FIA Region I policy study
Vision Zero, the ageing population, and the impact of rapidly developing vehicle and infrastructure transformations

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I. Task

The Vision Zero policy framework has proven to be an effective strategy for improving safety within transportation systems. Central to the Vision Zero concept is the belief that all fatalities and serious injuries resulting from traffic incidents can be reduced to zero. It posits that it is the duty of transportation planners and policymakers to establish secure environments for every road user. Vision Zero underscores the significance of designing roads and transportation systems that prioritize safety over speed and convenience.

This research delves into the application of the Vision Zero policy framework within the context of mobility clubs, other mobility sector stakeholders and related safety legislation, catering to elderly passengers. The study encompasses an examination of the advantages and challenges associated with adopting the Vision Zero approach. Additionally, it scrutinizes specific strategies, interventions, and technologies that can be employed to heighten safety for elderly individuals.

The investigation will address the unique needs of elderly passengers, including the potential impact of age-related declines in vision, hearing, and cognitive function on transportation safety but frequently having a high level of experience of deal with complex traffic situations and being risk averse, therefore being more prudent and better anticipating risky traffic situations. The ultimate goal of this study is to formulate recommendations and best practices for mobility clubs, other mobility sector stakeholders and the legislator, aiming to implement a Vision Zero approach that prioritizes safety for all passengers, with a particular focus on the elderly demographic.

II. Abbreviations

Symbol	Description
ABS	Anti-lock Braking System
ACPE	Acceleration Control for Pedal Error
ADAC	Allgemeiner Deutscher Automobil-Club e.V.
ADAS	Advanced Driving Assistant Systems
AEBS	Advanced Emergency Braking System
AIS	Abbreviated Injury Scale
ASAM	Association for Standardization of Automation and Measuring Systems
ASEAN NCAP	New Car Assessment Programme for Southeast Asian Countries
ATD	Anthropomorphic Test Device
ATRF	Australasian Transport Research Forum Incorporated
ATZ	Automobiltechnische Zeitschrift
AVT	Advanced Vehicle Technology
BDCMS	Bicyclist Detection and Collision Mitigation System
C-ITS	Cooperative Intelligent Transport System
CLEPA	European Association of Automotive Suppliers
C-NCAP	China New Car Assessment Programme
DESTATIS	Statistisches Bundesamt (German Federal Statistical Office)
DMS	Driver Monitoring System
DVR	Deutscher Verkehrssicherheitsrat (German Road Safety Council)
ESC	Electronic Stability Control
ETSC	European Traffic Safety Council
EU	European Union
Euro NCAP	European New Car Assessment Programme
EVA	Emergency Vehicle Approaching
GIDAS	German In-Depth Accident Study
GLOSA	Green Light Optimal Speed Advisory
GP	General Practitioner
GSD	Global Safety Database
HMI	Human Machine Interface
ICS	In-Cabin Sensing
IGLAD	Initiative for the Global Harmonisation of Accident Data

ITS	Intelligent Transport System
IVS	Intelligente Verkehrssystem (Intelligent Transport System)
JNCAP	Japan New Car Assessment Programme
KPI	Key Performance Indicator
MVW	Maintenance Vehicle Warning
NCAP	New Car Assessment Programme
ODD	Operational Design Domain
OMS	Occupant Monitoring System
PDCMS	Pedestrian Detection and Collision Mitigation System
PTW	Powered Two-Wheeler
PVD	Probe Vehicle Data
RWW	Road Works Warning
SAE	Society of Automotive Engineers
TJW	Traffic Jam Warning
TSP	Traffic Signal Priority Request
UN	United Nations
UNECE	United Nations Economic Commission for Europe
V2X	Vehicle-to-X
VRU	Vulnerable Road User
VVICW	Vehicle-to-Vehicle Intersection Collision Warning System

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IV. Executive summary

Vision Zero in a nutshell means the concept that all traffic-related deaths and serious injuries are preventable, and that it is the responsibility of policymakers and enforcement authorities to create safe environments for all road users. There is special emphasis on accident prevention of vulnerable road users like pedestrians and of two-wheeled vehicles. Within the category of vulnerable road users, the elderly population deserves special attention.

This report is intended to provide recommendations for action to help mobility clubs, other mobility sector stakeholders and the legislator to evaluate their own strategy for their Vision Zero development and implementation of safety measures, in particular with respect to elderly traffic participants. Among others, measures are highlighted that some mobility clubs are already using, which may be noted by other clubs as source of inspiration to implement measures to the benefit of their own members. The same approach is recommended for some governments and institutions. Current technologies implemented and applied by the automotive industry are examined and listed in this report. On the one hand, recommendations for action are provided regarding areas of technology which should be particularly considered when it comes to Vision Zero in the context of older members of society and vulnerable traffic participants. On the other hand, areas were identified in which additional studies appear to be necessary, especially when it comes to advanced vehicle systems and the interaction with senior citizens. The collection of current technology can also serve as a basis for far-reaching information campaigns.

The outcome of this report is based on three pillars that serve as the tenets of a Vision Zero safety strategy:

- Strengthen **awareness** of Vision Zero among decision-makers and society
- Perform **analysis** of data to identify intervention points
- Pay attention to new **trends** and promote implementation of state-of-the-art safety technologies, providing these are intuitive, user friendly and are affordable.

Awareness in society can be strengthened through comprehensive information campaigns that explain the topic of Vision Zero in terms of technical, social, sustainability and political aspects. Educating society and all age groups of traffic participants about latest technology was identified as a crucial point, where not only the functionalities of technical systems should be explained, but system limits of individual functions of a vehicle should also explicitly be addressed. By assessing accident figures alongside demographics, injury data or mobility concepts, potential areas of influence on strategies can be identified relatively quickly and reliably in a data-driven manner. The final pillar should be the monitoring of new trends, such as new forms of mobility or new characteristics of traffic behaviour and interaction with other traffic participants. Not all new trends provide a higher level of safety from the outset, e.g. deployment of personal mobility devices or e-bikes, in the quest of and trade-off with more sustainable transportation. Attention should not be limited to one's own region, but rather a global awareness should be raised. Knowledge about the traffic situation in other countries can be advantageous. This makes it possible to identify new fields of intervention before a critical level is reached. Benchmarking particular improvements in road safety in other countries and deploying those specific measures in one’s own country may also help prevent road accidents.

In addition to this strategy, concrete measures to achieve Vision Zero are presented in this report, in particular those that are understandable and beneficial for the elderly, more vulnerable road users. Such measures range from planning the route when driving, to personal exercises for body and mind to stay fit, to actively gathering information about new technologies or current rule changes. Mobility clubs can compile the necessary information and make it available to the public, thus creating a common level of knowledge. Some mobility clubs already offer voluntary fitness tests, cooperate with driving schools and explain driving dynamics and new technology. The rapid implementation and low costs of these actions are a major added value.

One of the most common safety components in a vehicle at present are Advanced Driving Assistant Systems and Driver Control Assistance Systems. The explanation of such systems should also explicitly address system limits, differences in different vehicles and safe operation. The report also highlights a few topics where further studies seem appropriate, like the issues in the Operational Design Domain or the lack of consideration for older people in the design of Human-Machine-Interface.

Further actions concern the mobility clubs, other mobility sector stakeholders and the legislator, in which they collect their own information. This can be done, for example, by analysing accidents or by observing the traffic situation in neighbouring regions, but also through official reports related to road safety. Data analysis is the basic principle for quick and reliable identification of areas for action, allowing a quick reaction to change in a timely and controlled manner. This report presents a data analysis inspired by the so-called PDCA cycle, the advantage of which is the continuous review and evaluation of the measures.

In general, some accident databases are already available for data analysis, such as GIDAS or IGLAD. The Global-Safety-Database provides an overview of existing data sources on accident figures. In this report, analyses were carried out with the German data from DESTATIS and GIDAS, as well as with the European databases CARE and IGLAD. In addition, the data analysis also includes an evaluation of a report from the European Transport Safety Council on reducing the number of senior citizens killed on European roads. With the help of the accident figures it was possible to identify situations in which senior citizens are primarily at a higher risk of having an accident on the road. Measures here could be the promotion of suitable systems, such as the Intersection-Movement-Assist, or infrastructural measures, which in turn require discussions with road authorities.

Possible measures range from discussions with authorities on infrastructural improvements, new safety technology to their own road safety campaigns, such as projects for enabling lifelong mobility. Depending on the size and budget of the individual mobility clubs, such projects can either be initiated or supported. Mobility clubs are also in a good position to bring security-related issues or concerns and wishes of members into the political arena, like discussions about alternative mobility options or more consideration for older people in the development of new vehicles.

Above all is the cooperation of all traffic stakeholders, from individuals to authorities, vehicle manufacturers and politicians. In this way, Vision Zero can be further advanced, taking into account the three pillars (Awareness-Analysis-Trends) mentioned above, so that all road users are safer on the road. With the help of the strategy and measures shown, improvements in road safety can be achieved quickly, continuously and cost-effectively.

1. Introduction

Mobility clubs play a significant role in advocating safe and reliable transportation services to individuals who may have limited access to public transportation or are unable to drive themselves. One of the key aspects of mobility clubs is to help ensure the safety of their members and other traffic participants. This is particularly important for the elderly population, who may be more vulnerable to accidents and injuries.

The Vision Zero policy framework is an effective approach to enhancing safety in transportation systems. The concept of Vision Zero is based on the belief that all traffic-related deaths and serious injuries are preventable, and that it is the responsibility of transportation planners, policymakers and enforcement authorities to create safe environments for all road users. Vision Zero emphasises the importance of designing roads and affordable transportation systems that prioritise safety over speed and convenience.

In this policy study, the implementation of the Vision Zero policy framework should be explored that serve elderly passengers and other vulnerable road users. The benefits and challenges of adopting a Vision Zero approach should be examined, as well as the specific strategies, interventions, and technologies that can be employed to enhance safety for elderly passengers in a mobile world, including public transport and other mobility options beyond the focus of passenger cars, such as pedelecs, etc.

The policy study will also consider the unique needs and concerns of elderly travellers, such as the potential impact of age-related decline in vision, hearing, and cognitive function on transportation safety. The consultant should explore how mobility clubs can address these challenges by incorporating age-friendly principles and providing additional support and training for drivers. The study will also look into the benefits that elderly traffic participants may bring to the benefit of younger participants, such as being more risk averse, having significantly more experience to safely cope with challenging traffic situations and better anticipate possibly dangerous traffic situations.

Ultimately, the goal of this study is to provide recommendations and best practices for mobility clubs, other traffic stakeholders and the legislator that are seeking to implement a Vision Zero approach that prioritises safety for all passengers and age groups, including elderly vulnerable road users. By adopting a proactive and holistic approach to transportation safety, mobility clubs, other mobility stakeholders and the legislator, that can enhance their perception and offer custom-tailored services or legislative requirements that improve the quality of life of all European citizens and create a safer traffic environment for all.

2. What is Vision Zero?

Vision Zero describes the common goal of various road safety strategies from different countries around the world. At the core of Vision Zero is the goal that no one should lose their life in traffic. Serious injuries with long-term consequences should also be avoided. The basis for Vision Zero is the right of every person to physical integrity. In 1997, Vision Zero was already incorporated into Swedish legal regulations as a principle and forming the basis of Swedish traffic legislation. At the same time, the "Sustainable Safety" programme was introduced in the Netherlands, which specifically contains a "safe system approach". The "safe system" forms a strategy that has Vision Zero as its goal (SWOV Institute for Road Safety Research, 2018). In 2021, Prof. Akinori Morimoto from Waseda University presented a conceptual framework for road safety at the 7th Global Interactive Forum on Traffic and Safety (Figure 2-1). The top priority is the common GOAL (Common Vision): Vision Zero. Below that lies the STRATEGY: the "Safe System Approach". The BASIS of this pyramid is the "Traffic Safety Culture", i.e. the shared values and beliefs of road users and interest groups.

Figure 2-1: Understanding the relationship between the concepts (International Association of Traffic and Safety Sciences, 2021)

Over the years, some countries have joined this shared vision, including international organisations such as the United Nations (UN) or the European Union (EU). For a better overview, some chronological classifications are shown in appendix 10.A.1. All actors have Vision Zero in common, even if the strategy may differ somewhat. Table 2-1 shows selected countries or organisations along with their Vision Zero principles.

Countries / International Organizations	Basic principles of the plan
Sweden (1997) – Vision Zero	The long-term goal for road safety is proposed to be that no one should be killed or seriously injured as a result of traffic accidents within the road transport system
Netherlands (2018) – Sustainable Safety	A sustainably safe road traffic system prevents road deaths, serious road injuries and permanent injury by systematically reducing the underlying risks of the entire traffic system
New Zealand (2019) – Road to ZERO	A New Zealand strategy targeting no one being killed or seriously injured in road crashes
Norway (2018) – National Plan of Action for Road Safety	The road safety work will be based on the vision of no one being killed or seriously injured within the road transport system
Australia (2011-2020) – National Road Safety Strategy	It is firmly based on Safe System principles and is framed by the guiding vision that no person should be killed or seriously injured on Australia's roads
Denmark (2013-2020) – Road Safety Commission National Action	To ensure that errors by road users do not cause serious accidents and also limit dangerous driving as far as possible. We all have a responsibility
Japan (2021) – The 11th Fundamental Traffic Safety Programme	Aiming to a society without traffic accidents
UN (2010) – Global Plan for the Decade of Action for Road Safety	The guiding principles are those included in the "safe system" approach. It starts from the acceptance of human error and thus the realization that traffic crashes cannot be completely avoided.
World Bank (2018) – Sustainable and Safe: A Vision and Guidance for Zero Road Deaths	The "safe system" approach outlined in this report starts from the basic premise that human error is inevitable, but traffic fatalities and serious injuries are not
European Commission (2020) – EU Road Safety Policy Framework	The premise that no loss of life is acceptable needs to inform all decision making on road safety. The Safe System approach aims for a more forgiving road system. Shared responsibility
UN (drafted 2021) – Global Plan of Action for the 2021-2030 Decade of Action for Road Safety	It draws further attention to effective governance as a central aspect of implementation of the safe system.

Table 2-1: Basic principles of strategies towards Vision Zero (International Association of Traffic and Safety Sciences, 2021)

It is clear that road traffic accidents are a major concern in many countries. Reducing traffic fatalities and serious injuries is the top priority. Vision Zero, as it is applied with regard to road safety, is fundamentally based on four pillars (Verkehrssicherheitsrat, 2012):

1. **Life is non-negotiable**

   Everyone has the right to live and on physical integrity. Vision Zero demands these rights.

2. **People are fallible**

   Humans are evolutionarily designed to move at maximum speeds of between 20 and 30 km/h. For thousands of years, human motor skills, coordination, perception, and information processing have been geared towards this. This means that in the speed ranges in which motorized traffic predominantly takes place, incorrect human decisions are not the exception, but rather the rule. In addition, there are errors caused by emotional or stress-related processes.

3. **The limits of what is tolerable are determined by people's physical resistance**

   The criterion for the design of the transport system is human biological tolerance. Accident research provides limit values for this. Most vulnerable road users like pedestrians (outside of vehicles) who are hit by a vehicle at up to 30 km/h can survive (Verkehrssicherheitsrat, 2012). The higher the impact speed, the higher the probability of severe injuries or fatalities. With the further development of passive and active safety systems, it will be increasingly possible to drop below these critical speeds at the moment of an accident. However, these limits do not take individual differences into account. For example, elderly people are at greater risk because their physical resistance is often lower and injuries heal more slowly.

4. **People have a right to safe transport and safe jobs**

   It is the task of the state and every individual to participate in creating a safe transport system. Individuals are responsible for complying with laws and regulations, while system designers are responsible for ensuring that the system as a whole is secure.

These four pillars determine the Vision Zero goal which countries and institutions around the world are working towards. With Vision Zero, traffic routes and means of transport are given particular consideration.

As the goal of road safety, this vision applies to all people without exception. However, in this study, special attention is paid to the older population. The aim is to show which special measures can be applied for seniors within the common goal of Vision Zero. To this end, strategies, guidelines, and actions from various authorities and institutions were examined and planned and already implemented measures were identified.

The first measure that can be mentioned here is a common understanding of Vision Zero, as well as a suitable strategy and the traffic safety culture. For a goal as big as Vision Zero, everyone must work together towards the same values.

3. Vision Zero – Measures

Sweden can be mentioned as an example of the implementation of Vision Zero as it has played a pioneering role in Europe in this regard. The results of the Vision Zero are already noticeable there, which can be seen in the change in the road environment (Straßenwesen, 1998).

- Traffic roundabouts have become more common as a traffic solution at intersections. Roundabouts slow down the flow of traffic, which means that collisions caused by different collision angles and speeds have less serious consequences.
- When constructing so-called 2+1 roads with a central barrier, a section of the route always provides alternating two lanes for one direction. The protection provided by a central barrier prevents head-on collisions.
- With the Vision Zero, municipalities have the opportunity to independently set up reduced speed zones (so-called 30 zones). This brings into focus the fact that a speed of 30 km/h is the limit at which unprotected road users still have a chance of surviving a collision.
- Guardrails were installed and the side of the road was cleared of stone blocks, trees, and the like. This reduces the consequences of damage if vehicles leave the road.
- Another point is checking the speed limits. It is now the exception if a road with a speed limit of 110 km/h still has no structural lane separation (guard rail, cable system).

A very important component for the implementation of Vision Zero is the close cooperation between the automotive industry and the road infrastructure engineers. In this way, the traffic environment can be adapted to the collision characteristics of the vehicles and the number of road deaths can be further reduced. With the New Car Assessment Programme (NCAP), new vehicles have become much safer. The results of tests are used to provide consumers with information about the safety standards of various vehicle types. By meeting consumer requirements for products and measures and complying with state requirements, the automotive industry can contribute to positive developments. (Straßenwesen, 1998)

A study from the Netherlands looked at the traffic patterns of its own elderly population (Kennisinstituut voor Mobiliteitsbeleid , 2008). One assumption on which the study is based is the increase in the proportion of older people in the total population. This means that in the future more older people will have a driving licence and a car. It can also be assumed that the level of education and income will be higher and that older people will be healthier and more vital. This in turn leads to a changed lifestyle, which can, among other things, be more focused on activities outside the home. In order to be able to classify the traffic behaviour of older people a little better, an overview with a few observations on the mobility of the elderly follows (Kennisinstituut voor Mobiliteitsbeleid , 2008).

- Among those over 65, 83% of men and 46% of women have a driving licence. Just ten years ago it was 75% and 29%, respectively.
- In line with the increase in holding of a driving licence, car ownership among older people has also increased: 72% of men and 25% of women now own a car.
- Older people mainly use cars. This proportion decreases rapidly with increasing age.
- As they get older, older people make fewer and shorter journeys.
- As they get older, older people increasingly choose travel destinations closer to where they live.
- Older people prefer to drive during off-peak hours.

In order to support older people in everyday traffic and not preventing their mobility, the solution presented here includes the provision of various mobility offers in combination with a differentiated tariff policy for senior citizens. These offers can be, for example, regional taxis or target group transport. In order to limit the costs of target group transport, it is advisable to make public transport for older people as accessible and user-friendly as possible.

A study by the “Australasian Transport Research Forum Incorporated” (ATRF) presented areas of action that should be considered in the context of Vision Zero. Here, too, it is assumed that the proportion of the older population will increase and therefore more older people will actively participate in traffic. To ensure traffic safety, it is not possible to rely simply on penalties and bans. One option that needs to be promoted by road construction companies and authorities is improving infrastructure as well as evaluating and, if necessary, reducing speed limits. Collision energy is particularly important when designing the infrastructure in the area abutting the road. By utilizing suitable structures, it is possible to reduce the collision energy significantly. Guardrails and a better separation of the pedestrian area from the street are also helpful, especially at intersections and in areas with a lot of pedestrian traffic. Individuals can also contribute to greater security. This includes better route planning and avoiding unnecessary driving at peak times. Appropriate route planning can mean, for example, that particularly difficult intersections are avoided and instead a route is taken that avoids confusing places or a lot of traffic. But the automotive industry can also contribute to greater safety and has done so continuously over the years through the introduction of new safety systems. A further development of these systems can be found in the form of Intelligent Transport Systems (ITS). Nevertheless, general requirements still remain a focus. This includes the further development of belt systems, improving the seating position of occupants, and the design of “soft” structures. A suitable seating position can prevent unnecessary contact with components in the event of a collision. “Softer” structures on the inside of the vehicle help if contact with components does occur. On the outside, these structures help those who are hit by a vehicle. (Fildes, 2001)

In addition, this study presents a summary of functional disorders that are associated with an increased risk of accidents and to which older people appear to be particularly susceptible (Fildes, 2001):

- Visual conditions (e.g., cataracts, glaucoma, diabetic retinopathy, major field of view losses);
- Cardiac conditions (e.g., irregular heartbeat, history of heart problems, severe angina);
- Cerebrovascular conditions (e.g., stroke with permanent impairment, history of transient ischaemic attacks);
- Insulin-dependent hypoglycaemia;
- Memory impairment and decline in cognitive skills (e.g., moderate and severe dementia including Alzheimer’s disease, reduced ability to divide attention);
- Mental illness (e.g., severe depression);
- Severe muscular and skeletal disorders, including severe arthritis;
- A range of conditions resulting in loss of upper body strength (e.g., restricted head and neck mobility, incomplete use of arms, excess tremor, weakness, rigidity, paralysis, severe loss of breath);
- A range of conditions resulting in loss of lower body strength (e.g., unable to walk unaided, loss of leg or foot, excessive tremor, rigidity, paralysis);
- History of falling;

- Conditions resulting from use of particular prescribed drugs and polypharmacy (e.g., anti-depressants, anxiolytics, sedatives / hypnotics);
- Alcoholism and drug abuse (e.g., abuse of prescribed, heightened sensitivity to alcohol)
- Sleep disorders (Sleep apnoea, narcolepsy), and
- Neurological conditions (e.g., Multiple Sclerosis and Parkinson's disease).

Another ATRF study looked at older people's travel behaviour and transportation-related technology (Bertolaccini, 2021). The behaviour described here may need to be considered differently for the European region, as the study comes from the state of Queensland in Australia and there are clear geographical differences. Nevertheless, many statements can also be applied to Europe. For example, a distinction is made between two types of trips. On the one hand, the journeys that are made because one's own health, which include visits to the doctor or hospital. This is particularly a challenge in rural areas with poor public transport connections. On the other hand, there are trips for shopping for everyday needs and for socialization. Shopping online is only a limited alternative, as the social aspect of an in-person sale is irreplaceable for some people. When using new technology, such as shopping over the internet, it must also be kept in mind that this technology simply overwhelms many older people. As a result of this study, the following suggestions emerged (Bertolaccini, 2021):

- Prioritise the building of safe and accessible pedestrian networks.
- Restructure and expand affordable, door-to-door transport options.
- Explicitly consider the location of retirement and aged care facilities when designing public transport routes.
- Consider restricted licencing over full removal of licence, especially in remote areas.
- Provide older people with clear, accurate information about the transport services they can expect to receive as they age.

A report by the German Road Safety Council (DVR), which was dedicated to the topic of mobility in connection with older people, also points out that today's seniors are significantly fitter compared to previous generations (Deutscher Verkehrssicherheitsrat, 2019). However, physical problems still increase with age, though many problems tend to occur gradually. This includes the loss of vision, which slowly increases in most people over the age of 35. Hearing problems also increase and the ability to react decreases. Such impairments can quickly become a danger in road traffic. Especially when driving vehicles, information must be quickly recorded, processed, and converted into correct movement impulses (braking and steering, for example). An overview of the mobility patterns of seniors shows that most people aged 65 and over drive or walk for everyday life (Figure 3-1).

74 %	• Drive a car themselves
27 %	• Ride in a car as a passenger
11 %	• Use a conventional bicycle
4 %	• Ride in a taxi
74 %	• Usually walk
48 %	• Ride public transportation

Figure 3-1: Distribution of mobility patterns for Germans aged 65+ (Deutscher Verkehrssicherheitsrat, 2019)

As they get older, most people have years of driving experience and, based on this experience, drive their vehicle more carefully, slowly, and with more foresight. However, as you get older, limitations that affect driving safety become noticeable. The older you get, the more your visual acuity decreases (Figure 3-2) and your sensitivity to glare increases.

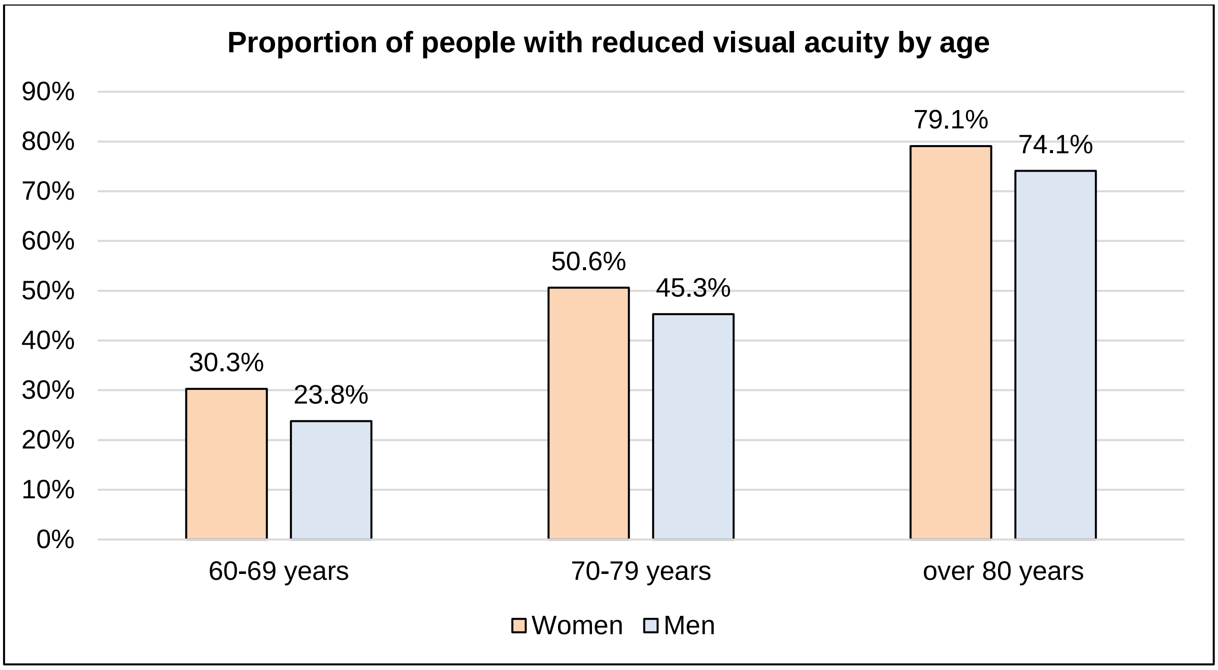


Figure 3-2: Visual acuity and age (Deutscher Verkehrssicherheitsrat, 2019)

Likewise, hearing ability decreases over time and irrelevant stimuli can no longer be ignored as easily. The ability to react slows down, so that simultaneous stimuli such as traffic lights, crossing traffic, and pedestrian traffic can cause the system to become overwhelmed. In addition, orthopaedic problems are another risk factor. Stiff joints can significantly delay braking and an immobile neck can severely limit the field of vision. Finally, medications that make you tired and reduce alertness can also have a strong influence on the safe controlling of a vehicle on the road.

Table 3-1 presents the main physical impacts of getting older and possible measures. (Deutscher Verkehrssicherheitsrat, 2019)

Risk factor	Measure
Vision decreases	Glasses; Eye surgery
Hearing worsens	Hearing aid
Attention decreases	
Reaction speed slows down	Experience (avoiding risky driving manoeuvres or situations); Electronic vehicle assistance systems; Mental exercising
Mobility is limited	Regular physical exercise
Diseases and medications	Follow medical advice; Adjust medication dosage

Table 3-1: Risk factors with age and appropriate measures (Deutscher Verkehrssicherheitsrat, 2019)

There are a few ways you can still drive safely despite your old age. With an active lifestyle and regular examinations by general practitioners, ophthalmologists, and ear doctors, physical limitations can be quickly identified and often remedied. Driving schools sometimes offer special test drives where older people can have their driving ability tested without obligation. Careful route planning, such as driving outside of peak times and in bad weather conditions, and new technological aids in the vehicles also contribute to improved safety.

Walking aids are available to increase safety when walking, especially when walking is physically challenging. One option is to use walkers, though it is important that the equipment is set correctly and that the required accessories are attached. (Deutscher Verkehrssicherheitsrat, 2020)

In Toronto there are 65 areas that are designed as "Senior Safety Zones" (City of Toronto). These areas have special features that are intended to help older people participate more safely in traffic:

- Signage alerting drivers to the presence of a Seniors Safety Zone
- Longer walk signals that give people more time to cross
- Enhanced crosswalks with zebra markings
- Reduced speed limits
- Automated speed enforcement
- Red light cameras
- Pedestrian head start signals
- Extended curbs to reduce crossing distances
- New sidewalks
- New safe crossings
- Safer intersection designs
- Traffic calming measures

There are also special transport services (Wheel-Trans Service) for people who are unable to use normal public transport. In Toronto, it is also mandatory to have your driver's licence renewed at the age of 80. Moreover, in the event of an accident when you are 70 or older that results in a conviction for a driving violation, you will have to take another driving test. (City of Toronto)

In 2018, the European Commission presented the new approach to EU road safety policy with the "Europe on the Move" package (European Commission, 2018), which was published in 2020 in the form of the EU road safety policy framework 2021-2030 (European Commission, 2020). This framework stipulates, first of all, that the idea of Vision Zero must become more widely accepted among political decision-makers and in society. The awareness that one fatality is one too many must be taken into account in all decisions affecting road safety. In addition, a so-called "Safe System" was presented which is able to provide clues for interventions using introduced key performance indicators (KPIs). This "Safe System" is divided into four points:

- Safe infrastructure
- Safe vehicles
- Safe road use
- Fast and effective rescue

Safe infrastructure means that roads must be well-designed and properly maintained to reduce the likelihood of accidents. Furthermore, "forgiving roads" (e.g. roads with a central guardrail) can reduce the severity of an accident. The KPI in this case should be the percentage of distance travelled on roads with a safety rating above an agreed threshold. In this context, safe vehicles are vehicles that comply with EU regulations No 661/2009 (Vehicle General Safety Regulation) and No 78/2009 (Pedestrian Safety Regulation). Innovations in vehicle technology help both reduce accidents and reduce the severity of traffic accidents. The severity is reduced through passive systems such as seat belts, airbags, and the general crashworthiness of vehicles. On the other hand, there are active systems with which the accident can be completely avoided. These include Advanced Emergency Braking Assist, Intelligent Speed Assistance, Stability Control, and Lane Departure Warning. In addition to EU legislation, vehicle manufacturers are required to maintain a high level of safety in the design of their vehicles. The European NCAP (Euro NCAP) serves as a basis for comparison. In addition to high technical security standards, it is also very important that security is checked regularly and that appropriate measures are taken in the event of safety issues. The relevant KPI here is the percentage of newly registered passenger cars with a safety rating equal to or above an agreed limit (e.g. 4 stars in the Euro NCAP rating).

Safe road use consists of several areas of action. These include speed, not driving under the influence of alcohol or drugs, driving without distraction, the use of seat belts and restraints, as well as helmet use. The KPIs for the respective fields of action include the percentage of those who drive within the permitted speed limit, who travel under the permitted blood alcohol concentration, who do not hold their mobile phone in their hand while driving, who use belt systems or child seat systems correctly and, in the case of two-wheeler riders, who are wearing a helmet. In general, this sub-section of the "Safe System" should focus more on targeted education and awareness-raising, supported by strict and sustainable regulations for compliance and enforcement. Effective care and rapid transport to the correct facility by qualified personnel reduces the consequences of injuries. The KPI here is the time between the emergency call and the arrival of the rescue services at the scene of the accident. Table 3-2 presents an overview of the various indicators and their definitions.

	Indicator	Definition
1	Speed	Percentage of vehicles travelling within the speed limit
2	Safety belt	Percentage of vehicle occupants using the safety belt or child restraint system correctly
3	Protective equipment	Percentage of riders of powered two wheelers and bicycles wearing a protective helmet
4	Alcohol	Percentage of drivers driving within the legal limit for blood alcohol content (BAC)
5	Distraction	Percentage of drivers not using a handheld mobile device
6	Vehicle safety	Percentage of new passenger cars with a Euro NCAP safety rating equal or above a predefined threshold
7	Infrastructure	Percentage of distance driven over roads with a safety rating above an agreed threshold*
8	Post-crash care	Time elapsed in minutes and seconds between the emergency call following a collision resulting in personal injury and the arrival at the scene of the collision of the emergency services

Table 3-2: List of KPIs and methodology (European Commission, 2020)

As a final strategy point, the framework emphasises attention to new trends, such as the growing phenomenon of distraction or new technologies in vehicle connectivity and automation. This package aims not only to provide a framework for the prevention of road deaths and injuries, but also to integrate road safety into the Sustainable Development Goals. In addition to the authorities and individuals as a driving force behind “Vision Zero”, the automotive industry and the constant development of safety systems also play an important role. The New Car Assessment Programme, which has found its way into many different countries and regions, has proven itself as a benchmark for safety in the automotive industry. These programmes perform crash tests and evaluate safety based on available safety systems. This information is then passed on to the consumer, resulting in the most transparent evaluation possible. There are smaller, regional differences in the tests carried out. For example, tests for “pedal misapplication” have long been the norm in the Japanese NCAP (JNCAP), but these are not due to be introduced in the Euro NCAP until 2026 and these tests are not carried out in all others. Apart from minor differences in the tests in the area of active safety, the tests for passive safety are designed more or less similarly for all NCAP programmes, so that the results of the individual NCAP tests are quite comparable. A somewhat more detailed picture of NCAP is provided in Chapter 4.9. Table 3-3 provides a summary of all existing, identified measures with reference to the elderly population.

Infrastructure: ▪ Traffic circles as a traffic solution at junctions ▪ Expansion of the road network with median barriers ▪ Municipal decisions on traffic-calmed areas ▪ Guard rails on roads and clearing the hard shoulder of potential collision objects ▪ Continuous review of the speed limits set ▪ Separation of the road from the pedestrian area at intersections ▪ Prioritise the building of safe and accessible pedestrian networks ▪ Signage alerting drivers to the presence of a Seniors Safety Zone ▪ Longer walk signals that give people more time to cross ▪ Pedestrian head start signals ▪ Extended curbs to reduce crossing distances ▪ Explicitly consider the location of retirement and aged care facilities when designing public transport routes
Policy: ▪ Provision of various mobility services (regional cabs, target group transportation, ...) ▪ Differentiated tariff policy (e.g. for older people) ▪ Restructure and expand affordable, door-to-door transport options ▪ Easily accessible and usable public transportation ▪ Consider restricted licensing over full removal of license, especially in remote areas ▪ Provide older people with clear, accurate information about the transport services they can expect to receive as they age
Personal: ▪ Good route planning ▪ Avoid driving at peak times ▪ Keep physically and mentally fit ▪ Question your own fitness to drive ▪ Regular visits to the doctor ▪ Follow doctor's instructions (e.g. when taking medication) ▪ Use aids as a pedestrian (e.g. rollator)
General: ▪ Close cooperation with the automotive industry and road construction authorities ▪ Transparent safety assessment of vehicles (e.g. NCAP) ▪ Safe system for evaluating measures (data-driven, KPIs)

Table 3-3: Measures identified for Vision Zero

4. Technology

The development or further development of active and passive safety systems is an essential part of safe traffic. The introduction of the anti-lock braking system (ABS), electronic stability control (ESC) or lane keeping assistants, as well as significant improvements in rigid body elements, are only a small number of the existing options for active and passive safety in vehicle development. Studies have shown that many older drivers have a positive attitude towards Advanced Driving Assistant Systems (ADAS), but there are still barriers to adoption, particularly in terms of their complexity, safety, and reliability (Hassan H, 2015). To maximise adoption, it is important that appropriate training materials are developed and information campaigns on functionality, benefits, and limitations are carried out (Young KL, 2017). A summary and classification of the types of advanced vehicle technology (AVT) is compiled in Table 4-1.

Classification	Type of AVT
Vehicle control	Roll stability control
	Traction control
	Brake assist
	Parking assist
	Adaptive cruise control
Warning and crash mitigation	Blind spot detection
	Forward collision warning and braking
	Lane departure warning
	Lane keeping assistance
	Cross-traffic detection
	Emergency response
Visibility	Advanced forward lighting systems
	Reversing cameras
	Night vision systems
	Pedestrian detection
Other driver assistance	Driver monitoring (including fatigue alert)
	Speed alert
	Tyre pressure monitor
	Integrated Bluetooth telephony
	Navigation
	Voice control

Table 4-1: Types of advanced vehicle technology by classification (Canada, 2023) (Gish J, 2017)

The list of possible assistance systems is quite long, so we will primarily focus on current or future systems that can have a possible positive influence on the older population.

4.1. Pedal Misapplication

In 2023, the European Association of Automotive Suppliers (CLEPA) presented a report on industry experience regarding Pedal Misapplication or Acceleration Control for Pedal Error (ACPE) (CLEPA, 2023). ACPE works at standstill and detects conditions under which a pedal error can be assumed. Such unintentional acceleration (typically a very strong acceleration or kick-down) is suppressed. The conditions for detecting such an error are not necessarily based on the detection of obstacles. Some systems detect obstacles and prevent or limit acceleration in order to avoid or mitigate possible collisions. Other systems do not detect obstacles, but rather conditions under which a pedal error can be assumed, for example if the driver suddenly presses the accelerator pedal hard while stationary. A few systems also work at low speeds in applications similar to the emergency braking assistant (Autonomous Emergency Braking System (AEBS)). Pedal misapplication has been tested in the Japanese NCAP (JNCAP) since 2018 and is also expected to be tested and evaluated in the Euro NCAP from 2026 (carhs.training gmbh, 2023).

4.2. Adaptive Restraint System

The adaptive restraint system intelligently controls the interaction between airbags and seat belt force limiters. This means that passengers of different sizes are protected more effectively than is the case with conventional systems. Sensors are used to detect how far forward or backward the seat is positioned. The control unit then recognizes the approximate position of the occupant and ensures that the distance over which the upper body is braked by the seat belt and airbag is better utilized (Audi AG, 2011).

The most commonly used standard for dummies is the so-called 50th percentile male with a height of 175 cm and a weight of 78 kg (ADAC, 2020). However, not all vehicle occupants meet these basic conditions, especially children, women, and older people. Medical impairments, including cognitive deficits, increase with age. At the same time, the strength of bones and internal organs decreases, which can increase the susceptibility to injury in accidents. Therefore, with the help of anthropomorphic test devices (ATD), a dummy was developed to represent an older person, the so-called Elderly ATD, with a height of 161 cm and a weight of 73 kg (Beebe M, 2017). In addition, new developments such as Advanced Driver Assistance Systems (ADAS) must be taken into account. These can affect the efficiency of passive safety systems by affecting the occupant. For example, when the emergency brake assist is activated, the body position of the occupants can change drastically, and if the airbag deployment is not adjusted accordingly, this can lead to injuries or even deaths. With the aim of creating an optimal safety environment for all occupants, Veoneer, emotion3D, and AVL have joined forces as part of the smart RCS project to develop a personalised restraint system (Emotion3D, 2023). A 3D camera combined with human analysis software is used to capture body characteristics and position while driving and just before impact. The resulting system was integrated into an existing adaptive restraint system to obtain crash and occupant information and to calculate an optimal airbag deployment strategy.

With the help of the European Union's Horizon 2020 research and innovation programme, a study was published that evaluated adaptive seat belt restraint systems to protect older occupants in frontal impacts (Krystoffer Mroz, 2018). Three belt configurations were compared with a modern, double-tensioned, 4 kN load-limited 3-point belt:

- 3-point double-pretensioned two-retractor belt system
- Triple-pretensioned 3+2 criss-cross belt
- Triple-pretensioned split buckle belt system

These three different belt configurations with adaptive two-stage load limitation successfully reduced the risk of chest injuries to older occupants, particularly at low impact levels, and provided better protection to both younger and older occupants at high impact levels.

4.3. Human-Machine Interface

Another factor in the development of new vehicles are the increasingly complex human-machine interfaces (HMI). While interactions with a large number of services in vehicles may still be safe, the combination of several functions drastically increases the complexity. The system then becomes complicated, too distracting, and sometimes “extremely dangerous” (Burkert, 2017). In a 2017 report from the Automobiltechnischen Zeitschrift (ATZ), the results of a user study that looked at infotainment systems in various vehicles were presented. The conclusion was that the use of voice control significantly reduces visual distraction, especially during navigation tasks. Another way to address the increasing functionality of infotainment systems is driver monitoring. An adaptive and fine-tuned driver recognition system identifies signs of fatigue and distraction and causes the vehicle to trigger warning tones or initiate safety measures independently (Burkert, 2017) (see also Section 4.7).

The basis of a study on the requirements of older drivers for human-machine interactions is the finding that the opinions, skills, and needs of older people are not adequately taken into account when designing on-board systems (Shuo Li, 2019). Recommendations from this study include clear instruction in assistance systems, in this case specifically for highly automated vehicles. The functionality of the vehicle should be clearly communicated and it should also be pointed out that automated driving tasks can be overridden manually at any time and that vehicles can request the driver to take control of the vehicle. Another recommendation is to create practical opportunities to gain experience with new vehicles or systems. Driving simulators represent one option here. Older people need an information system that informs them about current traffic-related events, journeys, vehicle status, and road conditions. In addition, it is also pointed out here that the driver must be monitored in order to be able to intervene accordingly. The actions of the systems should adapt to the urgency of the information. General information, e.g. about the trip, the vehicle status, the traffic situation, and the road condition, could be displayed visually or in combination with voice output. The voice here could be gentle. For urgent and safety-critical information, e.g. about fuel level or takeover requests, a visual representation could be used in combination with voice output. This voice should be loud and clear enough to attract the driver's attention quickly and effectively. Automated driving systems could also be able to analyse the driver's driving style. This way, when the vehicle detects potentially dangerous driving situations, it could send a reminder to the driver to help the driver correct them and drive more safely. Vehicles could also be designed to allow multiple user modes and automatically select them when new drivers are detected. Finally, it should also be possible to choose routes and save the purpose of the trip (Shuo Li, 2019).

The problem of too little attention being paid to the older population when designing HMIs was also the basis for a report on older drivers' perception of warnings (Luka Rukonic, 2021). Warning messages not only warn of dangers, such as an obstacle in the road, but also when decisions are made by the assistance systems, for example when changing lanes. The warning systems currently rely mainly on visual warnings, such as symbols in the instrument cluster on the dashboard. These visual cues may be unsuitable for older people because they may be too small and easily missed. To address this problem, the typography, lighting, and size of information signals and controls should be adjusted when designing the vehicle interior. Haptic cues may also be unsuitable under certain circumstances, as older drivers may have difficulty recognising tactile stimuli. Therefore, haptic cues should be combined with another type of cue, such as speech. In general, speech and auditory modalities appear to be a good solution to address the age-related decline in visual and cognitive abilities of older drivers. When considering the older population, not only the limited physical, sensory, and cognitive abilities need to be taken into account, but also the process of learning new skills in order to use new technology (Luka Rukonic, 2021).

A review of existing HMI performance guidelines found that several areas do not effectively address the potential sensory, cognitive, and physical limitations of older drivers (J, 2020). Two reports (Fernandes SC, 2017) (Young KL, 2017) provide concrete suggestions for the design of HMIs for older drivers.

4.4. Operational Design Domain

Operational Design Domain (ODD) describes a permissible operating range of automated systems. The Society of Automotive Engineers (SAE) has defined ODD in its SAE J3016 as follows: “Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics” (SAE International, 2021).

It should be noted that, due to the level of automation and the intended permissible operating range, each automated system has its own usage specifications. The ODDs represent an important aspect of ensuring the security of an automated system by showing the limits and capabilities of these systems (Salvi, 2022).

ODD is a vehicle-based concept, so it can differ from vehicle to vehicle. Since there is no uniform understanding of ODD, the Association for Standardization of Automation and Measuring Systems (ASAM), together with the University of Warwick and other international experts, has worked on a new international standardisation concept for the definitions of ODDs (ASAM, 2021). This concept allows governments and the automotive industry to access ODD descriptions that are interchangeable, comparable, and workable.

4.5. Rear View Automatic Emergency Brake System

Autonomous Emergency Braking Systems can prevent accidents between vehicles and other road users when reversing. Sensors mounted at the rear or on the side detect cross traffic behind the vehicle, which either warns the driver accordingly or actively brakes the vehicle. Emergency brake assistants with pedestrian detection are already being tested and evaluated in Euro NCAP, both forward and rear. The ADAC (“Allgemeiner Deutscher Automobil-Club”) tested a few vehicle models in which such systems are integrated in three test scenarios.

The test scenarios when pulling out of a parking space were as follows: The vehicle reverses into…

- a stationary dummy vehicle
- a standing person or pedestrian
- a crossing cyclist or passenger car

The results of these tests can be summarized as follows: the systems function relatively well when there is rear-crossing traffic. Stationary vehicles are also highly likely to be detected. However, there is potential for optimisation when detecting pedestrians, especially when they are moving (ADAC, 2023).

Another point that also plays a major role when reversing is the all-round visibility from a vehicle. Using a camera that reflects a driver's view and a database of 200 vehicle tests, the ADAC assessed all-round visibility according to vehicle classes. Micro and small cars perform best, and luxury class vehicles perform worst (ADAC, 2019). The following table shows the ranking of the vehicle classes according to all-round visibility (Table 4-2).

Rank	Vehicle category
1	Mini / small cars
2	Lower mid-class cars
3	Mid-class cars
4	Upper mid-class cars
5	Top class cars

Table 4-2: Ranking of vehicle categories according to all-round visibility (ADAC, 2019)

As an example of an evaluation of the view, the evaluation of an Aiways is shown here. In addition to all-round visibility, the front and rear near field is also evaluated, i.e. the view of possible obstacles directly in front of or behind the vehicle (Figure 4-1 and Figure 4-2).

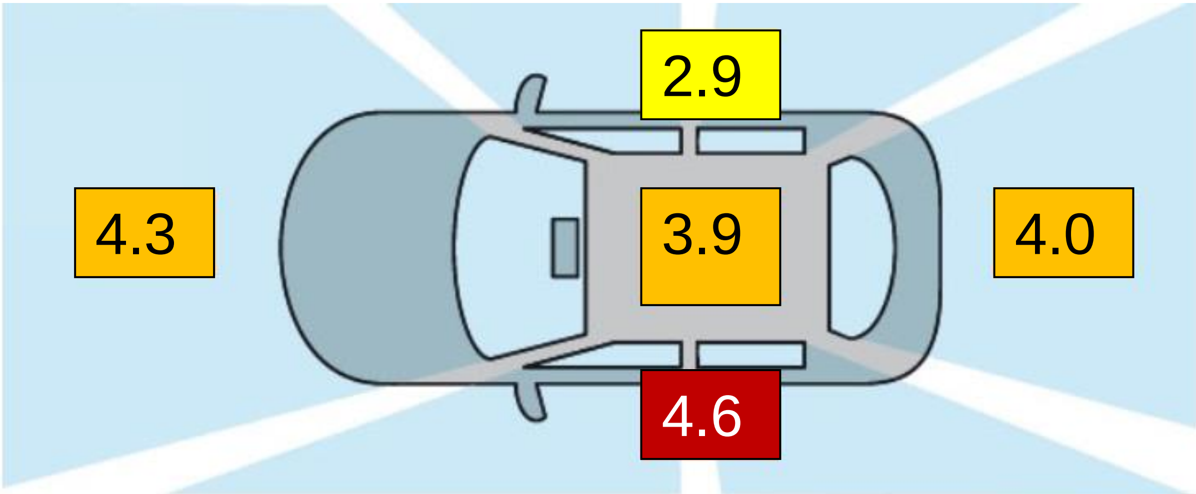


Figure 4-1: Assessment of all-round visibility (ADAC, 2021)

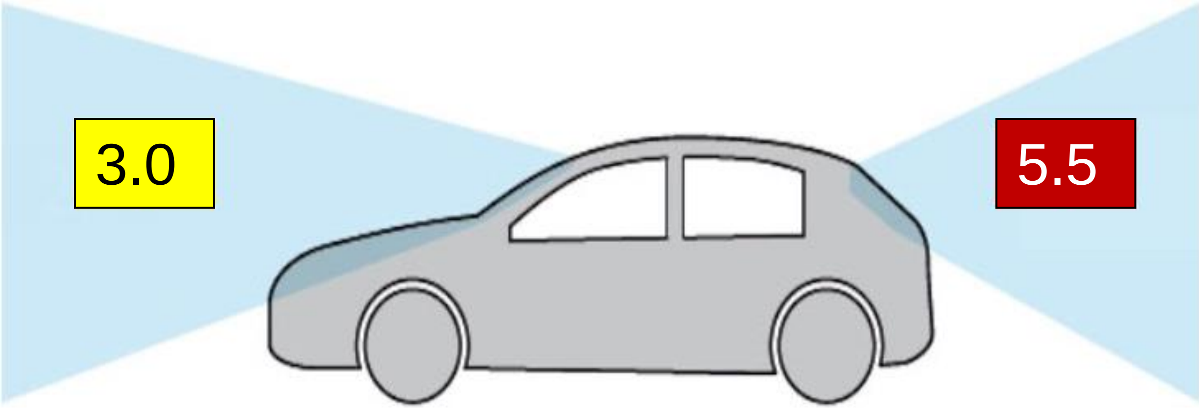


Figure 4-2: Assessment of near-field visibility (ADAC, 2021)

4.6. C-ITS and V2X Communication

Driver assistance systems help drivers maintain a safe speed and distance, stay in their own lane, avoid critical situations when overtaking, and pass intersections safely. All of this has a positive impact on road safety. However, the benefits can be increased if individual road users communicate with each other or with the road infrastructure (ETSI, 2023). Cooperative Intelligent Transport Systems (C-ITS) are the focus of research and refer to transport systems in which several ITS subsystems (personal, vehicle, roadside, and central) enable a common ITS service. C-ITS allows vehicles to communicate with other vehicles, traffic signals, infrastructure, and other road users. The cooperative V2X systems are also called Vehicle-to-Vehicle Communication (V2V), Vehicle-to-Infrastructure Communication (V2I), or Vehicle-to-Pedestrian Communication (V2P) and support a range of information, warning, and assistance services (Car 2 Car Communication Consortium, 2023).

Table 4-3 presents a selection of C-ITS services. Further descriptions of specified and harmonised C-ITS services at the European level are available on the C-Roads platform (C-Roads, 2023).

Abbreviation	Title / Use Case Description
PVD	Vehicle Data Collection (PVD-VDC) Event Data Collection (PVD-EDC)
RWW	Road Works – Mobile (RWW-RM)
TJW	Traffic Jam Ahead (HLN-TJA)
VRU	Vulnerable Road Users
MVW	Winter Maintenance (RWW-WM)
IVS	Traffic Signs (IVS-TS) Free Text (IVS-FT)

Abbreviation	Title / Use Case Description
EVA	Emergency Vehicle Approaching
TSP	Traffic Signal Priority Request
GLOSA	Green Light Optimal Speed Advisory
Route Advice	Route Advice

Table 4-3: Overview of C-ITS services (C-Roads Germany, 2023)

The introduction of C-ITS is also part of the European strategy and concrete measures have already been developed (European Commission, 2016).

4.7. Distraction Detection

In order to avoid or mitigate the consequences of poor driving ability or a careless or distracted driver, sensing of the vehicle interior (In-Cabin Sensing (ICS)) is recommended. With the help of such systems, accidents caused by tired, distracted, or unresponsive drivers can be avoided. The vehicle interior is observed with one or more infrared cameras, with the focus on the driver. In addition to the driver's direction of vision, eyelid opening, head tilt, and posture, other occupants can also be covered. In addition to the direct information from the camera, indirect information, such as driving time or steering behaviour, is also used to validate the direct information. These ICS systems warn the driver if fatigue, distraction, or physical incapacity are detected. In order to avoid resulting accidents, it is recommended to link ICS systems with the driving assistance systems (Österreichischer Automobil-, Motorrad- und Touring Club, 2022).

Expanding the scope of application to the entire interior could bring some advantages, especially when using the restraint systems. The use of the restraint system can be optimised by taking into account the passengers present, as well as the posture and stature of those passengers (Grover C, 2023).

4.8. Infrastructure

In the spirit of Vision Zero, which calls for cooperation from all stakeholders, not only are innovations of the automotive industry taken into account, but also the design of the road environment itself. Here too, technological innovations and facilities help ensure that everyone reaches their destination safely. The first thing that should be mentioned here as an effective measure within infrastructure are the guard rails. Serious head-on collisions can be avoided with the addition of a barrier to oncoming traffic. Clearing the roadsides of potential obstacles avoids more serious consequences if the vehicle ends up leaving the road (Straßenwesen, 1998). A clear separation of traffic types can also be advantageous in intersection areas. The highest priority should be pedestrian safety, i.e. safe and easily accessible pedestrian networks (Bertolaccini, 2021).

4.9. NCAP

The New Car Assessment Programme helps individuals assess the safety of vehicles as it uses standardised tests to check various characteristics of new vehicles. These tests are now being carried out in countries around the world and, thus, make a significant contribution to the transparency of safety in vehicles. Table 4-4 shows an overview of various NCAP locations and assessments of selected systems.

	Euro NCAP ANCAP	U.S. NCAP	Latin NCAP	ASEAN NCAP	C-NCAP	JNCAP
SBR Seat Belt Reminder	X		X	X	X	X
OSM/DSM Occupant/Driver Status Monitoring	X				X (on 2025 Roadmap)	
SAS Speed Assistance Systems	X		X		X	
LSS Lane Support Systems	X	X	X	X (2026)	X	X
BSM Blind Spot Monitoring	X	X	X	X	X	
AEB Car-to-Car	X	X	X	X	X	X
AEB Pedestrian	X	X	X		X	X
AEB Cyclist	X	X (tba)			X	X
AEB PTW	X	X (tba)		X (2026)	X	X (2024)
AEB Reverse	X	X (tba)			X	
Rear Cross Traffic Alert					X (on 2025 Roadmap)	
Headlights		X (tba)		X (Auto High Beam)	X (Low/High Beam)	X (Automatic antiglare)
Pedal Misapplication	X (2026)					X

Table 4-4: Consumer Testing (NCAP) Assistance System Rating Matrix (carhs.training gmbh, 2023)

A look at the Euro NCAP vision for 2030 shows current and future fields of action for the safety assessment of new vehicles (Table 4-5).

Safe Driving	Crash Avoidance	Crash Protection	Post-Crash
Occupant Monitoring - Seatbelt usage - Occupant classification - Occupant presence	Frontal Collisions - Car & PTW - Pedestrian & Cyclist	Frontal Impact - Offset - Full width	Rescue Information - Rescue sheets - Emergency response guide (ERG)
Driver Engagement - Driver Monitoring - Driving Controls - Assisted Engagement	Lane Change Collision - Run-off-road - Car & PTW	Side Impact - MDB - Pole - Farside	Post-Crash Intervention - E-Call/TPS/D-Call - Activation of Hazard Warning Lights - Multi-collision brake
Vehicle Assistance - Speed assistance - Steering assistance	Acceleration Prevention (Pedal Misapplication) - Car & PTW - Pedestrian & Cyclist	Whiplash - Front and rear seats	Vehicle Extrication - Energy management - Occupant extrication
		Vulnerable Road Users - Headforms - Leg forms	

Table 4-5: Euro NCAP Vision 2030 (carhs.training gmbh, 2023)

Table 4-6 presents a selection of safety systems related to Vision Zero. In general, both the active and passive safety of vehicles contribute to Vision Zero, as such systems are designed to prevent accidents or mitigate the consequences. The selection here is limited to systems or areas that specifically address the context of older members of society in road traffic.

Advanced Driving Assistant Systems (ADAS) and Cooperative Intelligent Transport Systems (C-ITS), e.g. :

- Lane keeping assistance
- Lane departure warning
- Pedestrian detection and collision mitigation
- Bicyclist detection and collision mitigation
- Road boundary departure prevention
- Automatic emergency brake
- V2X intersection collision warning
- Intersection movement assist
- Operational Design Domain (ODD) issues

Adaptive Restraint Systems

- New dummies (e.g. Elderly ATD)
- 3D camera in combination with software for analysing people (indoor observation)
- Different seat belt configurations

Low Speed Manoeuvring

- Pedal misapplication
- Corrective and Emergency steering function
- Rear View Automatic Emergency Brake

Human-Machine-Interface

- Lack of consideration for older people in the design of HMI
- Differentiated dissemination of warnings necessary
- Speech and auditory modalities seem to be a good solution
- Consider a possibly different learning process when using new technology

In-cabin sensing

- Distraction / Drowsiness Detection

NCAP assessment

- Transparent safety assessment of vehicles

Table 4-6: Technology and Vision Zero regarding to the elderly population

5. Club expert consultation

Existing measures and strategies were also identified through exchanges with various mobility clubs. Many mobility clubs have been dedicated to Vision Zero and its implementation for a long time. National accident statistics are used to constantly check progress and needs. This means that intervention points can be quickly identified based on current accident numbers. Regular exchanges with political decision-makers and road construction authorities are also an essential part of the strategy.

The measures include bonuses for members who follow the respective road safety strategy or who complete specific training courses, whether in the form of explanations of driving dynamics, raising awareness of traffic rules, or introducing current and new vehicle systems. With a view to new mobility offers, training courses are also offered on new types of mobility, such as the pedelec. Various mobility clubs also offer voluntary driving aptitude tests. In addition to these measures, there are also services such as legal advice, and there are often collaborations with driving schools. Some clubs also conduct their own studies and tests. Club priorities may vary from country to country. National accident figures provide an indication. While in Germany and Austria the intersection scenarios tend to predominate, in the Netherlands, for example, a bicycle scenario is more specifically identified as a field of action.

Table 5-1 shows measures taken by mobility clubs that have already been implemented and are part of Vision Zero.

Data analysis ▪ National data ▪ In-depth data ▪ Own accident research
Reward-based road safety strategy
Population education ▪ Driving physics ▪ Traffic rules ▪ Technology ▪ Cooperation with driving schools
Observing new trends ▪ Studies ▪ Training (e.g. pedelec training)
Offers of voluntary fitness to drive tests
Legal advice
Exchange with road construction authorities and politicians

Table 5-1: Measures of mobility clubs concerning Vision Zero

6. Data analysis

The evaluation of accident numbers or statistics is absolutely necessary in order to recognise points of intervention and identify areas for action. Some data sources have been evaluated here as examples of possible approaches.

6.1. DESTATIS

A look at the accident numbers in Germany from 2023 shows that, compared to the total population, older people are less likely to be involved in traffic accidents, but are usually significantly more seriously affected. The proportion of seniors (aged 65 or over) was 22% of the total population in 2021. However, the proportion of seniors in traffic accidents resulting in personal injury was 14%. In comparison, the proportion of people between 25 and 65 years of age in the total population was 54%. However, this age group also made up 63% of all those involved in accidents with personal injuries. The consequences of an accident are usually more severe for seniors than for other age groups. Figures from the Federal Statistical Office of Germany (DESTATIS) show that the age group of people aged 65 or over is most at risk (Table 6-1) (Statistisches Bundesamt, 2022).

	Deaths per 1 million residents in each age group
Average	31
Under 15 years	4
15 - 18 years	28
18 - 25 years	47
25 - 65 years	29
65+ years	48

Table 6-1: Deaths per 1 million residents in each age group in Germany in the year 2021 (Statistisches Bundesamt, 2022)

The high risk of dying in an accident is also related to the declining physical resistance of older people. Another possible reason is the type of participation of seniors in road traffic. Almost one in five pedestrians involved was 65 years or older. The same applies to cyclists; 18% of all cyclists involved were 65 years or older.

Table 6-2 shows an overview of all those involved in accidents with personal injuries in Germany in 2021, divided by type of road participation.

	Total	**65 years or older**	**Percentage [%]**
Total	480,184	66,812	14

	Total	65 years or older	Percentage [%]
Powered two-wheel-ers	35,091	3,002	9
Passenger cars	283,352	39,309	14
Buses	4,731	196	4
Bicycle	91,126	16,755	18
Pedestrian	25,070	5,365	21
Other	40,814	2,185	5

Table 6-2: Persons involved in accidents resulting in personal injury (Statistisches Bundesamt, 2022)

A total of 2,562 people died in road traffic in 2021. Of these, 868 were 65 years of age or older, which corresponds to a proportion of almost 34%. A further look at the numbers and the ratio of those killed shows once again that older people, especially those walking and cycling, are particularly at risk. Of the 372 cyclists killed, 222 of them were 65 years old or older. This corresponds to a share of 60%. A similar relationship can also be seen among those who walk. Of a total of 343 people killed, 195 of them were 65 years of age or older, which corresponds to 57%. In comparison, there is the proportion of car occupants killed. Of the 1,118 people killed, 332 of them were 65 years old or older. The proportion here is 30%. In addition to decreasing physical resistance, there may also be other factors, such as reduced flexibility, reduced perception and reaction times, or reduced hearing and vision. The latter examples can also be a reason why the proportion of people aged 65 or over are, on average, more likely to be the main cause of accidents. In total, there were 480,184 people involved in accidents with personal injuries in 2021. Of these, 66,812 were 65 years of age or older. This corresponds to a share of 14%. Of these 66,812 older people, 39,786 participants were assigned as being the main cause of the accident, which corresponds to a share of 60%.

Among seniors, human error is most likely to occur when turning, making U-turns, reversing, driving in and out of traffic, and in right-of-way and yielding situations. If you only look at those involved who were travelling in a car, this poor driving behaviour can be found in the same situations. Among senior cyclists, poor adherence to the rules in the situations mentioned above is also commonplace. Other accidents are caused by inadequate speeds and incorrect road use.

6.2. GIDAS

The analysis of accidents in the German In-Depth Accident Study (GIDAS) database shows a similar picture regarding the involvement and mortality of seniors in road traffic accidents. The GIDAS analysis is followed by special evaluations which, as a whole, represent unweighted results and therefore do not allow for any generalised statements to be made about German accidents.

Seniors represent 11% of all those involved in accidents, whereas seniors make up 26% of all fatalities. It is also clear here that, although older people are less likely to be involved in traffic accidents, they are much less likely to survive them.

If we look at the type of road participation of seniors, it can be seen that the majority of people in this age group used an M1 or N1 vehicle. However, almost one in five older people travelled by bicycle and just over one in ten walked (Figure 6-1).

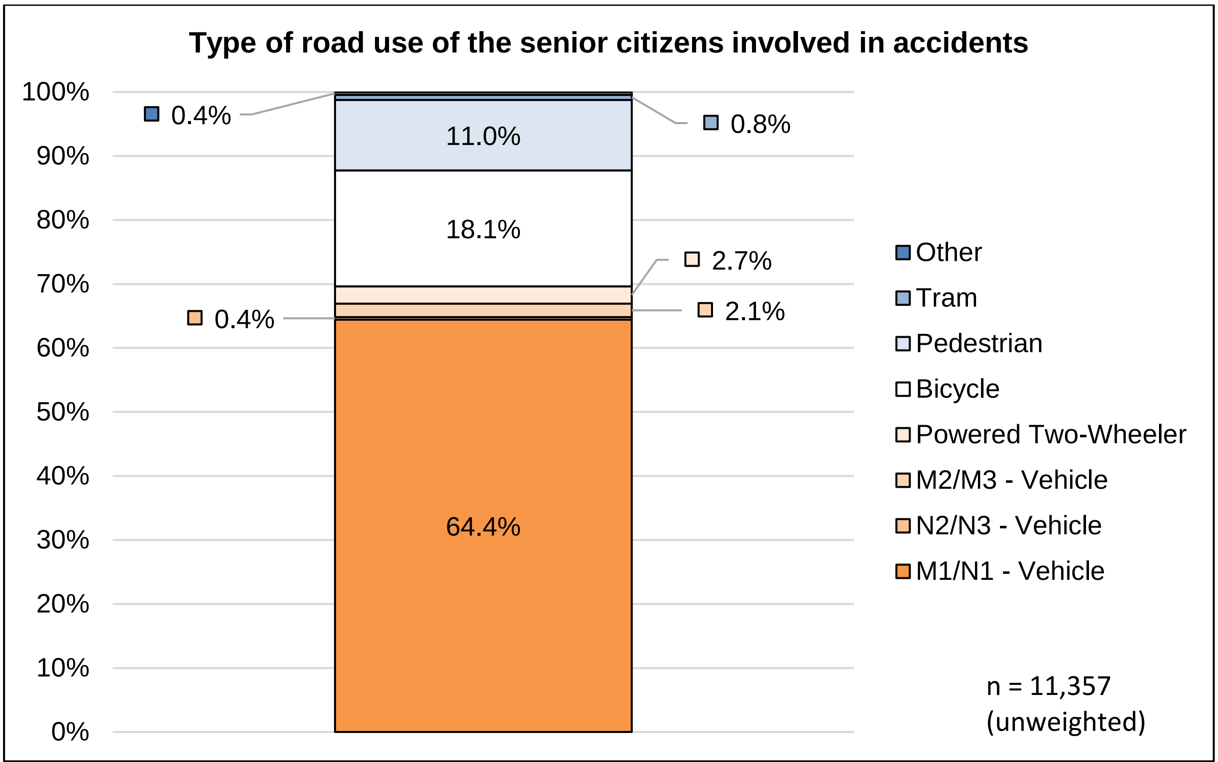
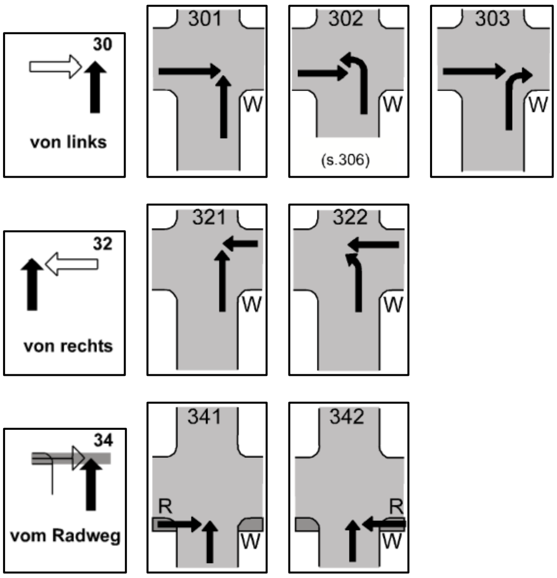


Figure 6-1: How senior citizens participate in traffic (GIDAS, 2022)

30% of all accidents involving personal injuries and senior citizens in the GIDAS database are crossing accidents, followed by accidents in parallel traffic (18%), and accidents when turning (17%). When it came to the identified driver failure, the most common errors were when turning, making U-turns, reversing, and driving in and out of traffic, followed by errors regarding the right of way and yielding (10.A.2). This breakdown could also be seen in the DESTATIS data from 2021 (see Section 6.1).

If you examine the crossing accidents a little more closely, the most common situations (just over one in three accidents of this type of accident) are when the person with the right of way came from the left. Almost 30% of the situations in the crossing scenario were situations in which a bicycle was involved on a cycle path and in almost every fourth case the participant with the right of way came from the right. In these situations there was a clear right of way rule. Figure 6-2 presents the most common scenarios graphically.

Figure 6-2: Frequent critical situations in the crossing scenario (Versicherer, 2017)



ITS assistance systems can provide good support, especially in these situations. In particular, systems such as the Vehicle-to-Vehicle intersection collision warning system (VVICW) and the Bicyclist detection and collision mitigation system (BDCMS), with the relevant ISO standards 23376:2021 and 22078:2020, respectively, can be used here.

If you only look at the seniors who were killed, the type of road participation changes. Over 40% of the people aged 65 and over who were killed were on foot (Figure 6-3).

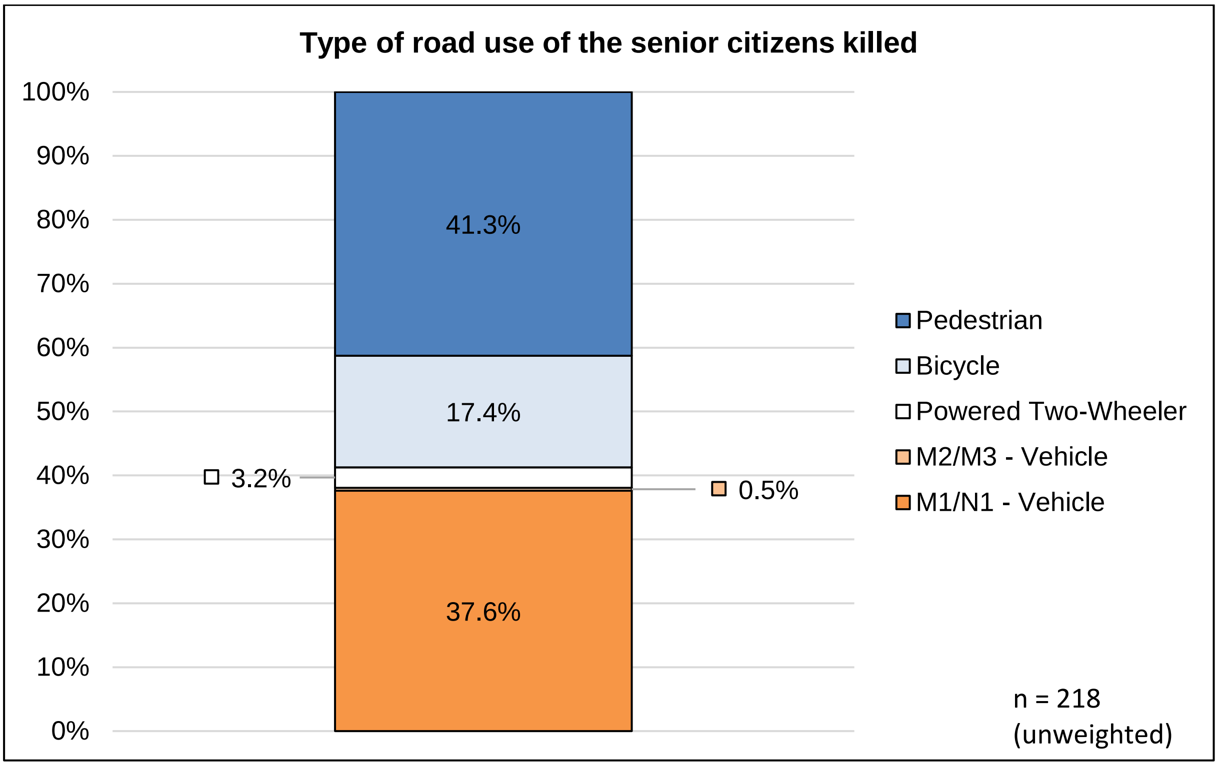


Figure 6-3: Type of road use of the senior citizens killed (GIDAS, 2022)

Other critical accident situations can also be found here. Overall, seniors are most often involved in crossing accidents. However, if you only look at the elderly people who were killed, almost every third critical situation represents a “Pedestrian Crossing Road” scenario, more precisely when crossing from the left or right without obstructing visibility and not in the intersection area. If you consider that over 40% also participated in road traffic as pedestrians, the distribution is not surprising. Almost one in four critical situations, and therefore the second most common occurrence, arise from sudden physical impairments. 89% of the official causes of pedestrian accidents involving older people are due to incorrect behaviour on the part of pedestrians (see 10.A.5). In order to go into a little more detail, only accidents in which incorrect behaviour on the part of pedestrians was the cause are considered. It can be seen here that a little more than half were caused by a lack of paying attention (Figure 6-4).

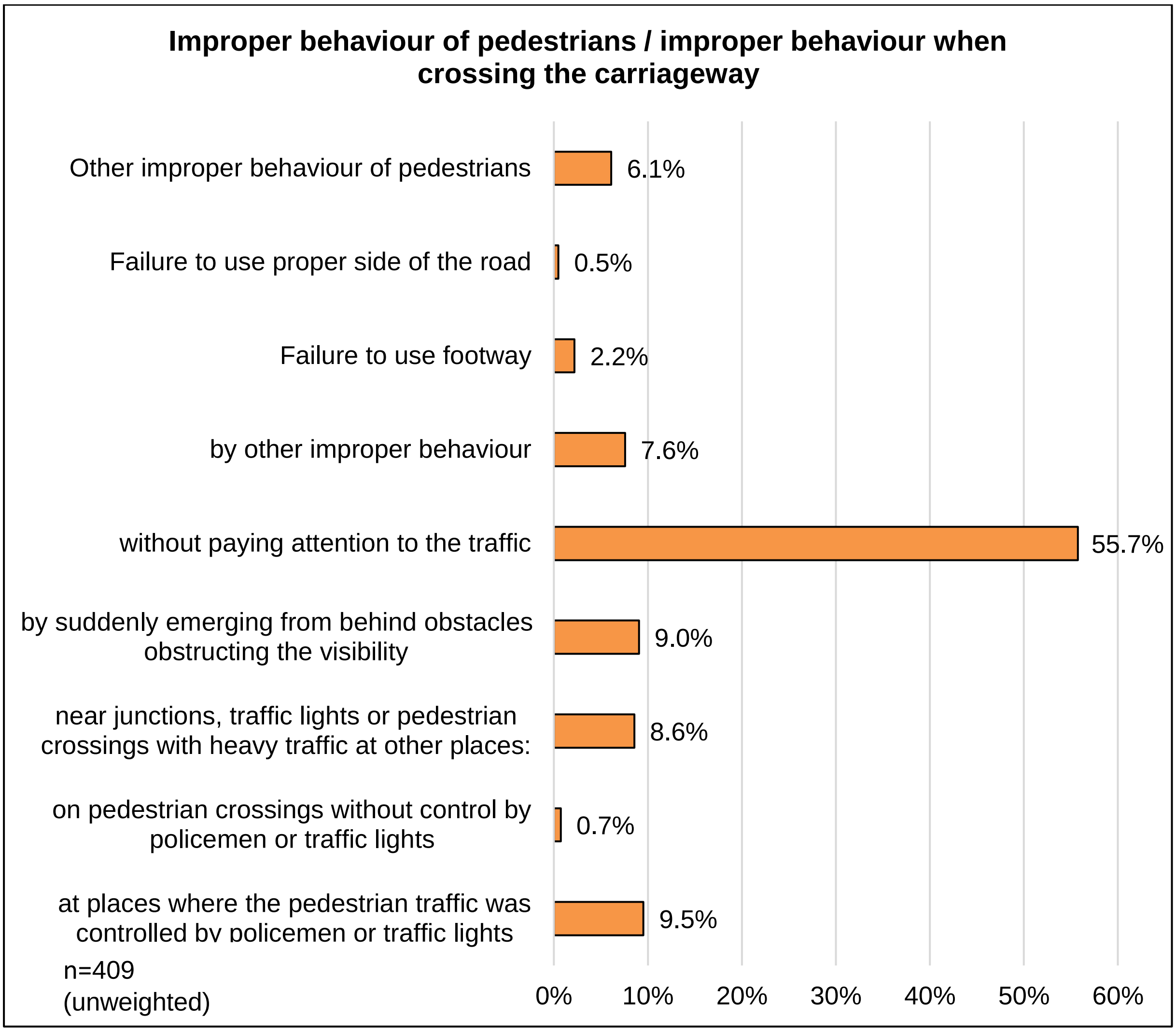


Figure 6-4: Official causes of improper behaviour of pedestrians (GIDAS, 2022)

Active driving assistance systems such as the pedestrian detection and collision mitigation system (PDCMS) can help reduce pedestrian accidents. Systems such as occupant monitoring and driver monitoring systems (OMS/DMS) can also be helpful in the event of sudden impairment of bodily motor functions.

The following diagrams (Figure 6-5 and Figure 6-6) show a comparison of injury severity by body region between people aged 65 and over and people between 18 and 65 years old. The definition of injury severity and region follows the Abbreviated Injury Scale (AIS).

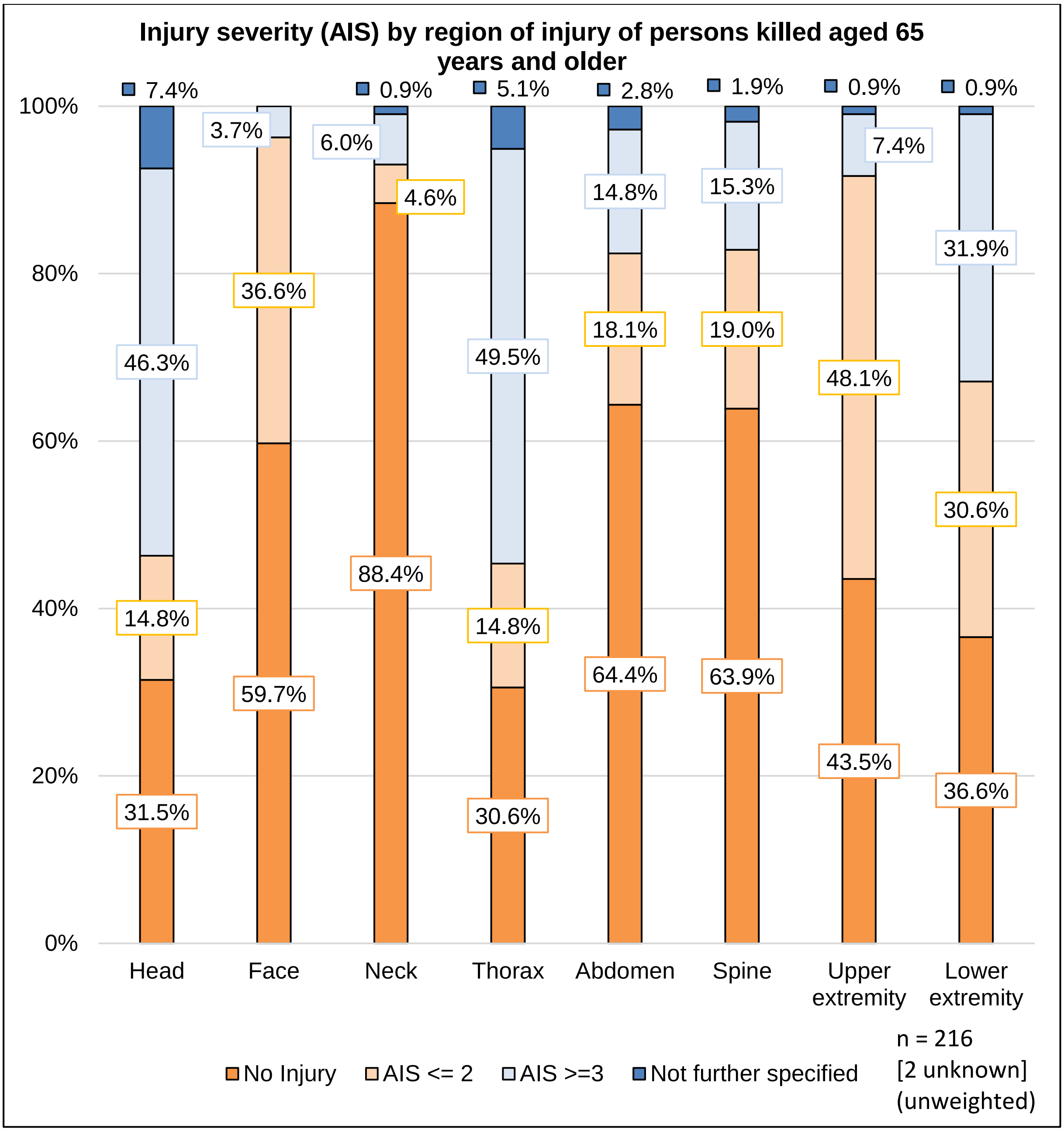


Figure 6-5: Injury severity by region of injury of persons killed aged 65 years and older (GIDAS, 2022)

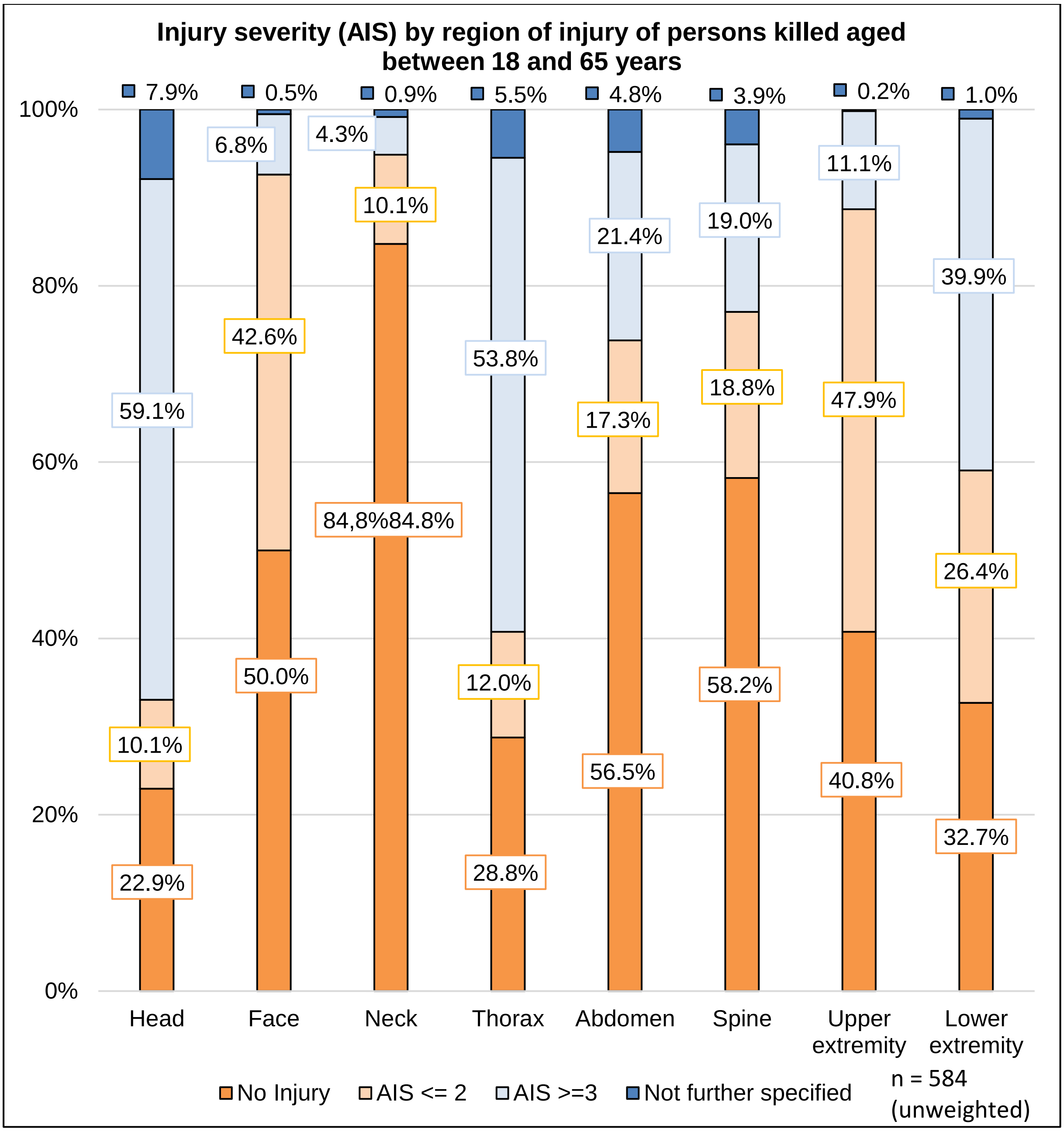


Figure 6-6: Injury severity by region of injury of persons killed aged between 18 and 65 years (GIDAS, 2022)

The comparison between both age groups shows a similar distribution of injury severity and regions. What is striking, however, is that in the 18 to 65 age group, the proportion of serious injuries (AIS from 3) is higher in almost all body regions, with the exception of the neck region. Conversely, this also means that older people are likely to suffer fatal injures even with less severe injuries. Both age groups have in common the regions with the most common serious injuries, namely the head and thorax regions.

If you place the vectorial speed difference (delta v) across the age groups of those killed between 18 and 65 years old and those killed over 65 years of age (Figure 6-7), a few differences can be identified. The delta v here describes the collision-related change from the speed shortly before the collision to that after the collision and is not calculated for pedestrians. As a result, 90 pedestrians are excluded from the total number of senior citizen fatalities.

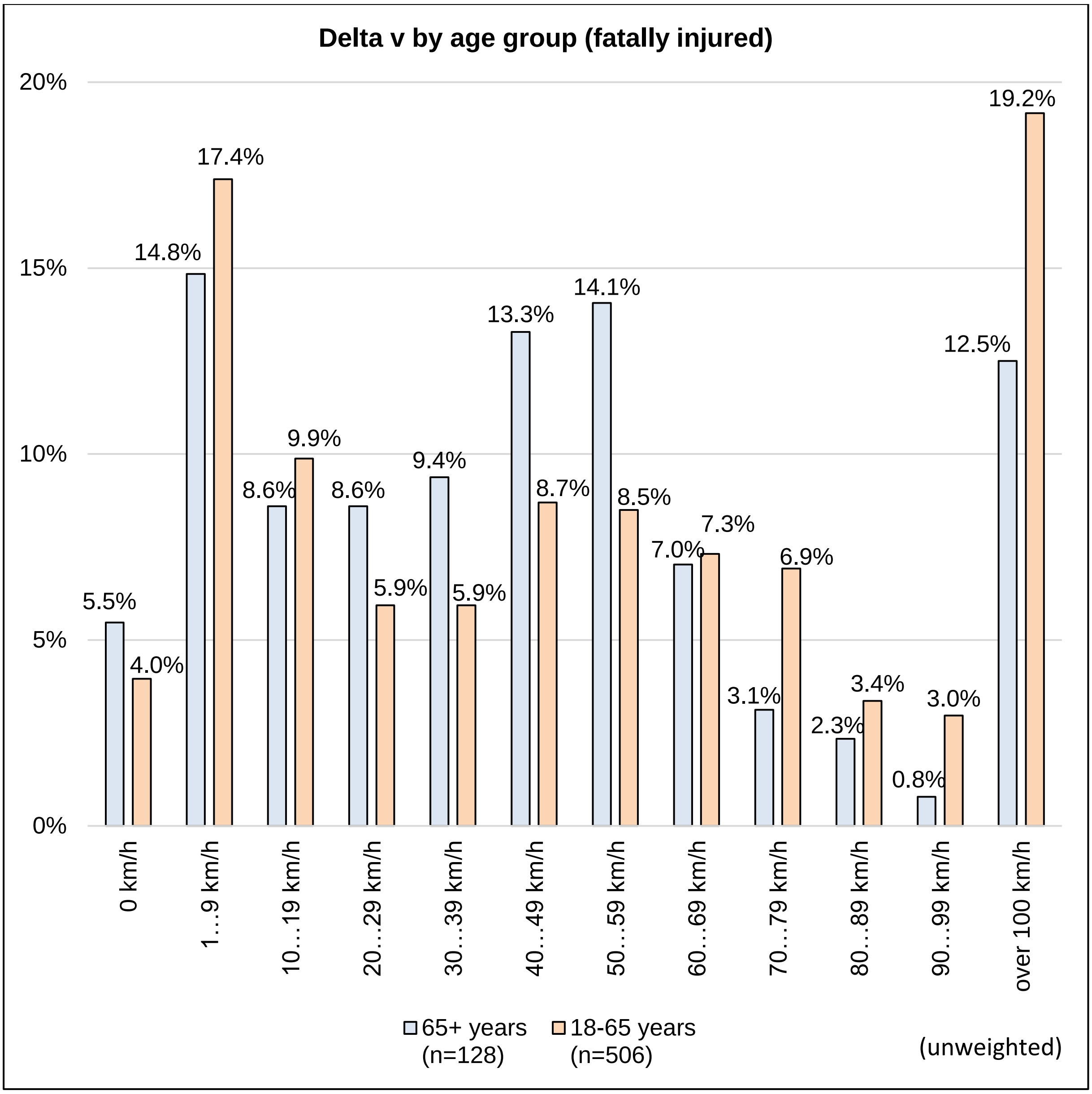


Figure 6-7: Delta v by age group (GIDAS, 2022)

For fatalities over the age of 65, the speed difference is somewhat more evenly distributed, apart from the delta v between 70 km/h and 99 km/h. The highest proportion in this age group is in the 1 to 9 km/h range. Among the 18- to 65-year-olds killed, there is a particularly high proportion of those whose speed difference is over 100 km/h, while only a relatively small speed difference can be observed at 1 to 9 km/h. On the one hand, this shows that delta v only provides a limited impression of the risk of dying in an accident. On the other hand, it is clear that older people are at similar risk for almost all speed differences.

6.3. CARE

In comparison to the GIDAS database, the EU's CARE database shows similar fatality ratios for seniors. The proportion of seniors killed has increased since 2010, reaching a maximum of almost 30% in 2018. The years 2016 and 2017 are an exception, as the share fell slightly here. The proportion of seniors killed has been falling since 2018 (Figure 6-8).

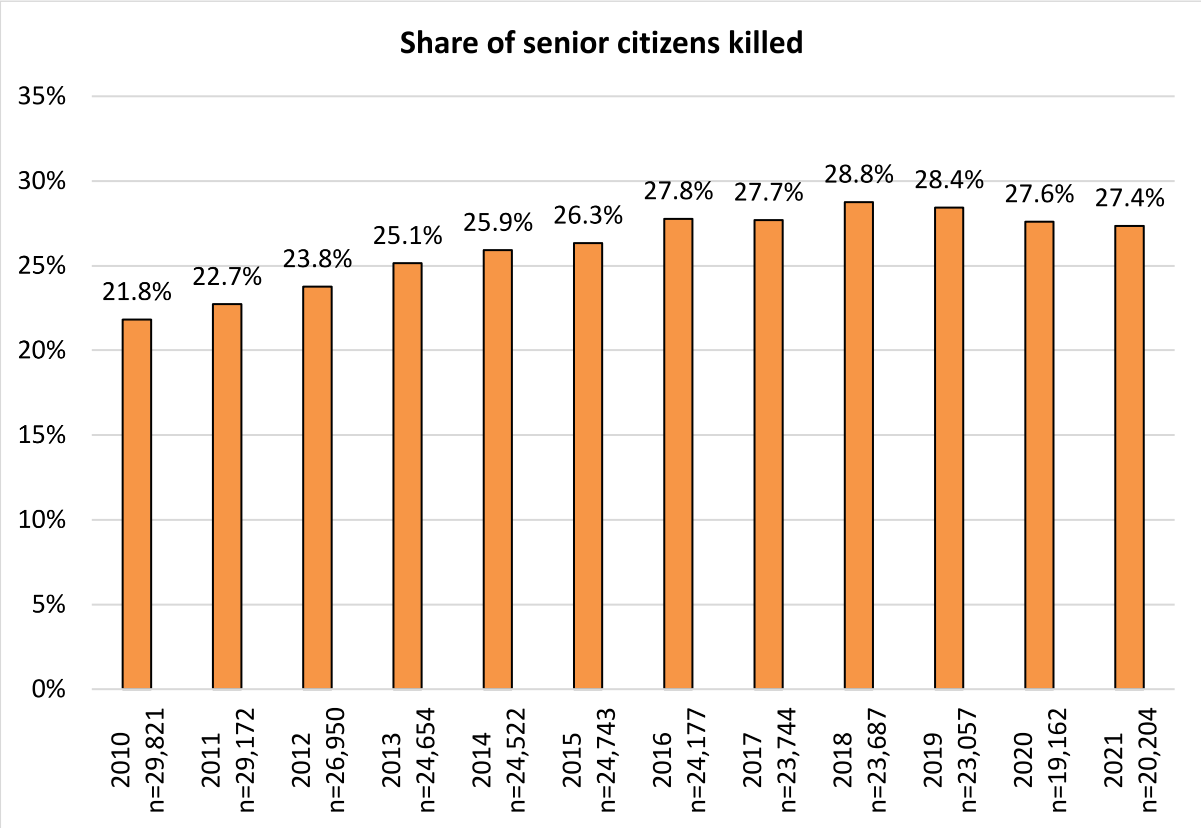


Figure 6-8: Share of senior citizens killed (CARE) (European Commission)

6.4. IGLAD

An analysis of the database of the Initiative for the Global Harmonisation of Accident Data (IGLAD) reveals a familiar picture for the distribution of senior citizens over the total number of fatalities. The European countries evaluated include Austria, the Czech Republic, Germany, France, Italy, Sweden, and Spain. A total of 2,870 fatal accidents are registered in IGLAD for these European countries. 751 of them were 65 years of age or older, which corresponds to a proportion of 26%.

Figure 6-9 presents an overview of the critical situations of fatal accidents in Europe compared to those in which seniors were killed.

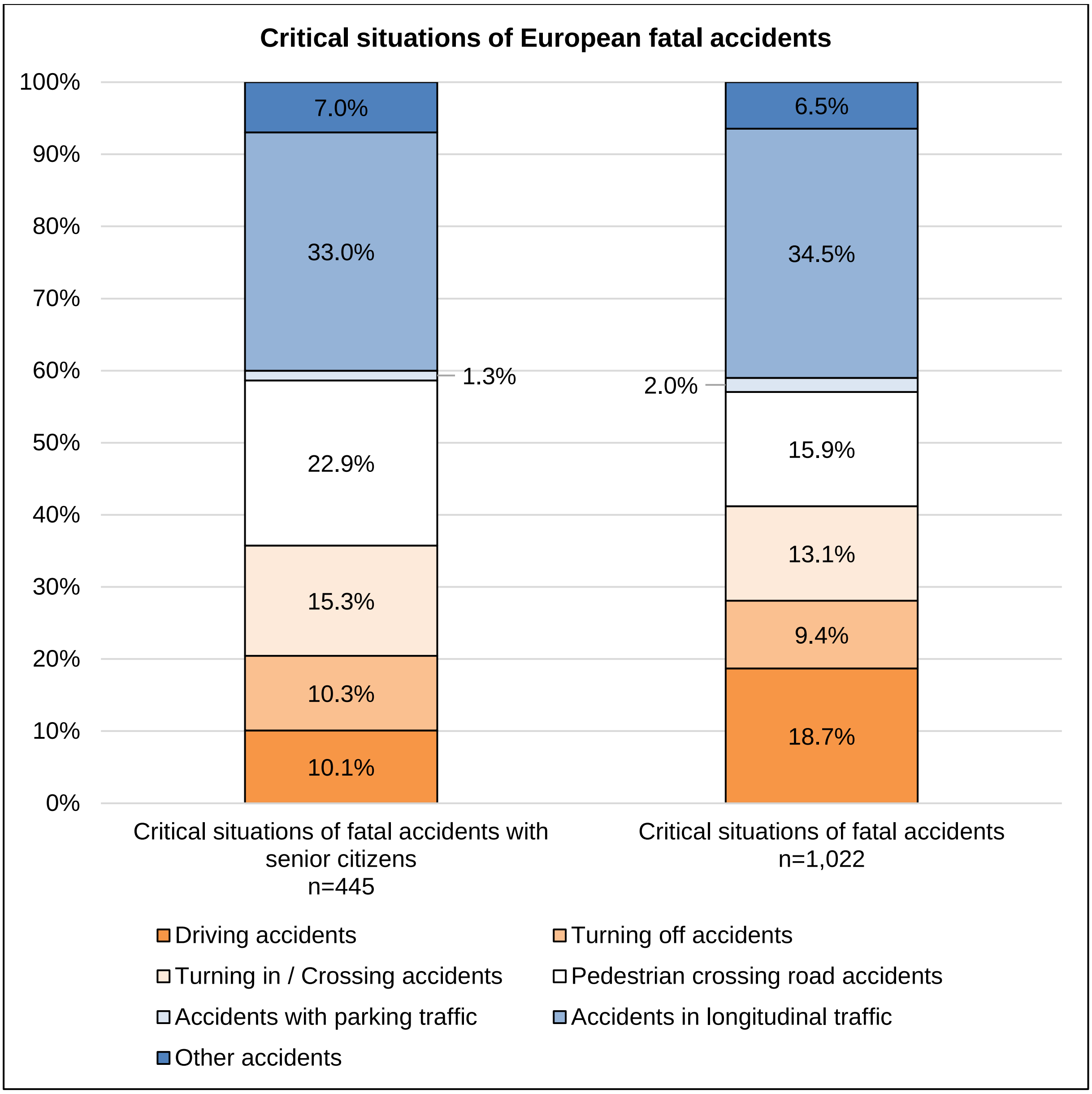


Figure 6-9: Critical situations in European fatal accidents (IGLAD, 2021)

The highest proportion of critical situations for both comparison groups is in the longitudinal traffic scenario. The second most common proportion of seniors with fatal accidents is in the “Pedestrian crossing road” scenario, followed by the “Turning in / Crossing” scenario. Here, slight differences to the critical situations across all fatal accidents can be seen. When considering all fatal accidents, the next most common scenario is the “Driving” accident, followed by the “Pedestrian crossing road” scenario. In order to gain a deeper insight into the accidents that occur involving senior citizens, the two scenarios “Longitudinal accidents” and “Pedestrian crossing road accidents” were examined in more detail.

In the most common scenario for fatal accidents for seniors, the “Longitudinal” scenario, the accidents primarily involve frontal impacts. The distribution of those involved is as follows (Figure 6-10).

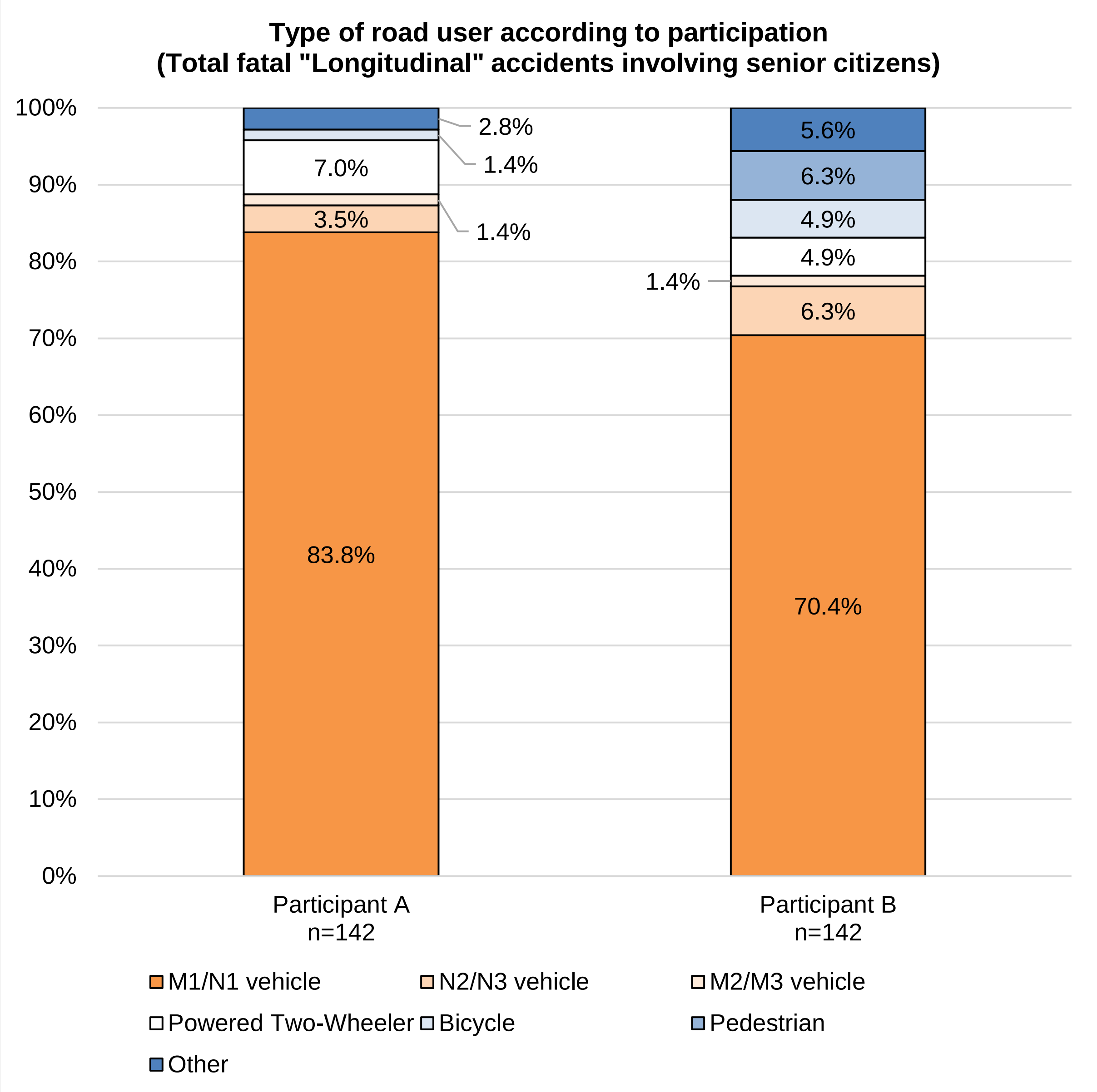


Figure 6-10: Type of road user in "Longitudinal traffic accidents" (IGLAD, 2021)

Referring to individuals listed as participant A, almost 84% were traveling in M1/N1 vehicles. 7%, and thus the second most frequent traffic participation for participant A, were powered two-wheelers. If you look at participant B, just over 70% are made up of M1/N1 vehicles. Both N2/N3 vehicles and pedestrians accounted for a share of over 6%.

The influencing factors for participant A include 27% using the wrong lane and 12% excessive speed. For participant B, no influence was determined in 66% of the cases, while in 10% of the cases excessive speed was the major contributor.

Since the most common scenarios for fatal accidents are in longitudinal traffic with frontal collisions, an analysis of the separation of oncoming traffic was carried out for accidents involving seniors (Figure 6-11).

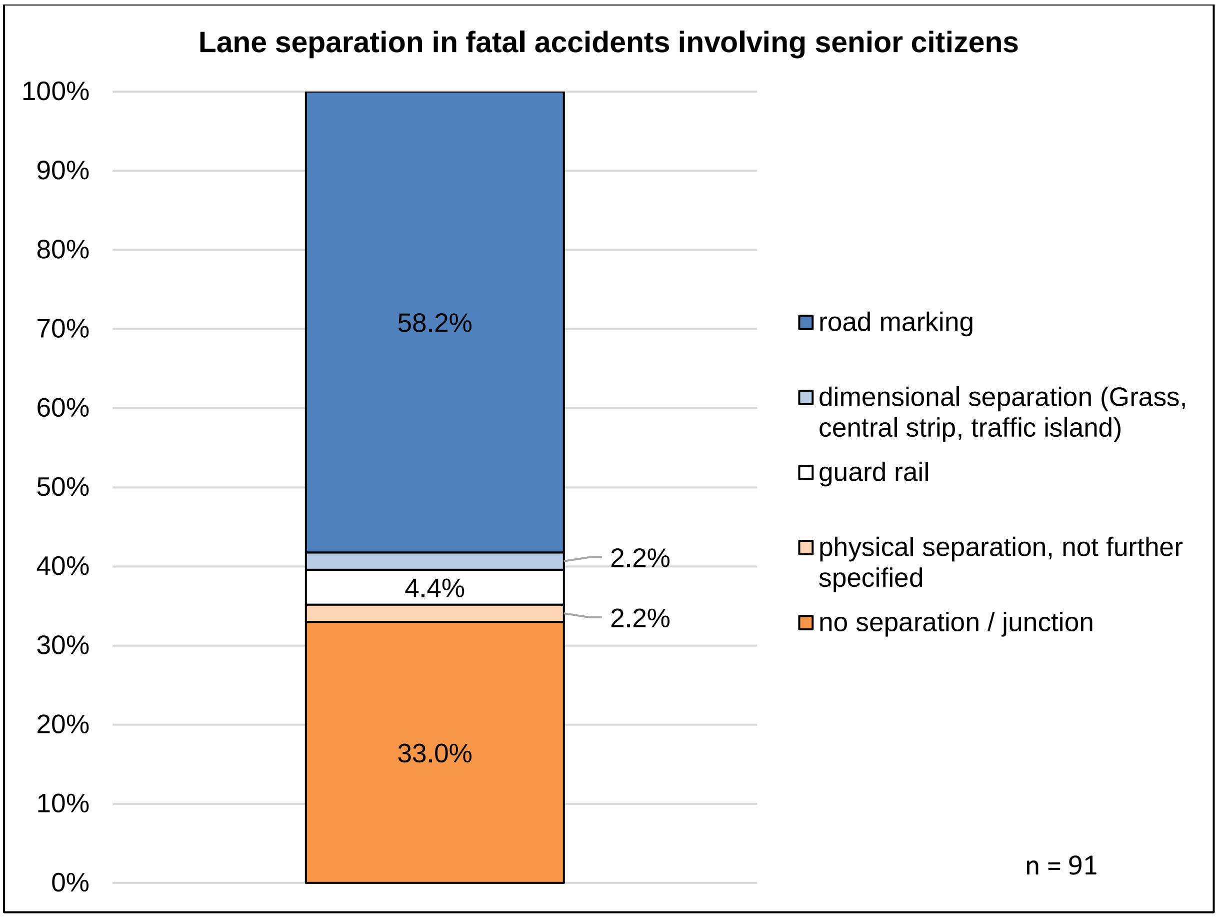


Figure 6-11: Lane separation in fatal accidents involving senior citizens (IGLAD, 2021)

A good 91% of the cases had no separation from oncoming traffic, while only 4% had a protective barrier from oncoming traffic. This suggests that, by creating a physical separation, serious accidents (head-on collisions) could be reduced.

In the "Pedestrian crossing road" scenario, critical situations primarily involve a pedestrian crossing the street from either the left or the right in a straight line without any obstructions to visibility. Figure 6-12 shows an overview of the type of traffic participation after involvement in critical situations in the "Pedestrian crossing road" scenario.

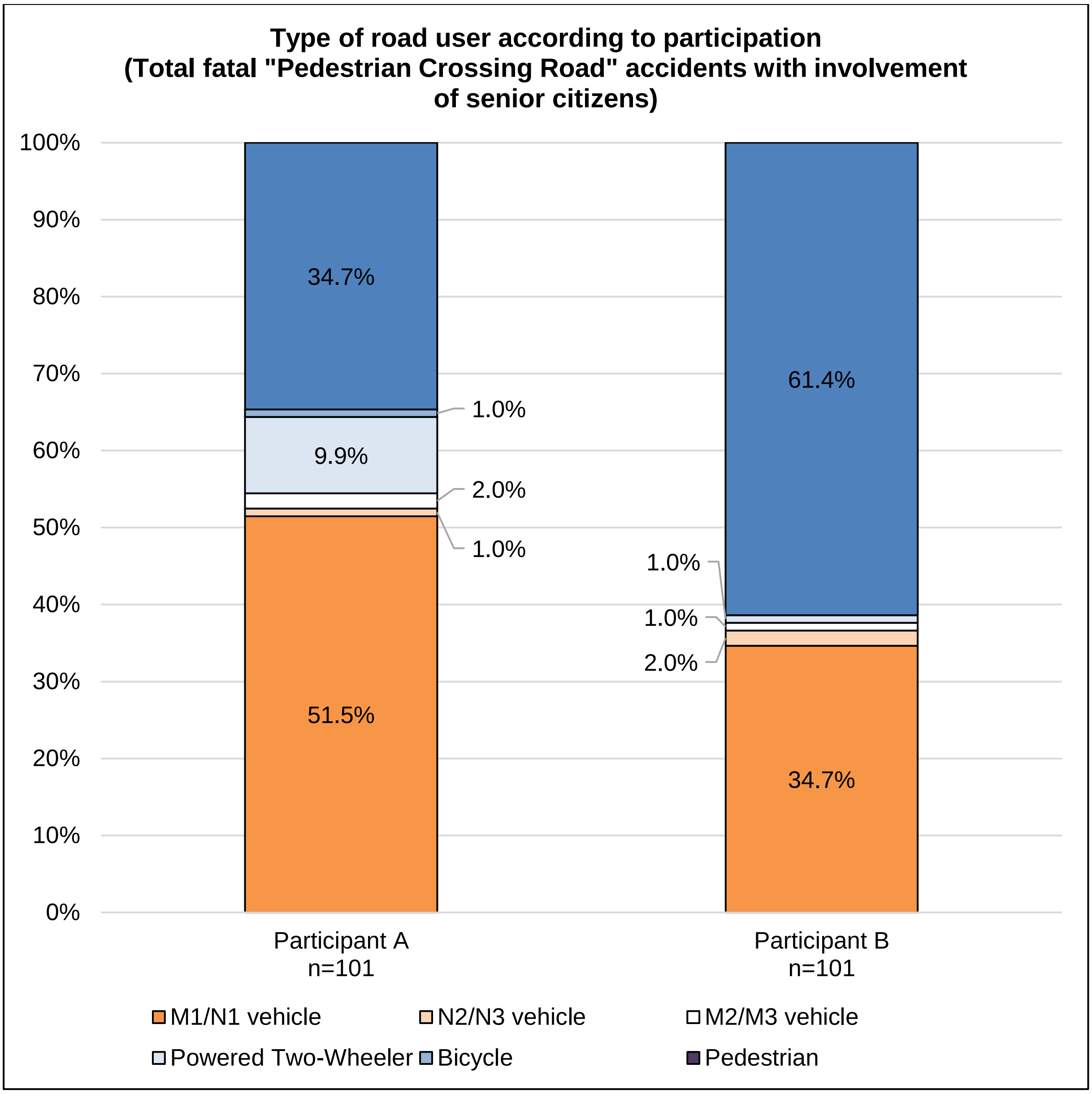


Figure 6-12: Type of road user in "Pedestrian crossing road accidents" (IGLAD, 2021)

For both parties involved, the most common types of traffic participation are M1/N1 vehicles and pedestrians. Among those listed as participant A, over half were travelling in an M1/N1 vehicle and almost 35% were pedestrians. 35% of those listed as participant B were found to be travelling in an M1/N1 vehicle and over 60% were pedestrians.

If we now look at the influencing factors of the respective participants in this scenario, we see that, for participant A, 27% of the cases report incorrect behaviour towards pedestrians having an influence on the accident, with a further 24% reporting incorrect behaviour on the part of the pedestrians themselves, while 21% of the cases reported no influence. For participant B, in 39% of the cases an influence from incorrect behaviour of the pedestrians themselves was suspected, in 29% there was no influence from participant B, and in 15% of the cases incorrect behaviour towards pedestrians was documented. A precise breakdown of the influencing factors can be found in Appendix 10.A.6. For both participant A and participant B, the proportion of incorrect behaviour towards pedestrians and incorrect behaviour of pedestrians in the “Pedestrian crossing road” scenario is over 50%.

6.5. Reports

If it is not possible to access (your own) current accident figures, various reports from authorities, associations, or research institutes can also be used for analysis. A current report from the European Transport Safety Council (ETSC) on reducing the number of senior citizens killed on European roads will serve as an example (Carson J, 2023). As the title suggests, this report focusses on Europe's older residents and their road safety. In addition to population figures for various European countries, the report also contains statistics on types of participants, injury overviews, and the main other participant in collisions from accidents in European countries. In addition to statistics, the report also contains an overview and summary of different studies, strategies, and campaigns from selected countries or institutions. This report specifically mentioned concrete measures aimed at governments, European institutions, or vehicle manufacturers in order to reduce senior citizen mortality on European roads. These measures are summarised in Table 6-3.

Main recommendations to national governments
- Improve registration of deaths and serious injuries of pedestrians and cyclists and tackle underreporting - Develop and implement evidence-based screening tools and protocols based on international best practice to help medical professionals consistently identify medical conditions which may affect fitness to drive - Within national medical fitness to drive guidelines and regulations, stress the role of General Practitioners (GPs) as the primary point of call for identifying those who may be at-risk in terms of their fitness to drive, initiating an assessment of a person’s fitness to drive and influencing how long and under what circumstances a person continues driving. This influence can range from direct advice to the patient to discussions started by family members about a person’s challenges with driving - Develop and mandate for medical professionals’ evidence-based training programmes - Provide alternative public transport options to private cars - Support and fund projects enabling life-long mobility - Plan for land use with older people’s mobility needs in mind and involve them in the process - Encourage cities to undertake road safety audits of urban infrastructure including needs of older road users - Construct highly visible, recognisable, and uniform pedestrian crossings (e.g. raised crossings)

Main recommendations to the EU institutions
- Support Member States in developing and promoting materials to support successful drivers' self-regulation and transition to reduced driving and driving cessation. These materials should be made freely available in all Member States, to assist individuals in undertaking assessment of their own fitness to drive - In order to increase consistency in assessing drivers' medical fitness to drive across the EU, develop an effective and transparent screening protocol based on international good practices to help medical professionals detect potential medical conditions - Develop and promote evidence-based guidelines for GPs and other medical professionals - Support and fund projects enabling life-long mobility - Involve older people in developing mobility policy - Draft guidelines for promoting best practice in traffic calming measures - Deliver an EU safe active mobility strategy which sets road safety measures and targets to increase the amount of distance safely travelled by walking and cycling, including by older people - Stimulate development of safer vehicles for older people - Encourage older people-friendly design and evaluate the impact of new technologies on older drivers
Main recommendations to car manufacturers and EU institutions
- Develop crash test dummies representative of more aspects of variability such as age, gender, size, and stature for those users outside of the vehicle

Table 6-3: Main recommendations for reducing older people's deaths on European roads (Carson J, 2023)

7. Summary / Discussion

Road safety is an important aspect for many countries and authorities. The Vision Zero policy was first introduced within Swedish legislation in 1997, laying a foundation that many countries and regions follow today. The common Vision Zero connects all actors who want to make road safety safer, from individuals to institutions and industries to authorities.

There is no replacing human life, and losing life, any life, in traffic must be prevented. The fact that more and more people are actively pursuing this goal is a promising and important step. However, this goal can only be achieved if certain truths are recognised and accepted, with the singular goal always in view and the involvement of all stakeholders ensured.

An important truth is that humans are prone to errors and accidents can never be completely avoided, but the fatal outcome of an accident can be. Based on existing Vision Zero implementation and strategies and some analyses that explicitly address the older population, recommendations have been compiled that may help mobility clubs implement Vision Zero.

A core measure should be understanding Vision Zero itself. Many decision-makers are no stranger to the approach of avoiding traffic fatalities, but awareness should continue to be raised and society should also be integrated. In addition, this vision must also be followed by a suitable strategy. The current EU Road Safety Policy Framework and the “Safe System” show what such a strategy could look like. Defined and, ideally, uniform KPIs help to identify intervention points. The EU KPIs serve as possible suggestions for indicators (see Table 3-2). Finally, current trends must be taken into account and reacted to accordingly, whether in the form of new mobility offers or responding to the increase in distraction caused by mobile phone use while driving. Such trends can also be identified through studies of other countries or regions.

Data analysis is the basic building block for a data-driven identification of areas of action. This can be done at a local, national, or global level, depending on which strategy is followed. Possible data sources include accident statistics, which many countries offer with the help of accidents reported to the police. On the other hand, there are also so-called in-depth databases, such as GIDAS or IGLAD, which contain detailed data on accidents. In addition, some mobility clubs also conduct their own accident research. An overview of existing sources for accident data can be found in the Global Safety Database (automotive technology). With the help of current data, intervention points can be identified very quickly. Figure 7-1 presents a possible procedure based on the PDCA cycle (Plan-Do-Check-Act) for identifying areas of action based on data.

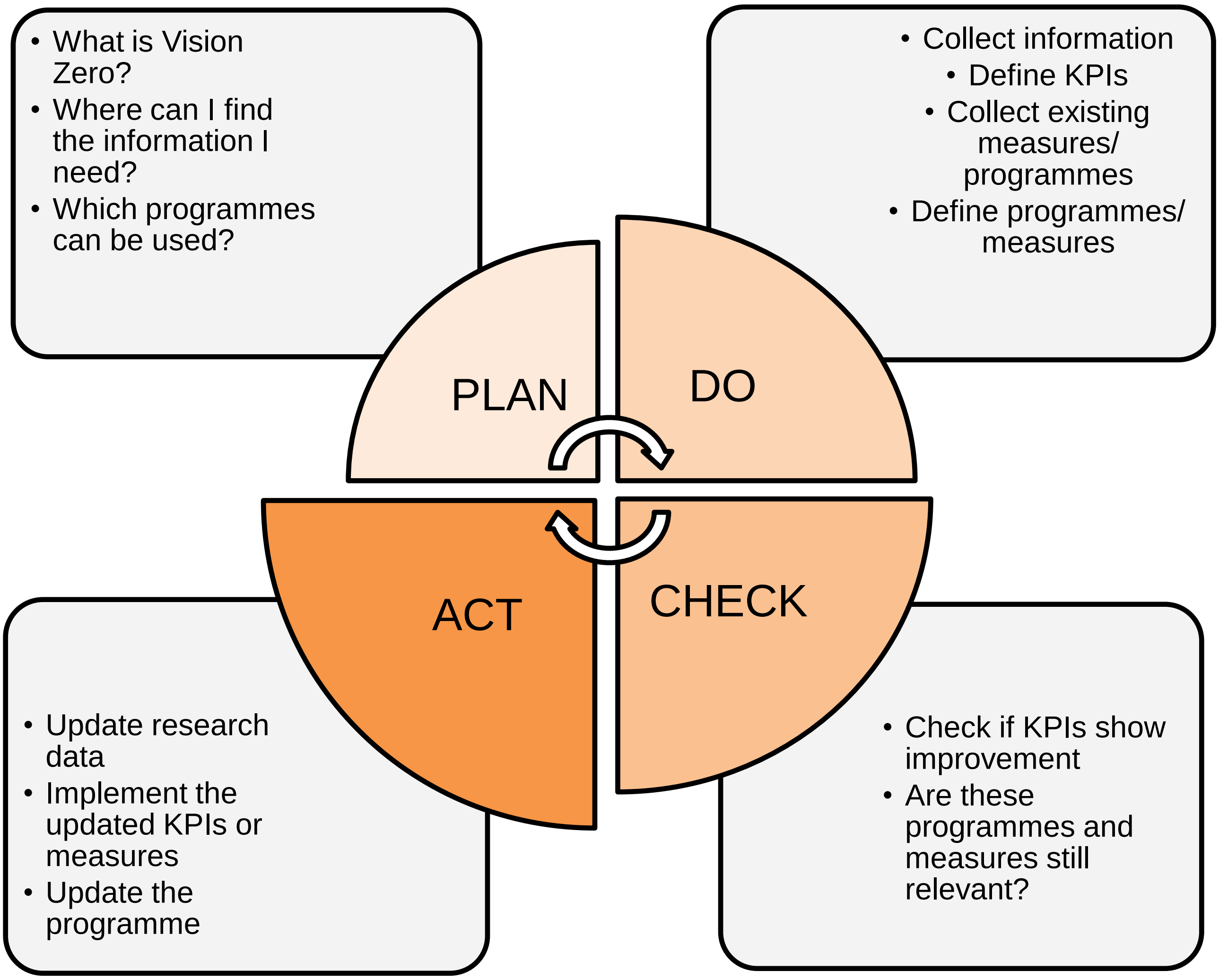


Figure 7-1: PDCA cycle to determine intervention points

The first step begins with the question: “Where can we find the data we need?” As an example, we will use a strategy that aims to reduce bicycle accidents. First, the right data sources must be found that list bicycle accidents and more detailed data. The Global Safety Database (GSD) provides an overview of data sources for accident data worldwide. It is still advisable to look for existing measures and adapt them if possible. The selected data sources are then evaluated based on defined KPIs. This could, for example, be a limit for the ratio of cyclists killed across age groups, a prioritisation of the official causes of accidents, or an evaluation of the critical situations before a collision (see Section 6.2). If no data basis is available, a separate database should be created. This can be done through targeted surveys or studies. An analysis can be used to determine whether an intervention point has been reached and whether there are further areas of action that influence your own strategy. In this specific case, this could be, for example, an increase in bicycle accidents when a new mobility concept is introduced (e.g. pedelec). One measure after identifying this point of intervention could be to raise society's awareness of this mobility concept. This can be done through information campaigns or targeted training. Furthermore, it should be checked at regular intervals to see whether the KPIs have improved or whether the current measures are still relevant. If this is not the case, the KPI and/or the measures should be adjusted.

The following tables provide an overview of possible measures that address Vision Zero and the aging population. The most important point remains the cooperation between authorities, institutions, the automotive industry, and individual citizens. Table 7-1 presents measures from literature and policy research and, in addition to general measures for the Vision Zero goal, also includes specific measures in the context of the older population.

General: - Close cooperation with the automotive industry and road construction authorities - Transparent safety assessment of vehicles (e.g. NCAP) - Safe system for evaluating measures (data-driven, KPIs) - Improve registration of deaths and serious injuries of pedestrians and cyclists and tackle underreporting - Develop and implement evidence-based screening tools and protocols based on international best practice to help medical professionals consistently identify medical conditions which may affect fitness to drive - Support projects enabling life-long mobility - Stimulate development of safer vehicles for older people and evaluate the impact of new technologies on older drivers - Develop crash test dummies representative of more aspects of variability such as age, gender, size, and stature (for individuals outside of the vehicle)
Infrastructure: - Traffic circles as a traffic solution at junctions - Expansion of the road network with median barriers - Municipal decisions regarding traffic-calmed areas - Guard rails on roads and clearing the hard shoulder of potential collision objects - Continuous review of speed limits - Separation of the road from the pedestrian area at intersections - Prioritise the building of safe and accessible pedestrian networks - Construct highly visible, recognisable, and uniform pedestrian crossings (e.g. raised crossings)

- Signage alerting drivers to the presence of a Seniors Safety Zone
- Longer walk signals that give people more time to cross
- Pedestrian head start signals
- Extended curbs to reduce crossing distances
- Explicitly consider the location of retirement and aged care facilities when designing public transport routes
- Encourage cities to undertake road safety audits of urban infrastructure including needs of older road users

Policy:

- Provision of various mobility services (e.g. regional cabs, target group transportation)
- Differentiated tariff policy (e.g. for older people)
- Restructure and expand affordable, door-to-door transport options
- Easily accessible and user-friendly public transportation
- Provide alternative public transport options to the private car
- Consider restricted licensing over full removal of license, especially in remote areas
- Provide older people with clear, accurate information about the transport services they can expect to receive as they age
- Stronger traffic monitoring (e.g. seatbelt wearing rate, speed controls, etc.) and appropriate sanctions
- Involve older people in developing mobility policy

Personal: - Good route planning - Avoid driving at peak times - Keep physically and mentally fit - Question your own fitness to drive self-critically - Doctor visits - Follow doctor's instructions (e.g. when taking medication) - Use aids as a pedestrian (e.g. rollator)

Table 7-1: Measures for Vision Zero from literature review

Table 7-2 shows measures that have already been implemented by various mobility clubs.

Data analysis: - National data - In-Depth data - Own accident research
Informing and educating the public: - Driving dynamics - Traffic rules - Technology - Cooperation with driving schools
Observing new trends: - Studies - Trainings (e.g. pedelec training)
Offers of voluntary fitness-to-drive tests
Exchange with road construction authorities and government decision-makers
Legal advice
Reward-based road safety strategy

Table 7-2: Measures for Vision Zero from club consultation

Table 7-3 presents an overview of technologies that directly address Vision Zero and the older segments of society. It also shows possible topic areas where further action or studies may be necessary.

Advanced Driving Assistant Systems (ADAS) and Cooperative Intelligent Transport Systems (C-ITS) - Lane keeping assistance - Lane departure warning - Pedestrian detection and collision mitigation - Bicyclist detection and collision mitigation - Road boundary departure prevention - Automatic emergency brake - V2X intersection collision warning - Intersection movement assistance - Operational Design Domain (ODD) issues
Adaptive Restraint Systems - New dummies (e.g. Elderly ATD) - 3D camera in combination with software for analysing people (indoor observation) - Different seat belt configurations
Human-Machine Interface (HMI) - Lack of consideration for older people in the design of HMI - Differentiated dissemination of warnings necessary - Speech and auditory modalities seem to be a good solution - Consider a possibly different learning process when using new technology
Low Speed Manoeuvring - Pedal misapplication - Corrective and emergency steering function - Rear View Automatic Emergency Brake
In-Cabin Sensing

- Distraction / Drowsiness Detection
NCAP assessment - Transparent safety assessment of vehicles

Table 7-3: Technology regarding Vision Zero and the elderly population

The tables are intended to represent an incentive or a "collection of ideas" that can be used to develop areas of action for your own strategy. In addition to the measures that mobility clubs have already taken (Table 7-2), they should also highlight subject areas that could possibly be used for information campaigns, further studies, or for political actions.

In order to achieve Vision Zero, all parties in road traffic must be taken into account. In this specific context, this means involving the older members of society more closely, both in our strategies for Vision Zero and in traffic planning and participation. In addition to targeted educational work, it is advisable to identify areas of action through data analysis. Part of the educational work should explicitly include explaining the boundaries of individual systems.

Developments in the automative industry and vehicle safety systems have led to new vehicles becoming increasingly safer, which is also a result of increases in the level of their autonomy. However, it is also important to ensure that these vehicles are operated safely. Targeted education and studies can be a key to success here. Older members of society can contribute to this goal themselves by critically assessing their own vehicle operation and driving abilities, and taking appropriate actions based on this assessment.

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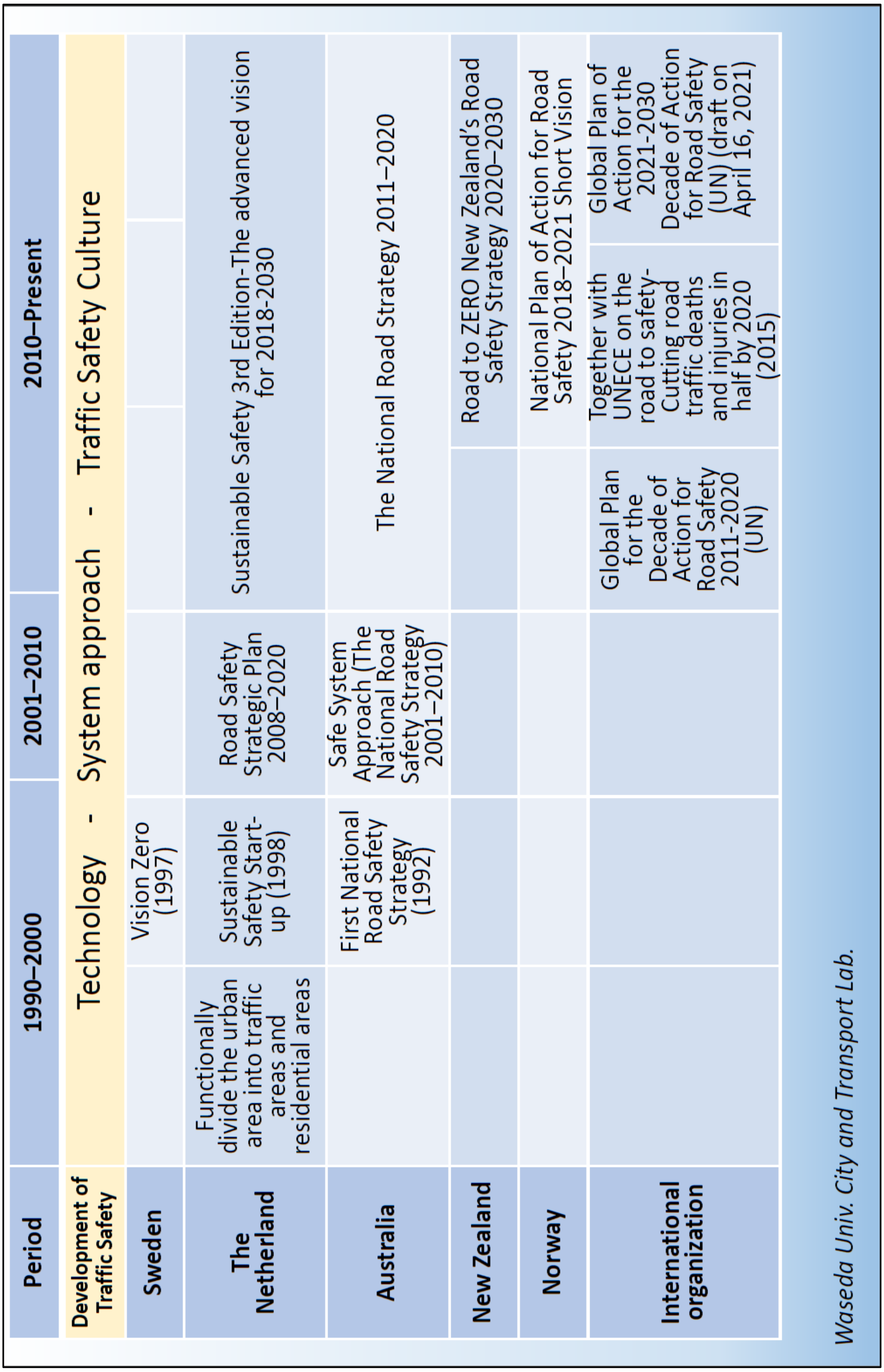
9. List of figures

10. List of tables

Appendix A

A.1 Vision Zero

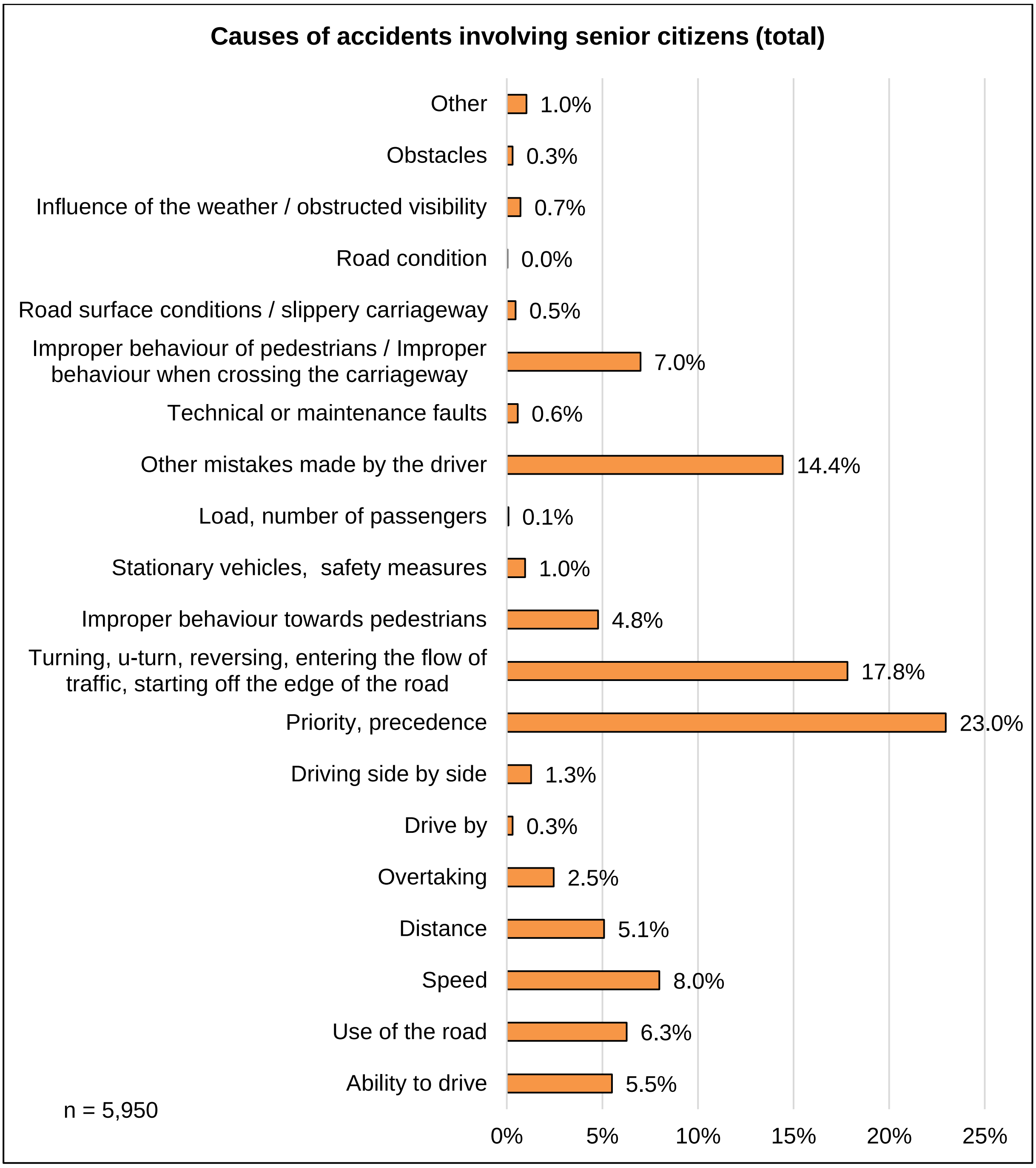


Period	1990–2000		2001–2010	2010–Present		
Development of Traffic Safety	Technology - System approach - Traffic Safety Culture					
Sweden		Vision Zero (1997)				
The Netherland	Functionally divide the urban area into traffic areas and residential areas	Sustainable Safety Start-up (1998)	Road Safety Strategic Plan 2008–2020	Sustainable Safety 3rd Edition-The advanced vision for 2018-2030		
Australia		First National Road Safety Strategy (1992)	Safe System Approach (The National Road Safety Strategy 2001–2010)	The National Road Strategy 2011–2020		
New Zealand					Road to ZERO New Zealand's Road Safety Strategy 2020–2030	
Norway					National Plan of Action for Road Safety 2018–2021 Short Vision	
International organization				Global Plan for the Decade of Action for Road Safety 2011-2020 (UN)	Together with UNECE on the road to safety- Cutting road traffic deaths and injuries in half by 2020 (2015)	Global Plan of Action for the 2021-2030 Decade of Action for Road Safety (UN) (draft on April 16, 2021)

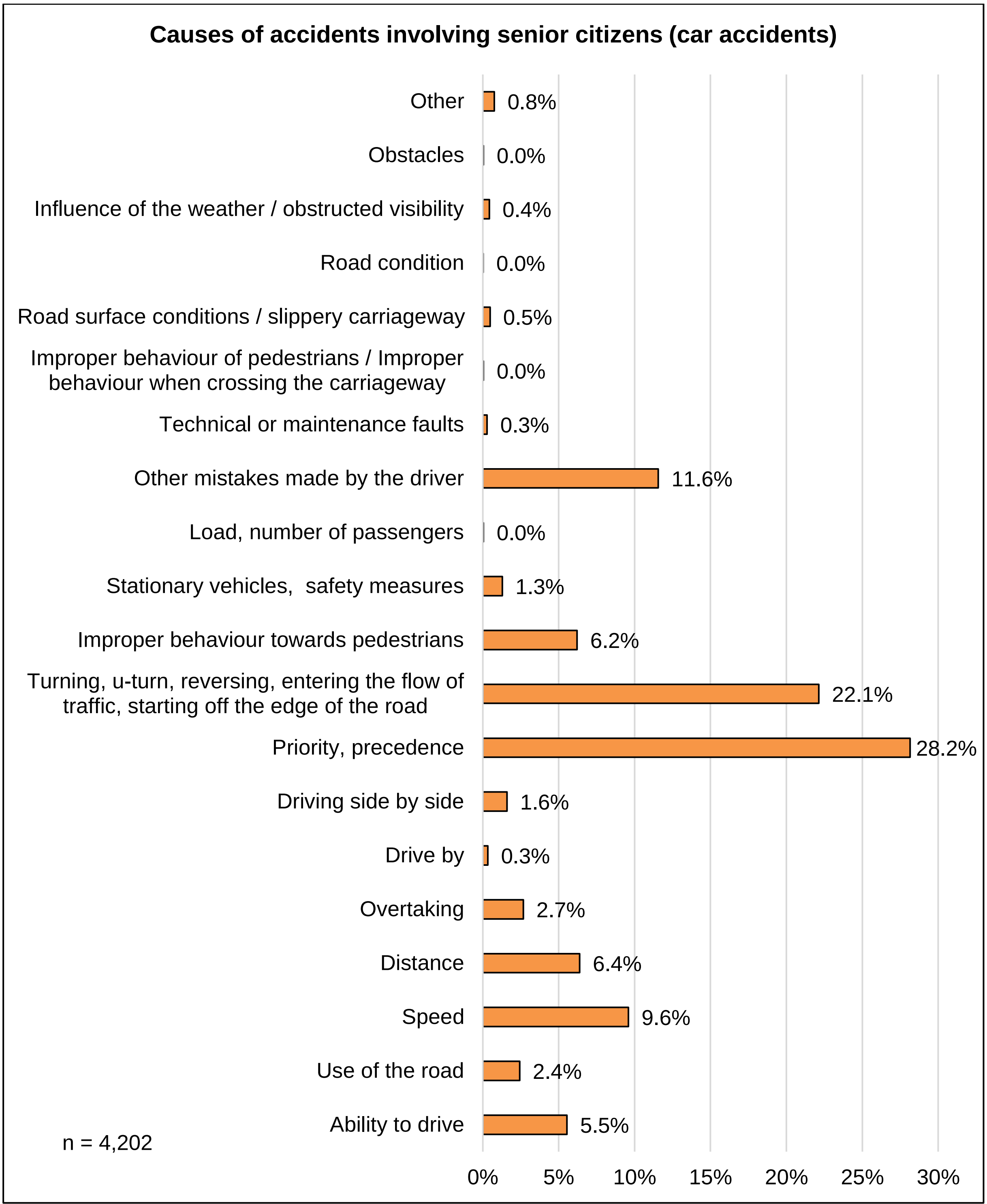
Waseda Univ. City and Transport Lab.

Figure 10-1: Roadmap towards a common Vision Zero (International Association of Traffic and Safety Sciences, 2021)

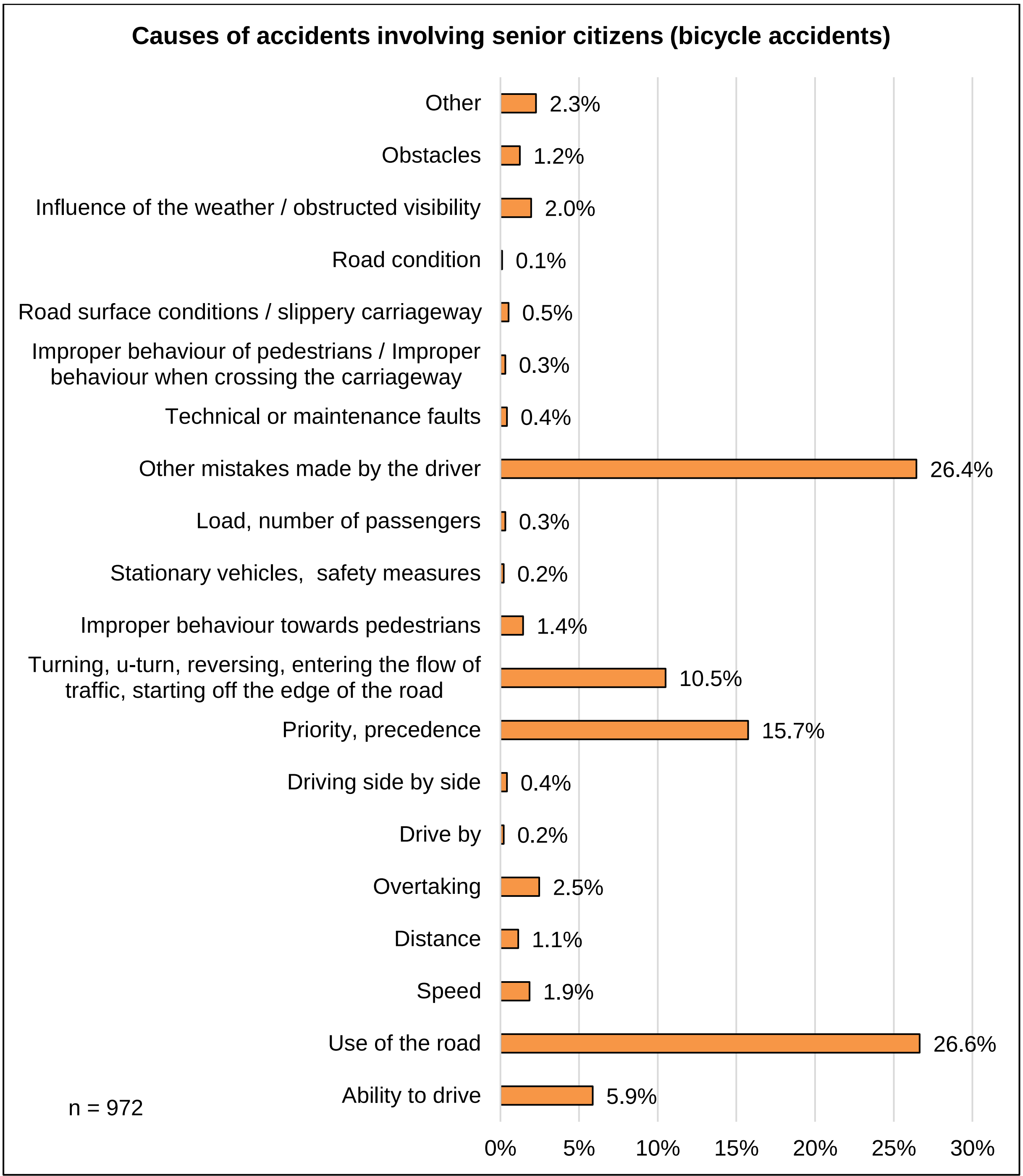
A.2 GIDAS –Causes of accidents involving senior citizens (total)



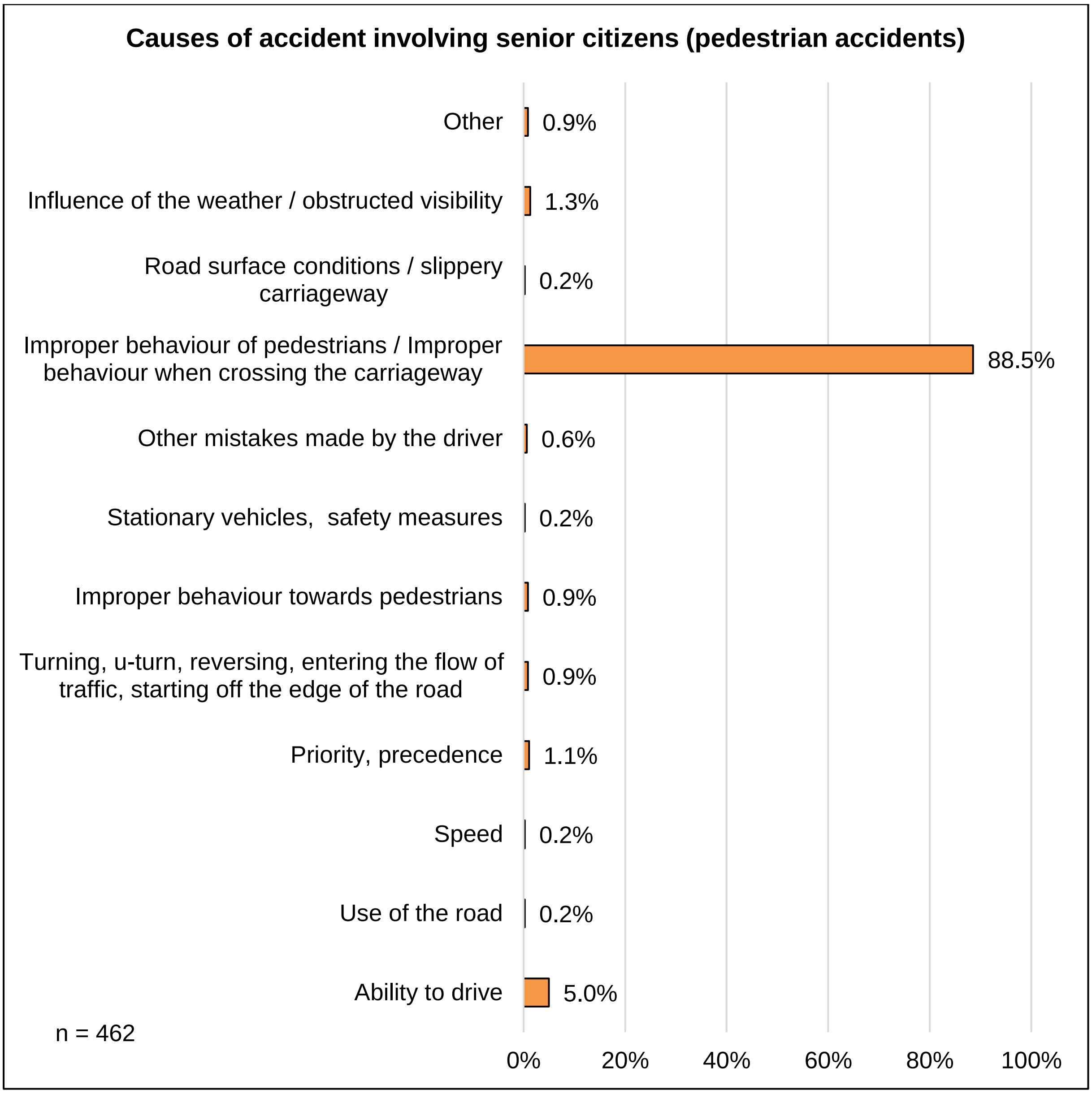
A.3 GIDAS - Causes of accidents involving senior citizens (car accidents)



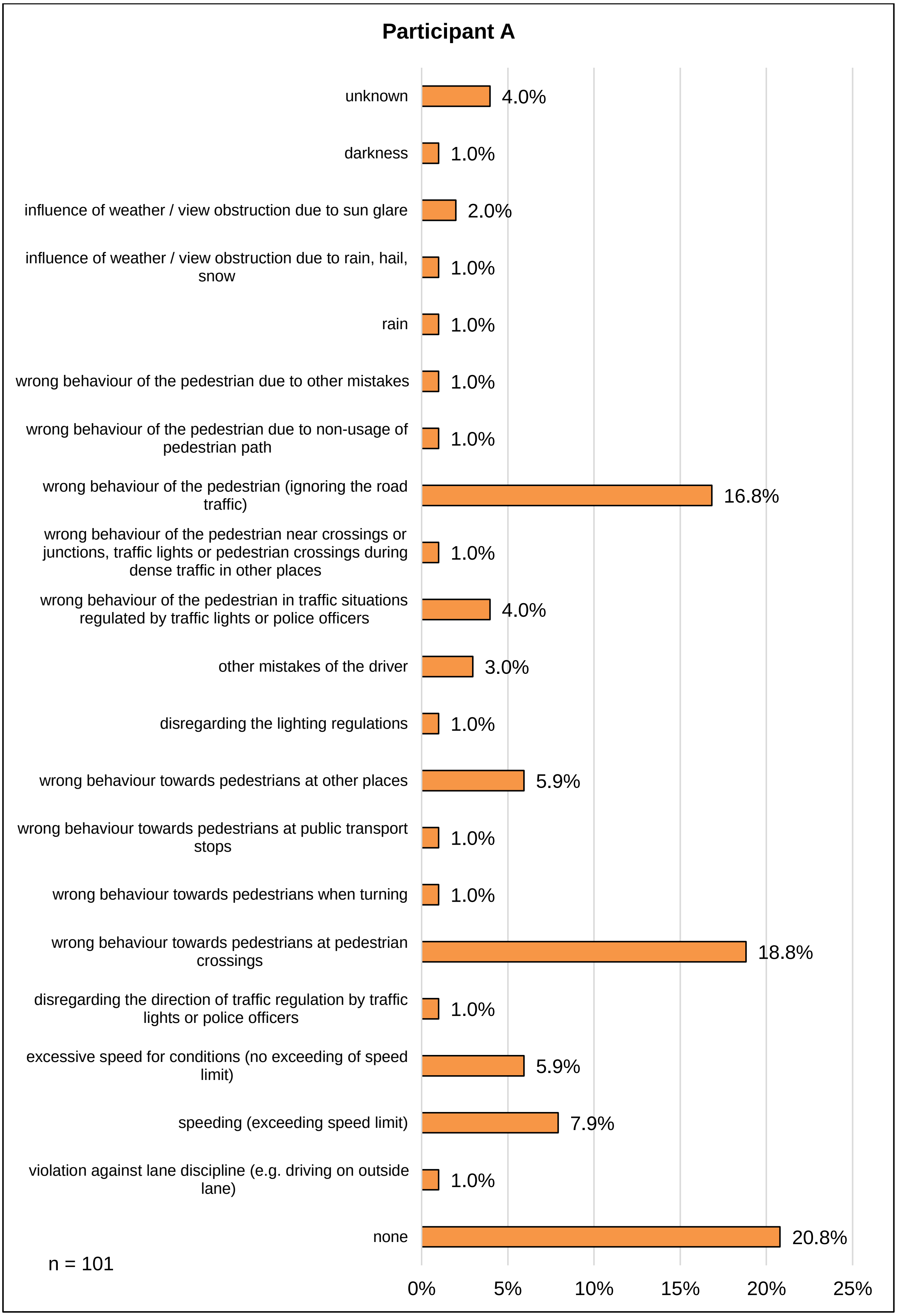
A.4 GIDAS - Causes of accidents involving senior citizens (bicycle accidents)

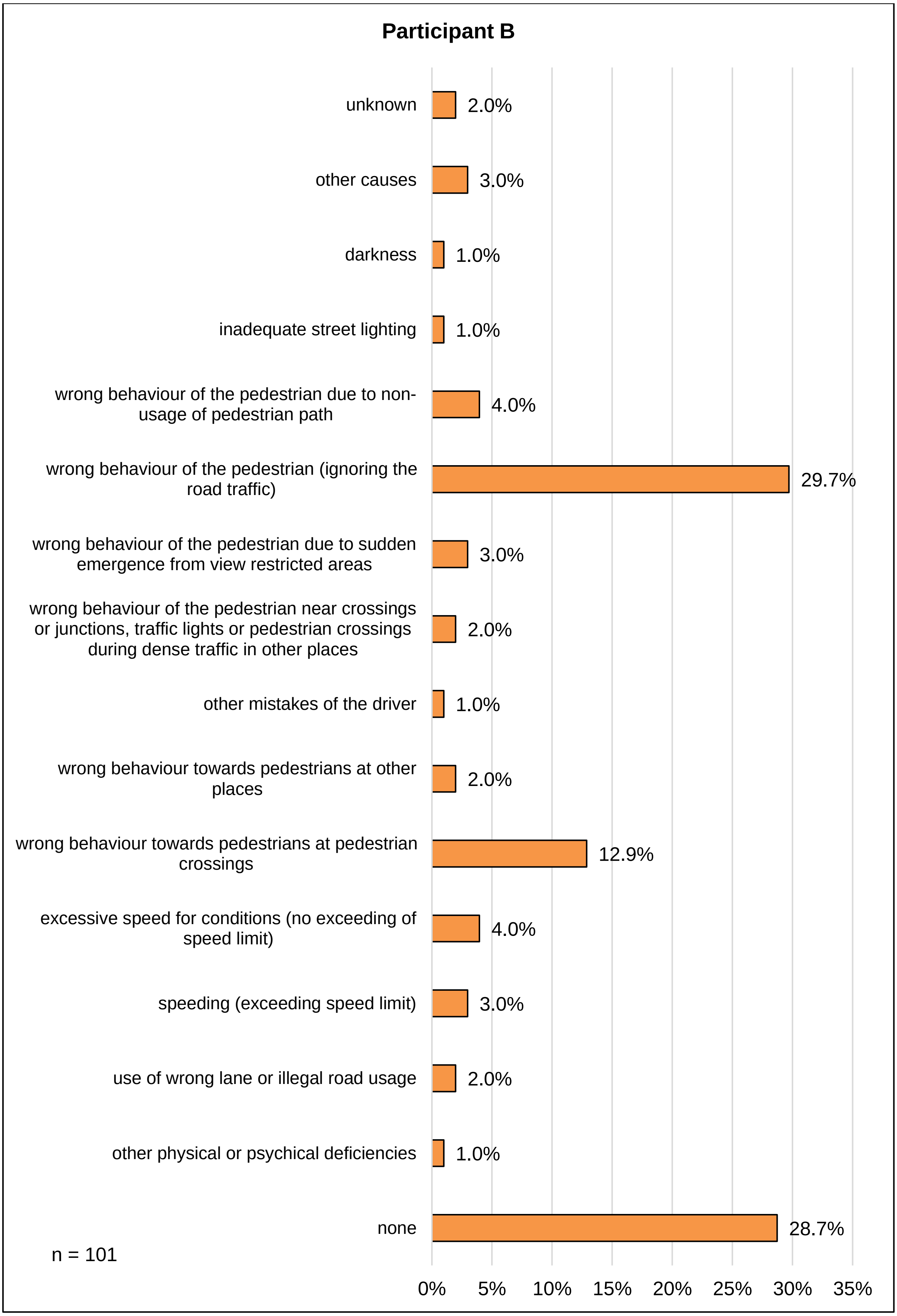


A.5 GIDAS - Causes of accidents involving senior citizens (pedestrian accidents)

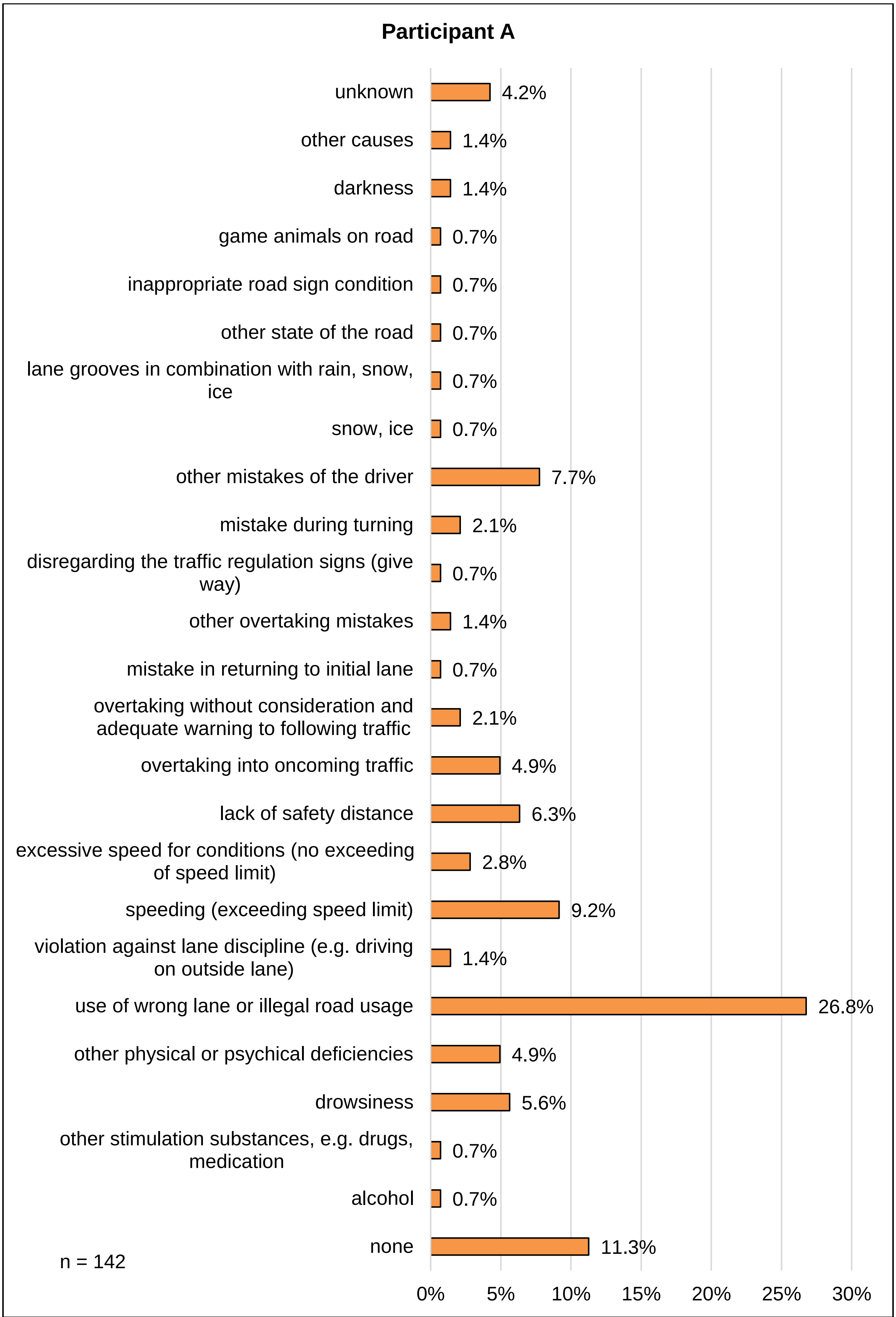


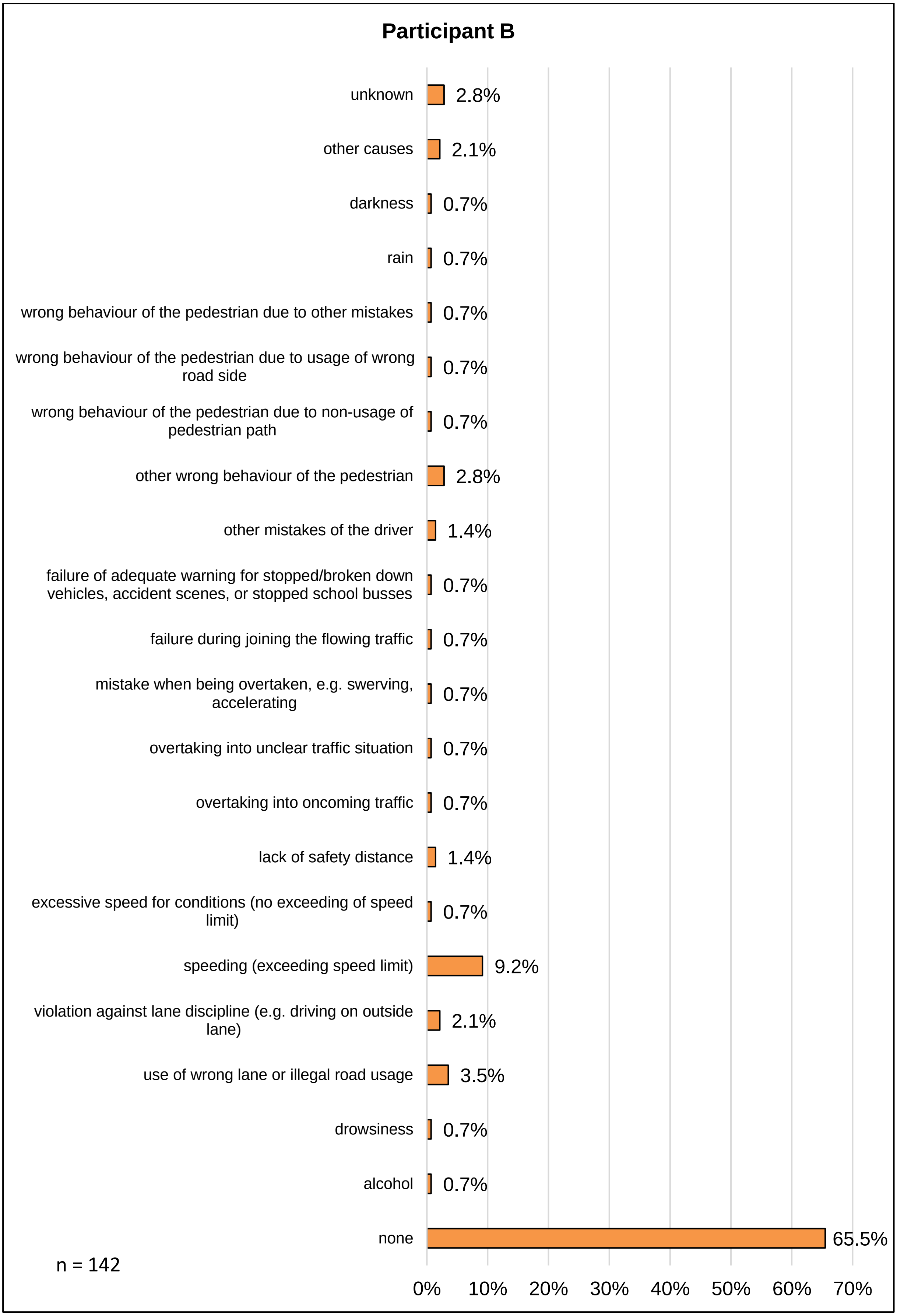
A.6 IGLAD – Causes of “Pedestrian crossing road” accidents




Participant B
unknown
2.0%
other causes
3.0%
darkness
1.0%
inadequate street lighting
1.0%
wrong behaviour of the pedestrian due to non-usage of pedestrian path
4.0%
wrong behaviour of the pedestrian (ignoring the road traffic)
29.7%
wrong behaviour of the pedestrian due to sudden emergence from view restricted areas
3.0%
wrong behaviour of the pedestrian near crossings or junctions, traffic lights or pedestrian crossings during dense traffic in other places
2.0%
other mistakes of the driver
1.0%
wrong behaviour towards pedestrians at other places
2.0%
wrong behaviour towards pedestrians at pedestrian crossings
12.9%
excessive speed for conditions (no exceeding of speed limit)
4.0%
speeding (exceeding speed limit)
3.0%
use of wrong lane or illegal road usage
2.0%
other physical or psychical deficiencies
1.0%
none
28.7%
n = 101
0%
5%
10%
15%
20%
25%
30%
35%

A.7 IGLAD - Causes of "Longitudinal traffic" accidents




Participant B
unknown 2.8%
other causes 2.1%
darkness 0.7%
rain 0.7%
wrong behaviour of the pedestrian due to other mistakes 0.7%
wrong behaviour of the pedestrian due to usage of wrong road side 0.7%
wrong behaviour of the pedestrian due to non-usage of pedestrian path 0.7%
other wrong behaviour of the pedestrian 2.8%
other mistakes of the driver 1.4%
failure of adequate warning for stopped/broken down vehicles, accident scenes, or stopped school busses 0.7%
failure during joining the flowing traffic 0.7%
mistake when being overtaken, e.g. swerving, accelerating 0.7%
overtaking into unclear traffic situation 0.7%
overtaking into oncoming traffic 0.7%
lack of safety distance 1.4%
excessive speed for conditions (no exceeding of speed limit) 0.7%
speeding (exceeding speed limit) 9.2%
violation against lane discipline (e.g. driving on outside lane) 2.1%
use of wrong lane or illegal road usage 3.5%
drowsiness 0.7%
alcohol 0.7%
none 65.5%
n = 142
0% 10% 20% 30% 40% 50% 60% 70%

A.8 Strategical Example: Vision Zero (Guidance)

VUFO GmbH

Strategical Example - Vision Zero

- Guidance -

FIA REGION I

PLAN

1. What is „Vision Zero" in general?

Vision Zero = Road safety project which aims to reduce the traffic injuries/ fatalities to zero

2. What strategies/ sources are useful to reach Vision Zero? What is the state of the art?

- ❑ Databases:

Worldwide	European	National
GSD … etc.	IGLAD CARE … etc.	DESTATIS GIDAS ASTRA STRADA … etc.

- ❑ Surveys
- ❑ Reports, papers, deliverables
- ❑ Websites … etc.

3. Which programs can be used?

Worldwide	National	Specific Mobility Clubs
- Reports, programs, papers by UN or EU - Euro NCAP - US NCAP - car manufacturers … etc.	National programs: - Road to ZERO (New Zealand) - Sustainable Safety (Netherlands) … etc. *More: Policy Study (VUFO)*	- ADAC, AVD (Germany) - ACP (Portugal) … etc. *More: fia.com* ► *Members* ► *Memberslist*

DO

4. Collect information:

What data is needed? What measures or programs are aimed?

- ❑ collect data from different sources
- ❑ rework the data to have a solid overview
- ❑ if there is no data, create data:
  - Survey/Poll
  - Studies
  - Reports etc.

5. Define Key Performance Indicators (KPI):

KPI = Chosen characteristic which is monitoring the relevant data

Are there any KPI already existing? Can they be used?

- ❑ Merge KPI's together

6. Are there any existing measures/ programs of Mobility Clubs?

#	Measurement
1	Accident research (Data analysis)
2	Cooperation with driving schools (Population education)
3	Exchange with road construction authorities and politicians
…	*More: Policy Study (VUFO)*

7. Define programs/ measures which suit the topic.

CHECK

8. Did the KPI's improve?

Example:

KPI = Fatalaties of elderly peope in traffic accidents

- KPI was calculated
- Measure: Lower the speed limit in cities
- KPI needs to be recalculated after certain time
- Compare old KPI with th new KPI

- ❑ When KPI of fatalities is lower than before: Program successful
- ❑ If not, program needs to be revised and measures need to be adjusted

➔ *Even if the KPI's improve:*
Measures need to be constantly supervised and adjusted to reduce the fatalities to ZERO.

9. Are these programs and measures still relevant?

Check the current state of the art:

- ❑ News
- ❑ Websites
- ❑ Magazines, Papers
- ❑ Conferences … etc.

ACT

10. Update the reseach data.

11. Implement the updated KPI's.

12. Implement the updated measures into the programs:

- ❑ Campaign
- ❑ Schooling
- ❑ Rework the statistical systems
- ❑ Adjust traffic rules

13. Update the programs.