors above the age of 65 (mainly bus and subways), usability and safety issues in public transport system must be a major focus of ensuring safe mobility in an ageing society.

According to expert information, more than 1 494 Silver Zones are designated around the premises of cultural centres for the elderly in Korea and around parks that are frequently visited by senior citizens. Within Silver Zones cars are required to keep to a speed limit of 30 km/h and crossing times are extended at crossings controlled by traffic lights to enable elderly people to cross safely. These are certainly very important steps to support both safety and mobility. However, in order to really improve the safety of senior citizens and at the same time to support their autonomous mobility, measures that affect the traffic system as a whole are needed, as older persons are resident in most locations. Motor vehicle speed management and speed control will play a central role in achieving a safe overall environment.

Finally, for commercial car drivers there are currently no regulations related to age in in Korea. This gap in the regulation of the industry should be closed as quickly as possible. Mandatory driving ability tests for bus drivers are being discussed. Again, these deliberations should be concluded as quickly as possible and regulation introduced.

References

Ahern A. and Hine J. (2012), "Rural transport – Valuing the mobility of older people". Research in Transportation Economics, Vol. 34(1), pp. 27–34.

Amann A., Reiterer B., Risser R. and Haindl G. (2006), "Life quality of senior citizens in relation to mobility preconditions." Final report of the EU-Project SIZE, Institute of Sociology of the University of Vienna and FACTUM Chaloupka and Risser OHG Vienna

Ausserer K., Füssl E. and Risser R. (2013), "NutzerInnenbefragung: Was gefällt am Gehen und was hält davon ab" (User survey: What aspects of walking are pleasant and what keeps one from walking). Studie im Auftrag der MA 18 Stadtentwicklung und Stadtplanung, Endbericht, Municipality of Vienna.

Bell D., Füssl E., Ausserer K., Risser R., Wunsch D., Braguti I., Oberlader M. and Friedwag-ner A. (2010),"Scenarios of the future mobility of elderly people: Life transition points and their impact on everyday mobility of elderly people; future mobility developments and necessary support measures with special regard to retirement and loss of partner." Final project report, ERA NET TRANSPORT, ENT14 Keep Moving, financed by the Austrian Federal Ministry for Transport, Innovation and Technology, Vienna.

Bell D., Pokriefke E., Risser R., Biler S., Šenk P., Parkes A., Stannard J., Armoogum J., Marin-Lamellet C., Gabaude C., Madre J. L., Alauzet A., Monterde i Bort H. and Henriksson P. (2013), "Mobility Patterns in the Ageing Populations". Work package 2 Summary report of the CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies. Accessible at: http://consolproject.eu/attachments/article/19/CONSOL%20Report_WP2-Mobility%20patterns%20in%20the%20ageing%20populations_summary%20report.pdf

Bell D., Pokriefke E., Risser R., Siren A., Haustein S., Meng A., Biler S., Šenk P., Dankova L., Kureckova V., Parkes A., Stannard J., Lang B., Armoogum J., Marin-Lamellet C., Gabaude C., Madre J. L., Alauzet A., Monterde i Bort H. and Henriksson P. (2013), Synthesis and Recommendations. Final Project Report of the project CONSOL (CONcerns and SOLutions – Road Safety in the Ageing Societies (MOVE/C4/SUB/2010-125/SI2.601704/CONSOL).

Blokpoel A. and De Niet M. (2000), "Spookrijders en frontale botsingen op autosnelwegen" [Wrong-way drivers and head-on collisions on motorways; number and development of their threat to road safety, in the period up to 1998]. R-2000-16. SWOV, Leidschendam.

Blomberg R. and Edwards J. (1990), "Development of Safety Information Materials and Media Plans for Elderly Pedestrians". Task 2 Report. Contract No. DTNH22-89-C-07397. National Highway Traffic Safety Administration, Washington, D.C.

Box E., Gandolfi J. and Mitchell K. (2010), "Maintaining Safe Mobility for the Ageing Population: The Role of the Private Car", RAC Foundation, London.

Brouwer R.F.T., Herland L. and Van der Horst A.R.A. (2000), "Sustainable safe design of roundabouts", TNO-report TM-00-D002. TNO Human Factors TM, Soesterberg.

Caird J.K., Chugh J.S., Wilcox S. and Dewar R.E. (1998), "A design guideline and evaluation framework to determine the relative safety of in-vehicle intelligent transportation systems for older drivers", TP 13349E. Transport Canada, Transportation Development Centre TDC, Montreal, Quebec.

CROW (1996), "Aanbevelingen voor verkeersvoorzieningen binnen de bebouwde kom (ASVV)", CROW-publicatie 110. CROW, Ede.

DaCoTa. (2011), Traffic Safety Basic Facts 2011: http://ec.europa.eu/transport/road_safety/pdf/statistics/dacota/bfs2011_dacota-ntua-young_people.pdf

Davidse R.J. (2000), “Ouderen achter het stuur” [Older drivers behind the steering wheel], D-2000-5. SWOV Institute for Road Safety Research, Leidschendam.

Davidse R.J. (2006), “Older drivers and ADAS - Which systems improve road safety?” *IATSS Research*, Vol. 30(1), pp. 6-20.

Davidse R.J. (2007), “Assisting the older driver; Intersection design and in-car devices to improve the safety of the older driver”, PhD thesis University of Groningen. SWOV Institute for Road Safety Research, Leidschendam.

Davidse R.J., Hagenzieker M.P., Van Wolffelaar P.C. and Brouwer W.H. (2009), “Effects of in-car support on mental workload and driving performance of older drivers”, *Human Factors*, Vol. 51(4), pp. 463-476.

DfT (2009), “Collisions involving older drivers: an in-depth study”, *Road Safety Research Report 109*, Department for Transport, London.

ETSC (1999), “Intelligent Transportation Systems and road safety”, European Transport Safety Council ETSC, Brussels.

Evans L. (1991), “Traffic safety and the driver”, Van Nostrand Reinhard, New York.

Färber B. (2000), „Neue Fahrzeugtechnologien zur Unterstützung der Mobilität Älterer“. Zeitschrift für Gerontologie und Geriatrie 33, p. 178-185.

Fastenmeier W., Gstalter H., Rompe K. and Risser R. (2015), Selektion oder Befähigung: Wie kann die Mobilität älterer Fahrer aufrechterhalten werden? Stellungnahme namens des Vorstandes der Deutschen Gesellschaft für Verkehrspsychologie e.V. (DGVP). *Zeitschrift für Verkehrssicherheit, 61*

Fildes B. and Charlton J. (2005), Older drivers and possibilities for injury avoidance. Berichte der Bundesanstalt fuer Strassenwesen. Unterreihe Fahrzeugtechnik (55), pp. 225-34.

Fonda S. J., Wallace R.B. and Herzog A.R. (2001), “Changes in driving patterns and worsening depressive symptoms among older adults”, *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* Vol. 56(6), pp. S343-S351.

Gardner-Bonneau D. and Gosbee J. (1997), « Health care and rehabilitation” in Fisk, A.D. and Rogers, W.A. (Eds.), *Handbook of human factors and the older adult*. Academic Press Inc., San Diego, pp.231-255.

Gelau Ch., Sirek J. and Dahmen-Zimmer K. (2011), “Effects of time pressure on left-turn decisions of elderly drivers in a fixed-base drivnig simulator”, *Transportation Research Part F*, Vol. 14, pp. 76-86.

Gilhooly M.L.M., Hamilton K., O’Neill M., Gow J., Webster N., Pike F. and Bainbridge C. (2002), “Transport and ageing: Extending quality of life via public and private transport”, ESCR Report L48025025, Brunel University Research Archive.

Green P. (2004), “Driver Distraction, Telematics Design, and Workload Managers: Safety Issues and Solutions”, *SAE Paper* No. 2004-21-0022

Guralnik J. M., Alecxih L., Branch L. and Wiener J. M. (2002), “Medical and long-term care costs when older persons become more dependent”, *American Journal of Public Health*, No. 9, pp. 1244–1245

Haddad H. and Musselwhite C. (2007), "Prolonging Safe Driving Through Technology", *SPARC Research Briefing Sheet 024*, Centre for Transport and Society, University of the West of England, Bristol.

Hakamies-Blomqvist L. (1993), "Fatal accidents of older drivers", *Accident Analysis and Prevention*, Vol. 25/1, pp. 19-27.

Hakamies-Blomqvist L. (1994), "Accident characteristics of older drivers: Can findings based on fatal accidents be generalized?", *Journal of Traffic Medicine*, Vol. 22(1), pp. 19-25.

Hakamies-Blomqvist L., Johansson K. and Lundberg C. (1996), "Medical screening of older drivers as a traffic safety measure: a comparative Finnish-Swedish evaluation study", *Journal of the American Geriatrics Society*, Vol.44(6), pp. 650-653.

Hakamies-Blomqvist and Wahlstrom B. (1998), "Why do older drivers give up driving?" *Accident Analysis and Prevention*, Vol. 30, pp. 305-312

Hakamies-Blomqvist L. (2003), "Ageing Europe : the challenges and opportunities for transport safety"; Fifth European Transport Safety Lecture, Brussels, 22nd January 2003. European Transport Safety Council ETSC, Brussels, accessible at: http://archive.etsc.eu/documents/5th%20European%20Transport%20Safety%20Lecture.pdf

Hakamies-Blomqvist L. and Siren A. (2003), "Deconstructing a gender difference: driving cessation and personal driving history of older women", *Journal of Safety Research*, Vol. 34/4, pp. 383–388.

Hakamies-Blomqvist L., Sirén. A. and Davidse R. (2004), Older drivers – a review. VTI rapport 497A. Linköping: VTI.

Harrison A. and Ragland D.R. (2003), "Consequences of driving reduction or cessation for older adults", *Transportation Research Record (1843)*, pp. 96-104.

Haustein S., Siren A., Franke E., Bell D., Pokriefke E., Alauzet A., Marin-Lamellet C., Armoogum J. and O'Neill D. (2013), "Demographic change and transport". Work package 1 report. CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies

Heijer T. et al. (2001), Action for Advanced Drivers Assistance and Vehicle Control System Implementation, Standardisation, Optimum Use of the Road Network and Safety. ADVISORS Deliverable D1/2.1 v1 : Problem identification, user needs and inventory of ADAS (Advanced Driver Assistance Systems): Final report. Contract No. DGTREN GRD1 2000-10047. Commission of the European Communities, Directorate-General for Energy and Transport, Brussels.

Heikkinen S., Meng A., Alauzet A., Bell D., Dankova L., Kureckova V., Lang B., Marin-Lamellet C., Monterde-i-Bort H., Parkes A., Pokriefke E., Snopek M. and Strnadova Z. (2013), "Stakeholders and practices in the field of senior safety and mobility". Work package 4 report CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies

Hjorthol R. and S. Nordbakke (2008), "Bilens betydning for eldre gruppers velferd og livskvalitet", TØI-rapport 1000/2008. Oslo: Transportøkonomisk institutt.

Jansen E., Holte H., Jung C., Kahmann V., Moritz K., Rietz C., Rudinger G. and Wiedemann C. (2001), Ältere Menschen im künftigen Sicherheitssystem Straße/Fahrzeug/ Mensch. Berichte der Bundesanstalt für Straßenwesen, Mensch und Sicherheit, Heft M134. Wirtschaftsverlag NW, Bremerhaven.

Kaiser H.J. and Kraus B. (2006), Results of the quantitative studies with senior citizens. Deliverable 12 in the frame of the EU-Project SIZE, Institute of Psychogerontology at the University of Erlangen-Nuremberg

Lang B., Parkes A. and Fernández Medina K. (2013), “Driving Choices for the Older Motorist – The role of self-assessment tools”, Transport Research Laboratory.

Langford J., Methorst R. and Hakamies-Blomqvist L. (2006), “Older drivers do not have a high crash risk - a replication of low mileage bias”, *Accident Analysis and Prevention* Vol. 38/3, pp. 574-578.

Lees M.N. and Lee J.D. (2009), “Enhancing safety by augmenting information acquisition in the driving environment”, in *Human Factors of Visual and Cognitive Performance in Driving*, C. Castro, Ed., pp. 167–186, CRC Press, Boca Raton

Marin-Lamellet C., Haustein S., Pokriefke E., Monterde i Bort H. and Strnadova Z. (2013), “Case analyses of practices aimed at managing the safety of senior road users”. CONSOL Case analyses of practices aimed at managing the safety of senior road users. Work package 5.2 Report.

Marottoli R.A., Mendes de Leon C.F., Glass T.A., Williams C.S., Cooney Jr. L.M. and Berkman L.F. (2000), “Consequences of driving cessation: decreased out-of-home activity levels”, *Journals of Gerontology Series B - Psychological Sciences and Social Sciences* Vol. 55/6, pp. 334-340.

May E., Garrett R. and Ballantyne A. (2010), ”Being mobile: electric mobility-scooters and their use by older people”, *Ageing and Society* Vol. 30/07, pp. 1219-1237.

McGwin Jr. G. and Brown D.B. (1999), “Characteristics of traffic crashes among young, middle-aged, and older drivers”, *Accident Analysis and Prevention*, Vol. 31/3, pp.181-198.

Mesken J. (2002), “Kennisleemten en -behoeften van oudere verkeersdeelnemers in Drenthe; Verslag van een vragenlijstonderzoek” [Knowledge gaps and needs among elderly road users in Drenthe; A questionnaire study]. R-2002-18. SWOV, Leidschendam.

Mitchell C. G. B. and Suen S. L. (1997), “ITS impact on elderly drivers” in *Proceedings of the 13th International Road Federation IRF World Meeting*, Toronto, Ontario, Canada, June 16 to 20, 1997, Toronto.

Methorst R., Monterde i Bort H., Risser R., Sauter D., Tight M. and Walker J. (Eds.) (2010), “Pedestrians' Quality Needs”. Final Report of the COST project 358, Cheltenham: Walk21.

Mollenkopf H., Marcellini F., Ruoppila I. and Tacken M. (2004), *Ageing and outdoor mobility; A European study*, IOS Press, Amsterdam.

Mollenkopf H., Baas S., Marcellini F. and Oswald F. (2005), Mobility and the Quality of Life. Eds.: "Enhanching Mobility in Later Life", IOS Press, 2005, Amsterdam, Netherlands, pp. 279 - 288

Nordbakke S. and Schwanen T. (2013), “Well-being and Mobility: A Theoretical Framework and Literature Review Focusing on Older People”, *Mobilities,*Vol. 9, Issue 1, pp. 104-129, 2014.

O’Neill D. (2013), “Accident patterns in the ageing population: non-collision injuries on public transport and injuries of single pedestrians”. Work package 3.2 report. CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies

OECD/ITF (2012), *Pedestrian Safety, Urban Space and Health*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789282103654-en .

OECD (2001), *Ageing and Transport: Mobility Needs and Safety Issues*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264195851-en

Oxley P. R. and Mitchell C. G. B. (1995), Final report on elderly and disabled drivers information telematics. Dedicated Road Infrastructure for Vehicle Safety in Europe DRIVE II Project V2031 Elderly and Disabled Drivers Information Telematics EDDIT. R&D Programme Telematics System in the Area of Transport (DRIVE II), Commission of The European Communities CEC, Directorate General XIII Telecommunications, Information Industries and Innovation, Brussels.

Pereira M., Bruyas M.-P. and Simoes, A. (2010), “Are elderly drivers more at risk when interacting with more than one in-vehicle system simultaneously?” *Le Travail Humain*, Vol. 73/1, pp.53-73.

Petzäll J. (1991), “Special Vehicles and Taxis for the Older and the Disabled”, in Gordon and Breach (eds.), *Mobility and Transport for Older and Disabled Persons*, Transport Studies 13, pp. 810-816.

Piechulla W., Mayser C., Gehrke H. and König W. (2003), „Reducing drivers' mental workload by means of an adaptive man–machine interface”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 6/4, pp. 233-248.

Reeves C., Lang B., Parkes A., Bernhoft I. M., Senk P. and Gabaude C. (2013), “Traffic accident patterns in the ageing population”. Work package 3.1 report. CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies

Risser R. (2004), “Philosophy of Traffic Calming”, *The Asian Journal. Journal of Transport and Infrastructure* Vol. 11/1, pp 1-9

Risser R., Haindl G. and Ståhl A. (2010), “Barriers to senior citizens’ outdoor mobility in Europe”, *European Journal of Ageing,* Vol. 7/2, pp. 69-80

Rosenbloom S. (2010), “How adult children in the UK and the US view the driving cessation of their parents: Is a policy window opening?” *Journal of Transport Geography*, Vol. 18/5, pp. 634-641.

Rosenkvist J., Risser R., Iwarsson S., Wendel K. and Ståhl A. (2009), “The Challenge of Using Public Transport: Descriptions by People with Cognitive Functional Limitations”, *Journal of Transport and Land Use*, Vol. 2, No 1.

Schwanen T., Hardill I. and Lucas S. (2012), “Spatialities of ageing: The co-construction and co-evolution of old age and space”, *Geoforum* No. 43 (2012); pp.1291–1295.

Siren A., Haustein S., Meng A., Bell D., Pokriefke E., Lang B., Medina K.F., Gabaude C., Marin-Lamellet C., Monterde i Bort H. and Strnadova Z. (2013), “Driver Licensing Legislation”. Work package 5.1 Report. CONSOL project, CONcerns and SOLutions – Road Safety in the Ageing Societies

Spinney J.E.L., Scott D.M. and Newbold B.K. (2009), “Transport mobility benefits and quality of life: A time-use perspective of elderly Canadians”, *Transport Policy*, Vol. 16/1, pp. 1-11.

Staplin L., Lococo K. and Byington S. (1998), “Older Driver Highway Design Handbook”, FHWA-RD-97-135.Department of Transportation, Federal Highway Administration, Washington, DC.

Staplin L., Lococo K., Byington S. and Harkey D.L. (2001), “Highway design handbook for older drivers and pedestrians”, FHWA-RD-01-103. U.S. Department of Transportation DOT, Federal Highway Administration FHWA, Turner-Fairbank Highway Research Center Research and Development RD, McLean, VA.

SWOV (2012), “The elderly in traffic”, SWOV Fact sheet. SWOV Institute for Road Safety Research, Leidschendam.

Torpey S.E. (1986), “License re-testing of older drivers”, Road Traffic Authority. Hawthorn, Melbourne.

Ulleberg P., Bjørnskau T. and Fostervold K. I. (2011), *Evaluation of a refresher course for older drivers* . Oslo: Transportøkonomisk institutt.

Viborg N. (1999), “Older and younger drivers'attitudes toward in-car ITS; A questionnaire survey”, Bulletin 181. Department of Technology and Society, Lund Institute of Technology, Lund, Sweden.

Vonk T., Van Arem B. and Hoedemaeker M. (2002), "Cooperative driving in an intelligent vehicle environment (co-drive)", in: *Proceedings of the 9th World Congress on Intelligent Transport Systems ITS, Chicago, Illinois, October 14-17 2002*. ITS America, Washington DC.

Wilde G.J.S. (1982), "The theory of risk homeostasis: Implications for safety and health", *Risk Analysis*, Vol. 2/4, pp. 209-225.

Wretstrand A., Svensson H., Fristedt S. and Falkmer T. (2009), "Older People and Local Public Transit: Mobility Effects of Accessibility Improvements in Sweden", *Journal of Transport and Land Use*, Vol. 2/2,pp. 49-65.

Young M.S. and Bunce D. (2011), "Driving into the Sunset: Supporting Cognitive Functioning in Older Drivers", *Journal of Aging Research*, Article ID 918782.

Notes

1. Concerning this topic see also the EU project GOAL http://www.goal-project.eu/

2. During the round table discussion in Seoul on December 11th electric wheel chairs and scooters were referred to as increasingly important modes. However, it is difficult to find any data concerning the importance of these modes in numbers.

3. For more detailed information concerning senior citizens' accidents see Reeves et al. (2013)
4. Information for many of the measures and also for the safety data has been taken from the websites http://safetyknowsys.swov.nl/Statistics/Basic%20fact%20sheets/2012/BFS2012_DaCoTA-TRL_Elderly.pdf and http://safetyknowsys.swov.nl/Safety_issues/pdf/Older%20Drivers.pdf

5. In Swedish "flexlinje" - flexible public-transport service where the bus can be ordered by phone to stop nearer to one's house, the arrival of a bus is provided within a certain acceptable time-period, a seating place is provided, the driver helps passengers to get on, to get off, to sit down, etc; earlier these lines could be used by older persons only, nowadays they may be used by everybody

6. Transport service provided and paid for by municipalities only for use by people who have severe and chronic functional impairments

Halving the Number of Road Deaths in Korea

Lessons from other Countries

Korea aims to radically improve its roads safety record and move from one of the highest shares of road deaths per heads of population of OECD countries to a place among OECD's top road safety performers. A number of successful measures have already been adopted, yet these will not be sufficient to deliver fewer road deaths on the desired scale. The Korean government invited the International Transport Forum (ITF) together with Korean experts to assess the road safety strategies in place, and to identify potential improvements. The analysis presented in this report draws on good practices in other OECD countries that are relevant for Korea with regard to both road safety policies as well as the institutional arrangement to support them.

This report is part of the International Transport Forum's Case-Specific Policy Analysis (CSPA) series. These are topical studies on specific transport policy issues of concern to a country carried out by ITF on request.

International Transport Forum
2 rue André Pascal
75775 Paris Cedex 16
France
T +33 (0)1 45 24 97 10
F +33 (0)1 45 24 13 22
Email : contact@itf-oecd.org
Web: www.itf-oecd.org

2016-04 /Photo credit: Kimmo Raisanen