European Commission

European Road Safety Observatory
www.erso.eu

Annual Accident Report

2018

Transport

OVERVIEW-MAJOR ISSUES

Safety performance
High vs Low

Data for **2016** or latest available year

European Road Safety Observatory www.erso.eu

European Commission

1 Million

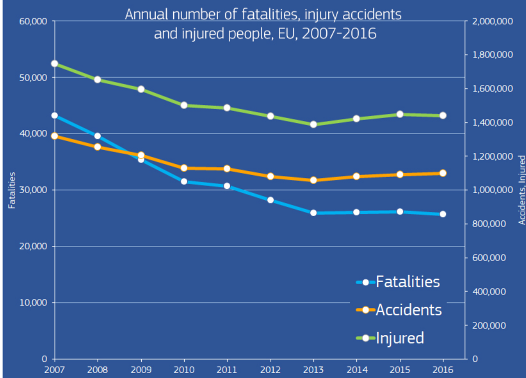
Road Accidents per Year - **3.000 per day** (2016) with consequences:

1,4 Million Injured

(3.600 per day)

25.600 Fatalities

(70 per day)

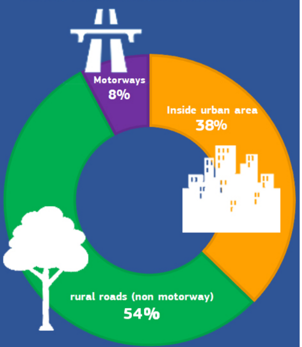


Main progress in **reducing fatalities**

-41%

less in **injury accidents**

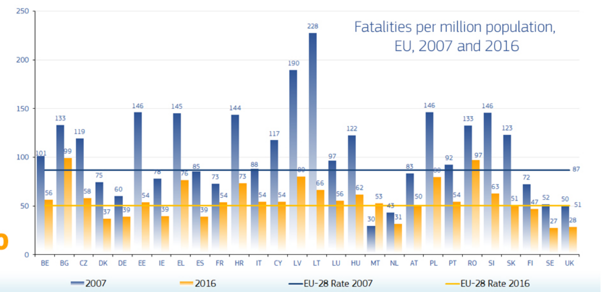
-17%



The overall **downward trend** in the number of road fatalities is different for each road user

-44% -27%

The most significant reduction in the overall number of fatalities between 2007 and 2016 occurred in **Lithuania, Estonia and Latvia**



FATALITIES 2016

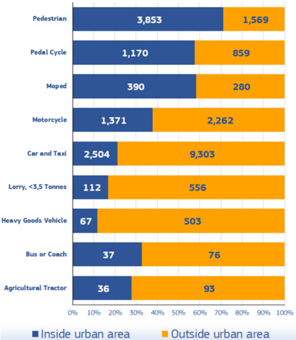
Safety performance
High vs Low

Data for **2016** or latest available year

European Road Safety Observatory
www.erso.eu

European Commission

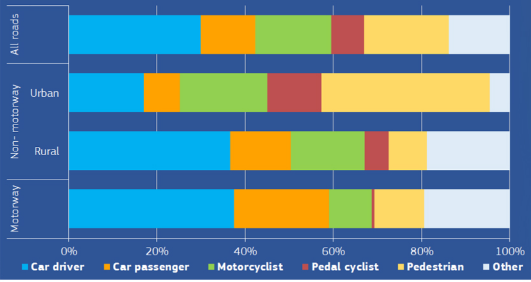
Fatalities by type of area and mode of transport in the EU, 2016



47% of all road fatalities are **car occupants**.

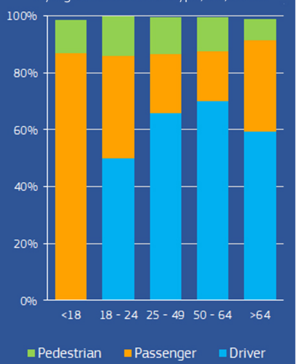
On **motorways** this proportion increases to almost **60%**

Distribution of fatalities by road user type on three types of road, 2016



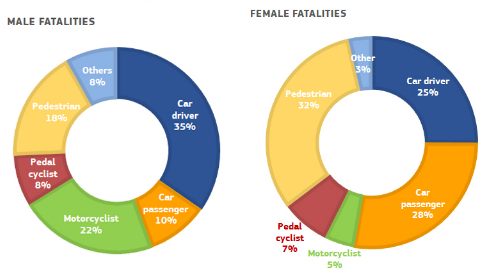
In 2016, **the elderly** (aged >64) represented almost **27%** of deaths in road accidents in the EU

Fatalities on motorways by age and road user type, EU, 2016



The proportion of fatalities **as passengers or pedestrians** is higher for females than for males

Fatalities by gender and mode of transport in the EU, 2016



Powered Two Wheelers (PTW) accounted for **17%** of the total number of road accident fatalities in the EU 2016:

Motorcycles

14%

3.644 deaths

Mopeds

3%

663 deaths

TIME SERIES
LAST 10 YEARS IN DETAIL

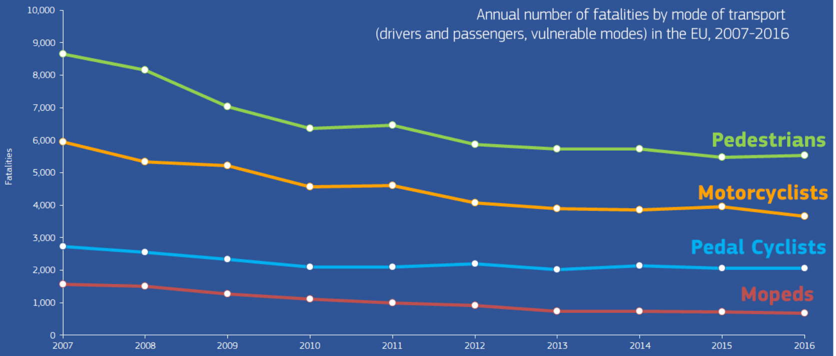
Safety performance
High vs Low

Data for **2016** or latest available year

European Road Safety Observatory
www.erso.eu

European Commission

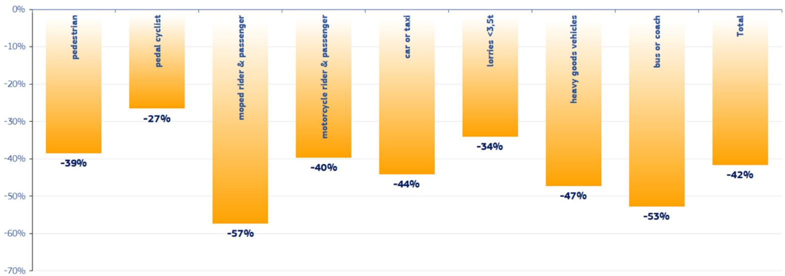
Annual number of fatalities by mode of transport (drivers and passengers, vulnerable modes) in the EU, 2007-2016



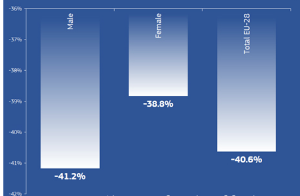
Fatalities on roads outside urban areas were **reduced by 41%** between 2007 and 2016

Over the decade 2006-2015 passenger fatalities in the EU decreased by **48%** driver fatalities by **39%** and pedestrian fatalities by **36%**

Percentage change in number of fatalities by mode of transport in the EU (2016 compared to 2007)



Male fatalities were reduced by 41% and female fatalities were reduced by 39% within the decade 2007-2016



Increase/decrease of number of fatalities by gender in the EU, 2016 and 2007

European Commission

ROAD SAFETY IN THE EUROPEAN UNION

Trends, statistics and main challenges

April 2018

Mobility and Transport

Road Safety in the European Union – Trends, statistics and main challenges

European Commission

This report is an internal working document summarising recent road safety statistics reported by the EU Member States.

For more information, contact the European Commission, Directorate-General Mobility and Transport, Unit C2 – Road Safety
move-infos@ec.europa.eu

http://ec.europa.eu/roadsafety

Manuscript completed in April 2018

Luxembourg: Publications Office of the European Union, 2018

Print	ISBN 978-92-79-80284-3	ISSN 2363-4375	doi:10.2832/169706	MI-AC-18-001-EN-C
PDF	ISBN 978-92-79-80281-2	ISSN 2363-4383	doi:10.2832/060333	MI-AC-18-001-EN-N

Table of contents

Foreword 5

1. The EU road safety situation in 2017 6

2. Monthly variation in road fatalities 12

3. Seasonality by modes of transport and type of roads 16

4. Day of the week and time of the day 20

Conclusions 24

COUNTRY ABBREVIATIONS:	
AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
SE	Sweden
UK	United Kingdom

People's safety has always been close to my heart. All road users, be it for private or professional reasons, deserve the highest level of safety and care.

The European Union has some of the safest roads in the world. It is leading by example, putting its experience and knowledge at the service of other regions, and is also promoting the highest possible standards on the global stage.

That being said, every year more than 25 000 people still lose their lives on EU roads, while another 135 000 are seriously injured. This is an enormous loss for individuals, families and society as a whole. The socio-economic consequences of this alone are estimated at EUR 120 billion annually for the EU. In light of this, there simply cannot be business as usual when it comes to road safety – I want to see changes urgently.

A year ago, EU transport ministers adopted the 'Valletta Declaration on Road Safety'. This was a major achievement, paving the way for the future, particularly on a new reduction target for serious injuries of 50 % between 2020 and 2030.

On the back of this strong political commitment, we have started work on the road safety policy framework for the period 2020-2030. We intend to reconfirm 'Vision Zero' as our long-term objective and base this framework on the 'Safe System' approach. This is a holistic and inclusive way of ensuring that all key factors are addressed in preventing death and serious injury. The framework will also respond to new challenges, such as the growing number of vulnerable road users, the risk of distraction on the roads, and vehicle automation.

Any action we propose is based on road-safety data that we collect from the 28 EU Member States and beyond. This data allows us to adjust our policies and fine-tune the measures we recommend. There are many factors at play in serious and fatal road crashes, such as the type of roads, the vehicles we use, and the age and gender of road users. In this publication, we give you an in-depth view of monthly, weekly and daily variations in road fatalities.

We strive to further improve road safety in the EU by setting a common agenda for the decade to come and by ensuring road safety actors in the ecosystem come on-board for better results. Let's continue our work today for safer roads tomorrow!

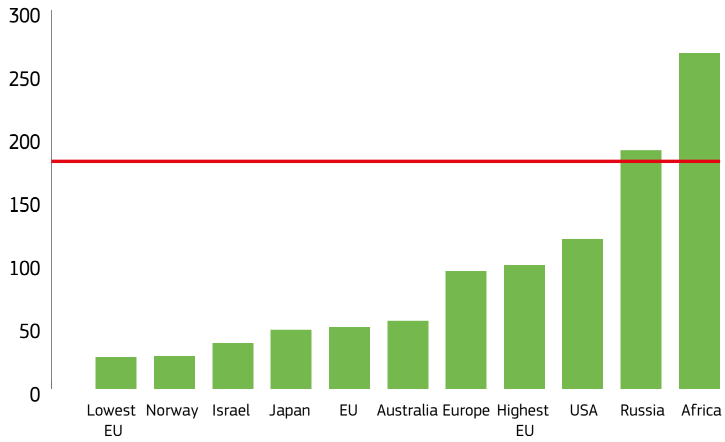
Violeta Bulc
EU Commissioner for Transport

1. The EU road safety situation in 2017

- In 2017, 25 300 people lost their lives on EU roads.
- This means a 2 % decrease in the number of road deaths compared to the previous year.
- Between 2010 and 2017, the number of road deaths decreased by 20 %, so 6 200 fewer people died on the roads last year than in 2010.
- The EU road fatality rate in 2017 was the lowest ever with 49 dead per million inhabitants.
- In 2017, countries with the lowest number of road deaths per million inhabitants were Sweden (25), the UK (27), the Netherlands (31), Denmark (32), Ireland (33) and Estonia (36).
- Countries with the weakest road safety records were Romania (98), Bulgaria (96) and Croatia (80).
- In 2017, eight EU countries recorded a fatality rate below 40 deaths per million inhabitants and 26 countries below 80 deaths per million inhabitants.

Roads in the EU are the safest in the world. The EU counts on average less than 50 deaths per million inhabitants, against 174 deaths per million globally, 106 deaths per million in the USA and 93 deaths per million in geographical Europe.

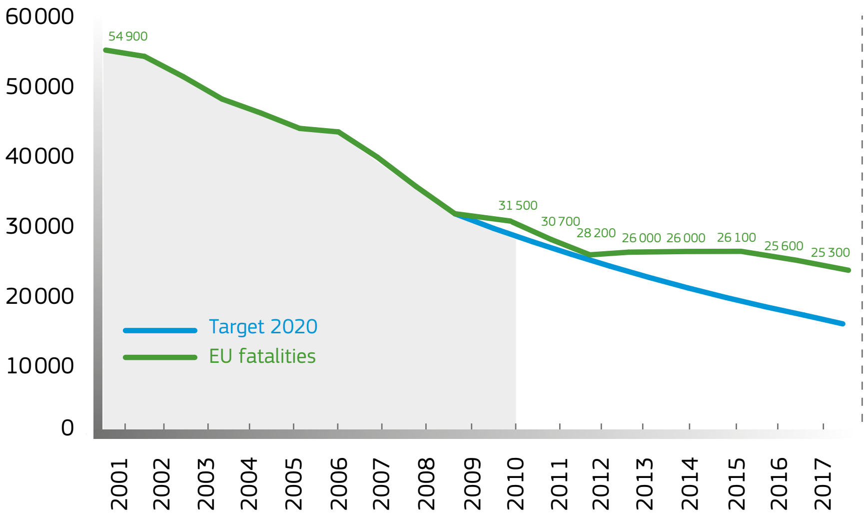
FATALITIES BY POPULATION



Progress in the last two decades in the EU has been remarkable: the number of fatal crashes fell by 43 % from 2001 to 2010, and by another 20 % between 2010 and 2017. However, the progress rate has slowed down in recent years. After two years of stagnation, 2016 marked a 2 % decrease in the number of road deaths, and 2017 repeated the same pattern.

It is now quite clear that the current rate of reducing fatalities on EU roads will not be enough to reach the 2020 target of halving their number compared to the baseline year of 2010. A reduction rate of 14% would be necessary every year from now on to reach the targeted figures. Nevertheless, the aspirational target remains an important political tool and a powerful driver to achieve better results.

EU FATALITIES AND TARGETS (2010-2020)



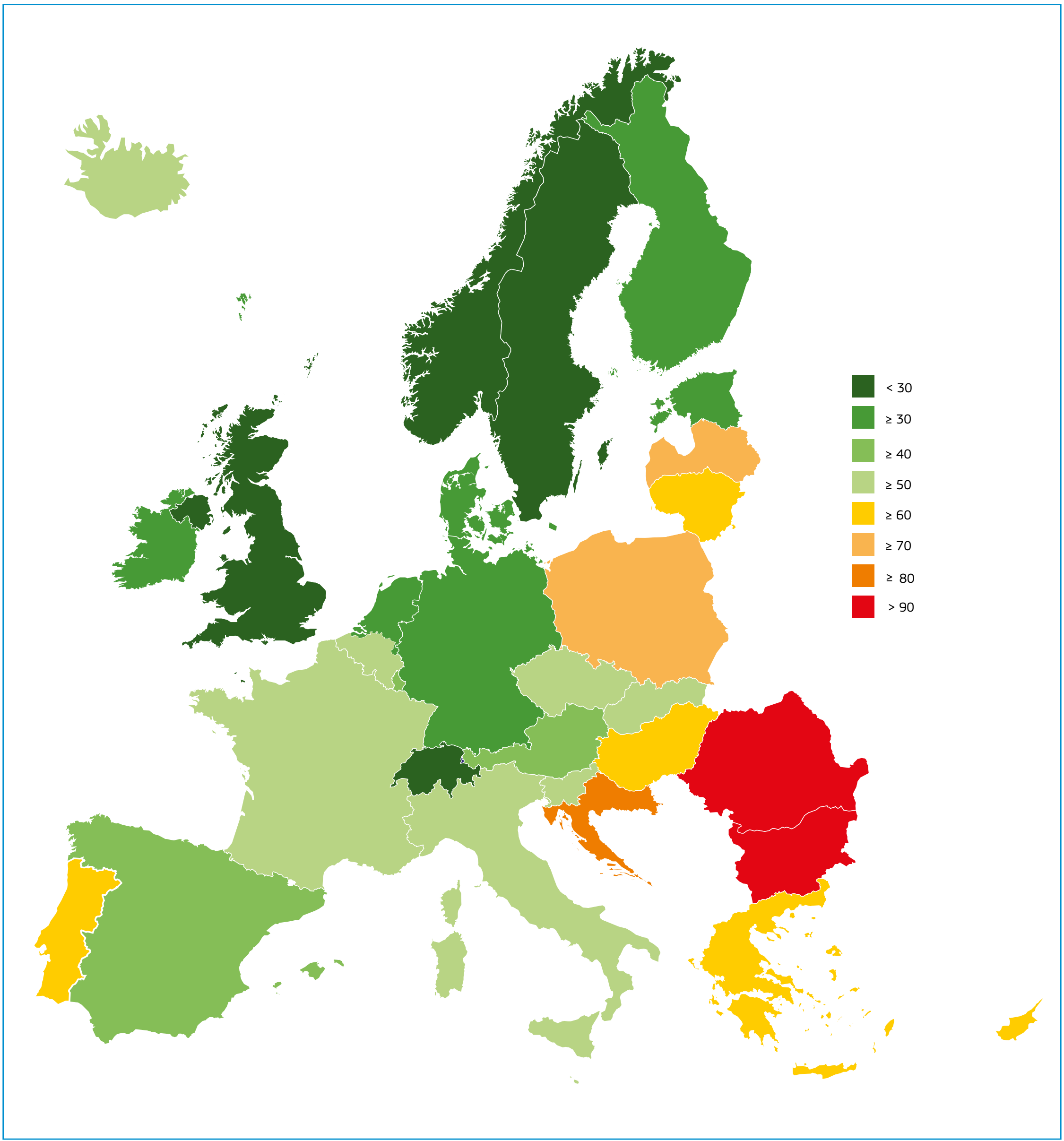
The road safety situation differs widely between Member States. Some of them report substantial progress, while others are still performing significantly below the EU average. However, the gap between the worst- and the best-performing EU Member States has been narrowing year after year. In 2017, none of the Member States registered a fatality rate higher than 100 deaths per million inhabitants, and eight of them recorded a fatality rate lower than 40 deaths per million inhabitants.

In 2017, the EU's best road-safety performers were Sweden (25), the UK (27), the Netherlands (31), Denmark (32), Estonia (36) and Ireland (33). On the other hand, the highest fatality rates were registered in Romania (98) and Bulgaria (96), followed by Croatia (80). From the beginning of the decade, the highest drops in the number of road deaths were recorded in Greece (-41 %), Estonia (-39 %), Latvia (-38 %) and Lithuania (-36 %). The EU average decrease was 20 %.

In 2017, on average only about 8 % of road fatalities occurred on motorways; 37 % happened in urban areas and 55 % on rural roads.

Car occupants accounted for the largest share of victims (46 %). Together, vulnerable road users, including pedestrians, cyclists and motorcyclists accounted for the same proportion and were particularly exposed in urban areas. 21 % of all

ROAD FATALITY RATES 2017



people killed on roads were pedestrians. Cyclists accounted for 8 % of all road deaths in the EU. Motorcyclists, who are less protected during a crash, accounted for 14 % of road fatalities. In general, fatalities among vulnerable road users have fallen to a much lesser degree in recent decades than among all road users.

In 2017, almost 14 % of people killed on EU roads were aged between 18 and 24, although only 8 % of the population fell within this age group. Young people are almost twice as likely to be killed in a road crash than the average person. Men were still largely over-represented among young victims: 80 % of the young people who died in road crashes were men. This can be explained by different risk-taking behaviour and by the fact that young men statistically tend to take longer trips than young women.

Although older drivers are involved in fewer road crashes, elderly people in general are one of the highest risk groups, due to their fragility and reduced tolerance to injury. Even if the number of elderly road victims has decreased over time, the total number of road deaths has fallen faster, meaning that the proportion of elderly victims tended to rise. While 18 % of road fatalities concerned elderly people in 2010, this ratio reached 26 % in 2017. Compared to the average population, the risk of being killed on the roads is almost one and a half times higher for an elderly road user.

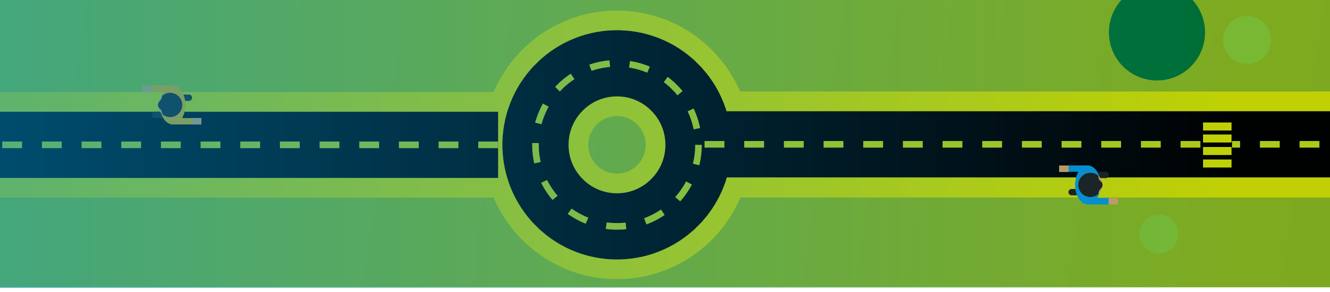
In general, far more men than women are killed in road crashes: less than one quarter, 24 % of all fatalities, concern women, against 76 % of male fatalities. The fatality rate of elderly men is over twice the rate of elderly women in most EU countries. Male and female road fatalities also differ by type of road user. Among pedestrians, road fatalities affected almost twice as many women than men.

ROAD FATALITIES IN THE EU BY TYPE OF ROADS (2017)

8 % Motorway

37 % Urban areas

55 % Rural roads



SERIOUS ROAD TRAFFIC INJURIES

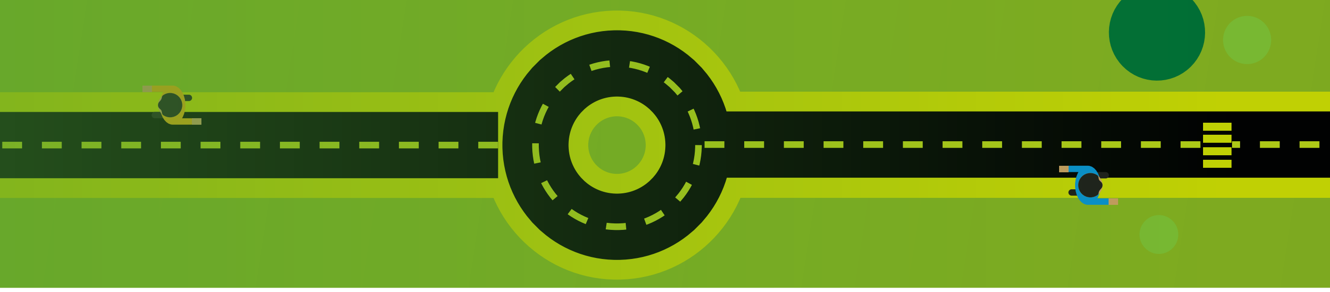
According to the European Commission's estimates, about 135 000 people sustain serious road traffic injuries on EU roads per year. This means that for every person killed in traffic crashes, five more suffer serious injuries. Serious injuries are not only more common but also often more costly to society because of long-time rehabilitation and healthcare needs.

As from 2015, Member States started to report data on serious injuries based on a new, commonly agreed definition following medical standards. The international MAIS trauma scale (Maximum Abbreviated Injury Score) has been chosen for the EU definition of serious road traffic injuries. The Scale 3 and more (MAIS3+) applies to the seriously injured.This was a milestone in the work addressing serious road traffic injuries.

With the adoption of the 'Valletta Declaration on Road Safety' in 2017, EU transport ministers made a major step forward with far-reaching joint commitments. Among others, EU Member States agreed to introduce a 50% reduction target for serious road traffic injuries in the period 2020-2030. The Commission will continue to monitor and benchmark Member States' performance. Member States are encouraged to prioritise actions for the safety of vulnerable road users and safety in urban areas.

2. Monthly variation in road fatalities

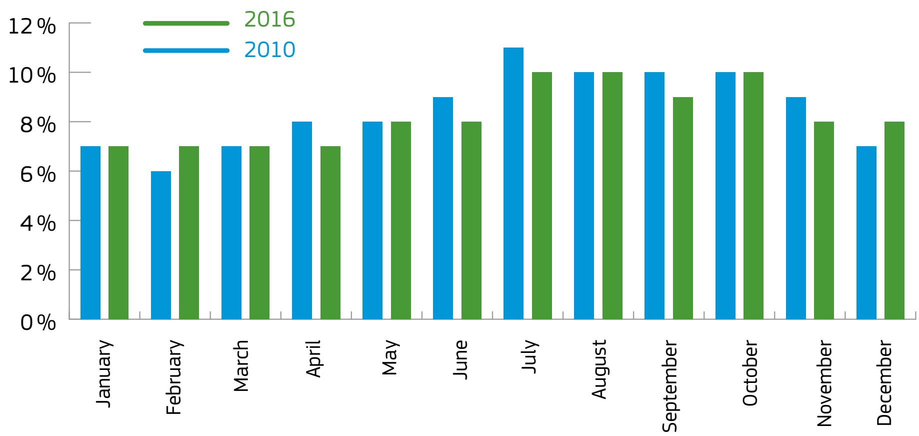
- Every year, the least number of road deaths are recorded in February, whilst most fatal accidents happen in July and August.
- The contribution of road fatalities by month varies however from country to country.
- Accident risk also varies seasonally with changing weather conditions.
- Variations throughout the year in the hours of daylight are likely to contribute to seasonal differences too.



The number of fatal road crashes shows a certain monthly variation in the EU. The seasonality or seasonal variations in road fatalities follows a very similar pattern year after year. Although the number of people who die in road accidents in Europe per year has fallen over many years, the monthly distribution of road fatalities has scarcely changed.

Generally speaking, the least number of road fatalities are recorded in February, whilst the most fatal accidents happen during summer holidays, in July and August. Without seasonality, 8.3 % of fatalities would occur every month. Compared to this 'no seasonality' average, there are relatively few fatalities per month from January to April and relatively many more from June to October and in December.

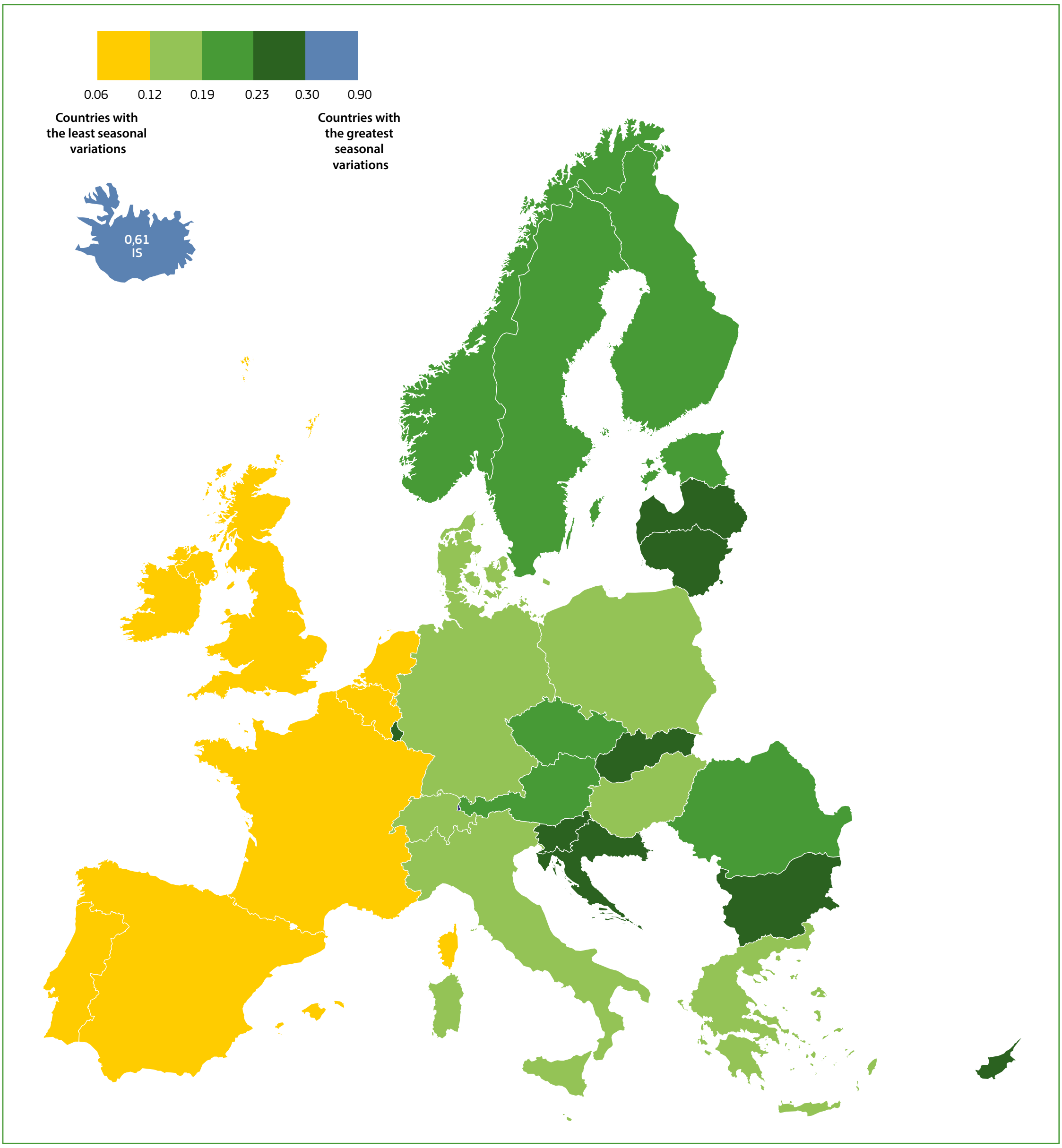
% OF FATALITIES BY MONTH



The seasonal variation of road fatalities is the result of several factors. The main cause is probably the change in travel patterns throughout the year. For example, many more trips are made for leisure and recreation during summer than winter.

The monthly variation in road fatalities differs considerably from one country to another. Seasonal variations are below average in most of the Western EU countries, and above average in most Central and Northern EU countries.

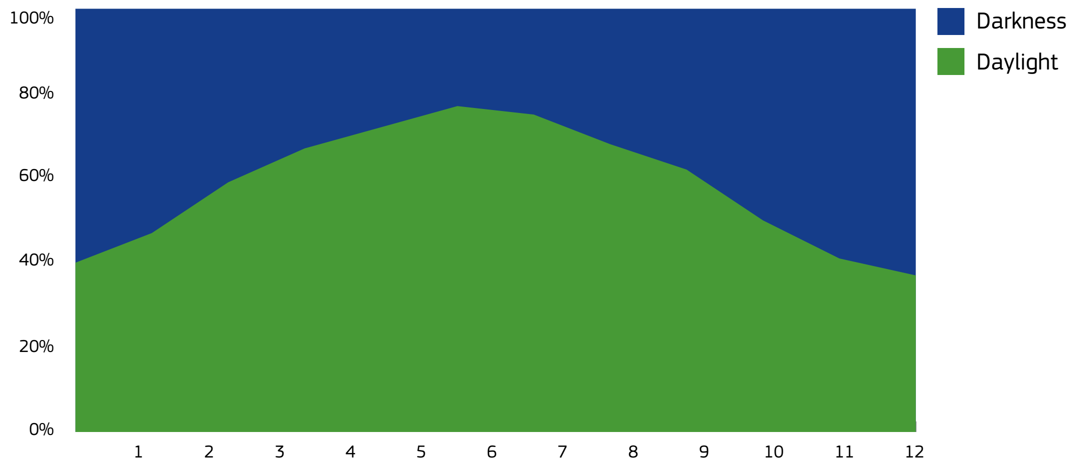
SEASONAL VARIATIONS IN ROAD FATALITIES



Accident risk also varies seasonally with changing weather conditions. The relative harshness of winters in Northern and Central Europe is likely to contribute to the greater seasonality for several countries in these areas.

Variations throughout the year in the hours of daylight are also likely to contribute to seasonality, as this affects people's mobility patterns, which also vary across Europe. In the EU Member States, over the whole year, 64 % of fatalities occurred in daylight (including twilight), but the percentage was below 50 % between November and January.

% OF FATALITIES BY MONTH AND LIGHT



Source: CARE database, data available in April 2018.

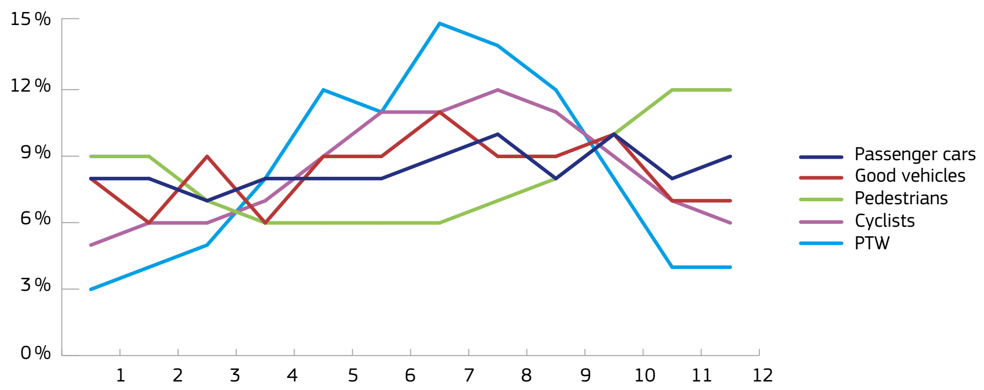
3. Seasonality by modes of transport and type of roads

- The monthly distribution of road fatalities varies by modes of transport and type of road.
- The number of pedestrian deaths is highest in the winter, while the number of fatal accidents among motorcyclists is highest in June.
- Motorcycling is the mode of transport with the most seasonal fatality variations.
- There is less seasonal variation on urban roads than on rural roads and motorways.

The seasonal variation in road fatalities also depends on the mode of transport. The seasonality for certain user groups clearly differs from the overall pattern. This is particularly true for vulnerable road users (VRU), such as riders of motorcycles and mopeds (powered two-wheelers), cyclists and pedestrians. For example, more riders of powered two-wheelers (PTW) are killed in summer, and fewer in winter, as a result of there being more users in this group on the roads when the weather is better.

Deviations from the average are similar for cyclists, although to a lesser degree. Their travel habits are certainly affected by weather conditions but less so than PTW riders.

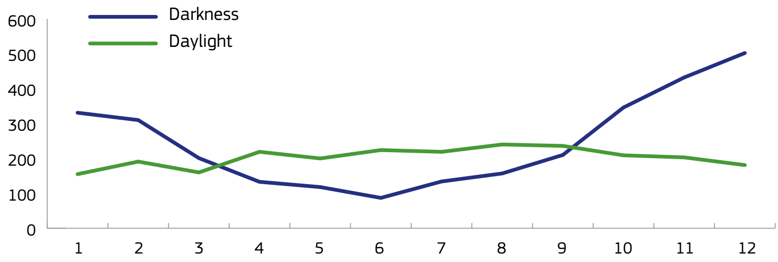
% OF ROAD FATALITIES BY MONTH



However, there is a category of vulnerable road users for which the monthly distribution of road deaths shows a very different pattern over the year. Most pedestrians are killed in winter, and especially in December, while there are relatively few road fatalities among them in summer.

The reason for the increase in pedestrian fatalities from 6 % of the annual total in April to 13 % in December is probably due to hours of daylight and darkness. The number of pedestrian fatalities in December is almost twice that in June.

PEDESTRIAN FATALITIES



The seasonality of road fatalities also differs by geographical area. In Spain, for example, the proportion of road fatalities shows relatively little change by month, except for cyclists. By contrast, the proportions in the Nordic countries vary considerably by month, especially for pedestrians and motorcyclists. This phenomenon is mostly due to greater changes in weather conditions and hours of daylight in the Northern countries.

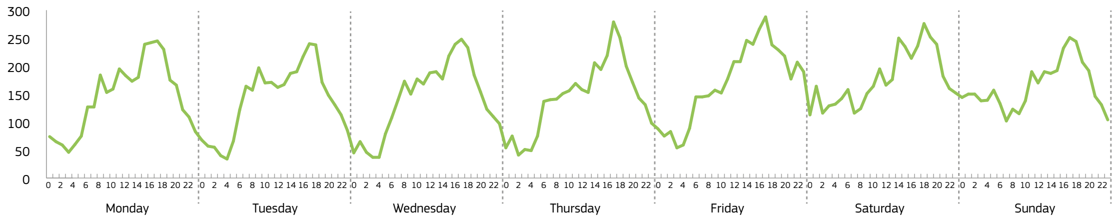
The monthly variation in fatal crashes can also be examined by types of road: motorways, rural roads and urban roads. Even if there are no drastic differences, in general, seasonality is in general is lower on urban roads than on rural roads and motorways. This is probably because changes in the hours of daylight and weather conditions have less impact in towns and cities.

4. Day of the week and time of the day

- The distribution of road deaths also varies according to the day of the week and the hour of the day.
- The daily variation in road fatalities is greater on Sundays than on any other day of the week.
- The distribution of road deaths by time of the day is similar from Monday to Thursday.
- Most fatalities happen in the afternoon and relatively few during the night.
- However, there is a peak in fatalities early on Saturday and Sunday mornings.

The distribution of road fatalities also varies by day of the week and time of the day. There are 168 hours in a week so, on average, 0.6 % of fatalities would occur each hour throughout the week, if equally distributed..

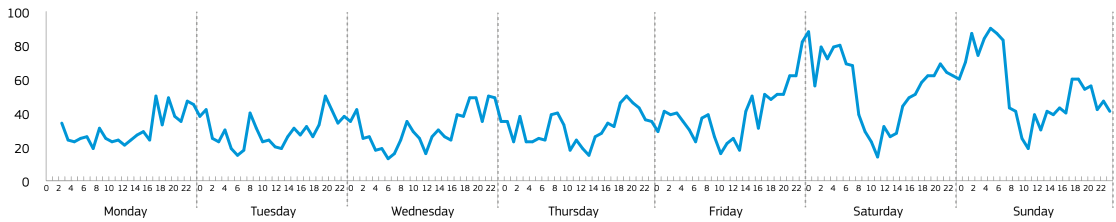
FATALITIES BY DAY OF THE WEEK AND HOUR OF THE DAY



The distribution of road deaths by time of the day is similar from Monday to Thursday. There is an afternoon peak every day and relatively few fatalities during the night. This is in line with changing traffic volumes. A high number of fatalities early on Saturday and Sunday mornings is also notable.

The peak during weekends is particularly pronounced for the age group between 15 and 30, reflecting the social habits of youngsters, and especially young drivers.

FATALITIES OF YOUNG PEOPLE (15-30) BY DAY OF THE WEEK AND HOUR OF THE DAY



On a daily basis, seasonality is quite similar throughout the year. The main difference concerns Sundays: there are relatively many fatalities on Sundays between June and September, and relatively few between November and February. This can be explained by an increased activity among road users during the summer holidays and a change in the choice of mode of transport, with a preference for riding and cycling.

Comparing different periods of the day, the greatest seasonal variations in the number of road deaths are recorded during the night, between 10pm and 4am. There is a clear peak during the night period in August, reflecting greater mobility during the longer days of the summer holidays.

The variation in road fatalities by time of the day is also affected by geographical factors. The number of fatalities in Spain show a limited variation by month, while much bigger differences can be observed in the EU's Nordic countries. This is certainly due to more significant differences in hours of daylight and weather conditions in the Northern part of Europe over the year.

EXAMPLES OF MEASURES REDUCING ROAD-SAFETY RISKS LINKED TO SEASONALITY

EDUCATION

- Raising awareness on road-safety risks in difficult weather conditions;
- Increasing hazard perception in driver training and developing skills to drive in difficult weather conditions;
- Launching targeted communication campaigns for young drivers and passengers travelling in the evening, at night and during the weekend;
- Promoting the use of reflective material by pedestrians, cyclists and motorcyclists.

VEHICLES

- Making daytime running lights compulsory to improve visibility and increase distance and speed perception;
- Promoting the use of winter tyres for adverse weather conditions.

ENFORCEMENT

- Enforcing speed limits adapted to specific weather conditions;
- Enforcing rules on the use of protective equipment for vulnerable road users;
- Intensifying controls for drivers who infringe rules at pedestrian crossings and for pedestrians in breach of traffic regulations.

INFRASTRUCTURE

- Adapting speed limits to weather conditions, i.e introducing winter speed limits;
- Providing safe areas for pedestrian mobility (low-speed zones in residential areas, safe zebra crossings, etc.).

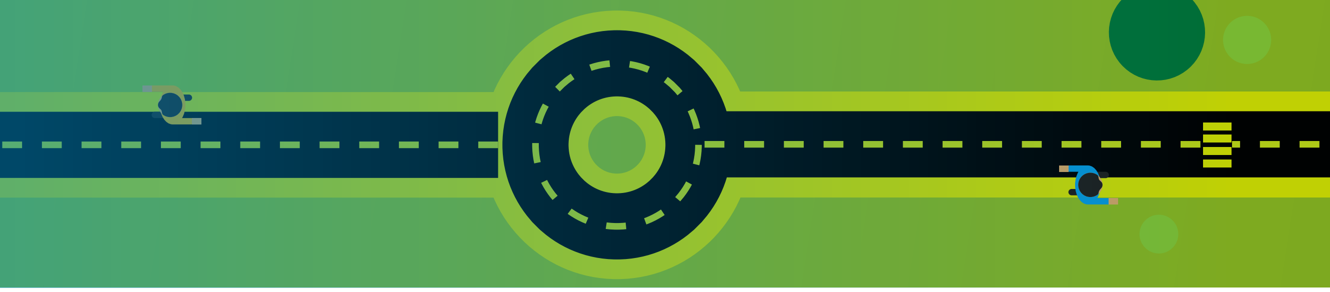
Conclusions

The European Union's progress in making its roads safer has been impressive. The EU cut the number of fatal road crashes by 43 % between 2000 and 2010, and reduced them further by 20 % from 2011 to 2017. The results are tangible: today, the EU is the world's safest region with 49 deaths per million inhabitants.

However, progress has stalled recently, and has been unequally distributed between different groups of road users. Fatalities among pedestrians, cyclists, motorcyclists and moped riders have not decreased at the same pace as in the overall population. Therefore, these vulnerable groups of road users deserve special attention from policymakers.

Road-safety risks linked to changes in weather conditions as well as risks involved in different mobility patterns depending on the day of the week or the time of day are affecting pedestrians, cyclists and motorcyclists, but also novice drivers much more than other road users. Data on seasonal variations in road fatalities can thus be very useful to fine-tune measures that aim to increase the safety of vulnerable road users. Such measures may encompass a wide range of actions, from education and awareness-raising to infrastructure design and minimum vehicle safety standards through better enforcement of traffic rules.

Today, when fresh efforts are needed to further improve the EU's road-safety records, any progress achieved in the safety of vulnerable road users will have a significant impact. However, this remains a common challenge where decision-makers, road managers and road users share the responsibility of creating a safe mobility system.



For more information about the European Commission

and road safety, visit our website:

http://ec.europa.eu/roadsafety

MI-AC-18-001-EN-C

Publications Office

ISBN: 978-92-79-80284-3
ISSN: 2363-4375
doi:10.2832/169706

GOVERNMENT STATUS REPORT, 2019
FEDERAL REPUBLIC OF GERMANY

Stefan Strick, President of Federal Highway Research Institute (BASt)
Germany

26th ESV-Conference

Eindhoven, Netherlands, June 10-13, 2019

1. STATUS AND TRENDS

1.1. Road accidents in Germany

The total number of police registered road accidents has increased by 12 per cent since 2000 – from 2.4 to 2.6 million road accidents in 2017. In the beginning of the century slight increases were offset by slight decreases, resulting in almost the same accident figures in 2011 as in 2000. Since then the number of accidents has started to increase slightly year by year, with yearly increases between 0 and 5 percent. The forecast for 2018 also indicates a further increase in accident figures by about 1 percent.

The number of road accidents with personal injury has decreased by more than 20 % since 2000, resulting in 302,656 road accidents with personal injury in 2017. The decrease has mainly been realized from 2000 to 2009 (- 19 percent). Since then, no further substantial decrease has been noted, the figures have stagnated around 300,000 injury accidents. A slight increase is expected for 2018.

Casualty figures have also decreased since 2000, with lower reductions for slight injuries and higher reductions for severe injuries and fatalities. The total number of casualties has decreased by approximately 23 percent from 511,577 in 2000 to 393,492 in 2017. The stagnating number of injury accidents in the last years is mirrored in the stagnating number of casualties. In 2018 an increase to about 400,000 casualties is expected.

Since 2000, the number of serious injuries has been reduced by about 35 percent to 66,513 seriously injured road users in 2017 and the number of slight injuries has been reduced by more than 19 percent to 323,799 slightly injured road users. Both injury severity groups follow the same pattern: Most of the decrease has been realized until 2009/2010. In the years after, no decrease was noted for slight and serious injuries.

Fatalities have decreased by almost 58 percent from 7,503 fatalities in 2000 to 3,180 fatalities in 2017. Although a deceleration of the decrease can be noticed since 2010 fatality figures are still slowly regressing. For 2018 an increase to approximately 3,230 fatalities has been predicted. This might be the first year with an increase following two consecutive years with decreasing fatality figures.

While many factors concerning e.g. safety behavior or vehicle and infrastructure safety play an important role for the long term development of fatality and crash figures, short-term increases result mainly from changes in mobility and traffic behavior due to different and extreme weather conditions. The year 2018 was characterized by very dry and sunny weather from spring to late autumn, very likely entailing an increase in traffic of certain modes of transport associated with this kind of weather. As a result fatality figures increased especially for cyclists and riders of mopeds. Increases are also expected for children and the elderly.

1.2. Socio-economic costs due to road traffic accidents in Germany

The Federal Highway Research Institute (BASt) calculates the costs of traffic accidents on an annual basis. The costs burden of German national economy caused by traffic accidents includes costs of fatalities, injuries and damage to goods.

The socio-economic accident costs include direct costs (e.g. medical treatment, vehicle repair/replacement), indirect costs (police services, legal system, insurance administration, replacement of employees), lost potential output (including the shadow economy), lost added value of housework and voluntary work, humanitarian costs and costs of monetised travel time losses due to traffic jams caused by accidents. The mathematical model developed for the purpose of accident costs assessment enables an analysis of slight, severe and severest injuries and the effect of underreporting on total accident costs.

The total traffic accident costs amounted in 2017 to approximately 34.23 billion Euro. The costs of fatalities and injuries reached 13.19 billion Euro whereas the costs of about 21.04 billion Euro were caused by damage to goods. Comparing 2017 data with accident costs occurred 2015 (previous reporting year) we observe an 8% decrease of fatalities costs and injuries costs. However, the increase of damage to goods by 4.5% equalized the above positive effect and the total amount of accident costs was 2017 only 0.5% lower than that of 2015.

The costs per person added up to 1.150 million Euro for a fatality, 116,335 Euro for a severely injured person and 5,138 Euro for a slightly injured person.

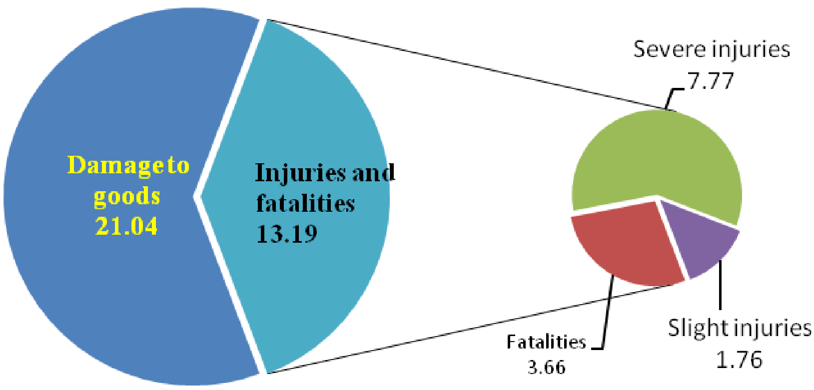


Figure 1: Costs due to road traffic accidents in 2017 (billion Euro)

1.3. German Road Safety Programme

The present German Road Safety Program was launched in autumn 2011 and will be running for ten years until 2020. The principal aim of the program is to enable safe, ecologically sensitive and sustainable mobility for all road users in Germany. It comprises a wide range of road safety measures addressing road users, vehicles and the road infrastructure.

The program addresses new challenges (e.g. demographic change and mobility of elderly) and aims at safeguarding the efficiency of the road network. At the same time, it reflects recent technological developments in vehicles such as driver assistance systems, cooperative vehicle systems or new engine concepts. In these latter areas, the main focus lies on ensuring that the development of vehicle technology induces safety gains rather than safety risks. Activities also focus on rural roads and on reducing not only the number of fatalities, but also the number of serious injuries. Work is currently underway to develop the following German Road Safety Programme.

2. RESEARCH

2.1. Finished projects

2.1.1. Turning Assist Systems for Trucks

Accidents between right turning trucks and straight riding cyclists often show massive consequences. Accident severity is much higher than in other accidents. The situation is critical especially due to the fact that, in spite of the mirrors that are mandatory for ensuring the field of view for the truck drivers, cyclists in some situations cannot be seen or are not seen by the driver. Either the cyclist is overlooked or is in a blind spot area that results from the turning manoeuvre of the truck and its articulation if it is a truck trailer or truck semitrailer combination.

Assistance systems that provide the driver with an information way before a situation becomes control are considered to be a solution. Such systems would generally bear a high potential to avoid accidents of right turning trucks and cyclists no matter if they ride on the road or on a parallel bicycle path.

BASt therefore carried out a research project in order to develop a testing method and elaborate requirements for turning assist systems for trucks. In-depth accident data was evaluated. These findings served to determine characteristic parameters (e.g. boundary conditions, trajectories of truck and cyclist, speeds during the critical situation, impact points). Based on these parameters and technical feasibility by current sensor and actuator technology, representative test scenarios and pass/fail-criteria were defined. This work has led to activities on UN ECE level, namely a working document was submitted to GRSG early 2017, which was send to an informal group for further optimization. Finally, the 115th GRSG in October 2018 adopted a proposal for a new regulation for blind spot information systems for heavy vehicles and sent it to WP.29 for further consideration in its March 2019 meeting.

2.1.2. Handbook „Accessibility in long-distance bus transport“

Accessible travel is becoming increasingly important, considering demographic change and the increasing demand for mobility by older passengers and those with restricted mobility. Since the liberalisation of bus transport in Germany, travel on long-distance buses has increased greatly. A new regulation (the passenger transport law, PBefG) came into effect on 1 January 2013. Under an agreement in the coalition contract for the 18th legislature period, the production of a handbook “Accessibility in long-distance bus transport” was foreseen, including an accessible electronic version. The intention was to prepare the handbook as an easily understandable, succinct brochure with examples of best practice for the implementation of accessibility in practice by stakeholders. The handbook thus not only covers the accessibility measures for vehicles but is also applicable to infrastructure and operation.

The research project had the objective of describing extensive accessibility for all user groups, with not just the interests of wheelchair users and people with reduced mobility being considered but also passengers with sensory, cognitive and movement limitations as well as the elderly and families with children.

The handbook was produced with significant involvement of the decisive stakeholders and shows good examples of accessibility in long-distance bus transport. It offers a guideline for the various users, vehicles manufacturers, transport provides, councils, operators of bus stations and representatives of people with disabilities in order to implement accessibility in long-distance bus transport. For this purpose the viewpoint comprised vehicles, infrastructure and operation. Only the cooperation of all three areas will enable a continuously accessible travel chain in long-distance bus transport.

The handbook "Accessibility in long-distance bus transport" was published in a printed version by the Federal Ministry of Transport and Digital Infrastructure (BMVI) as a seperate publication. The handbook was also made available in an accessible version (PDF) so that the content is available for people who are blind or poorly sighted.

2.1.3. EU project PROSPECT

BASt participated in the EU-funded Horizon 2020 project „PROSPECT“ (PROactive Safety for PEdestrians and CyclisTs). The goal of this project was to increase the overall traffic safety for pedestrians and cyclists by generating a better understanding of relevant critical scenarios and the advancement of active vehicle safety systems, such as autonomous emergency braking and evasive steering applications. On the basis of a detailed analysis of accident data from various countries, the focus for the development of prototype functions and test protocols was set to urban intersection scenarios, which are the most relevant for occurring severe injuries of vulnerable road users (VRU). The developed prototypes within this project feature innovative methods for robust and early VRU detection of pedestrians and bicyclists. The control systems use an increased radial sensor range and high performance actuators to find the optimal combination of quick steering and braking interventions. Advanced sensor interpretation systems allow to better judge the intention of pedestrians and cyclists along the vehicle path with respect to their direction of movement. For the evaluation of these prototypes, new realistic trajectories for cornering maneuvers had to be specified on the test track. Finally, the user acceptance was proved in several simulator studies to verify the high socio-economic benefit of improved future active safety systems. The derived test procedure will expand towards European consumer testing in the next years to achieve a high market penetration as soon as possible.

2.1.4. Intersection assistance (Euro NCAP)

Automatic Emergency Braking (AEB) systems increasingly offer the possibility to address even complex conflict situations, such as found in intersection traffic. Against this background, the development of novel test scenarios with regard to the requirements of consumer information and legislative procedures is of interest. Euro NCAP plans to introduce the assessment of car-to-car junction assist systems from 2020 on. One objective of a project concerning intersections is to provide substantial information on car-to-car accidents in Europe. The Use Cases identified in this context serve as a basis for the definition of representative test scenarios. Based on the official German Road Accident Statistics (Destatis), most relevant accident scenarios were derived by grouping and weighting certain accident types. Subsequently, an investigation of associated crash parameters obtained by the German In-Depth Accident Study (GIDAS) took place, which finally led to the Use Cases. Severe accidents at intersections in Europe occur most frequently at “crossings” and “t- or staggered junctions”. Although pedestrians, cyclists and motorcyclists play a dominant role within these accidents, car-to-car accidents still amount to a share of one-fifth of all severe accidents and of one-quarter of all related fatalities. The Accident Scenarios Straight Crossing Paths (SCP), Left Turn Across Path with an opponent coming from the Opposite Direction (LTAP/OD) and Left Turn Across Path with an opponent coming from the Lateral Direction (LTAP/LD) are of highest relevance. For each of these scenarios, up to six crash parameters (e. g. speed profile, turning radius, collision angle, impact point) could be evaluated. The derived test procedure can expanded towards European consumer testing in the next years to achieve a high market penetration as soon as possible.

2.1.5. Personal Light Electric Vehicles (PLEV)

The aim of this project was to determine whether and under which conditions very small electric vehicles so called Personal Light Electric Vehicles (PLEV) can be operated safely in road traffic, which technical requirements need to be satisfied and which potential conflicts with other road users are to be expected. PLEV are those vehicles without a seat such as electric kick scooters and self-balancing vehicles (e.g. similar to the Segway). They could be approved up to 2016 in accordance with the Framework Directive 2002/24/EC (Type-approval of two or three-wheel motor vehicles / category L vehicles), which is no longer in force. The new Type Approval Regulation (EU) No. 168/2013 for two or threewheel vehicles and quadricycles has been in force since 2016. However, PLEV of this type are out of the scope of this regulation. Instead the approval can be regulated at a national level. An assessment of the traffic safety of such vehicles is required on the one hand to be able to decide on whether they can be approved. On the other hand vehicle dynamics tests are needed to provide information for the classification of these vehicles and to stipulate respective requirements. In this research project, the Federal Highway Research Institute (BASt) prepared suggestions for a classification of this type of specific small electric vehicles and for the technical requirements to be placed on them so that they may be used safely in road traffic. PLEV were investigated in four sub-studies: considerations with regard to active and passive safety, user behaviour and risk assessment as well as traffic area. It emerged that it is possible to propose new categories of PLEV with certain minimum requirements. It is recommended that PLEV should comply with these requirements to be allowed to be driven in traffic. Depending on the proposed vehicle categories, corresponding traffic areas are recommended for use, based on the analysis of subjective safety and of the potential conflicts with other road users. Recommendations were also derived for (safety-related) technical equipment for the newly proposed PLEV categories. The requirements are based on those for the existing vehicle categories "light moped" and "moped".

2.1.6. Automatic Emergency Braking for Heavy Goods Vehicles

Automatic braking systems for heavy goods vehicles are mandatory across the European Union. While the requirements for pre-accident speed reduction on a moving target with 68 km/h reduction from 80 km/h are quite demanding, the required speed reduction towards a stationary target is not so strict (13 or 28 km/h from 80 km/h, depending on truck type). One major vulnerability of the current technical requirements in the AEBS regulation (UN-Regulation No. 131) is the possibility for drivers to switch the systems off (required for rare conditions where the AEBS sensors cannot interpret the environment and thus might act inappropriately) without requiring a mechanism to re-activate the AEBS at a time when the need to switch off has disappeared. The other aspect that could be optimized is that vehicle deceleration is limited during the mandatory warning phase.

BASt was carrying out a research project to investigate how an automatic re-engagement of those systems could be handled and if an adaption of the speed reduction requirements to the current state of the art might be appropriate. The findings have been delivered to the German Ministry of Transport, which then have been incorporated into a proposal to modify UN-Regulation No. 131 in the following aspects:

- Collisions between heavy vehicles and stationary targets should be avoided up to driving speeds of 70 km/h; the brake strategy should not drastically change for higher driving speeds.
- Driver warnings should not be mandatory anymore in favor of automatic brake intervention for low relative speeds.
- It should not be possible anymore to deactivate AEBS systems at driving speeds above 30 km/h, and systems should automatically reactivate.

Germany's modification proposal is currently in discussion between interested contracting parties and the Industry; delivery of a consensus proposal is aimed for by autumn 2019.

2.1.7. KO-HAF

From 2015 to the end of 2018, a research project concerning cooperative, Level 3 driving (Ko-HAF) was performed. BASt joined a national consortium with automobile and electronics manufacturers, suppliers, communication technology and software companies, research institutes and road administration. The project aimed at the development of cooperative, Level 3 driving on motorways, i.e. for high speed ranges on well constructed road infrastructure. This included a significant improvement of forecasts for environmental detection in addition to the automation of the longitudinal and lateral control of vehicles. Key activities of BASt – in an academic part – was the definition and specification of relevant data on traffic and road conditions to be stored in the backend, the evaluation of usability of external data for the use cases of Level 3 driving, the design of data exchange with third parties and the evaluation of data protection issues. Based on this, BASt supported the development of highly accurate maps acting as an expanded forecast for automated driving. Furthermore, the driver cannot be taken entirely out of the loop during Level 3-driving. Therefore, the resumption of the driving task by the human driver within a certain lead time was also subject to research in Ko-HAF. Several test vehicles were constructed for testing and demonstration of highly automated driving under normal conditions and in case of system failure. The new vehicle operation took place on test tracks and on public roads.

In a practical part, BASt conducted a first driving test to classify the effect of driver’s vigilance and fatigue in a Level 2 drive when permanent monitoring of an automated driving function is necessary over long time intervals. Participants were driven in a 'Wizard of Oz' vehicle, meanwhile fatigue measurements were performed by using psycho-physiological data, e.g. EEG (electroencephalography) as well as behavioral data. The experiment also focused on the influence of small automation failures regarding driver’s vigilance. Typical fatigue patterns influenced by automation failures emerging in fatigue oscillations with strong individual differences were found. In a second step, the effectiveness of possible countermeasures was investigated. At this the driver was free from monitoring and should perform motivating so called “driving unrelated tasks” like texting on a smartphone or reading a book. In contrast to Level 2 driving, the Level 3 automated period showed a significant decrease in fatigue level.

2.1.8. AFAS

The project "aFAS" ("Driverless Safeguarding Vehicle for Highway Shoulder Roadworks"), was funded by the Federal Ministry of Economic Affairs and Energy. The project focussed on the goal to actually operate a safeguarding vehicle under traffic in driverless mode. As far as known, this was the very first driverless operation of a vehicle in Germany, under traffic and without a safety driver on board. The demonstration was shown alongside the final project event in Frankfurt on the 20th June 2018. The Demonstration took place on the German Motorway "A3" near Frankfurt and under heavy (real) traffic conditions. A video of the driverless demonstration can be accessed under https://youtu.be/8BUWjRs3n_w

Figure 2: MAN Truck & Bus AG, Driverless demonstration of the safeguarding vehicle following on the German Motorway, aFAS press-release, 20th June 2018

The overall focus of the project was on the reduction of risks for workers driving safeguarding vehicles today. During operation the maximum speed of the vehicle was limited to 10 kph (~6 mph) which is the average speed required for roadworks by the vehicle in front (for cleaning, grass cuttings etc.). The safeguarding vehicle is intended to be driven manually up to the place of work where the automation is activated so that no driver is needed within the domain (SAE J3016 Standard version 06/2018; Level 4: driverless within a specific operational design domain, without any expectation that a user will respond to a request to intervene.). The safeguarding vehicle was connected via Wifi to the leading vehicle and relied on a sensor system for safety.

The development of the safety concept required for the driverless application under traffic was the most challenging part. It needed to be ensured that the automated, driverless vehicle would by no means leave the hard shoulder and head into the traffic passing by (being the most critical scenario) to be examined closely. This key aspect was implemented by means of a reliable sensor system able to detect the road marking and activating an immediate emergency stop in this specific case (as minimal risk or safe state on the hard shoulder). This was technically implemented by designing an independent second "safety-path" completely separated from the vehicle control system. Within safety-design the standard ISO 26262 was considered as guideline and reference for the safety-relevant design. BASt was involved in the identification of the legal aspects of driverless implementation and legal inconsistencies in the application of the ISO-Standard 26262 against the background of Road Traffic Regulations and liability.

2.1.9. SENIORS

The efforts put the last years in road safety derived to a reduction of almost 48% of total fatalities in Europe, and the number of elderly fatalities due to road accidents has also decreased. However, among all the road fatalities, the proportion of elderly is steadily increasing. Considering these statistics and the expected demographic change in our society, the SENIORS project (Safety ENhanced Innovations for Older Road users) funded by the European Commission (GA No. 636136) and coordinated by BASt aimed at providing the needed knowledge and enabling the suitable tools to reduce the number of elderly fatalities and serious injuries suffered in road traffic accidents. The project runtime was from June 2015 to May 2018 (www.seniors-project.eu).

This project primarily investigated and assessed the injury reduction in road traffic crashes that can be achieved through innovative and suitable tools, test and assessment procedures, as well as safety systems in the area of passive vehicle safety. The goal was to reduce the numbers of fatally and seriously injured older road users for both major groups car occupants and external road users (pedestrians, cyclists) by enhancing the introduction of advanced safety systems through the implementation of assessment tools for elderly protection based on PMHS studies, volunteer testing and accident data. The research covered topics such as crash, hospital and behavioural data analysis, biomechanics, the development of test tools, procedures, and assessments. Further, to gain required data, tests with volunteers and with post-mortem human subjects are carried out, sled and impactor tests were conducted and numerical human body model simulations were performed. BASt was deeply involved in nearly all of these technical activities.

Accident data analysis showed that elderly car occupants have a higher risk of injury than younger occupants in particular in the thorax area even in accidents at lower velocities of 30 to 40 kilometers per hour. This issue was addressed within the SENIORS project by various approaches. Improved chest injury criteria for the frontal impact dummy THOR were developed. A new simulation-based approach making use of comparative computer simulations of a human model and a THOR dummy model were applied. The injury criteria for the dummy were thus optimized in the area relevant for older road users. SENIORS proposed the introduction of advanced chest injury criteria and a reduced-impact frontal impact test in new frontal impact test and assessment procedures. Sled tests have shown that these proposals can demonstrate benefits of advanced occupant restraint systems - such as adaptive systems and four-point harnesses - and thus provide improved protection in particular for older occupants.

Based on current injury patterns of pedestrians and cyclists, the vulnerable road user (VRU) safety branch of SENIORS, mainly driven by BASt, proposed modifications to the state-of-the-art pedestrian test and assessment procedures described in legislation and consumer programmes. Human body model (HBM) simulations with MAthematical DYnamic MOdels (MADYMO), replicating the most relevant motor vehicle to cyclist accident scenarios concluded in an extension of the pedestrian head impact zone and modified test parameters towards a combined VRU test procedure. FE simulations with the Total HUman body Model for Safety (THUMS) were used as input for test parameters within the scope of new test and assessment procedures, where a prototyped thorax injury prediction tool (TIPT) was tested against vehicle frontends for the first time. An upper body mass (UBM), representing the pedestrian’s torso was applied to the lower legform impactor FlexPLI, improving its injury assessment ability particularly in the femur area and its applicability for high vehicle frontends and against angled surfaces, combing the upper legform to WAD775 and the upper (or lower) legform to bumper test within one single test.

2.1.10. Adoption of UN-GTR9-PH2

With its last meeting in December 2017, the United Nations Informal Working Group on the development of Phase 2 of the Global Technical Regulation on Pedestrian Safety (GTR9-PH2), chaired by Germany, concluded its work related to the introduction of the flexible pedestrian legform impactor (FlexPLI) alongside the definition of injury assessment reference values (IARVs) and the extension of the vehicle bumper test area (BTA); however the modified headform test could not be included. GRSP endorsed the proposal in May 2018 and AC.3 considered and voted for the Amendment 2 to UN-GTR9 during its November 2018 session.

2.1.11. CODECS

Communication of vehicles directly amongst each other and with road infrastructure enables a plethora of information and warning services for a safe, sustainable and comfortable future mobility. These services require new cooperation between private and public sector in order to provide seamless experience for the end user. The issues to be tackles jointly have very different nature ranging from fundamental technical and organisational aspects to legal concerns. Therefore lively exchange between the new collaboration partners is essential. In order to support this and to foster C-ITS deployment in Europe, CODECS (COoperative ITS DEployment Coordination Support) was set up as a nodal point for the various involved stakeholder groups. The Horizon

2020 support action (36 months, 05/2015 – 04/2018) has facilitated the C-ITS deployment coordination activities on European scale.

The CODECS consortium, consisting of road operators, car manufacturers, automotive industry experts as well as user and cities representatives, aimed at pooling the main actors' preferences and requirements for a concerted C-ITS roll-out across Europe. As starting point, in the inventory phase numerous pilots, deployment initiatives and private key stakeholders were brought together and the current plans, concepts and ideas were gathered. Numerous documents were analysed and several workshops organised. The experiences of this knowledge exchange and the constant survey of the C-ITS landscape in Europe were used in the consolidation phase to come up with guidelines and recommendations. The CODECS activities complemented the EC activities like the C-ITS Platform. The harmonisation activities within the project and in the workshops can be seen as precursor of the C-Roads platform which is harmonising specifications and deployment activities within 16 European countries today. CODECS has held its final event at TRA 2018 in Vienna. The heritage of CODECS (Deliverables, workshop documentations etc.) has taken on board of the Amsterdam Group website.

2.2. Ongoing and planned research

2.2.1. Safety potential and testing of reversing assistants for passengers cars (M1) and LGV´s (N1)

To increase the active and passive safety of motor vehicles and also for stylistic reasons, it can be observed that the pillars in vehicle design (A-, B-, C-, D-pillar) were constructed more massive over the years. Next to the advantages in terms of the integrity of the passenger compartment and the torsional stiffness of the vehicle, this measure may also have disadvantages in relation to the driver's field of vision.
Accidents while reversing are often pure material damage accidents when manoeuvring. However, accidents involving personal injury are also reported, e.g. with approaching cyclists while backing out from the driveway or running over children who are behind the vehicle.

Reversing assistance systems (for example radar sensors with acoustic and / or optical display, rear-view cameras, etc.) have been installed in motor vehicles for a number of years and are also frequently retrofitted. These are advertised in particular for the avoidance of property damage accidents or for the ease of manoeuvring. In principle, however, they also have the potential to prevent accidents involving personal injury. At present, however, there are no uniform requirements for such systems that would be necessary in order to generally estimate their safety potential. This is why BASt assigned a study to examine the safety potential and possible test methods for reversing assistance.

When it comes to accidents with reversing vehicles mostly pedestrians and cyclists are injured according to the GIDAS database. These generally move at an angle of approximately 90° to the reversing vehicle.
The analysis of the development of the rearward field of view of various vehicle models confirms the decline of the visual conditions out of the vehicle since the 1970s.
Observations of the view strategies when reversing showed that the available reversing display systems in vehicles are not always used.

In order to configure a test method, the today installed systems were subjected to a benchmark test. For this purpose, ultrasonic sensors were first tested by moving three different test bodies in the direction of the rear end of the vehicle. In doing so the various warning levels were determined and compared. In order to test radar systems, a moving pedestrian dummy was used. In order to test existing camera systems, a standardized dummy was equipped with a scale and placed behind the vehicle. The detection area of the camera was then explored.

Based on an analysis of the systems potential using pre-crash matrix simulations of 200 GIDAS reversing collisions, the quality of the back-up assistance system to avoid accidents with injuries could be evaluated.

2.2.2. Study on winter tires

Winter tire use is mandatory in Germany if there is snow or ice on the road. Commercial vehicles (N1, N2, M2 and M3) are required to have tires with winter characteristics at least fitted to their driven axles due to the current national regulation.

Theoretical considerations suggest that specific winter tires on steering axles might contribute to better braking behavior of commercial vehicles. The steering axle has a large influence on empty truck-and-trailer combinations, while the effect is expected to be lower for fully laden vehicles. The current regulation on tires UN-R 117 specifies requirements for traction tires, but not for steering axle tires. Currently available steering axle winter tires therefore are tested according to these requirements.

Therefore, BASt was asked to compare the performance of winter tires and summer tires that are designed for use on steering axles. Experiments were carried out on prepared snow tracks in northern Europe; the project is expected to finish by Summer 2019.

2.2.3. Automatic Emergency Braking for passenger cars

Automatic braking systems for passenger cars, designed to address car accidents with other cars, pedestrians and / or (to some extent) bicyclists are state of the art and already available in various production vehicles. It is expected that those systems will have a significant effect in improving traffic safety, so the European

Commission has included them in their proposal for the new "General Safety Regulation". The preferred way of setting requirements for technical systems is a broad international discussion on UN ECE level, so the European Commission together with Japan initiated an informal working group with the goal of setting agreed requirements for automatic emergency braking systems for N1/M1 vehicles.

Germany was part of that group and contributed with calculations, simulations as well as experimental data. Finally, the group agreed that AEBS systems should be able to avoid accidents up to a driving speed of 42 km/h on stationary targets and pedestrians and deliver a comparable performance for slow moving targets. These results have been delivered to UN ECE in January 2019 and are expected to be formerly adopted in June this year. The European Commission currently plans to make these systems mandatory in steps and beginning from 2022 (for new types).
Further work is concentrated on developing appropriate requirements for AEB systems also addressing bicycle accidents.

2.2.4. Motorcyclist-friendly safety barriers

Road restraint systems, which offer improved protection for motorcyclists in addition to the protection of vehicle occupants, should comply with the Technical Specification CEN/TS 1317-8:2012 "Motorcycle road restraint systems" published in 2012. In the beginning of 2000 when the systems for motorcyclist protection have been developed and tested in Germany there was no European standard for testing. Since it is now uncertain whether the original systems also meet the requirements of this new specification, this question will be investigated in an ongoing research project. For this purpose, impact tests are carried out on the original and if necessary a modified system (Figure 3). On basis of the results of these impact tests, recommendations for use will then be developed, which will conclude the research project by the end of 2019. The results can be used directly in practice to retrofit existing road restraint systems. This will adapt the systems to the current state of the art and will help to reduce the consequences of an accident of a motorcyclist with a road restraint system.

Figure 3: Impact according CEN/TS 1317-8:2012 (source: DEKRA)

Up to now, the assessment of the sharpness of construction elements in road restraint systems, especially with regard to the impact of motorcyclists, has been rather subjective. In a further research project, therefore, specific indications for the definition of system-neutral sharp-edged construction elements road restraint systems are to be determined. Here, impact tests were carried out with a new type of biofidelic crash test dummy, modeled on humans, on variants of individual construction parts. Initial impact tests (Figure 4) have shown enormous differences in the injury potential of individual construction elements. The impact parameters were derived on basis of an accident analysis and also on CEN/TS 1317-8:2012. Objective criteria for the evaluation of sharp edged construction elements will be developed. In practice, this makes it possible to distinguish between dangerous and less dangerous systems and to achieve a frequent use of good-natured systems. In addition, the results are to be incorporated into national and international regulations or guidelines as well as into European standardization.

Figure 4: Biofidelic crash test dummy at impact point (sigma post covered with a pipe)

2.2.5. Active motorcycle safety

Motorcycle riders are still one of the most endangered groups in modern traffic. Due to the specific driving dynamics of one-track vehicles and the location of the predominantly driven roads, the severity of accidents tends to be considerably above average. Analyses of available accidentology data in the past showed that the cause for a typical accident with a motorcycle on rural roads is loss of control over the vehicle. Prevention of mistakes by the rider in relation to occurring roll angles and braking while cornering are promising starting points for a reduction in motorcycle accidents on rural roads.

To increase the traffic safety for motorcycle riders, BASt conducts own research as well as supervising several external research projects on various topics related to motorcycle safety. Recently, braking in curves is a challenging scenario addressed by the motorcycle industry. Since there are no public studies available evaluating the benefits of the current systems, BASt claims to provide an overview of the potentials for traffic safety including user acceptance. Options for future rider trainings are to be assessed. The comparison of objective and subjective assessment can also serve as a basis for the performance and the limits of future AEB motorcycle safety systems. The currently ongoing research aims to identify boundaries that are set by rider limits (e. g max. longitudinal deceleration or rider acceptance) in which AEB systems could provide a safety benefit. In terms of riding dynamics, it is important that the rider is able to stabilize the vehicle at any time. With the current research roadmap BASt aims to further promote the development of innovative safety systems in motorcycles, which actively support the rider in critical situations.

2.2.6. EU-Project PIONEERS

PIONEERS (Protective Innovations Of New Equipment for Enhanced Rider Safety) updates the current test methods and standards for personal protective equipment for riders and on-board systems.
The main pillars of PIONEERS are to achieve a deep understanding of the injuries sustained by PTW (Powered Two Wheeler) users, improve the performance of safety systems (Personal Protective Equipment, PPEs, and on-board systems), to develop better test and assessment methods and to increase the use rate of PPE.

The improved performance will be achieved by understanding the most safety-critical accident scenarios and impact conditions to reach a higher level of understanding on how the injuries occur and by developing more reliable, realistic and robust test methods. An increased use will be fulfilled by listening to the riders' needs, improving the systems in terms of comfort (without compromising safety) and carrying out active awareness raising and dissemination actions. The main goal of the PIONEERS project is to improve the safety of PTWs by providing an integrated approach to rider protection considering on-rider (PPE) and on-board systems. Therefore, this project will investigate and assess the direct contribution to the reduction of fatalities and the severity of injuries, as well as the number of injured PTW users. The tools for that are developing new PPEs and on-board safety systems, as well as improving the validation and assessment methods and increasing the usage rate of such devices. Developing high-quality products (PPEs and on-board systems) from the European manufacturers and sensitizing the PTW users for the enhanced safety potential of those products will not only increase the safety level for PTW users but will also strengthen European competitiveness.

Finally, the main results of PIONEERS will be: (i) higher understanding of injuries suffered by the riders (ii) better testing methods enabling better performance assessment and (iii) better products (PPEs and on-board systems) achieving an increased safety level for PTW users.

BASt participates in this project by delivering and analysing accident data with the focus on body regions addressed by different elements of PPE. Furthermore BASt will develop test methods to assess helmets and neck protectors. Especially the test method for helmets will consider the current knowledge on head injury mechanisms and will be used to support the update of helmet requirements during the revision of the UNECE-R 22.

2.2.7. Friction prediction

Precise knowledge of the friction potential is of great importance for safe longitudinal and lateral control of a car. This potential is influenced by many parameters like weather conditions, road surface and tyres. While today it is the driver who assesses friction values, it will be necessary for future highly automated vehicles to independently obtain information on environmental conditions. A cause-based estimation procedure for estimating the maximum friction coefficient has been developed which relies solely on information that is available without additional vehicle sensors. This information consists of data which is present in the vehicle itself, such as outside temperature, vehicle speed or rain intensity and on data provided by the surrounding infrastructure. This includes weather data from weather stations or information on road conditions obtained from road weather information systems. By combining and integrating these fields of information, the range of the maximum coefficient of friction is established using the estimation procedure developed in the project. The result of a huge number of test brakes is a comprehensive database with more than 5,000 data sets which includes for each full braking manoeuvre more than 80 parameter information about weather, road state etc. Based on these data the mentioned friction estimation algorithm was developed. Detailed analysis of the data sets of single braking points should help to understand under which circumstances the friction coefficient changes. The evaluation of the estimation algorithm showed, that it provides satisfactory results even if some information are not available.

For the future it is imaginable that numerical weather simulation models, which give detailed weather information and which also consider local effects of the vegetation can improve the friction estimation a lot. Additionally, the use of vehicle dynamic parameters like wheel speed and interventions of ABS and ESP might improve the estimation algorithm.

2.2.8. Bus safety: smoke gas toxicity

Despite that busses are one of the safest means for transport, singular accidents and especially fire events with and without connection to an accidents can become very severe. Vehicle regulations for busses have been adjusted to address various aspects of fire safety, e.g. by introducing fire detection and control systems and burning behavior tests.

One aspect that has not yet been regulated is the smoke gas toxicity. Several standards with specific advantages and disadvantages from other modes of transport exist, but it is unclear which of those standards could best be adopted towards busses.

The focus of an upcoming research project, funded by BASt, will be the investigation of appropriate requirements for bus material smoke gas toxicity and the development of a corresponding, probably more efficient test procedure.

2.2.9. HMI aspects on Camera-Monitor-Systems

Since June 2016 conventional outside and inside rear-view mirrors can be replaced by Camera-Monitor-Systems to present views of the traffic situation behind the vehicle to the driver. At that time the corresponding UN Regulation No. 46 "Uniform provisions concerning the approval of devices for indirect vision and of motor vehicles with regard to the installation of these devices" entered into force.

Based on a previous BASt-study (F112b; Camera-Monitor systems as a replacement for exterior mirrors in cars and trucks) and UN Regulation No. 46 BASt has started a follow-up project which focuses on specific human machine interaction aspects. On the one hand, different display positions (peripheral, central in front of the driver and in the center of the vehicle – according to height variations in accordance with UN-R 46) should be investigated in terms of perceptional speed, discrimination possibilities and human's (direct) view. On the other hand, the effects of merged presentations of backward information on human's perception are explored. Besides that, the project focuses on human's perception of distances and velocities at high differential velocities in a real driving scenario. This project will terminate end of 2019.

2.2.10. Activities with regard to UN R 22 and helmets for S-Pedelecs

Within the frame of the UNECE/GRSP Informal Working Group for Protective Helmets the revision of the UNECE-R 22 has started. The update will include the test methods and test parameters to further extend the protective effects of motorcycle helmets. The new test methods will take tangential impacts and rotational kinematics of head and brain into account to enable an assessment of helmets under more realistic loading conditions. Beside the test method the use of a more advanced headform and the consideration of relevant injury criteria will contribute to helmets with higher protection in the future.
So far, the assessment of motorcycle helmets was mainly focused on linear impacts and excluded the rotational effects of impacts during real accidents associated with brain injuries.
Based on a previous BASt research project to identify the potential optimization of motorcycle helmets BASt will contribute to the working group by promoting and discussing the results.

With the continuing trend towards the electrification of mobility the safety of S-Pedelecs has to be considered. One important aspect is the use of personal protective equipment by the riders of S-Pedelecs. Since these vehicles are classified as motor vehicles (L1e) the use of suitable protective helmets is mandatory in Germany. Current requirements for suitable helmets are defined within the UNECE-R 22 for motorcycle helmets. As motorcycle helmets are made for higher speeds and low physical activity of the rider, the ventilation and mass of current motorcycle helmets are not seen optimal for the use on S-Pedelecs.
BASt compared the protective as well as the comfort related requirements defined in different standards and regulations for helmets. Tests showed that the protective effect of UNECE-R 22 compliant helmets is higher then of helmets for bicycles (EN 1078) and S-Pedelecs (NTA 8776). Since the comfort related characteristics (e.g. ventilation) are not defined or restricted in any of the relevant standards, the optimization of motorcycle helmets is seen as a solution to provide suitable and safe helmets for the use on S-Pedelecs.

2.2.11. Seriously injured road accident casualties

So far, the German Road Traffic Accident Statistics have defined "seriously injured" as those casualties who are treated in a hospital as in-patients and survive for at least 30 days. According to the new common European definition, seriously injured road-users are casualties with an injury severity classified as MAIS3+, i.e. injuries of the maximum abbreviated injury severity of level {3, 4, 5, 6}, and who do not die within 30 days from the effects of the accident. The abbreviated injury scale (AIS) is an anatomical-based coding system that classifies the injury severity by the AIS severity score on a six-point ordinal scale indicating risk for death.

The working group developed methods to determine the number of seriously injured road accident casualties in Germany on the basis of established data sources. The projections were based on the German In-depth Accident Study (GIDAS) and the TraumaRegister of the German Trauma Society® (TraumaRegister DGU®). The applied projection approaches are described in detail and their limitations are discussed. Though GIDAS and the TraumaRegister DGU® have basically different aims (crash analyses versus quality management in hospitals), both databases produce comparable results: the total number of serious injuries in Germany in the year 2015 is 15.442 resp. 14.370 persons. It must be assumed that also in coming years projections are the sole way to determine the number of serious injuries in Germany, as there is no golden standard meaning no nationwide assessment of injured road users according to the new definition.

2.2.12. UNECE IWG on Deployable Pedestrian Protection Systems (Active bonnets)

The UNECE-GRSP Task Force on Deployable Pedestrian Protection Systems (TF-DPPS), chaired by the Republic of Korea, experienced an upgrade to an Informal Working Group in 2018 with the aim to interest a higher number of contracting parties to the 1998 agreement in the development of an amendment to UN-GTR9, implementing a test procedure for deployable bonnets. BASt emphasized the need for active systems providing at least the same level of protection to vulnerable road users as passive systems, to be ensured by a set of prerequisites prior to impactor testing. Due to very controversial discussions, BASt organized a subgroup of interested parties for developing a common understanding in what needs to be addressed by this IWG. Consensus was found regarding the principal need of DPPS capability to detect pedestrians, to ensure a certain protection level at speeds below the deployment threshold and to provide a correct timing of the system. No agreement was found with respect to the need for pedestrian protection at higher speeds and the actual protection level of active bonnets. The group continues working on further outstanding topics such as an adequate surrogate for the hardest to detect pedestrian and the legitimacy of human body model simulations within UN regulations. The current schedule foresees an adoption of Amendment 4 to UN-GTR9 by AC.3 in June 2020.

2.2.13. GIDAS – new requirements to address new vehicle technology

In summer 1999, a cooperation between FAT (Research Association of Automotive Technology) and BASt (Federal Highway Research Institute) started the German In-Depth Accident Study (GIDAS) which is one of the largest in-depth accident data collections, recording more about 3,500 parameters per crash. Since then vehicles, objectives in road traffic policies and consequently research questions have changed. While the enhancement of passive vehicle safety has been the main objective during the start of GIDAS, requirements to modern field data collections change to gathering crucial information about pre-crash maneuvers and vehicle equipment with respect to crash avoidance technologies.

In modern vehicles, driver assistance functions are increasingly supporting the driver in complex or dangerous situations by applying preventive strategies. These strategies include warnings, enhanced braking assistance, and automatic interventions to increase road safety. A key challenge is to quantitatively assess the safety performance in terms of reduction or mitigation of traffic crashes, as these real-life effects are key considerations for all stakeholders involved in the planning of future mobility. Crash re-simulation and stochastic traffic simulation provide large opportunities to predict these effects. Both approaches require widely recognized models and reliable simulation. Hence, in order to agree on validity and reproducibility, the overall method, from the combined use of heterogeneous data sources in modeling to simulation metrics must be transparent.

Virtual “what-if” re-simulation based on reconstructed crash trajectories may show if a system had affected particular crashes on a case-by-case basis. However, reconstruction relies on limited traces and does not cover the complete traffic situation. But stochastic traffic simulation based on accident data can model how conflicts emerge and how to avoid or mitigate them. The GIDAS consortium supports such activities.
Further, GIDAS will investigate how electronic data recording systems (e.g., EDR) of vehicles which had an accident could be accessed in a larger scale considering the latest data protection laws. By this, the pre-crash and crash phase could be assessed much better than today and in particular in the cases of automatic system interventions. In addition, this forms one basis to be prepared for investigating future accidents involving (highly) automated vehicles.
Note: GIDAS is celebrating its 20th birthday now in 2019.

2.2.14. Human Body Modelling

The relevance of Human Body Models (HBMs) in vehicle safety research is significantly increasing for various reasons. On the hand HBMs are an important research tool for evaluation and improvement of dummies and test experimental tools as well as the respective injury assessment criteria. In the future HBMs might also be directly used for vehicle safety assessment complimentary to experimental based test and assessment procedures. Therefore HBMs are meanwhile used by BASt for various internal and cooperative research studies.

For example within the EU funded project SENIORS HBM simulations were used to develop updated dummy based chest injury criteria to achieve improve injury assessment methods for elderly car occupants. A new simulations based approach was proposed by BASt together with project partners, which makes use of HBM and dummy simulations. To consider age related particularities of elderly car occupant an updated HBM was used for this method taking into account the morphologies differences of an elderly rib cage. The model was developed within the SENIORS project and implemented into the THUMS human model. Based on first promising results BASt will continue to further improve this HBM simulation based approach to further improve injury assessment criteria.

Another part of SENIORS focused on external road users in which an improved legform impactor with upper body mass (FlexPLI-UBM) and a thorax injury prediction tool (TIPT) were developed mainly based on HBM simulations. Corresponding HBM and impactor simulations were conducted against several actual vehicles and rigs, representing different frontends (Sedan, SUV, Sportscar, MPV). Based on this work impactor prototypes have been developed within SENIORS. Further studies have shown a significantly improved biofidelity of the newly developed FlexPLI-UBM compared to the current FlexPLI. In the next step BASt will extend the biofidelity studies to finalize the development.

In accidents with highly automated vehicles new accident scenarios and new occupant seating positions will be expected. For these new accident conditions current physical test tools like dummies might not be applicable anymore for safety assessment. This will require new simulation based test procedures including human body models. Some of the question related to this will be addressed by BASt in the EU project OSCCAR.

Furthermore, a prerequisite for the potential future use of HBMs in virtual testing procedures will be harmonized HBM validation requirements and application methods. Therefore, BASt continues to support the THUMS User Community (TUC). Within the TUC all project partners are working closely together to archive these goals.

2.2.15. Child Safety at the UNECE with regard to R 129

Within the frame of the UNECE/GRSP Informal Working Group for Child Restraint Systems the work on the third phase for the development of the new regulation on enhanced child restraint systems was finalized. In this third phase, integral child restraint systems, connected to the car by using the vehicle belt system, are included in UN R 129. The proposal was agreed in June 2018 by WP 29, entering into force on the 29. December 2018.

The UN R 129 now includes Integral ISOFIX Enhanced Child Restraint Systems (i-Size and specific vehicle), Non-integral Enhanced Child Restraint Systems (i-Size and specific vehicle booster seat) and Integral Belted Enhanced Child Restraint Systems (universal and specific vehicle). For all Enhanced Child Restraint Systems according to UN R 129 a stature based system depending on the standing height of the child is used. All i-Size CRS will fit on an i-Size labeled vehicle seat.

For the time being only boosters without backrest are not included in UN R 129. A task force of interested experts was asked by GRSP to streamline discussions on draft amendments to the UN R 129, especially with regard to booster cushions. The works of the UNECE/GRSP Informal Group “Child Safety” as well as the task force are supported by BASt.

2.2.16. Development of requirements on automated driving functions for vehicle regulations

Automated driving functions are supposed to be available and to be used in vehicles to a greater extend. The development from the pure driver assistance to higher automation of single driving functions is an evolutionary process with a crucial step to be executed at the moment: The driver can be released in some dedicated parts of the road traffic of his obligation to perform driving task because the vehicle is supposed to be able to take over this task in some defined areas completely. This challenge has to be met both technologically and from the legislator. First changes for technical vehicle regulations on UNECE level were implemented in the UN-Regulation No. 79 for continuously assisted steering functions. The responsible Informal Working Group, chaired by Germany and Japan, which revised UN-Regulation No. 79 regarding automated steering functions (ACSF = Automatically Commanded Steering Functions), now, after requirements for corrective and emergency steering have been established, has the task to develop technical requirements for higher levels of automation (automated lane keeping system (hands-off) for highway applications, e.g. low speed/ traffic jam situations). There are big challenges of the technical requirements on automated steering without the continuous surveillance of the driving task by the driver to be overcome. Reliable safety systems shall be installed and present in the vehicle when automated steering is allowed to be activated and the driver is not any longer obliged to have the hands on the steering wheel and the eyes on the road. In this case the braking system is also of special importance because in case of transferring complete driving task to the vehicle, the longitudinal control with speed and distance control has to be transferred as well. If during the automated driving phase a sudden and unexpected situation occurs the system shall be able to cope with the situation by itself e.g. by emergency braking. There is a qualitative difference to today's emergency braking systems where normally a warning phase leads to the braking phase and where the systems have to incorporate a possible driver reaction like steering to avoid a crash. In terms of safety a very important issue to decide on is the transition procedure of the driving task from the automated system back to manual driving to ensure at any time a 'driver' is in control of the vehicle.

2.2.17. EU-Project L3-Pilot

In the project "L3Pilot", 34 partners from research, industry and government agencies cooperate in order to test the safety, efficiency and usability of automated cars (SAE levels 3 and 4). BASt participates with a study on user acceptance and trust, and provides input to the safety impact assessment. The project is co-funded by the European Union under the Horizon 2020 programme.

To understand the attitude of drivers towards automated vehicles, it is crucial to examine their trust and acceptance with respect to these technologies. Too much trust can cause misuse, too little trust or acceptance can hinder the use of automated driving functions and thus their positive effects on road safety and efficiency. In L3Pilot, BASt will perform a long-term study with a research vehicle in real motorway traffic in order to investigate participants' trust, acceptance and secondary task engagement and their change over time. The results will show if e.g. gender or age of drivers affects trust and acceptance and if the participants are willing to use the automated riving function for a longer trip.

In the project methods for different fields of evaluation are developed. BASt participates in defining the methods for the impact assessment particularly having a look at implications for safety (accidents with injured casualties) and the scaling up of the results to EU level. The verification of those methods is another important part to make sure plans are feasible to implement. In a top-down approach the proposed methodologies will be checked with respect to the information flow from the intended response to the research questions and also with respect to the outputs and inputs to the processing of indicators and the logging of data.

In contrast to existing projects, the impact assessment in L3Pilot will be based on real world (pilot) data which are complemented with other sources where necessary. GIDAS is a source that will be used to determine the possible effect of the L3Pilot systems.

2.2.18. Development of evaluation methods for driver interaction with assistance and automation (national research and Euro NCAP)

Safety of continuously automated functions strongly depend on and result from successful driver-vehicle-interaction. In short term, this effect is particularly strong in case of already available parallel automation as provided by SAE Level 2 (L2) Systems. Per definition, any L2 system performs both the lateral and longitudinal vehicle motion control with the expectation that the driver completes the Object and Event Detection and Response (OEDR). Nevertheless, every system performs also parts of the OEDR itself, for example providing steering torque if lane markings indicate curvature. This amount of OEDR performed by the system and the expectation that the driver completes the remainder of OEDR varies between different L2 systems. Especially highly reliable L2 systems performing a greater amount of OEDR while at the same time requiring only little driver input over time can make it difficult for drivers to correctly identify their role and responsibility. Based on international standards, literature reviews and expert consultations, a first checklist-based expert-evaluation for currently available vehicles with L2 systems was developed. Assessments are focusing on different sources of user information (e.g. user manual), human-machine-interface design as well as the prevention of unintended use by different driver monitoring techniques. The checklist-tool was developed in cooperation with experts and validated in a common expert workshop to gain high level of standardization and agreement. Besides the assessment of these rather explicit forms of information design criteria, also implicit forms of driver-vehicle-interaction, for example vehicle dynamics or system behavior and reliability within different situations and contexts (e.g. how strong is the steering wheel resisting input of human driver when the system is active), play an important role. Therefore, it is intended that further assessments also include observational and interview measures of user studies. To ensure a holistic assessment, the methodological aim is to take also interaction related processes regarding user´s understanding of roles and responsibilities when applying automated driving functions as well as user´s awareness of automation modes or traffic situations into account. Based on the results of the development of evaluation methods for assistant functions (L2), further methods and categories for the assessment of higher level automated functions (Level 3 and above) will be developed soon.

2.2.19. EU-Project OSCCAR

The EU project "OSCCAR - Future Occupant Safety for Crashes in Cars" - is dedicated to the improvement and assessment of vehicle safety for car occupants in future accidents involving highly automated vehicles. Highly automated vehicles might enable new, more comfortable seating positions (swivel seats and reclined positions). Furthermore, collisions with highly automated vehicles might also lead to new accident scenarios and thus load condition of vehicle occupants. To continue to protect all passengers in the best possible way, innovative occupant restraint systems (belts, airbags and new seating concepts) will be required.

OSCCAR aims to develop protection principles for these new innovative restraint systems. Furthermore, conventional crash test dummies might not be suitable for the design and evaluation of these new protection systems, especially in new impact scenarios. A possible alternative approach could be the use of human body models. These virtual test tools, which can also represent different road user types in terms of anthropometry and age, could be a possible solution in a process of virtual testing. The further development and improvement of these virtual test and development tools is one main objective of OSCCAR. A new virtual test and assessment method involving human body models will also require a validation procedure for the vehicle environment including new restraint systems. The development of this procedure is one main task of BASt within the OSCCAR project.

2.2.20. PEGASUS

PEGASUS (**p**roject for the **e**stablishment of **g**enerally **a**ccepted quality criteria, tools and methods as well as **s**cenarios and **s**ituations for the release of SAE Level 3 driving functions) develops tools and procedures for the testing and homologation of automated vehicles. The 17 project partners from science and industry fields define a state-of-the-art technology for the safeguarding of Level 3 driving and demonstrate the development in a practical manner, using the example of the ‘highway chauffeur’ until midyear 2019. The objective is to develop a procedure for the testing of automated driving functions, in order to facilitate the rapid implementation of automated driving into practice.

In a practical study BASt focuses on the identification of risks that can arise in the interaction between a highly automated vehicle and the driver. In a field study performed on highways, the influence of traffic density on the driver's takeover capability will first be examined. The driving tests should uncover possible safety risks during transitions and enable an initial assessment of the influence of the traffic situation. In a second study, a test site will be used to investigate effects of a preceding automated drive on the ability to cope with unexpected situations following the successful completion of the takeover request. Both empirical studies use the BASt 'Wizard of Oz' vehicle which is able to simulate the considered automated driving functions.

2.2.21. Development of basic scenarios for the description of control-relevant requirements for continuous automated vehicle guidance

In order to assess and quantify the safety performance of continuously automated vehicles – and thereby assuring their safe deployment into the vehicle fleet - relevant testing procedures have to be developed. Such testing procedures have to be able to reflect realistic traffic scenarios, in particular focusing on critical, accident prone situations. Furthermore they have to provide ways to challenge Level 3 automated vehicle systems with complex situations and environmental conditions which can notably tempt their sensory and decision making abilities. Presently various attempts to establish such testing procedures are primarily based on the selection and appropriate parameterization of traffic scenarios, which are either derived from real world traffic recordings (e.g. NDS, FOTs or In-Depth accident investigations) or generated synthetically.

Testing scenarios can provide a basis for deriving either laboratory track driving tests or can be translated into virtual testing environments for simulation based driving tests. Both techniques will require performance criteria as well; however simple “no crash” criteria might not be sufficient to fully express necessary requirements.
The research project PEGASUS, promoted by the German Ministry of Economic Affairs and Energy, has developed a showcase to demonstrate a complete step-by-step procedure of a scenario based assessment and

validation of Level 3 automated vehicle functions by focusing on the example of the “Highway chauffeur function”. The results of the project can serve as a blueprint for the further development of any scenario based validation approach and shall thereby also enhance associated international co-operation.

2.2.22. EU project HEADSTART

BASt participates in the EU-funded Horizon 2020 project „HEADSTART” (Harmonised European Solutions for Testing Automated Road Transport). The HEADSTART project will define testing and validation procedures of Connected and Automated Driving (CAD) functions including its key enabling technologies (i.e. communications, cyber-security, positioning) by cross-linking of all test instances such as simulation, proving ground and real world field tests to validate safety and security performance according to the needs of key user groups (technology developers, consumer testing groups and type approval authorities).
Five major objectives encompass the HEADSTART project:
Create a dynamic catalogue of existing methodologies, procedures, tools for testing, validation and certification considering multi-stakeholder requirements. Harmonisation of existing testing and validation approaches taking into account other industries and domains. Define and develop test, validation and certification methodologies and procedures for CAD functions building upon existing initiatives. Demonstrate the developed methodologies, procedures and tools through the testing of four CAD use cases (to be defined within the project). Reach consensus by creating and managing an expert network of CAD testing to promote adoption of the project results considering multistakeholder needs.

HEADSTART brings together a large representation of stakeholders across the value chain leveraging the knowledge from European and national activities on CAD testing. The consortium and associated stakeholders will cluster the most relevant initiatives, develop the specific procedures and tools missing and harmonise the whole approach to reach a harmonised European solution for testing, validating and certifying automated road vehicles. This will be achieved by international cooperation with industry, academia and policy makers participating in dedicated working groups of a managed expert network during the whole project duration.

2.2.23. C-Roads Germany

The European Commission has published its C-ITS strategy (COM (2016) 766) in November 2016 which heavily builds on the results of the C-ITS Platform (first phase). C-Roads, as a family of deployment pilots for C-ITS services, is seen from this perspective as the most important, infrastructure related, element of practical pre-deployment throughout the EU. The C-Roads Platform started with eight Member States and doubled this number to 16 in the meantime. Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden and UK jointly work on harmonising specifications and the necessary measures for a Europe-wide deployment of C-ITS with seamless experience for the end user.

Together they mobilise approx. 199 Mn EUR (thereof 107 Mn EUR co-funded by Connecting Europe Facility) of infrastructure investment in C-ITS services. The investments complements the huge efforts of the automotive industry incl. their suppliers to kick start mass market deployment of C-ITS services in the vehicle fleet by 2019. C-Roads has been officially launched in Brussels in December 2016 (see Figure 8). C-Roads Germany ties together the pilots in Hesse (Rhine Main region) and Lower Saxony (around Braunschweig and Wolfsburg). It is a 10 Mn pilot running until 2020 with the overarching goal of providing interoperable, safety and efficiency targeting C-ITS services. The BASt roles are devoted to the national technical coordination of C-Roads Germany and the provision of coordinated expert input into the various expert groups (addressing issues to be solved for deployment, i.e. organisational issues, security, service harmonisation, infrastructure communication, hybrid communication, validation, evaluation and assessment of the pilots) of the C-Roads Platform. Especially, BASt chairs the task force on security aspects and co-chairs the task forces on hybrid communication and on validation. BASt also supports the Federal Ministry of Transport and Digital Infrastructure in the Steering Committee representation.

As first important results, C-Roads has released the Harmonised C-ITS Specifications for services with infrastructure involvement in Europe which have been included in the Delegated Act on C-ITS (Draft Delegated Act published for Public Consultation on 11.01.2019)). Furthermore, reports on legal and organisational structures as well as on the European security mechanism for C-ITS have been published.

Figure 5: Official launch of C-Roads by EU Commissioner Bulc on 12th December 2016 in Brussels ©EC.

Perspectively, the C-Roads Platform will further grow as a result of projects funded from the CEF Call Transport 2018. This will enlarge the number of cooperating Member States to approximately 20. Even more important is the inclusion of urban C-ITS services into the C-Roads programme. Like several other Member States, Germany has submitted a proposal “C-Roads Germany Urban Nodes” which includes pilots in Hamburg, Kassel and Dresden. The co-funding decision is expected for spring 2019.

2.2.24. Practical Test for the Quality of Congestion-Tail Information

The overall objective of this activity is to reduce the number of end-of-congestion accidents, by providing on-time and accurate warnings on occurring congestion-tails to road travellers. Corresponding information can be nowadays acquired by commercial traffic-data providers, which generate such information from movement patterns of connected road users. Such data seem to offer a good alternative or supplement to conventional detection by road authorities, e.g. via cameras or manual reporting.

However, minimum requirements for such third-party-generated congestion-tail information, as well as framework conditions for their procurement by the public sector, must be defined in advance.

So far, a concept study is available on corresponding minimum requirements and a testing approach (FE 82.0637/2015 "Minimum Requirements for Congestion-Tail Information and Concept for their Practical Testing"). This study suggests an implementation of a practical test to validate the conceptual approaches.
The follow-up project "Concept and Monitoring of a Practical Test for the Quality of Congestion-Tail Information" (FE 03.563/2017)) has been initiated in January 2019. It includes the implementation and evaluation of a test in real-world environment during at least 6 months. During this test, data from different, commercial traffic-data providers will be assessed; and suitable quality assessment criteria will be defined. As a goal, public road authorities will receive guidance in assessing and procuring commercially available congestion-tail information, through e.g. calls for tenders.

The test is planned to start in summer 2019. A final report, including the test evaluation and guidance documents for road authorities, is expected for summer 2020.

2.2.25. Research program road safety

BASt has the task to carry out purposeful planning and coordination of research in the area of road safety and to examine traffic safety improvements.

For this reason BASt elaborates an annual research program, which addresses specific and anticipated safety deficits in road traffic in order to provide scientifically sound information as a base for advice and support of the Federal Ministry of Transport and Digital Infrastructure (BMVI). For example safety of pedestrians in urban areas was the main topic in the 2017 research program road safety, Safety Performance Indicators will be evaluated in the 2019 program.

GOVERNMENT STATUS REPORT OF JAPAN

Hiroyuki INOMATA
Director,
International Affairs Office,
Engineering Policy Division,
Road Transport Bureau,
Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT)

1. TRENDS OF THE ROAD TRAFFIC ACCIDENTS IN JAPAN

The number of fatalities (those who died within 24 hours) resulting from traffic accidents in 2018 was 3,532. This represents a great decrease compared to the previous year and is about one-fifth the 16,765 fatalities in 1970, which was the year in which the number reached its peak. In addition, both the number of accidents resulting in injury or death and the number of injured persons decreased for the 14th consecutive year in a row since 2004, when the numbers were at their worst.

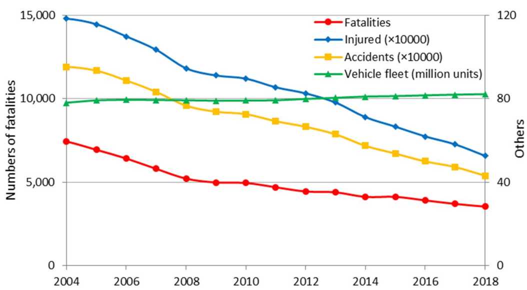


Figure 1. Recent trends of the road traffic accidents in Japan

Japan has had a low rate of road traffic fatalities per 100,000 population, which was 2.8 in 2018, but as a further step, new targets were established in the 10th Fundamental Traffic Safety Program for 2016 - 2020: to reduce the number of fatalities to below 2,500 (those who died within 24 hours) and to below around 3,500(those who died within 30 days) by 2020.

The road transport environment is beginning to change greatly due to the aging society and the introduction of Advanced Safety Technologies. Therefore, on 24th June 2016 the Working Group on Technology and Vehicle Safety of the Council for Transport Policy of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) reported a target for 2020 to reduce the number of fatalities by 1,000 from the one for 2011 by implementing vehicle safety measures, evaluating their effect, and setting the policy for reaching the new targets.

2. Effective Vehicle Safety Measures

To spread active safety and other safety technologies and to enhance development, it is necessary not only to establish safety regulations, but also to implement various rational measures. These should be considered based on quantitative assessment of the effects and performance as well as the required costs. Therefore, the MLIT is promoting vehicle safety measures through effective linkage between the safety regulations, the Advanced

Safety Vehicle (ASV) project and the New Car Assessment Program (NCAP).

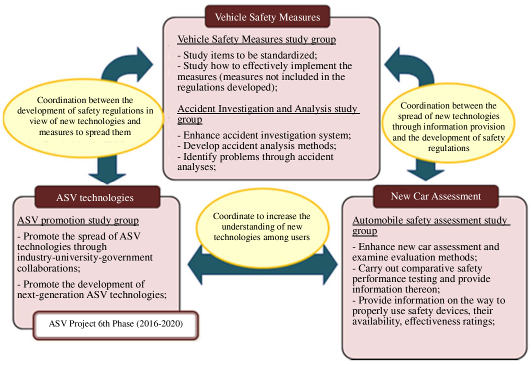


Figure 2. Vehicle safety measures promotion system

2.1. Enhancement of Safety Regulations

With regard to the expansion and enhancement of safety regulations, the MLIT has been considering the introduction of UN regulations and UN GTRs mainly for advanced safety technologies with the harmonization of international regulations in mind.

Recent amendments to safety regulations:

2018 Introduction of amendment to UN R79 on automated lane-change functions; introduction of UN R144 on Accident Emergency Call Systems;

2017 Introduction of amendment to UN R79 on automated lane-keep functions; extension of seats to be covered by seatbelt reminder (UN R16)

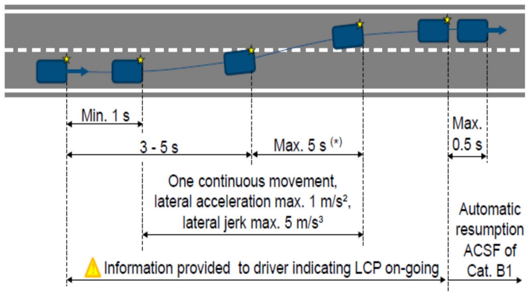


Figure 3. Outline of the international regulation on automated lane-change functions

2.2. Advanced Safety Vehicle (ASV) project

Regarding the ASV Promotion Project which is to promote the development and commercialization of Advanced Safety Vehicles (ASV), the MLIT has been promoting ASV toward automated driving, the theme of the 6th Phase of the project, such as the study of technical requirements of Emergency Driving Stop System, the spread of automated driving technologies including ASV technologies that have already been achieved. Regarding large vehicles such as trucks and buses, we are promoting the introduction of advanced safety technologies such as Advanced Emergency Braking System (AEBS), Emergency Driving Stop System, and Blind Spot Information System through tax incentives and budget distribution.

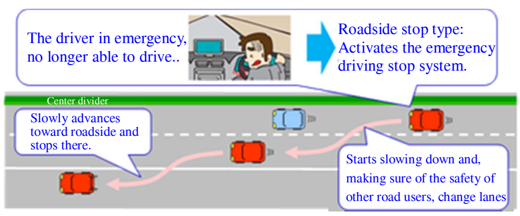


Figure 4. Emergency Driving Stop System in the event that the driver is incapacitated

2.3. New Car Assessment Program (NCAP)

To allow motor vehicle users to select safer vehicles and promote the development of safer motor vehicles by auto manufacturers, the New Car Assessment Program (NCAP), which assesses and publishes the safety performance of motor vehicles, has been in place since 1995 (Fiscal year; hereinafter the same in this chapter). Since 2011, the collision safety performance assessment has been carried out that assesses each vehicle’s performance in both occupant protection and pedestrian protection, and publishes the results with one to five stars. To further improve the collision safety performance, study is now under way to take the safety of elderly occupants into account.

Meanwhile, the preventive safety performance assessment of AEBS or other preventive safety systems has been conducted since 2014, enhancing the assessment by gradually increasing systems to be assessed.

The assessment of acceleration control systems for pedal misapplication was added in 2018 and the assessment will start in 2019 of AEBS to avoid collision with pedestrians under night-time no-streetlight conditions.

From 2020, we will integrate the assessment and publication of the results of collision safety performance and preventive safety performance, which has been conducted separately.

In order to improve the awareness of NCAP among consumers, efforts are being made to spread knowledge and information in cooperation with National Agency for Automotive Safety and Victims’ Aid (NASVA) and Regional Transport Bureaus.

Figure 5. Assessment of AEBS to avoid collision with pedestrians (under night-time)

3. Efforts toward the realization of automated driving

Automated driving is expected to have great effects in solving problems such as reducing traffic accidents, relieving traffic jams, ensuring the means of transport for the elderly, etc. As the objectives of the whole government, it aims at realizing highly automated driving on expressways, unmanned autonomous mobility service in specified areas, etc. by around 2020. To this end, the MLIT set up Automated Driving Strategy Headquarters and works to make automated driving a reality, i.e., to (i) develop and improve an environment (regulations and legal systems) for, (ii) promote the development and deployment of, and (iii) carry out field operational testing and social implementation of these technologies.

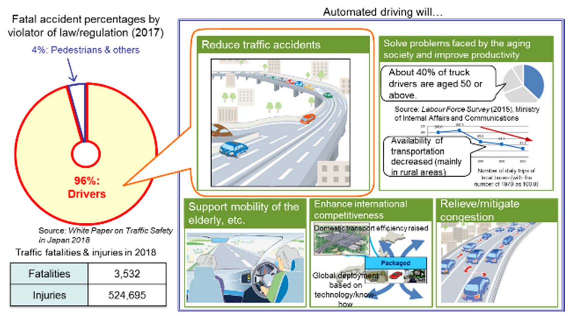


Figure 6. Importance of Automated Driving

3.1. Develop and improve an environment for realizing automated driving

Regarding the development of safety

regulations for automated vehicles, the government, based on the agreement reached at the G7 meeting of ministers in charge of transport held in June 2017 in Italy that the member countries would cooperate at the international level at the United Nations World Forum for Harmonization of Vehicle Regulations (WP.29) to put more highly automated/autonomous driving technology (Level 3 and Level 4) into practical use, contributes to discussions at WP.29 for the development of international regulations on automatically commanded steering function, AEBS, cybersecurity, etc. Domestically, the MLIT developed the Guideline regarding Safety Technology for Automated/Autonomous Vehicles in September 2018 to promote the development and commercialization of safe automated/autonomous vehicles even before the implementation of international regulations on automated/autonomous vehicles of Level 3 and Level 4. This guideline sets the safety goal of "realizing society where traffic accidents caused by automated/autonomous driving systems resulting in injury or death become zero" for the first time in the world and defines ten safety requirements to be satisfied by automated/autonomous vehicles including the safety of the automated/autonomous driving systems, installation of data storage systems, and cybersecurity.

3.2. Promote the development and deployment of automated driving technology

Regarding promoting the development and deployment of automated driving technology, the government set a new numerical target of increasing the rate of newly registered passenger vehicles with AEBS to 90% or more by 2020. To achieve this goal, the MLIT is multiplying efforts both in public and private sectors to promote the development and deployment.

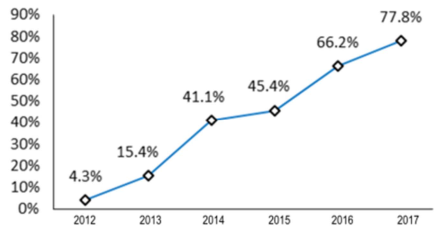


Figure 7. Evolution of the rate of newly registered passenger vehicles with AEBS

3.3. Field operational testing for automated/autonomous driving and its social implementation

The government is working on field operational testing of last mile automated mobility service that connects the nearest stations, etc. and final destinations with automated mini carts, buses, etc. and truck platooning. In the tests of last mile automated mobility service, a two-on-one remote control experiment started in November 2018 in which two vehicles are operated by a single remote monitor/driver.

Regarding truck platooning, a public-road test started in January 2019 on the Shin-Tomei Expressway in which the following vehicles were unmanned.

Figure 8. Field operational testing of last mile automated driving and truck platooning

4. Promote the international harmonization of vehicle regulations in cooperation with various countries

Regarding the promotion of the international harmonization of vehicle regulations, the MLIT makes all-out efforts to work on them as a major task, as mentioned in its growth strategy "Investments for the Future Strategy 2018" (adopted by the Cabinet on June 15, 2018).

Figure 9. Structure of WP.29

4.1. Contribution to international discussion

At the WP.29, in cooperation with other countries, the MLIT contributes to the development of international regulations on automated driving technologies such as automatically commanded steering function and AEBS as well as new technologies such as cybersecurity, detection and warning system for vulnerable road users in close proximity of the vehicle and so on.

4.2. Promote International Whole Vehicle Type Approval (IWVTA)

At the WP.29, an international regulation (UN R0) was adopted in November 2017 and entered into force in July 2018. The MLIT is striving for the smooth operation of IWVTA and promote an active utilization thereof. We are currently studying how we could further enhance IWVTA in the future, including expansion of target devices.

4.3. Promote emerging countries' accession to UN Agreements, etc.

The MLIT actively supports ASEAN and other emerging countries in their accession to UN Agreements, participation in the WP.29 and introducing IWVTA. Moreover, in order to promote the introduction of appropriate traffic safety/environmental preservation measures based on their own traffic and environmental conditions, the MLIT is cooperating with them making good use of its expertise and experience.

CONCLUSION

Measures that are being taken in Japan have been described above. When promoting these measures, the MLIT gathers and analyzes traffic data, and runs a PDCA cycle with the cooperation from various stakeholders. **Furthermore, considering that motor vehicles are globally distributed products, international harmonization should be kept in mind when studying and discussing regulations.**

The MLIT would like to continue contributing to international discussions by actively making proposals based on technical grounds.

Government Status Report

GSR19’

26th ESV 19 NETHERLANDS

JUNE 2019

Dr. Ir. Peter Striekwold, Special Advisor to the Director RDW | **The Netherlands**

Safety Overview for the Netherlands

GSR19'

- **Status of Motor Vehicle Crashes/Fatalities/Injuries**
- **Status of Advances in Motor Vehicle and Infrastructure Safety**
- **Evolving Research/Rulemaking Strategy**
- **Status of Current Key Research Programs**

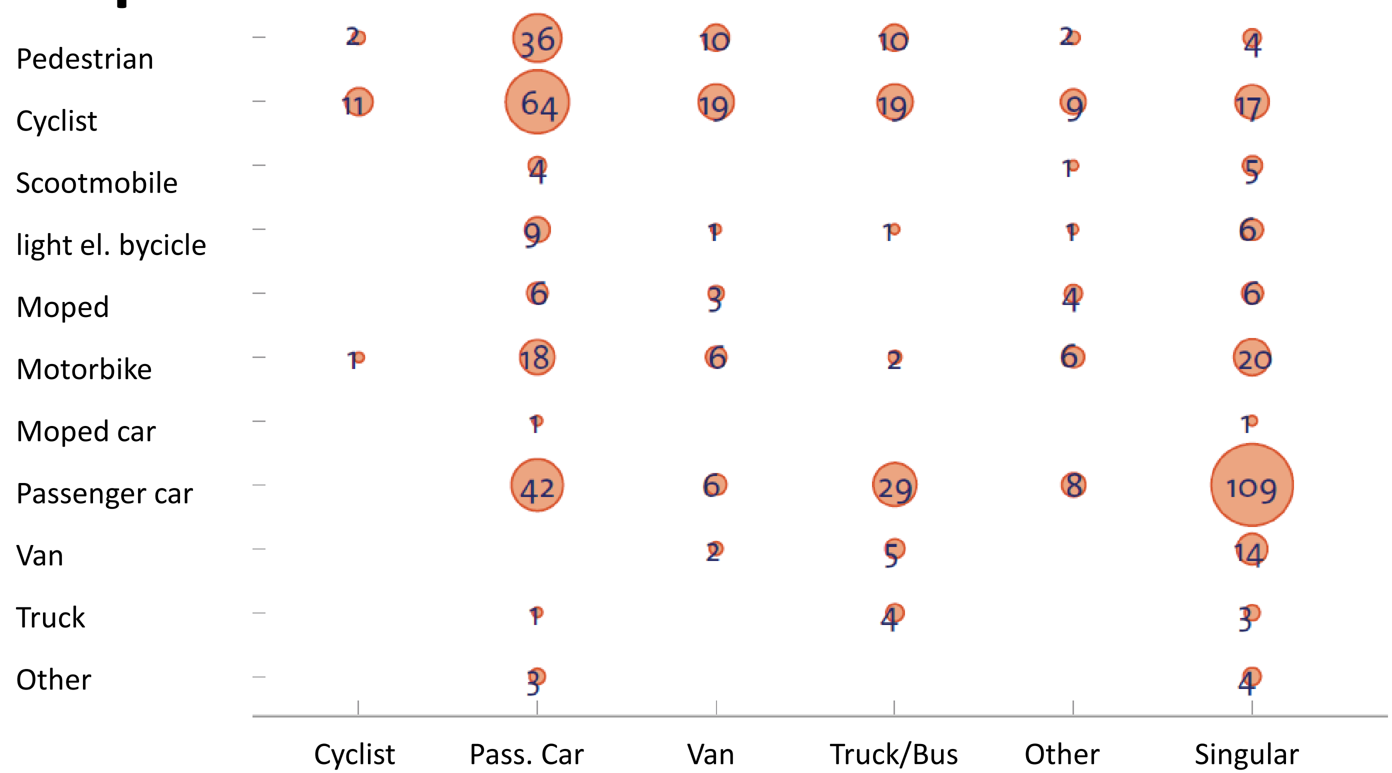
Status of Motor Vehicle Crashes/Fatalities/Injuries

- **Source: Institute for Road Safety Research (SWOV)**
- **2017: 613 casualties, appr. 20.800 severely injured (of which 25% permanent impact)**
  - Casualties: 34% bicycles, 33% passenger cars
    72% of cyclists older than 60; 31% of cyclists older than 80
  - Severely injured: 53% bicycles without motor vehicle, 11% bicycles with motorvehicle, 11% cars, 6 % motorbikes, 13 % scooters
- **The historical improvement seems to cease, figures are a bit worse than 5 years ago**

Status of Motor Vehicle Crashes/Fatalities/Injuries

GSR19'

- **Fatalities: relation transport mode victim and counterpart**

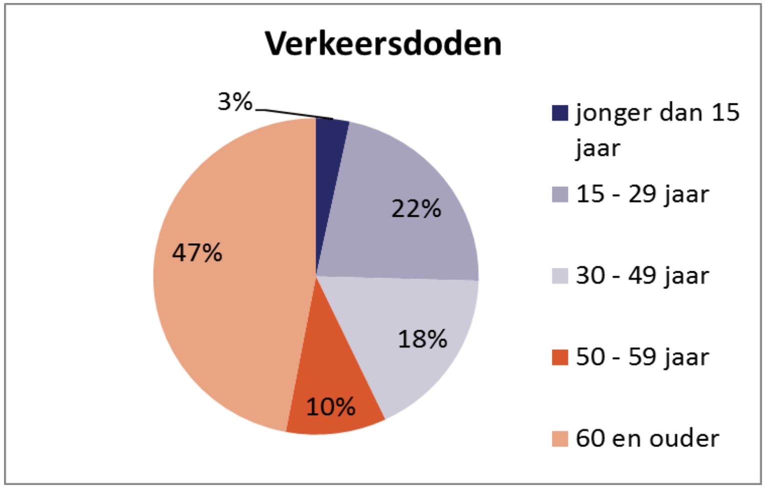


Status of Motor Vehicle Crashes/Fatalities/Injuries

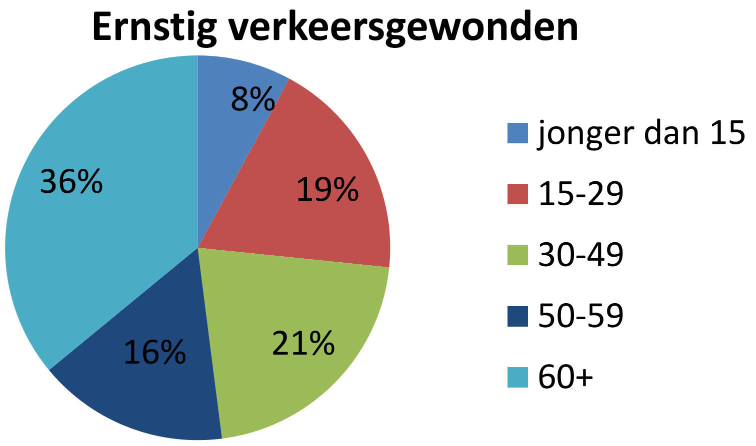
GSR19'

- **Fatalities and severe injuries: percentage related to age**

Fatalities



Severe Injuries



Status of Advances in Motor Vehicle and Infrastructure Safety

GSR19'

- **Extension of the prohibition to use a mobile device from car drivers to cyclists (due 2019)**
- **Campaign to switch off mobile devices while driving ("drive MONO")**
- **Publication of Strategic Plan Road Safety**

Vision how traffic safety can be improved until 2030

- Higher priority
- More and better collaboration between relevant organizations
- Risk-based approach with proper statistical analysis
- Integral approach
- Monitoring the actual effects and adjustments when appropriate

Evolving Research/Rulemaking Strategy

GSR19'

- **2019 introduction of new "Experiments Law"**
  - Stimulating experiments with fully automated vehicles without driver
  - Ministry decides per request
    - RDW coordinates related organizations for the advice to the Ministry
- **Development of a strategy for admittance of innovative vehicles (e.g. e-step)**
  - Supporting innovation without compromising safety
- **Development of a Smart Mobility roadmap**
  - Together with relevant stakeholders (RWS, RDW, CBR, SWOV)
  - Horizon 4 years, including practical consequences
    - Covering safety, security and privacy

Status of Current Key Research Programs

GSR19'

- **National project "Vehicle Safety and Security Framework"**
  - Developing a method to assess safety and security
  - Already used with several OEM's awaiting the UNECE requirements, includes more aspects then the UNECE requirements
- **National project "Vehicle Driving License Framework"**
  - Developing a method to assess the vehicle as driver when in automated mode, used for experiments on public roads
  - Approach is adjusted with other projects (Headstart, …) and results may be used by UNECE working group Validation Method for Automated Driving

Status of Current Key Research Programs

GSR19'

- **Development of ADAS covenant with all Dutch stakeholders to stimulate introduction and use**

Monday, June 10, 2019

Thank you

GOVERNMENT STATUS REPORT OF REPUBLIC OF KOREA

Su-sang KIM
Director General,
Bureau of Motor Vehicles Policy
Ministry of Land, Infrastructure and Transport,
Republic of Korea

Status of Road Traffic Accidents and Policies

Analysis of Road Traffic Accidents Statistics

The fatalities from road traffic accidents steadily decreased due to the Korean government's continuous efforts and the implementation of policies to reduce traffic accidents, while the number of motor vehicle registrations continued to increase over the past 20 years. The number of motor vehicle registrations increased by four folds in 2017 compared to that in 1997, but the fatalities due to traffic accidents decreased by about one third from 1997 to 2017. The fatalities per 100,000 people also declined to below 10 in 2014 for the first time, decreased steadily to 8.1 in 2017.

Table 1. Total fatalities and fatalities per 100,000 (unit: death)

Year	2011	2012	2013	2014	2015	2016	2017
Total Fatalities	5,229	5,392	5,092	4,762	4,621	4,294	4,185
Fatalities per 100,000	10.5	10.8	10.1	9.4	9.1	8.5	8.1
Number of Vehicle Registration (million unit)	18.44	18.87	19.40	20.12	20.99	21.80	22.53

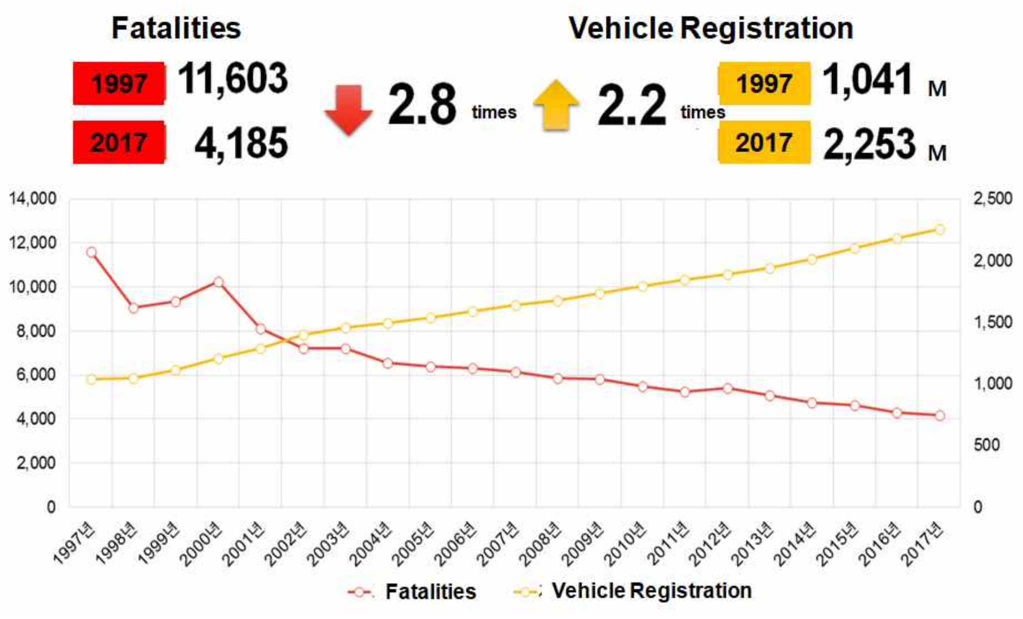


Figure 1. Road traffic fatalities

In order to improve road traffic safety, the Korean government has established a 5-year National Transportation Safety Master Plan every five years. According to the 8th Plan (2017 ~ 2021), the government aims to reduce the fatalities from road traffic accidents to 2,800 or less by 2021 by implementing various measures.

The 2nd Vehicle Policy Framework Plan(2017~2021)

The 2nd Vehicle Policy Framework Plan(2017~2021), established in 2016, sets policy directions for strengthening vehicle safety, strengthening passenger and pedestrian protection from traffic accidents, and implementing vehicle safety and management measures. In particular, regarding the activities for strengthening vehicle safety, the feasibility and implementation studies of international vehicle regulations have been carried out. Regarding international cooperation, Korea has actively participated in the UN ECE WP.29 for the past two years with the aim of strengthening our role in international vehicle regulation legislation.

Activities in International Harmonization of Vehicle Regulations

The Republic Korea is a contracting party to the 1958 Agreement and the 1998 Agreement of UN ECE(United Nations Economic Commission for Europe) WP.29(World Forum for Harmonization of Vehicle Regulations). UN Regulations and UN Global Technical Regulations have been reflected in domestic vehicle regulations.

Researches for International Harmonization of Vehicle Regulations

Since 2006, Korea has introduced international vehicle regulations to domestic vehicle regulations every year based on the feasibility studies to promote international harmonization. From 2017, an annual plan has been established and the feasibility study and implementation of international vehicle regulations have been carried out under the 2nd Vehicle Policy Framework Plan.
In 2019 the studies have been initiated to introduce seven UN Regulations, such as Mechanical coupling(UN Reg 55), the Rollover Stability of Tank Vehicles(UN Reg 111), Superstructure and Seat Strength of a Bus(UN Reg 14, 16, 66, 80, 107).
As of February 2019, about 68% of the domestic vehicle safety regulations were harmonized with international vehicle regulations by introducing 68 UN Regulations and 14 UN Global Technical Regulations. In 2017, 16 items in the domestic vehicle safety regulations were harmonized with UN Regulations including UN Reg 18 and 4 items in the domestic vehicle safety regulations were harmonized with UN Global Technical Regulations including GTR No. 2. Five items in the domestic vehicle safety regulations were harmonized with UN Regulations including UN Reg 77 in 2018.
Table 2 shows the number of items to be revised by year, 16 items of international vehicle regulations to be studied to reflect on domestic vehicle safety regulations, and a total of 43 international vehicle regulations will be reflected on domestic vehicle safety regulations by 2023.

Table 2. Harmonization Rate and Number of Research Items

Category		2019	2020	2021	2022	2023	Total
UN Regulation	to be reflected after study	3	7	4	1	1	16
	to be reflected	10	3	3	2	1	27
UN Global Technical Regulation	to be reflected	4	1	3	-	-	
Number of Items		17	11	10	3	2	43

Activities at UN/ECE WP.29

The Republic of Korea is actively participating in the WP.29 Plenary Meetings and six Expert Meetings(GR) and informal technical group meetings. As of 2019, The Delegate of Korea is serving as Vice-Chairperson of Working Party on Passive Safety(GRSP).

The Delegates of Korea also chair for the informal working group on Panoramic Sunroof Glazing (PSG) to develop an international vehicle regulations to prevent the damage of panorama sunroof and for the informal working group on Deployable Pedestrian Protection System (DPPS) to develop test procedures to mitigate pedestrian injury in pedestrian accidents.
The Delegates of Korea are serving as Vice-Chairperson for the informal working group on 2nd phase Hydrogen and Fuel Cell Vehicles (HFCV) and the informal working group on Vehicle Interior Air Quality (VIAQ) to develop international vehicle regulations in the 2nd phase. The Republic of Korea is actively participating in 13 informal technical working group meetings.
In addition, in order to develop international vehicle regulations for autonomous vehicles, at its February 2018 session, the Inland Transport Committee (ITC) requested WP.29 to consider establishing a dedicated subsidiary Working Party. Following this request, WP.29, at its June 2018 session, decided to convert the Working Party on Brakes and Running Gear (GRRF) into a new Working Party on Automated/Autonomous and Connected Vehicles (GRVA). Five informal technical working group meetings will be operating under GRVA. In response to transition, the Republic of Korea will exercise her full capabilities and participate in the informal technical working group meetings to pursue active roles and activities.

Korean New Car Assessment Program (KNCAP)

The Korean New Car Assessment Program was introduced in 1999 with a full frontal crash test of Hyundai Avante model. Since then, 175 models have been assessed by 2018, and 22 items in the three areas of collision safety, pedestrian safety and accident prevention safety are being evaluated by continuously expanding models and assessment items.
Reflecting technological and social changes such as strengthening the safety of vulnerable road users, cutting-edge automotive technology, and commercialization of autonomous vehicles, the Korean New Car Assessment Program began the evaluation of the collision safety for vulnerable road users such as women drivers and children in 2017. The safety of the accident prevention field was enhanced by including the assessment of ADAS such as AEBS.
To enhance passenger safety in the second row seat the assessment was extended to evaluate the neck injuries of passengers in 2018 and the crash safety of women passengers in 2019. The assessment has been continuously enhanced by evaluating the safety of women and children, whose safety has been somewhat neglected in the program.
In addition, after expanding the number of evaluated ADAS to 13 in 2017 in the accident prevention area, the installation rate of safety devices increased from 57% in 2017 to 66% in 2018 by 9 % points. The Korean New Car Assessment Program played a leading role in enhancing vehicle safety in the accident prevention area.
The second mid to long-term Korean New Car Assessment Program Plan (2019-2023) was established in 2017. The current status of domestic traffic accidents, technological development trends, and overseas NCAP trends were reflected in this Plan according to the 8th National Transportation Safety Master Plan(2017 ~ 2021) and the 2nd Vehicle Policy Framework Plan(2017~2021). In this Plan the following three major strategies and detailed implementations were decided as follows:

A. Strengthening collision protection: Strengthening collision safety of vulnerable occupant such as female passengers in the second row, etc. and strengthening occupant protection in consideration of real world traffic accidents other than typical collision tests.
   1. Safety evaluation of female passengers in the second row seats
   2. Car-to-car collision safety, Far-side passenger safety
   3. Strengthening occupant protection in side impacts
B. Strengthening protection of vulnerable road users: Improving evaluation technology for pedestrian protection with a 40% fatality rate and introducing evaluation for cyclist protection.
   1. Enlargement of pedestrian head impact zone in consideration of vehicle-to-bicycle accidents
   2. A Study on the Improved Pedestrian Leg Model Evaluation Technique
C. Improving accident prevention safety: Encourage the Development and Mandatory Installation of Advanced Emergency Braking System(AEBS), Emergency Steering System (ESF), etc. to cope with

the commercialization of autonomous vehicles in advance.
1. Extending AEBS assessment items to cyclists
2. Research for Evaluation Technology of ESF and Expansion of Evaluation Items
3. Study on the Combined Assessment Scenario of ADAS

Research and Development

Research for the safety assessment technology of autonomous vehicle

The safety assessment technology of autonomous vehicle means a technology for evaluating and verifying the safety of an automobile equipped with autonomous driving technology. As shown in Figure 2, the government's plan to support the commercialization of autonomous driving vehicles focuses on the development of safety assessment technologies and identification of evaluation items that can be applied to level 3 autonomous vehicles safely driven on public highways.

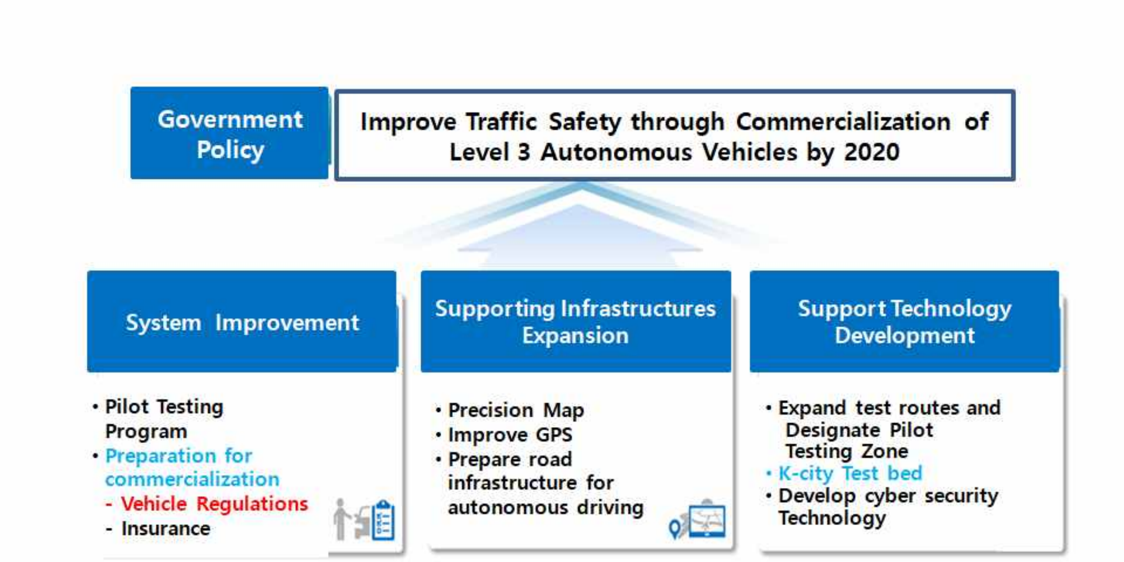


Figure 2. Government Policy for supporting the commercialization of Autonomous Vehicle(5. 2015)

In order to verify and assess the safety of autonomous vehicles the testing environment dedicated to evaluate autonomous driving systems will be established in this study. Also the assessment technology of autonomous driving and fail-safe systems under the normal driving or abnormal situations (including failure conditions) will be developed to assess the safety of the autonomous vehicle. The evaluation technology related to cyber security of autonomous driving systems in the internal and external communication environments will be developed too. Figure 3 shows the overall scope of development processes.

- Establishment of Testing Environment : Establishment of K-City and Evaluation System (e.g. Robo-vehicle) simulating actual roads in order to evaluate autonomous driving systems
- Assessment Technology of Autonomous Driving and Fail-safe Systems: Develop scenario-based evaluation technology to ensure the safe driving of autonomous driving systems in various normal and abnormal conditions such as ODD exit, system failures, emergencies.
- Evaluation Technology of Cyber Security of Autonomous Driving Systems: Conduct a phased study of cyber security of autonomous driving systems in the internal and external communication environments in order to assess the system security against communication disturbances such as jamming radio waves, forgery of communication data and arbitrary collection of operation data.

In order to effectively study and verify these detailed technologies, a consortium of 16 organizations including Hyundai Motors and Seoul National University has been established by the Korea Automobile Testing and Research Institute(KATRI). From June 2016 to June 2019, a total of 21.7 billion wons(roughly 20 million dollars) was funded(including the government fund of 18 billion wons(roughly 16 million dollars)).

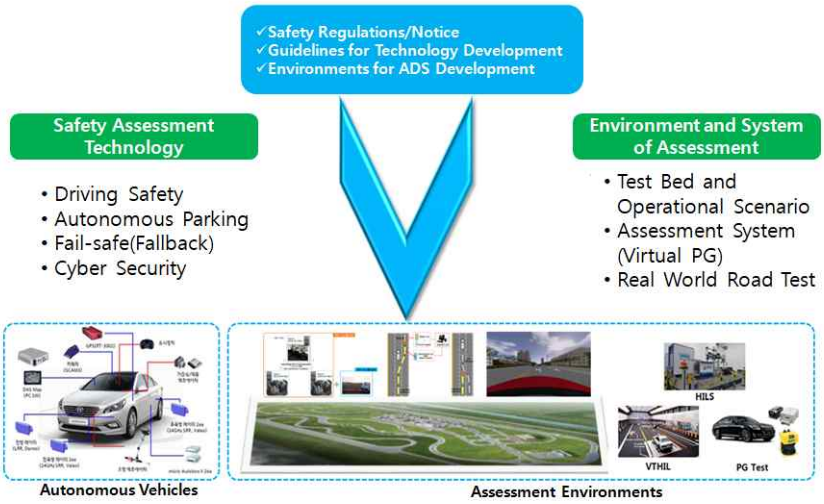


Figure 3. Overview of Assessment Technology Research for Autonomous Vehicle

Based on the research results of this project, the government will amend the existing legal system and present the safety guidelines for of autonomous driving vehicles(motor vehicle safety regulations, NCAP). The government will pave the road for the commercialization of level 3 autonomous driving vehicles on dedicated highways by 2020. Also The government is actively participating in international regulation activities related to autonomous vehicles such as UN/ECE WP29.

Construction of K-City, Test bed for autonomous driving vehicles

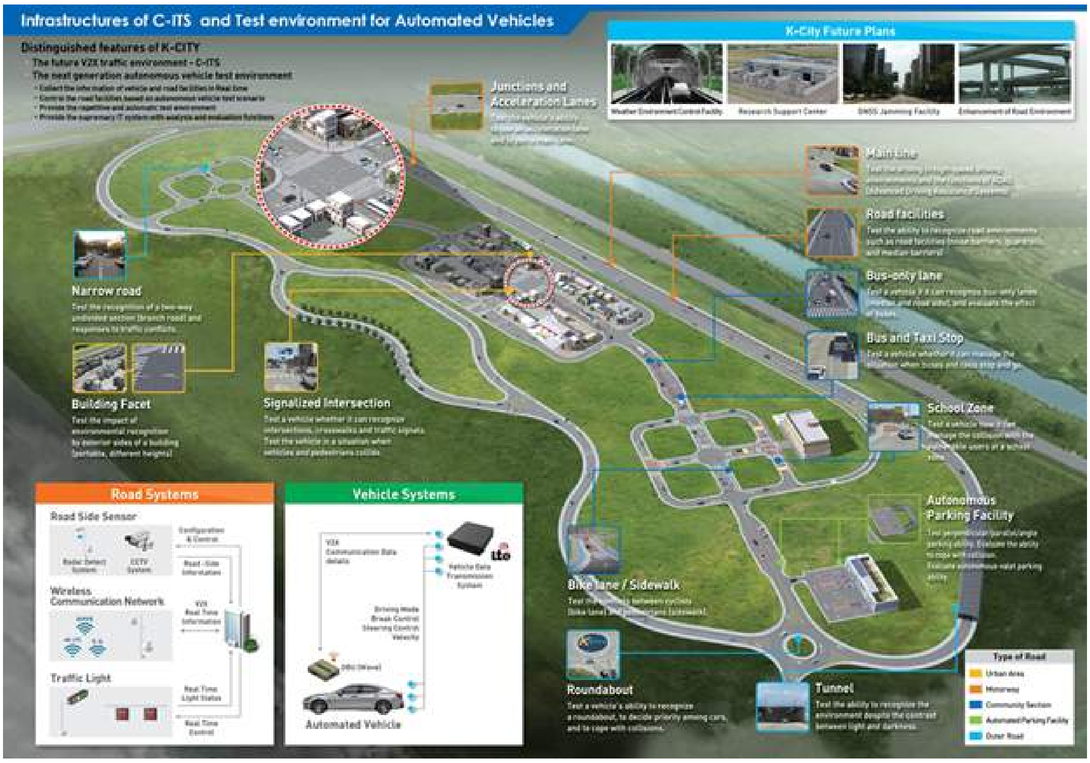


Figure 4. K-City Enhancement Project

- Location : KATRI Proving Ground(Hwaseong city, Gyeonggi-do)
- Composition : motorway, urban area, rural area, residential area(school zone), autonomous parking area
- Size : 3.6 million m2, 5.5km

K-City, a test bed that allows autonomous vehicles to be operated repeatedly and reproduciblely in a real world environment, was opened on 10 Dec. 2018. It has been open to small and medium-sized businesses and universities without charges for three months since March to support active development of autonomous driving vehicle technologies.
K-City, shown in Figure 4, provides comprehensive communication environments such as WAVE, LTE and 5G in addition to road infrastructures. It provides 15 virtual service of co-operative Intelligent Transportation Systems (C-ITS) compliant with domestic standards. It is possible to test level 3 or higher autonomous vehicles, too.
In addition, the Ministry of Land, Infrastructure and Transport will build an advanced testing facility that can provide harsh test environments such as weather conditions of rainfall, fog, and communication disturbance like GPS jamming under the K-City Enhancement Project.
It plans to provide an integrated environment for development of autonomous vehicles by adding maintenance centers and data analysis stations in consideration of the characteristics of autonomous vehicles

Autonomous Vehicles DVI

The government aims to establish legal systems to allow the commercialization of level 3 autonomous vehicles(refer to SAE J3016) by 2020 and revise overall systems allow level 5 autonomous vehicles by 2022.
At level 3 of autonomous driving vehicles, the control of the vehicle can be switched between the system and the driver.
In case autonomous driving system experiences a system failure, it needs to develop evaluation technology to verify and ensure the safe transition of vehicle control to a driver.
In addition, this study was conducted to devise measures to promote user acceptance of autonomous vehicles.
DVI research aims to develop elemental technologies to verify the safe transition of vehicle control to a driver and to improve user acceptance in preparation for the commercialization of autonomous driving technology.
In this project there are three main sub-projects as follows; "Development of Evaluation Criteria and Evaluation Platform for Control Transition of Autonomous Driving Vehicles", "In-depth Research and Development of Human Factors and DB in Autonomous Driving Situations", "Improvement of Legal, Ethical, Technical, and Standard Perspectives for Improving Social Acceptance"
KATRI and 21 other agencies are carrying out these projects with a budget of 15.5 billion wons(roughly 13.5 million dollars) from 2017 to 2020. Through this, it is going to ensure the safe transition of vehicle control and present DVI design guidelines. We also expect to resolve distrust and anxiety over autonomous vehicles and protect the lives and property of the people.

Current Status of Amendments to Domestic Safety Regulations

Expansion of Vehicles Categories subject to ESC(14. 11. 2017)

The electronic stability control is a computerized technology that improves a vehicle's stability by detecting and reducing loss of traction. ESC will be applied to all vehicle categories while it was previously applied to passenger vehicles and small trucks with GVW 4.5 tons or less to. Dump trucks and special purpose trucks are exempted.

Safety Regulations for MicroCar(refers to L7 in ECE Regulation) (11. 7. 2018)

Safety regulations for microcars were established on 11. 7. 2018. The criteria for this category are the vehicle weight 600 kg for passenger vehicle, 705 kg for goods, and the maximum speed of 80 km/h. Some Regulations, such as braking, head restraint, esc, seat back, were relaxed. Some Regulations, such as headlamps, braking lamps, etc. were prepared in consideration of vehicle dimensions.

Expansion of Vehicles Categories subject to AEBS and LDWS(11. 7. 2018)

AEBS and LDWS is applied to all buses and trucks and special-purpose trucks with GVW of 3.5 tons or more to prevent vehicle accidents involving heavy vehicles. This requirement was in force from 1. 1. 2019 for buses with a pneumatic service brake, 1. 7. 2021 for other vehicles. Mini-sized buses are exempted.

Relaxation of Ground Clearance and Various Materials for Windows(31. 12. 2018)

The ground clearance regulation was amended from 12 cm to 10 cm to accommodate the dimensions of speed bumps. Various materials are allowed for windows. The direction of an exhaust pipe was relaxed to give more flexibility for vehicle design and performance.

Improvement for Lift Axle and Retro-reflective Markings(31. 12. 2018)

Lift Axles shall be automatically lifted or lowered according to goods weight to prevent serious traffic accidents involving overloaded heavy trucks. Regulations for Retro-reflective Markings was harmonized with UN-R48 and UN-R104 to prevent traffic accidents, such as rear end collision with trucks in the night. Retro-reflective Markings should be fitted on the sides and rear of a truck.

Harmonization of Collision Regulations with International Regulations(31. 12. 2018)

The existing collision regulations similar to US FMVSS were harmonized with UN-R94, UN-R95, UN-R135, UN-R137 in case of off-set frontal collision and pole side impact in consideration of various collision accident types due to changes in the traffic environments.

Conclusion

The Korean government has been making diverse efforts through international cooperation and developing efficient policies to pave the roads in advance for future motor vehicles such as autonomous vehicles and to enhance safety. The Ministry of Land, Infrastructure and Transport has proposed a road map for Korean New Car Assessment Program, which further strengthens vehicle safety even beyond the scope of safety regulations. In addition, the 1st phase of K-City for testing autonomous vehicles was completed so that it provides a place for domestic and overseas vehicle manufacturers to be able to perform the tests of Level 3 autonomous vehicles. Through the K-City Enhancement Project KATRI plans to provide an integrated environment for the development of autonomous vehicles. The Ministry of Land, Infrastructure and Transport strongly promotes the international harmonization of vehicle regulations and will make every effort to build an environment to enhance the safety of future vehicle technology.

REFERENCES

[1] MOLIT, 2017, The 8th Transportation Safety Master Plan
[2] National Police Agency, 2019, "2017 Load Traffic Safety a White Paper
[3] MOLIT, 2016, The 2nd Vehicle Policy Master Plan (2017-2021)
[4] MOLIT, 2018, KNCAP 2023 Roadmap
[5] MOLIT, 2018, Korean Motor Vehicle Safety Standard: KMVSS

GOVERNMENT STATUS REPORT, 2019

Dr. Ir. Peter Striekwold

RDW, special advisor to the director

The Netherlands

Status of Motor Vehicle Crashes/Fatalities/Injuries

The trend of a yearly decrease in road victims was not seen in the last two years. In 2017, there were 613 casualties and 20.800 severely injured. The percentage of casualties with cars equals that for cyclists. Casualties under cyclists are on average above 60 years old. The majority of severely injured persons are caused in accidents with bicycles without a motor vehicle.

Status of Advances in Motor Vehicle and Infrastructure Safety

In order to further decrease casualties and injuries a number developments have taken place. One action is to extend the prohibition to use mobile devices during driving from car drivers to cyclists. Also, a campaign was developed to stimulate people to switch of the mobile devices when driving, e.g. by using apps or others ways which may arrange this automatically. Moreover, a new Strategic Plan Road Safety has been published, with a huge number of different actions to improve road safety. These methods include improved collaboration between stakeholders, introducing risk-based approaches with proper statistical analyses and monitoring the actual effects in order to find out if and where adjustments are appropriate.

Evolving Research/Rulemaking Strategy

With regard to Research and Rulemaking, a number of developments are worthwhile mentioning. The first one it the introduction of the new “Experiments Law”. This law stimulates experiments with fully automated vehicles without a driver on public roads. Several stakeholders for road safety are involved in the preparation of the decision by the Ministry. The second one is the development of a strategy for admittance of innovative vehicles like e-steps. Some of these innovative vehicles do not fit in existing regulation, and safety should not be compromised whereas on the other hand there is a desire to support innovation. Finally, the Ministry started development of a Smart Mobility roadmap. With a 4 year horizon, together with other institutes for road safety, relevant changes in legislation are identified, supporting Safety, Security and Privacy.

Status of Current Key Research Programs

There are three elements in the current research programs. The first one is the development of a Vehicle Safety and Security Framework. This method is developed to assess safety and security for new vehicles, including OEM’s processes. This framework is developed in collaboration with some of our type approval OEM’s and includes elements of UNECE work (Security/Updates/Validation Methods). In addition, the second program is related to the determination of the driving capabilities of automated functions. In order to support the new Experiments Law, we are developing criteria and methods to decide if the automated functions can replace the human driver. The experience from application of this framework might be input for future legislation. The third part in our program is the development of an ADAS covenant to stimulate introduction and above all proper use of automated functions by drivers.

TIM JOHNSON| NHTSA
United States Department of Transportation

UNITED STATES GOVERNMENT STATUS REPORT

There were 37,133 people killed in motor vehicle traffic crashes on U.S. roadways during 2017, a 1.8-percent decrease from 37,806 people killed in 2016. The 2017 increase followed two yearly consecutive increases in 2015 and 2016.

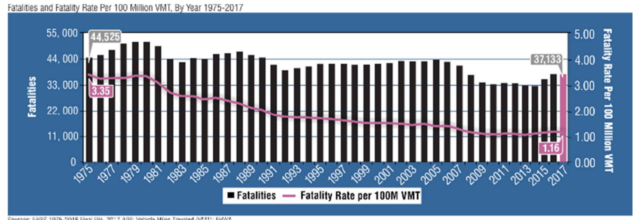
10.8-percent decrease from 37,806 806 people killed in 2016

TRENDS IN ROADWAY FATALITIES

Over the past 40 years, there has been a general downward trend in traffic fatalities. Safety programs such as those increasing seat belt use and reducing impaired driving have substantially lowered the traffic fatalities over the years. Vehicle improvements such as air bags and electronic stability control have also contributed to the reduction of traffic fatalities.

Beginning in 2015, the long-term decline in fatalities on U.S. roadways began to shift, raising questions about the general decline in deaths and whether a new pattern was emerging. The 37,133 motor vehicle traffic fatalities in 2017 are 673 fewer fatalities than the 37,806 that occurred in 2016. The 1.8-percent decrease compares to the 6.5-percent increase from 2015 to 2016 and the 8.4-percent increase from 2014 to 2015. NHTSA has been closely monitoring the yearly changes in fatality data and the constructs and characteristics of those fatal incidents.

Fatalities and Fatality Rate Per 100 Million VMT, By Year 1975-2017

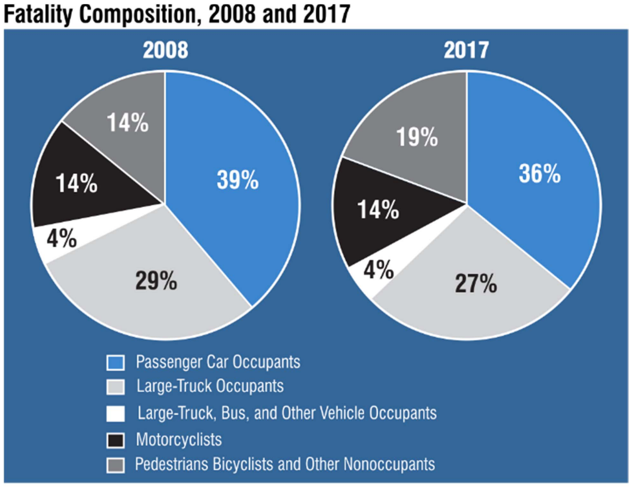


Sources: FARS 1975-2016 Final File, 2017 ARF; Vehicle Miles Traveled (VMT): FHWA

The fatality rate per 100 million vehicle miles travelled (VMT) decreased by 2.5 percent from 1.19 in 2016 to 1.16 in 2017. The 2017 rates are based on VMT estimates from the Federal Highway Administration's (FHWA) May 2018 Traffic Volume Trends (TVT). Overall, 2017 VMT increased by 1.2 percent from 2016 VMT – from 3,174 billion to 3,213 billion. This 2017 VMT increase of 1.2 percent is less than the increase of 2.6 percent from 2015 to 2016.

Looking at a 10-year change in fatalities based on the type of vehicle the occupant was in or if the person was outside a vehicle shows the major shifts over this time. The fatality compositions for 2008 and 2017 are shown in the figure. The biggest change is the proportion of nonoccupant fatalities, which increased from 14 percent to 19 percent from 2008 to 2017. During this same decade, the percentage of passenger car occupant fatalities decreased from 39 percent of the fatalities to 36 percent. The percentage of light-truck occupant fatalities decreased from 29 percent in 2008 to 27 percent in 2017. The proportion of motorcyclist fatalities stayed the same, at 14 percent.

Fatality Composition, 2008 and 2017



Source: FARS 2008 Final File, 2017 ARF
Note: Sum of individual slices may not add up to 100 percent due to rounding.

Recent Crash-Related Statistics

Certain crash characteristics stand out for the 2017 year.

In 2016 and 2017, urban fatalities have overtaken rural fatalities with an emerging trend towards an increasing divide. The U.S., in general, has seen a resurgence in urban living in recent years which could contribute to this change in fatality location.

Notable in 2017 was that 6,988 nonoccupants were killed in motor vehicle crashes – this includes pedestrians, bicyclists and other nonoccupants. While there was a slight decrease in nonoccupant fatalities, the general trend for this group of individuals has been increasing since 2010.

In 2017, 10,874 people died on U.S. roadways in crashes involving an alcohol-impaired driver. An alcohol-impaired driving fatality is defined as a fatality in a crash involving a driver or motorcycle rider (operator) with a blood alcohol concentration of .08 grams per deciliter (g/dL) or greater. These deaths constitute 29 percent of all fatalities in the year. Most alarming of these fatality figures is the number of large truck drivers involved. Alcohol-impaired drivers of large trucks involved in fatal crashes had the largest percent increase of 61.1 percent from 2016 to 2017, and this is at a .08 g/dL. However, commercial drivers that often drive large trucks, have a lower threshold for legal intoxication than the general public which makes the data striking.

Alcohol-Impaired* Drivers Involved in Fatal Crashes by Vehicle Type, 2016 and 2017

Type	2016	2017	Change	% Change
Passenger Car	4,411	4,297	-114	-2.6%
Light Truck - Van	280	284	+4	+1.4%
Light Truck - Utility	1,632	1,721	+89	+5.5%
Light Truck - Pickup	2,030	1,932	+98	-4.8%
Motorcycle	1,425	1,454	+29	+2.0%
Large Truck	72	116	+44	+61.1%

Source: FARS 2016 Final File, 2017 ARF
*See definition in text.

Restraint use, measured by the National Occupant Protection Use Survey (NOPUS) in a roadside observational survey, in 2017 was 89.7 percent. This contrasts with only 53 percent restraint use for those occupants that died in passenger vehicles in crashes in 2017 as reported through the Fatality Analysis Reporting System.

DATA MODERNIZATION

NHTSA has collected crash data since the early 1970s to support its mission to reduce motor vehicle crashes, injuries, and deaths on our Nation’s highways. The Fatality Analysis Reporting

System (FARS) is a census of fatal crashes in the 50 States, the District of Columbia, and Puerto Rico (Puerto Rico is not included in the U.S. totals discussed above). This system has been in place since the 1970s and remains the data collection source for fatalities on U.S. roadways. However, NHTSA's National Center for Statistics and Analysis redesigned the nationally representative sample of police-reported traffic crashes, which enables NHTSA to estimate the number of police-reported injury and property-damage-only crashes in the United States. The new system, called the Crash Report Sampling System (CRSS), replaced National Automotive Sampling System (NASS) General Estimates System (GES) in 2016. The 2016 CRSS data was initially released in March 2018 and rereleased with corrections in May 2018. This is the latest year for which CRSS data is available.

In 2016, there were an estimated 7,277,000 police-reported traffic crashes, in which estimated 3,144,000 people were injured. There were an estimated 5,065,000 property-damage-only crashes in 2016. A direct comparison of the 2016 injury, and property-damage-only crash estimates cannot be made with any previous year, due to the change in data collection practices.

VEHICLE SAFETY RESEARCH

NHTSA's Office of Vehicle Safety Research executes short- and long-term research projects with the goal of providing a scientific basis to help inform future agency decisions. The research covers all phases of the crash scenario – advanced pre-crash and crash-avoidance warnings, technologies, and equipment; occupant protection and vehicle behavior during a crash; and post-crash vehicle integrity, egress, and notifications. Emerging technologies are a constant source of research activities which offer the opportunity to encourage the safety of the technologies, conduct assessments and develop performance criteria and test procedures when necessary.

Advanced Driver Assistance Systems – Current crash avoidance systems rely on sensors such as radar, lidar, camera, ultrasonic, and others to detect potential collisions with other vehicles, pedestrians, or objects and then warn the driver to take appropriate action, as well as technologies that automatically intervene by applying brakes or providing steering inputs to avoid or mitigate a crash if the driver's actions are delayed or insufficient. Advanced driver assistance systems (ADAS) provide the driver with added convenience, safety or functionality during "normal" driving scenarios, but still require the driver to be fully engaged in the driving task. The overall objective of NHTSA's ADAS research program is to provide automotive industry stakeholders with information, analyses, and tools to help evaluate and advance the safe development and deployment of these crash avoidance systems. When appropriate, the program also facilitates (e.g. by developing more technologically neutral performance criteria and test procedures) the removal of unnecessary regulatory barriers that may prevent introduction of these systems.

Automated Driving Systems – Vehicle Safety Research's focus on Automated Driving Systems (ADS) aims to establish a safety assessment framework, contribute to the body of knowledge, and provide leadership that advances the safe testing and deployment of ADSs such that their benefits are optimized and risks appropriately mitigated. Current and upcoming efforts address the technical challenges associated with safe testing and deployment of SAE automation levels 3 through 5 – conditional, high, and full – driving automation. NHTSA's ADS research follows *Automated Driving Systems 2.0: A Vision for Safety*, the Secretary's strategic goals, *Preparing for the Future of Transportation: Automated Vehicles 3.0*, and involves efforts with stakeholders, other DOT modal administrations, States and other federal agencies. While interests of the different types of stakeholders vary widely, the main goal of the NHTSA ADS research is to support the development of safety criteria, metrics, and assessment methods for ADSs. This is a challenge of considerable breadth and depth that the agency is still in the early stages of addressing.

Crashworthiness – This research program focuses on understanding causes of human injury in motor vehicle crashes and vehicle safety countermeasures that can reduce their severity and frequency of occurrence. This program is responsible for developing and upgrading test procedures for evaluating motor vehicle crash safety and developing associated test tools, such as crash test dummies and injury metrics. Crashworthiness research encompasses new and improved vehicle design, biomechanics and injury causation, field data collection and analysis of serious injury cases, and safety countermeasures and vehicle equipment to enhance safety for all road users. Current and upcoming research includes evaluating the safety of occupants in vehicles with Automated Driving Systems (ADS – SAE International Automation Levels 3-5) due to potential non-traditional occupant compartment designs and seating conditions. Additional research is ongoing related to the safety of alternative fuel vehicles safety including electric and hydrogen vehicles.

Human Factors – The effectiveness of many crash avoidance technologies available on motor vehicles relies in part on the way the (human) driver interfaces with the system – ranging from simply whether (or not) they engage the system (i.e., controls), to how warnings are conveyed (i.e., driver-vehicle interface). Other factors include a driver's ability to regain situational awareness and make and execute a correct decision quickly enough. In addition, more advanced driving automation systems (that are anything short of "fully automated") also rely on the driver's ability to properly understand the capabilities, constraints, and control settings of driving automation – including the circumstances and way the human driver takes-over or "partners" with the automated systems to complete the driving task. Even fully automated systems may need some degree of user engagement to ensure safe operation. Efforts within Vehicle Safety Research aim to: establish a basis for efficient and objective methods for evaluating driver-vehicle interfaces; use such methods to profile effective interface design approaches; understand how driver readiness (or "state") may impact the efficacy of such designs and engagement methods; and, determine if and how drivers may adapt to such technologies, thereby also impacting effectiveness (either positively or negatively).

Vehicle Cybersecurity – Digital electronics that include many new safety, mobility, and efficiency features commonly are included in modern vehicles today. These software-intensive functions, and wired and wireless data exchange interfaces, introduce cybersecurity challenges and potential safety concerns. While cybersecurity is germane to data security, intellectual property, and privacy, NHTSA is primarily focused on the safety implications of vehicle cybersecurity. NHTSA's Research activities include research tracks that identify risks, defensive methods, test tools, and ecosystem factors impacting vehicle security; lifecycle cybersecurity risk management; processes that manage associated safety and security risks; and efforts to identify emerging research opportunities that have the potential to facilitate continuous improvement in the cybersecurity of motor vehicles.

RESEARCH AREA ACTIVITIES

Crashworthiness

The crashworthiness research program is responsible for developing and upgrading test procedures for evaluating motor vehicle safety and developing the test devices and appropriate injury metrics. The purpose of the program is to investigate the problems of vehicle crash safety and associated factors that contribute to serious injuries and fatalities. Ongoing research includes:

- Biomechanics research to develop publicly available data, tools, performance measures, and procedures;
- Work with trauma centers to understand the detailed nature of occupant injuries;
- Completing biofidelity testing and development of associated requirements for tools to be used in the assessment of potential alternative seating arrangements that are forecasted for ADS-equipped vehicles;
- Safety Systems research to utilize the tools developed through Biomechanics and begin development strategies for enhancing occupant safety for alternative seating arrangements;
- Completion of technical documents for the THOR 5th percentile female;
- Evaluation of potential crash interaction between current vehicles and commercial ADS-equipped vehicles designed to carry cargo without occupants.

Crash Avoidance

Given that more than seven million police-reported crashes occur every year in the U.S., NHTSA sees an increased emphasis on crash avoidance and driver assistance technologies. These technologies have the potential to reduce fatalities and injuries by preventing the crash from occurring, or reducing the severity of crashes by providing timely warnings to the driver to take appropriate action. NHTSA's continued research activities in crash avoidance include:

- ADAS research, which includes SAE level 0-2 vehicles, to develop objective test procedures and performance evaluation methods;
- Evaluation of system reliability, unintended consequences, and potential safety benefits of new emerging ADAS technologies;

- Understanding performance characteristics and operational envelope of crash avoidance technology and systems;
- Assisting the agency in developing approaches to addressing potential regulatory barriers for emerging driver assistance systems;
- Human Factors research to help develop the community's understanding around the safety impacts of human-machine interface approaches as well as potential longer term behavioral changes related to ADAS uses and how they might impact safety outcomes.

Alternative Fuel Safety

Recently introduced vehicle engine technologies, including hydrogen and advanced lithium ion battery vehicles, are being introduced to the market at a fast rate. This research will examine the safety issues and promote research to enhance industry best practices. NHTSA will continue to perform research activities such as:

- Continuing fleet safety validation testing of high voltage traction battery systems;
- Conducting thermal propagation testing at the pack- and full-vehicle level to assess test procedure suitability and evaluate performance criteria;
- Assessing battery management system. functionality, including all levels of charging.
- Developing and evaluating lithium ion battery diagnostics that can detect damage prior to battery fire initiation;
- Evaluating the safety of the fiber-wrapped pressure vessels used for storing high pressure hydrogen and compressed natural gas in vehicle systems. Refine, demonstrate, and document safety best practices for laboratory testing.

Vehicle Electronic and Emerging Technology

This program advances NHTSA's expertise in vehicle electronics to address the safety and security of emerging electronics and software technologies, and their implications to the safety of vehicle occupants and other road users. NHTSA will continue to pursue the following activities:

- Perform cybersecurity research to facilitate cyber-resilient vehicle designs that mitigate safety risks. This includes a focus on developing test and validation approaches to vehicle software, application of the NIST framework to automotive architectures, and assessing wireless interface vulnerabilities.
- Expand functional safety research to include emerging subsystems used to support advanced technology vehicle designs including perception/sensor systems and decision-support software.

Automated Driving Systems

Preliminary research indicates that there is the potential for significant safety enhancement associated with Automated Driving Systems (ADS), which includes SAE level 3-5 vehicles. The main goal of the ADS research program is to assure that ADS are being designed, operated, and used safely within their given operational design domain. NHTSA activities include:

- Research to support policy decisions on potential changes to federal safety standards to facilitate continued safe innovation in ADS technologies;

- Perform research with key stakeholders, including the automotive industry, standards setting organizations, academia, and other safety organizations to refine safety principles for ADS, and develop test procedures and performance criteria;
- Complete critical human factors research including research on “takeover-ready driver” attributes and governing factors for SAE L3 systems as well as research on how ADS can communicate their intent with other road users (drivers, pedestrians, and cyclists);
- Initiate new research on the ADS design needs for disabled and vulnerable populations;
- Perform crashworthiness research to develop test tools to support safety testing of future ADS vehicle designs with non-traditional seating (as outlined above in the *crashworthiness* activities area).