GOVERNMENT STATUS REPORT, SWEDEN 2023

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SWEDISH ROAD SAFETY ORGANISATION

The Ministry of Infrastructure is responsible for road traffic safety in Sweden. However, due to the decentralized structure in Sweden, the Ministry works with budget, targets, and policy related issues while the operations are managed by the **Swedish Transport Administration** based on the directions from the Ministry. The Administration is responsible for the planning of the entire transport system with all modes of transport. It is also responsible for building and maintaining roads and railroads. The Swedish Transport Administration also has an overarching role in the development of long-term strategies and plans for all modes of transport in the transport system, contributing to the targets set up by the government for the transport sector. The Transport Administration holds responsibility for research within the fields of mobility, environment and traffic safety. In-depth studies of each fatal crash in road traffic are also performed. The Transport Administration has the task of coordinating the road safety work in Sweden in collaboration with other stakeholders.

The other authority in the transport sector is the **Swedish Transport Agency** which has overall responsibility for regulations within air, sea, rail road and road traffic. Within the Swedish Transport Agency the Road and Railway Department formulates regulations, examines and grants permits, as well as exercise supervision within the field of road transport over e.g. road traffic, vehicles, driving licenses and commercial transport. The agency also conducts analyses of road traffic and manages the reporting of injury crashes within the road transport system. The Swedish Transport Agency also manages vehicle and driver license registers.

The Swedish Transport Administration and the Swedish Transport Agency are both responsible to work towards the transport policy targets. In Sweden the main other bodies active in road traffic safety efforts are the police, the local authorities and the vehicle importers association. Other important parties are the NGOs, for example the National Society for Road Safety (NTF), with its member organizations, and transport industry organizations. The Group for National Road Safety Co-operation (GNS) is a central body that coordinates the co-operation between the Swedish Transport Administration and Agency, the local authorities, the authority for occupational health and safety and the police.

ROAD TRAFFIC FATALITIES AND MANAGEMENTS BY OBJECTIVES

The Swedish overarching long-term safety objective within the road transport system was settled 25 years ago, in 1997, when the Swedish parliament voted for the “Vision Zero”. This vision states that ultimately no one should be killed or seriously injured in the road transport system (Johansson, 2009). The design and function of the system should be adapted to the conditions required to achieve this target. Since Sweden introduced a visionary goal in the middle of the 1990s several jurisdictions have taken the same approach. In some jurisdictions the name has been changed to Safe Systems Approach to avoid the strong focus on the number zero (OECD, 2008; ITF, 2016). The UN General Assembly Resolution 74/299 declared the current decade of action for road safety with the target to reduce road traffic deaths and injuries by at least 50% during the period 2021-2030 (UN, 2020), and the Commission of the European Communities has in its White Paper on transports set out the goal “by 2050, move close to zero fatalities in road transport” (EC, 2020).

In 2016 the Ministry of Infrastructure made a renewed commitment to Vision Zero (Swedish Government, 2016). The current Swedish road safety operation is based on a system of management by objectives. This system is based on cooperation between stakeholders, targets on Safety Performance Indicators (SPIs), and annual result conferences where road safety developments and targets are followed up. The aim is to create long-term and systematic road safety cooperation between stakeholders. The previous target for the period 2007-2020 aimed at reducing the number of road traffic fatalities and serious injuries by 50% and 25%, respectively. This meant a maximum of 220 fatalities in 2020. The targets for 2020, both in terms of fatalities and serious injured, were achieved and the positive trends for several SPIs during the period 2007–2020 can explain a large part of the target achievement. This applies especially to SPIs with great traffic safety benefits such as reduced average travel speed, increased vehicle mileage with safe cars, increased vehicle mileage on divided roads, and increased use of seat belts.

In February 2020, the government decided on a new road safety target for 2030, aiming at reducing the number of fatalities and serious injuries by 50% and 25%, respectively. The baseline for these reductions was set as the averages for the years 2017-2019, thus resulting in a target of maximum 133 fatalities by 2030.

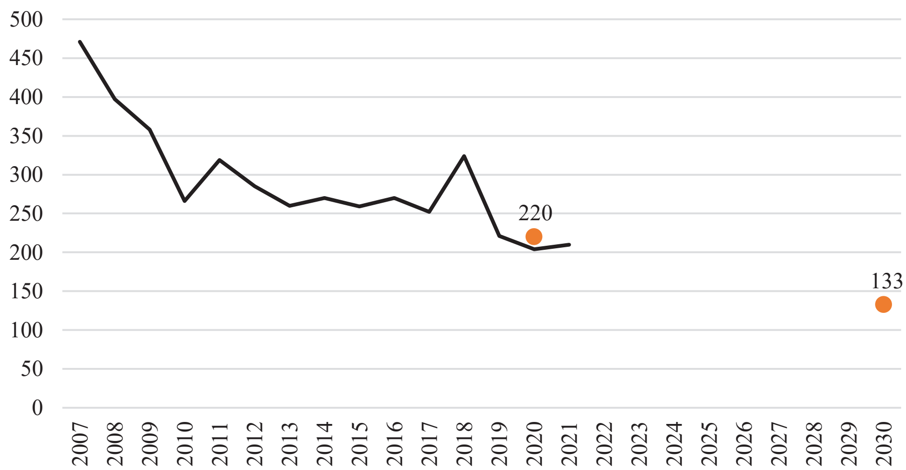

Figure 1. Number of fatalities in Swedish road traffic since 2007. The 2020 and 2030 targets are shown in orange. Since 2010, suicide in road traffic is no longer included among road traffic fatalities.

In 2021, 210 fatalities were recorded in Swedish road traffic. The outcome for 2020 and 2021 were unarguably influenced by changed boundary conditions in society due to the pandemic, for instance reduced vehicle mileage and changes in the composition of traffic. Although vehicle mileage returned to more normal levels towards the end of 2021, measurements showed a decrease of 5.1% for the whole year compared to 2019, i.e. before the pandemic. Compared to 2020, the vehicle mileage in 2021 increased by 4.2%. The pandemic has also led to increased unemployment, which historically has led to fewer fatalities and seriously injured (ITF, 2015). With roughly 200 fatalities per year Sweden is one of the safest countries when it comes to road traffic, with a level of 2.1 fatalities per 100,000 population in 2021. This is about half of the European Union risk average (4.2 fatalities per 100,000 population in 2021). As shown in Figure 2, the 2030 interim target would imply approximately 1.2 fatalities per 100,000 population, assuming an increase of Swedish population to approximately 11 million (SCB, 2022).

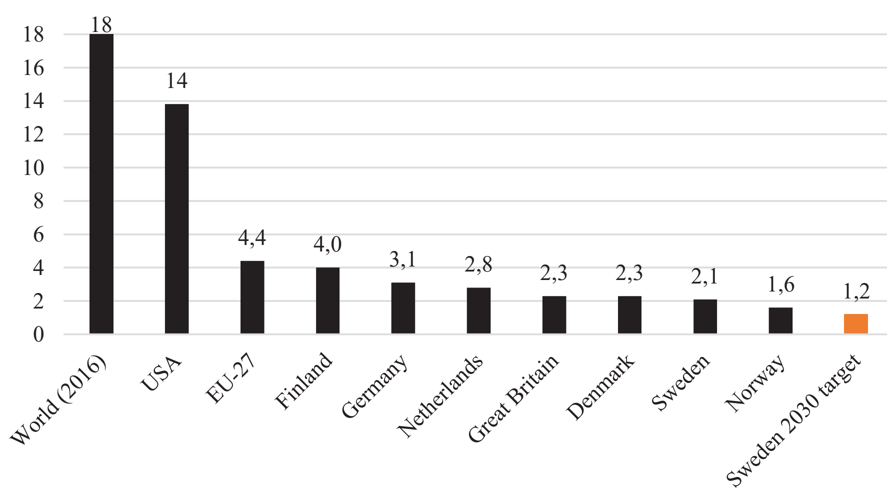

Figure 2. Number of road traffic fatalities per 100,000 population in 2021.

ALIGNING CRASH SEVERITY WITH CRASH PROTECTION

With the Vision Zero approach, an injured or killed road user is a victim of an inadequately designed road transport system unable to protect him/her from the human inability to handle certain complex traffic situations. The aim of the Vision Zero approach is not to totally eliminate the number of crashes but to align the crash severity with the potential to protect from bodily harm. This puts much greater focus on injury prevention, rather than crash prevention. Avoiding crashes is only one strategy if fatalities and severe injuries are to be eliminated. By focusing on the injury outcome, rather than crashes, the problem will have another profile and different countermeasures can be developed. An attempt to structure the problem was firstly done in a multidimensional model for safe driving by Tingvall and Lie in 1997.

This model has been previously used to analyze fatal crashes from 1998 and 1999, and more recently by the Swedish Transport Administration using 2016-2018 data. Every fatal case was classified in three groups, as follows.

1. The road users made a mistake or misjudgment, leading to a crash with fatal outcome,
2. The killed road users failed to protect themselves by using seat belts, helmets, etc,
3. The road users deliberately and widely overstepped the traffic rules and regulations and consequently exposed themselves to high crash severity beyond survival.

The results for the analysis based on 2016-2018 fatal crashes are shown in Figure 3. The classification of the fatal crashes shows that harmonizing the vehicle design, the road design and the travelling speed can do major improvements. It also shows that illegal behaviors involving deliberate violations (most often severe speeding) are a limited problem. However, it should be noted that minor offences of the speed limits were considered a mistake, not a deliberate violation, and were therefore coded in the first group.

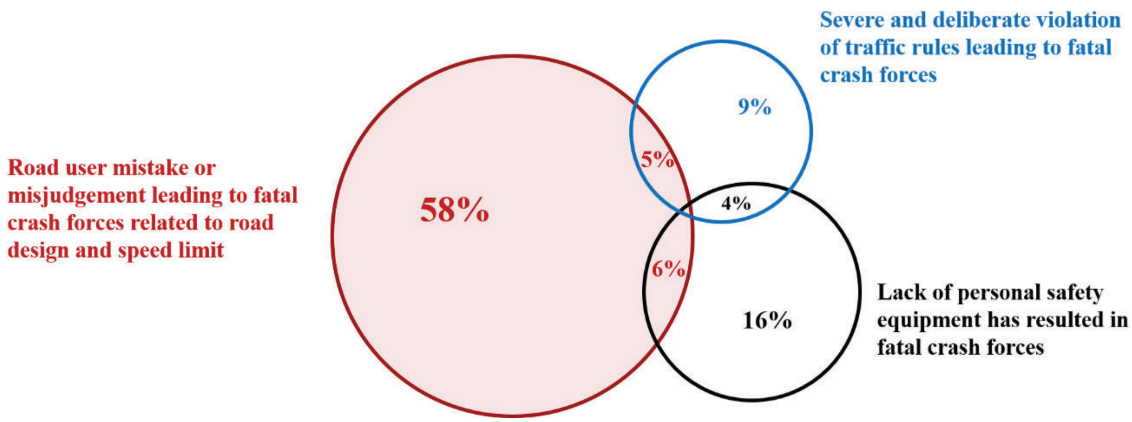

Figure 3. Classification of fatal crashes in Sweden 2016-2018.

Different trauma reduction strategies may be used to address fatalities in different groups. The largest group (up to 69%) consisted of road users being killed due to a mismatch between the crash severity they were exposed to, and the level of protection they were given. This implies that in order to address the gap, we would need to:

- lower the crash severity by lowering the collision speed, for instance with Autonomous Emergency Braking and/or lower travelling speeds.
- Increase the crash protection, for instance with increased vehicle crashworthiness, further developed personal safety equipment, and more crashworthy road designs.
- A combination of both lowered crash severity and increased crash protection.

The second group (up to 26%) consisted of road users who would have survived the crash if they had used seat belts or helmets. It should be noted that, unrestrained occupants of cars fitted with Seat Belt Reminders (SBR) were also coded in this group. In order to address these fatalities, further development and implementation of effective SBRs would be needed, in combination with other strategies aiming at increasing helmet use rates among bicyclists and PTW riders.

The third group (up to 18%) consisted of road users who deliberately exposed themselves to a high crash severity, most often through severe speed limit violations. Strategies to address such fatalities would include, among other things, police enforcement and vehicle technologies that actively control travel speed.

Overall, the results of this analysis suggested that more needs to be done to align crash severity with crash protection, thus providing valuable insights for the following steps aiming at the development of a new road safety strategy and a set of Safety Performance Indicators.

DEVELOPMENT OF ROAD SAFETY STRATEGY TO ACHIEVE THE 2030 TARGETS

In order to investigate what is needed to achieve a sustainable trauma reduction that achieves the 2030 targets, as well as creating a pathway towards close to zero fatalities in 2050, a trauma modelling task was undertaken by the Swedish Transport Administration. Many different approaches to modelling have been used in road safety strategy development. In this case, the main approach applied was a case-by-case methodology, a validated analytical approach to inform strategy development. Such method has been previously applied in Sweden and other countries (Strandroth, 2015). The case-by-case methodology is not only statistical modelling, but rather a logical reduction of current crashes into future casualty outcomes based on what we know about delivery of future safety measures and system improvements at specific points in time.

In addition to the case-by-case analysis of fatalities, a statistical dose-response model on serious injuries was developed to as close as possible mirror the analysis for the large number of serious injuries given it was not practical to analyze case-by-case (this analysis will be presented elsewhere). The stepwise approach undertaken throughout the trauma modelling process underpinning the plan was performed in several steps, as follows.

1. Develop a baseline "business-as-usual" scenario to illustrate future trends in fatalities and serious injuries, given no interventions are implemented in addition to the existing pipeline of road safety measures (including the impact of ongoing vehicle safety improvements, safety infrastructure programs, and speed camera programs). This gives also the possibility to analyze residual future trauma to guide future interventions;
2. Define a future Safe System to achieve close to zero fatalities and serious injuries in 2050;
3. Develop a strategic response scenario to achieve close to zero fatalities in 2050 and to achieve the 2030 targets;
4. Develop Safety Performance Indicators (SPI) and targets to monitor system transformation.

Step 1 - baseline "business-as-usual" scenario
In the first step, a critical aspect was predicting the fitment of safety technologies among new cars, i.e. when (which model year) a certain vehicle technology would become standard, either as a result of legislation or through other mechanisms e.g. Euro NCAP. In this case, standard means that almost all new cars would be equipped with the technology. For technologies that are already standard, for instance Seat Belt Reminders or Electronic Stability Control, this task is clearly straight-forward, although predicting the fitment rate of future technologies may pose a much greater challenge. In these cases, a group of vehicle experts from the Swedish Transport Administration, the Swedish Transport Agency and Folksam Research were consulted to reach consensus. A basic assumption was then adopted, that it would take approximately 5 years between the introduction in the Euro NCAP test protocol until a technology is largely standard among new cars. While historical data do support this assumption, it is evident that future follow-ups will be needed. In addition to the planned road treatments, an average 1% traffic growth per year was assumed for the period 2020-2030, thus resulting in increased exposure and crash likelihood.

The results of the baseline scenario are presented in Figure 4. It was calculated that by 2050 current fatalities would be reduced by approximately 50%. However, the best estimates for the baseline scenario in 2030 and 2050 were 185 and 102, respectively, thus pointing out a significant gap between the baseline scenario and targets set for 2030 and 2050.

An important aspect to take into account in the planning of traffic safety countermeasures is the time between introduction and benefits in terms of reduced fatalities and serious injuries. With regard to new infrastructure treatments, the effect is often immediate, although geographically limited to the treated road section or place. For vehicle safety technologies, however, it may be the other way around: the benefits may be more geographically spread although there is often a certain delay between the introduction of the technology and tangible benefits. This is simply because older cars are generally overrepresented in serious crashes. As a general rule of thumb, due to the current renewal rate of the Swedish passenger car fleet, it could be stated that it takes 10-15 years from introduction of a certain technology to significant benefits in terms of reduction of serious crashes. Among the included technologies in the baseline scenario, the delayed effect of Emergency Lane Keeping (ELK) and Lane Keeping Assist (LKA) could be mentioned. These technologies are generally expected to deliver significant reductions of fatalities, although the largest portion of these benefits is expected to be delivered after 2030.

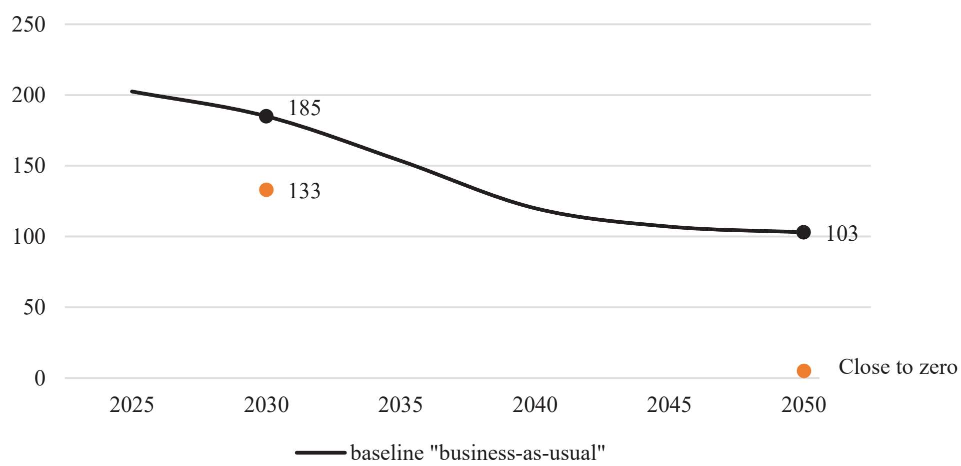

Figure 4. Best estimate for the baseline "business-as-usual" scenario, including a traffic growth of 1% per year up to 2030. The 2030 and 2050 targets are shown in orange.

Step 2 - definition of future Safe System

The following step was to define a Safe System to achieve close to zero fatalities and serious injuries in 2050. Overall, this implied full scale implementation of current road safety strategies aiming at aligning crash severity and crash protection. More specifically, the following components were included.

Road infrastructure

- All currently undivided roads with speed limit ≥ 80 km/h and AADT > 2000 are upgraded to divided roads
- Other currently undivided roads, with speed limit ≥ 80 km/h and AADT < 2000 have speed cameras, centerline rumble strips and maximum 80 km/h speed limit
- All roads with speed limit ≥ 70 km/h have road markings of good quality
- All roads with speed limit ≥ 80 km/h have a safety zone of good standard or roadside barriers
- All PTW-prioritized roads with speed limit ≥ 70 km/h have Motorcycle Protection Systems
- All intersections in the national road network are of good safety standard (STA 2016)
- All roads with speed limit ≤ 40 km/h have pedestrian and bicycle crossings of good safety standard (STA 2016)
- All roads with speed limit ≥ 50 km/h have separated pedestrian and bicycle paths and grade separated crossings
- All urban areas have speed limit 40 km/h or 30 km/h
- All pedestrian and bicycle paths are well-maintained (for instance, free of gravel, ice or snow)

Vehicles

- All passenger cars and light commercial vehicles have a 5-stars rating in Euro NCAP 2030
- All heavy goods vehicles meet EU-regulations
- All PTWs have Antilock Brakes and Traction Control
- All bicycles, including e-bikes, have winter tires during winter conditions and Antilock Brakes

Usage

- 100% speed limit compliance
- 100% vehicle mileage with sober drivers
- 100% seat belt use rate
- 100% helmet usage for bicyclists and PTW riders

- 100% usage of additional personal protection for bicyclists and PTW riders

It was calculated that the full implementation of all components would result in approximately 35 fatalities in 2050. Two main conclusions can be drawn from this result. Firstly, with currently known countermeasures, we have the theoretical possibility of almost halving the number of fatality every decade until 2050. In other words, the current toolbox of countermeasures can be expected to be more than sufficient to define a strategic response scenario to achieve the 2030 targets. Secondly, it can be concluded that the presented definition of Safe System could provide a reduction of current fatalities by almost 85%. Although this may be considered a very promising result, it is clearly not close to zero. If "close to zero" fatalities was interpreted as achieving the same level of safety offered to train passengers today, it would mean approximately 5 fatalities in road traffic per year in Sweden (Tingvall and Lie, 2021). Further research is needed to assess what kind of countermeasures would be needed to prevent the 35 fatalities that are expected to occur in 2050. It should also be noted that the current analysis did not include automated vehicles, thus the possible extra benefits of full automation were not quantified.

Step 3 - strategic response scenario

A strategic response scenario was developed with the purpose of closing the gap between the baseline outcome and the targets. In this context, a scenario is a combination of treatments that together over time would be expected to save the number of lives and prevent the number of severe injuries needed to achieve the targets. A strategic scenario would be considered one that includes interventions that are both long-term transformative and near-term cost effective, includes all components of the Safe System in terms of vehicles, infrastructure and road user behavior, and seeks to achieve interim targets but also ultimately to eliminate all fatalities and severe injuries.

The results are shown in Figure 5, in two separate layers, with the baseline scenario also shown as a reference. First, the best estimate for successively increasing speed limit compliance is presented (blue line), with a level of 80% in 2030, 90% in 2040 and 100% in 2050, respectively. While the number of fatalities would be further decreased compared to the “business-as-usual” scenario, it is evident that there still would be a significant gap between baseline outcomes and targets.

A further layer was applied, including the infrastructure treatments and the other components presented in the previous section. Here, the investments in the infrastructure between 2020 and 2030 were tuned so that the 2030 would be achieved, thus implying that even larger investments may be needed between 2030 and 2050 in order to close the gap between baseline scenario and 2050 target.

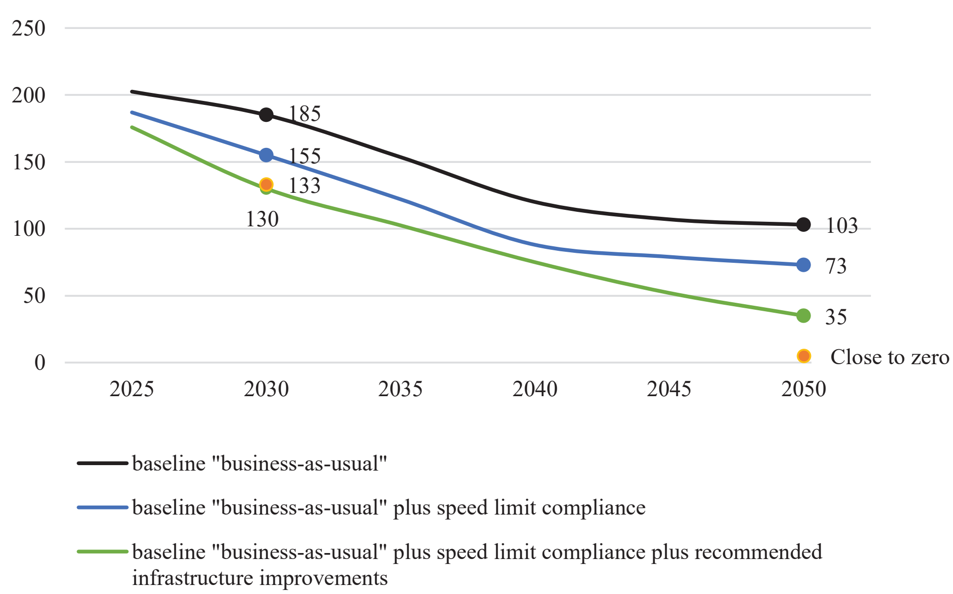

Figure 5. Best estimate for strategic response scenario, including a traffic growth of 1.0% per year up to 2030. The 2030 and 2050 targets are shown in orange.

Step 4 – Safety Performance Indicators
Based on the strategic response scenario, a set of revised Safety Performance Indicators were developed for the period 2020-2030. While the basic structure is still the same as for the previous decade, the new SPIs included a few additions, for instance safe intersections on national roads. The safety standards of intersections and pedestrian and bicycle crossings were defined according to STA's safety classification (STA, 2016). Naturally, the necessary levels to achieve the 2030 targets were also updated, see Table 1.

Table 1.
Safety Performance Indicators for the period 2020-2030

Safety Performance Indicators			**Status in 2020**	**Necessary to achieve the 2030 targets**
National road network	Mid-block sections	% of vehicle mileage on divided roads with speed limit ≥ 80 km/h	65 %	70 %
		% of vehicle mileage on divided roads with speed limit ≥ 90 km/h	85 %	96 %
	Intersections	% of AADT* in intersections with good or very good safety standard**	80 %	85 %
		% of AADT* in intersections with very good/good/medium safety standard**	93 %	99 %
	Ped & bike crossings	% of crossings with good or medium safety standard**	60 %	80 %
	Speed limit compliance	% of vehicle mileage within the posted speed limit	49 %	80 %
Municipal road network	Urban roads	% of urban roads with speed limit 30-40 km/h	65 %	99 %
	Ped & bike crossings	% of crossings with good or medium safety standard**	50 %	75 %
	Systematic work for VRU safety	% of surveyed municipalities with good results	17 %	70 %
	Speed limit compliance	% of vehicle mileage within the posted speed limit	67 %	80 %
Safe vehicles	Passenger cars	% of sold cars with a 5-stars Euro NCAP rating	89%	90 %
Safe road users	Seat belt use	% of observed car occupants using seat belts	97,9 %	99,5 %
	Bicycle helmet use	% of observed bicyclists using helmets	47 %	80 %
	Sober drivers	% of vehicle mileage with sober drivers	99,8 %	99,9 %

*AADT = Annual Average Daily Traffic
** Defined according to STA's safety classification

With regard to safe vehicles, it was calculated the proportion of sold cars with the highest safety rating in Euro NCAP needs to be at least 90 percent in 2030, which is approximately the same level as in 2020. While this may seem somewhat modest, it is important to point out that the Euro NCAP rating covers approximately 95% of new car sales in Sweden. More than 100 individual car models account for the remaining 5% of car sales, thus suggesting that increasing the number of tested cars would only have minor effects on the overall rating coverage. Furthermore, it should be stressed that the requirements for the highest rating are raised gradually between 2020 and 2030, which means that a 5-stars car tested in 2030 will have completely different safety features than a 5-stars car tested in 2020.

With regard to the use of seat belts in passenger cars, it was calculated that the necessary increase from 97.9% to 99.5% of vehicle mileage with restrained car occupants by 2030 would be achieved with the increased penetration of Seat Belt Reminders across the entire car fleet, including more advanced SBR technologies. Clearly, this calculation will need follow-ups in the future.

Significant investments in the road infrastructure will also be needed to achieve the 2030 targets, as follows:
- 1,000 km of new divided roads in the national road network
- 3,300 km of speed limit reduction on national undivided roads
- 800 intersections on national roads with low safety standards need to be upgraded to higher safety standards
- 2,500 km of new side crash barriers
- 5600 bicycle and pedestrian crossings with low safety standards need to be upgraded to higher safety standards (i.e. speed-calming treatments or grade-separation)

- Speed limits in urban areas need to be lowered to 40 km/h or 30 km/h

The biggest challenge appears to be speed limit compliance, especially on the national road network. While 2,300 speed cameras are currently installed on Swedish rural roads, further countermeasures need to be implemented to increase speed limit compliance from 49% to 80%. Intelligent Speed Assistance (ISA) is one of the vehicle safety technologies included in the EU's new General Safety Regulation for motor vehicles (European Union, 2021). Also, the recently published Euro NCAP road map can be expected to play an important role towards the implementation of more advanced ISA technologies beyond legislation (Euro NCAP, 2022). Finally, it should be stressed that further actions can be taken in addition to road treatments, vehicle technology development and implementation of lowered speed limits. During the 3rd Global Minister Conference on Road Safety 2020, important recommendations were presented, pointing out that he level of engagement from larger corporations and businesses needs to increase as a complement to road safety actions from governments (AEG, 2020). A preliminary analysis performed by STA and Folksam Research suggests that approximately 45% of all road fatalities in Sweden involve the value chain of at least one organized stakeholder. Therefore sustainable practices, reporting of road safety footprints, as well as targeted procurements, are essential tools to stimulate fleet management systems based on new technologies such as ISA as well as geofencing.

CONCLUSIONS

The present report outlined some of the strategic road safety work performed in Sweden during the last few years. The key points were:

- The previous targets for the period 2007-2020, aiming at reducing the number of road traffic fatalities and serious injuries by 50% and 25% respectively, were achieved.
- New interim targets for 2030 were set, in combination with the EU target 2050, close to zero fatalities. The 2030 targets aim at reducing the number of fatalities and serious injuries by 50% and 25%, respectively, thus resulting in maximum 133 fatalities by 2030.
- The majority of current road fatalities in Sweden (up to 69%) are still due to a mismatch between crash severity and crash protection.
- A road safety strategy was developed to achieve the 2030 and 2050 targets.
- A baseline scenario was developed, including the impact of ongoing vehicle safety improvements, safety infrastructure programs, and speed camera programs. This was calculated to reduce the number of fatalities by approximately 50% in 2050.
- Full scale implementation of current strategies aiming at aligning crash severity and crash protection would reduce current fatalities by approximately 85%.
- A strategic response scenario was developed, aiming at addressing the gap between baseline outcomes and targets.
- A set of new Safety Performance Indicators was developed to monitor system transformation towards the 2030 and 2050 targets.

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GOVERNMENT STATUS REPORT, 2023
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1. STATUS AND TRENDS

1.1. Road accidents in Germany

The total number of police registered road crashes has decreased by 4 percent since 2010 – from 2.4 to 2.3 million crashes in 2021. The number increased slightly between 2010 and 2019, with yearly changes between -2 and 5 percent. The highest value was reached in 2019 with 2.7 million road crashes. In 2020 and 2021, during the COVID-19 pandemic, the number of crashes steeply declined.
The number of road crashes with personal injury has decreased by more than 10 % since 2010, resulting in 258,987 crashes with personal injury in 2021. Between 2010 and 2019, the number of personal injury crashes were relatively constant and stagnated around 300,000. This figure declined substantially in 2020 and 2021. According to provisional data for the first nine months of 2022, the number increased by more than 12 percent compared to the same period in 2021.

Casualty figures have also decreased since 2010, with lower reductions for slight and severe injuries and higher reductions for fatalities. The total number of casualties has decreased by approximately 13 percent from 374,818 in 2010 to 325,691 in 2021. The trend in casualty numbers is similar to the trend in personal injury crashes: The numbers remained nearly unchanged between 2010 and 2019 and then dropped substantially during the COVID-19 pandemic in 2020 and 2021. According to provisional data for the first nine months of 2022, the number of casualties rose by more than 12 percent compared to the same period in 2021.

Since 2010, the number of serious injuries has been reduced by 12 percent to 55,137 seriously injured road users in 2021 and the number of slight injuries has declined by 13 percent to 267,992 slightly injured road users. Both injury severity groups follow the same pattern: The numbers were quite similar between 2010 and 2019. In the two years after, slight and serious injuries considerably decreased.
Fatalities have declined by 30 percent from 3,648 fatalities in 2010 to 2,562 fatalities in 2021. In contrast to the number of injuries, the number of fatalities fell constantly in the considered time period. However, the impact of the COVID-19 pandemic is of course notable: Between 2019 and 2021, the number of fatalities fell by 16 percent. According to provisional data, the number of fatalities increased by about 11 percent in the first nine months of 2022 compared to the same period in the preceding year.

Most COVID-19 restrictions ended in the beginning of 2022 and kilometres driven are nearly as high as 2019. A similar trend can be observed for crash and casualty figures. For 2022, an increase in these numbers is to be expected. (See fig.1 for overview).

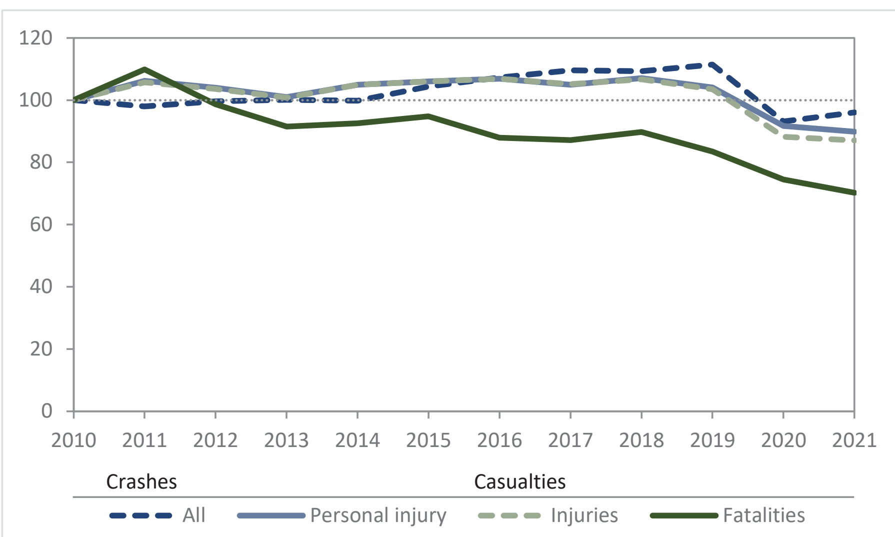

Figure 1: Development of crashes and casualties in Germany (Index 100=2010)

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 2020 to approximately 31.47 billion Euro. The costs of fatalities and injuries reached 11.79 billion Euro whereas the costs of about 19.68 billion Euro were caused by damage to goods (figure 2). Comparing 2020 data with accident costs occurred 2019 (previous reporting year) we observe an 12% decrease of fatalities costs and injuries costs. However, the decrease of damage to goods by 16% is even stronger and the total amount of accident costs was 2020 about 15% lower than that of 2019. It is assumed that the Covid-19 situation explains the change. The costs per person added up to 1.219 million Euro for a fatality, 119,788 Euro for a severely injured person and 5,391 Euro for a slightly injured person.

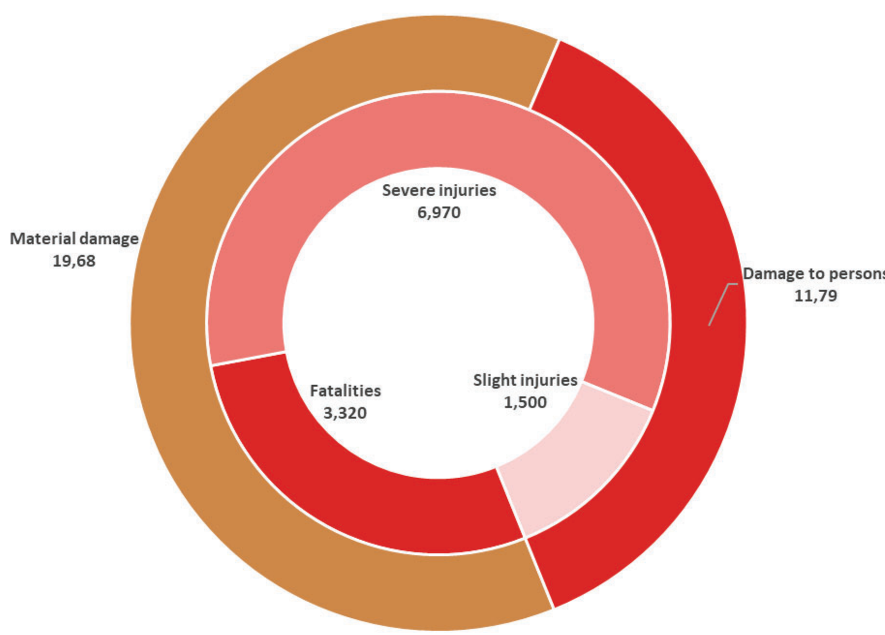

Figure 2: Costs due to road traffic accidents in 2020 (billion Euro)

1.3. German Road Safety Programme

The Federal Government's Road Safety Program 2021 to 2030 is the follow-up to the 2011 Road Safety Program, which expired at the end of 2020. It describes the Federal Government’s measures to improve road safety on German roads by 2030. The focus is on commitment to "Vision Zero" - i.e. the reduction of road deaths to zero. The aim is to reduce the number of traffic fatalities by 40% and serious injuries significantly by 2030.

With the "Road Safety Pact", the Federal Government, the federal states and other stakeholders have adopted, for the first time, a joint strategy for road safety work in Germany to reach this goal. Under the slogan "Safe mobility - everybody is responsible, everyone is involved", this strategy combines the efforts of all stakeholders. The measures are assigned to 12 fields of action. At the beginning of the decade, the Federal Government wants to focus e.g. on exploiting the potential of automated, autonomous and connected driving for better road safety, expanding the use of driver assistance systems, improving road infrastructure, as well as on safe cycling.

2. RESEARCH

2.1. Finished projects

2.1.1. Automatic emergency braking systems 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 in the original versions of Regulation (UN) No. 131 (series of amendments 00 and 01) was not so strict (13 or 28 km/h from 80 km/h, depending on truck type). Another major downside of the current technical requirements was 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.

All these items had been improved for the new revision 02 of this regulation, developed by an Informal Working Group at UN level, led by Japan and Germany: When deactivated, the systems will reactivate typically after 15 minutes; accidents with stationary vehicles need to be avoided at least up to 70 km/h traveling speed, and braking can commence when needed, even if the warning phase has not yet finished. Additionally, there are requirements foreseen for AEB interventions towards crossing pedestrians.

The revision 02 of Regulation (UN) No. 131 will enter into force approximately in February 2023, it will be mandatory for new vehicle types from September 2025 and for new registrations by September 2028.

2.1.2. Automatic emergency braking systems 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 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, pedestrians and cyclists and deliver a comparable performance for slow moving targets. The results of the Informal Working Group had been already adopted in Regulation 152 with the series of amendments 00, 01 and 02 is already in force. The European Commission currently plans to make these systems mandatory in steps and beginning from 2022 (for new types, car-car accidents) until 2026 (for all registrations, including AEB pedestrians and cyclists).

2.1.3. Driven trailers

Trailers are by definition non-propelled, towed vehicles. They pose resistance forces to the towing vehicle, resulting from e.g. rolling resistance, friction, air resistance. New concepts are proposed where trailers would be able to support the towing vehicle by reduction of the tow ball forces, sometimes even pushing the towing vehicle. This would allow for higher traction of the vehicle combination, possibly even a higher overall energy efficiency when the required energy storage system of electric vehicles would be distributed to both vehicles.

A study conducted by BASt did investigate the possible influence of driven trailers on the driving dynamic properties of the vehicle combinations.
Driving experiments with two prototype trailers (caravans) had been carried out in direct comparisons with active and inactive trailer motors. The experiments focused on possible effects on the handling (double lane change test) and lateral stability (yaw damping test). Additionally, calculations had been carried out to investigate the transferability of the results.

Based on the available data, it was shown that there is no negative impact of the propelled trailer to the stability of the towing vehicle and vehicle combination, provided that there is always a remaining towing force in the tow ball, and no torque vectoring between the trailer wheels. It was also found that handling benefits from a driven trailer. Theoretical calculations show that when these two conditions are met (=no torque vectoring, no pushing), propelled trailers are safe with regards to driving dynamics.
Theoretical calculations also show that torque vectoring has a potential to even further improve handling and stability, however possible faults of the drive system and control strategy could negatively influence handling and stability.

The study had been carried out with only two prototype vehicles. Calculations checked that the results can be transferred to almost all kinds of trailers. Articulated trailers that have a steering of their own, however, need to be excluded from the conclusions without further research. Trailers for single-track vehicles (motorcycles, bicycles) are still under investigation.

As a conclusion, it has been identified that propelled trailers where a towing force in the coupling remains (=the trailers compensate their driving resistance only partially, they do not push the towing vehicle) and without torque vectoring do not have negative effects on the stability of the combination and can have possible effects on the handling. This is true for non-articulated trailers, including semi-trailers and central-axle trailers. Regulations could as a next step be adapted, so that the positive effects towards traction and energy efficiency could be demonstrated. Also as a next step, the benefits and possible issues with torque vectoring should be identified.

2.1.4. Active motorcycle safety

Motorcycle riders are still one of the most endangered groups in modern traffic. Due to the specific driving dynamics of single-track vehicles and the location of the predominantly driven roads, the severity of accidents tends to be considerably above average. Previous analyses of available accident data have shown that the typical cause for accidents 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 supervised several external research projects on various topics related to motorcycle safety. Potential and limits of autonomous emergency braking (AEB) systems were evaluated. Several studies proved that preparatory partial braking prior to a full emergency braking provides an increase in safety regarding the targeted relevant scenarios. A warning of the rider prior to a brake intervention is considered beneficial. In various studies, the acceptance of those system was high.

In a different project, driven roll angles were studied. In conclusion, a large scattering of the achieved roll angles of individual riders in curves is observed. According to a preliminary survey, the achieved lean angles are smaller for riders who reported to have a high fear of lean angles. However, a clear threshold is not apparent from the data. It also shows that the self-evaluation of the study participants does not necessarily correspond to the recorded roll angles. Thus, even a participant with a high subjective fear rating can achieve high roll angles.

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. The results have shown that individual driving behaviour has a huge impact on the effectiveness of cornering ABS systems. In the short, conducted study, no adaption of rider behaviour could be recorded.

2.1.5. 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 (now DIN CEN/TS 17342:2019-10) "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 was uncertain whether the original systems also meet the requirements of this new specification, this question was investigated in a finished research project.

Aim of this project was to design, assess and modify additional components for a frequently installed vehicle restraint system in Germany (ESP; simple steel guardrail) in regard to pass the Technical Standard.

The nowadays commonly used underride protection of the ESP 4.0 UFS as well as additional components to reduce the impact severity have been tested and designed (Figure 3). Unfortunately, it was not possible to achieve a solution for ESP which passed the tests. Especially the measured neck compression force on the dummy remained a fail criterion for all modifications. However, certain improvements were made on the system as well as further problems and fail criteria were identified which can be used as a basis for further projects. Today, however, alternative protective devices with positive tested underride protection (e.g. Eco Safe) are available for new construction, which can be selected when installing new protective devices.

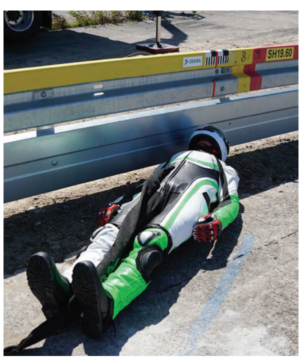

Figure 3: Impact according CEN/TS 1317-8:2012 (source: BASt)

In the past, the assessment of the sharpness of construction elements in vehicle restraint systems, especially with regard to the impact of motorcyclists, has been rather subjective. The aim of a further research project was to solve this problem by determining specific indications for the definition of system-neutral sharp-edged construction elements of vehicle restraint systems. Here, impact tests were carried out with a new type of biofidelic crash test dummy, modelled on humans, on variants of individual construction parts (Figure 4).

As a result, various criteria for assessing sharpness were identified. Examples are the horizontal offset between two parts of a vehicle restraint system or the minimum tangent angle of a specific part. All criteria were summarized in a flow chart and can be used to evaluate individual design elements with regard to sharpness. Unfortunately, there is no evaluation of the whole system. Nevertheless, the results can be used by the designers to reduce the sharpness of the vehicle restraint system or by users to choose systems with a reduced sharpness if needed.

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

2.1.6. Euro NCAP VRU (Vulnerable Road Users)

Subsequent to the last overhaul of Euro NCAP passive pedestrian test and assessment procedures in 2016, the protocols were revised and transposed into VRU procedures by the technical subgroup for application as from January 2023 onwards.

The headform test area is extended to better account for bicyclists as the second big group of vulnerable road users with the highest portion of killed and seriously injured of all road participants in German urban areas. Headform tests to the roof have been included up to WAD 2500, compare Figure 5 (Zander et al., 2020-2). Grid points in the windscreen area were removed from being defaulted green but, to account for atypical fracture of the windscreen, two repetitions of green predictions will be allowed in case of a colour change of three or more boundaries.

The FlexPLI is replaced by the new advanced pedestrian legform impactor aPLI with upper body surrogate which is, in principle, based on the same concept as the FlexPLI with upper body mass in order to improve biofidelity, to better predict femur injuries, and the idea of a replacement of the upper legform impactor (Zander et al., IRCOBI 2019). However, latter one will continue to be in use for the assessment of pelvis injuries. Finally, a capping is introduced in order to avoid the negligence of any relevant pedestrian body region.

Figure 5. Vehicle corner to bicyclist impact simulation with bicycle speed of 15km/h (orange) and 25km/h (blue) (source: BASt)

2.1.7. Assessment of windscreens as injury-causing vehicle parts for pedestrians and cyclists

Subsequent to the establishment of Regulation (EU) 2019/2144 („General Safety Regulation 2“), UN Regulation No. 127 has been amended to account for head protection of bicyclists, amongst other things by a rearward extension of the head impact zone until wrap around distance 2500 or the rear edge of the windscreen. In a series of tests BASt has found the fracture behaviour of the windscreen being atypical in many, but not repeatable cases, see Figure 6 (Zander et al., 2020). A Task Force under the umbrella of the European Commission developed criteria for atypical windscreen fracture which allow for a maximum of three test repetitions in case of a failed requirement during type approval testing: jerk criterion, acceleration criterion and absence of visible glass breaking. In case of atypical windscreen fracture while the HIC values meeting the requirements, the Technical Services may decide upon a repetition of the corresponding test.

Figure 6. Windscreen behaviour during headform tests: no breakage (upper row, left), typical pattern (upper row, right) and atypical windscreen fracture modes (lower row) (source: BASt)

2.1.8. PPE (Personal Protective Equipment) for bicyclists

The test and assessment procedures according to UN Regulation No. 127 and Euro NCAP are extended in order to better protect bicyclists in the event of a collision with a motor vehicle. However, single accidents or accidents involving bicyclist interaction with areas other than the vehicle front are not addressed. BASt investigated the potential of airbag-based personal protective equipment (head protection system, airbag vest, see fig. 7+8) and found that in a variety of accident constellations head or chest injuries can be mitigated in particular due to the damping effect of the protective system. Nevertheless, in a number of potential use cases the accident was not or not in time detected by the corresponding sensing system, or the total response time (TRT) of the system was greater than the head or chest impact time of the bicyclist. An airbag-based head protection system cannot replace a conventional bicyclist helmet. However, it may altogether contribute to an increased helmet usage rate - especially amongst road users normally not wearing a helmet - and thus to head injury mitigation (Zander, 2019). Furthermore, the airbag vest addresses the upper body / thorax region which is to this point in time not protected by any specific vehicle-based countermeasure (Zander et al., 2020-3).

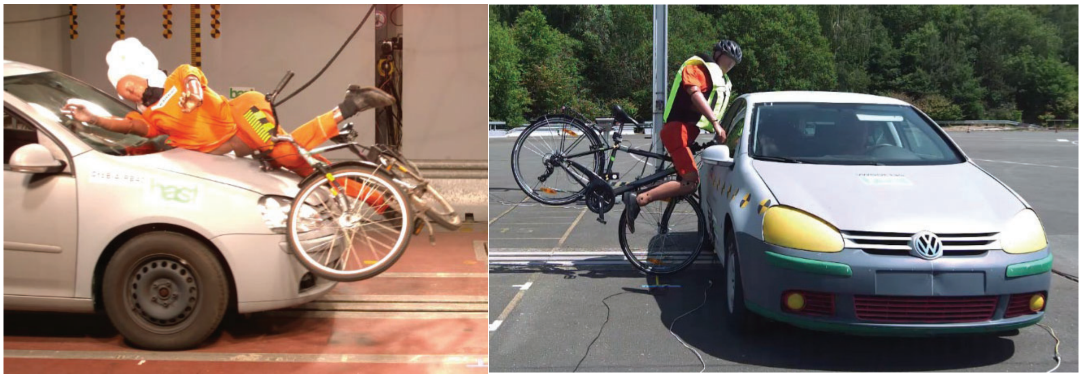

Figure 7 + 8. Vehicle to bicyclist accident simulation with different airbag based personal protective equipment: head protection system (left, fig. 7) and airbag vest (right, fig.8) (source: BASt)

2.1.9. Automated driving on highways: further development of UN Regulation No. 157

On roads with structurally separated directional lanes, systems that automatically take over the longitudinal and lateral control of the vehicle within its own lane up to a speed of 60 km/h can be type approved since January 2021. Such systems are referred to as ALKS (Automated Lane Keeping Systems, UN Regulation No. 157). An ALKS is thus the first system in a vehicle in which the driving task is temporarily carried out completely by the vehicle itself (Level 3 according to SAE Standard J3016) - for example in a traffic jam on the motorway. Major challenges regarding the technical requirements on the lateral and the longitudinal control of the vehicle by the system without the continuous surveillance of the driving task by the driver have been solved during the development of the UN Regulation No. 157 and reliable safety measures have been installed. Another challenge was to transfer duties of the human driver established in national behaviour laws into dedicated technical requirements on the vehicle system to create the opportunity for the transition of the complete dynamic driving task to the vehicle and also ensure a safe transition back to manual driving to always guarantee a safe and normal behaviour of the vehicle in traffic. The first serial production systems in vehicles received a type approval at the beginning of 2022 and the vehicles can now be regularly driven on the road with an ALKS in these countries where the national laws allow the regular use of self-driving cars.

Since 2020, on the initiative of the German Federal Ministry of Digital and Transport (BMDV) and with extensive support from the associated Federal Highway Research Institute BASt, the work on the regulation UN Regulation No.157 has been expanded in the corresponding expert committee at UN level from the area of application and the necessary technical requirements in such a way that higher maximum speeds of up to 130 km/h and automated lane changes are to be made possible. This enables the possibility for the manufactures to gain a type approval for a complete "motorway chauffeur" for their vehicles. In addition, the regulation will be partly opened up for trucks and buses. This extension of UN Regulation No. 157 was finally put to the vote at the decisive body, WP.29 of the UNECE, in June 2022, was adopted and can thus enter into force at the beginning of 2023. This means that from 2023 onwards, automated driving systems, which for example are able to manage a complete motorway journey, can be type approved for regular vehicles.

2.1.10. EU-Project L3-Pilot

In the EU-project “L3Pilot”, 34 partners from research, industry and government agencies cooperated in order to test the safety, efficiency and usability of automated cars (SAE levels 3 and 4). BASt participated with a study on user acceptance and trust, and provided input to the safety impact assessment. The project was co-funded by the European Union under the Horizon 2020 program.

In the study on user acceptance and trust, test participants were given the freedom to hand over driving to an automated system in a test vehicle at speeds of up to 130 kilometres per hour while, for example, using their phones or reading. The automated system did not need to be monitored, but the test participants had to be able to take over control at any time when prompted to do so by an acoustic and optical signal. The test participants drove on a motorway stretch for about 100 kilometres three times on different days and were free to switch the automated system on and off as they wished. The study's central aim was to determine how often they in fact used the automation, what they were doing when they had it switched on and whether their behaviour and their opinion on automation changed over time. It is crucial to examine trust and acceptance with respect to automated driving: Too much trust can cause misuse, too little trust or acceptance can hinder the use of automated driving functions and thus their anticipated positive effects on road safety and efficiency. Results indicate that the test participants had the automation switched on almost all the time– for between 88 and 99 per cent of the driving time. Only in rare cases did they decide to switch the automation off themselves. Every test participant was successful in taking back control; they needed between 0.78 and 7.76 seconds to do so. However, during many take-overs they did not check their rear-view mirrors, which, depending on the traffic situation, could be evaluated as a critical point.

One important topic within the project was the analysis of how to assess the seemingly very technical topic of road safety as a consequence of increased automation. Using a range of data, for example, from simulations, from L3Pilot test drives and accident data from today's traffic – including the GIDAS and IGLAD data bases – the project estimated how many lives would be saved or how many serious injuries would be prevented across the EU through automated driving on motorways or in urban areas. It is thus encouraging that in urban traffic an overall positive development can be expected in the case of light, medium and severe accidents– regardless of the number of automated vehicles on the streets. Furthermore, at a 30 per cent ratio of automated vehicles in road traffic, accordingly, about 12 per cent of all lethal accidents and about 13 per cent of all severe accidents can be prevented.

2.1.11. OSCCAR

The increasing level of vehicle automatization towards autonomous driving enables new interior concepts with more comfortable seating positions (e.g. swivel seats or reclined seating positions) and allows the driver to engage in non-driving activities. However, crashes with conventional vehicles in mixed traffic scenarios will still occur, thus occupant safety needs to be maintained even in these new interior concepts. From 2018 to 2021 BASt was involved in the EU-funded project OSCCAR (Future Occupant Safety for Crashes in Cars), which focused on the improvement and assessment of vehicle safety for car occupants in future accidents involving highly automated vehicles. The project aimed to protect all passengers in the best possible way by developing innovative occupant restraint systems (belts, airbags and new seating concepts), future accident scenarios and improved vehicle safety assessment methods in a virtual, simulation-based approach.

Within the OSCCAR project several protection principles for possible new interior concepts as well as the corresponding accident scenarios were developed. The protectiveness for some protection principles was assessed with physical tests and the suitability of existing crash test dummies was investigated. The project intended to use human models where no suitable dummies are available – therefore, existing human models were improved and harmonized injury criteria developed. For the future implementation of virtual assessment methods, among others the virtual vehicle models need to be validated. The development of the corresponding validation procedure was led by BASt within the OSCCAR project. Results from the OSCCAR project are available through the homepage (https://www.osccarproject.eu/).

2.1.12. EU-Project HADRIAN

The project "HADRIAN – Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs" was funded by the EU Horizon 2020 program and brought together 16 European partners from large industry, SME, academia and research. The HADRIAN project was focused on Human-Systems Integration for the definition of driver roles in automated driving and implemented a novel approach to create automated driving systems that integrated human drivers, vehicles, and road infrastructure. HADRIAN partners designed and validated novel, adaptive, and fluid Human-Systems Interactions that were enabled by advanced driver monitoring to reduce the interaction complexity and increase trust and acceptance of drivers and users. Also, active road Infrastructure Support Levels for Automated Driving (ISAD) were explored to increase the predictability of automated driving as well as support minimum risk manoeuvres. AD level transitions require well-designed human machine interfaces (HMIs) to allow the driver to establish accurate situation awareness. The project investigated how fluid HMIs improve and allow for appropriate performance of the driver role during active driving automation and transitions. HADRIAN aimed at safe transitions and high trust in automation. In addition to research on human-machine-interaction, BASt also contributed to HADRIAN with analyses regarding infrastructure constraints and opportunities.

2.2. Ongoing and planned research

2.2.1. Personal Light Electric Vehicles PLEV

The scope of the European Type Approval Regulation (EU) No. 168/2013 (for category L vehicles) excludes self-balancing vehicles and vehicles not equipped with at least one seating position. Such vehicles were called Personal Light Electric Vehicles (PLEV). PLEV therefore could be regulated on national level. As a consequence, on June 15th 2019, the German Personal Light Electric Vehicles Regulation went into force with scope on PLEV: Those micro-mobility devices are for instance electronic kick scooters (e-scooters) or self-balancing vehicles. More precisely: In Germany this category subsumes specific electrically powered motor vehicles with a maximum design speed not exceeding 20 km/h, namely such without a seat or self-balancing vehicles with or without a seat.

Currently, a research project is ongoing for a detailed analysis of the PLEV impact with regard to road safety. This evaluation project places emphasis among others on following aspects: Primarily an in-depth accident analysis focuses on crash causes and injury patterns. In another work page the potential of conflicts with other road users, in particular children, mobility-impaired persons and senior citizens, is assessed. Additionally, the project will answer questions regarding traffic issues as well as user behaviour and user characteristics.

2.2.2. Technical innovations for safe cycling

To ride a bicycle is one of the most sustainable and green transportation modes. Since it is accessible to almost everyone and enables an easy participation in road traffic, it is very popular. However, as the current development of road accident statistics shows, there is potential to make cycling safer: While the total number of accidents involving personal injury in Germany is falling continuously, this trend is not discernible for accidents involving bicycles. The objective of current various projects is to examine how cycling can be made safer and more comfortable by using technical innovations.

One field of activities focuses on technical requirements for lighting devices of bicycles and bicycle-trailers. As new forms of light sources (e.g. LED) have been established on the market, it is necessary to examine how to adopt the test requirements taking the state of the art and possible new solutions into account. For example, cornering light can improve illumination of the path. Therefore, adequate technical requirements have to be developed which also prevent oncoming traffic from being dazzled.
With another project the technical requirements for the braking device of bicycles (including electrically power assisted cycles (EPAC) and cargo bicycles) and their trailers (braked and unbraked) are to be developed in a technology-neutral manner. New technical devices like anti-lock braking system, brake force distribution system and overrun brakes for trailers should be considered as well.
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2.2.3. Cargo bicycles

Cargo bicycles and cargo bicycle trailers continually gain more popularity, as they offer an environmentally friendly way to transport heavy loads and have a potential in reducing local traffic emissions. They are used for private and commercial purposes, which also provides a wide field of application. Since they are an uprising enrichment to the variety of vehicles found on public roads, it has to be scrutinized if they should be addressed by distinct regulations, e.g. by defining different categories of cargo bicycles with different technical requirements. To ensure a sensible development of design categories with regard of the given road infrastructure which could be used by cargo bicycles and cargo trailers already using public roads, BASt is supervising an external research project. The aim of this project is to evaluate various aspects of cargo bicycles used on public roads with regard to potential modifications of existing regulatory aspects. With completion of the project, scientific-proofed recommendations that support enhanced traffic safety for cargo bicycles will be available regarding design categories of cargo bicycles and cargo trailers and, if applicable, to the usable infrastructure. Selected categories should fit seamlessly and without contradiction into the categorization of other vehicle classes. In this project, the main focus is on cargo bicycles and cargo trailers for the purpose of transporting goods. In practice, mixed use - simultaneous or exclusive transport of people, especially children - is common and therefore, it is included in the ongoing evaluation.

2.2.4. Urban emergency braking systems

Collisions between Vulnerable Road Users (VRU) and large commercial vehicles that are undertaking low speed manoeuvres, such as turning or moving off from rest, typically occur at low driving speeds. They usually have serious consequences for VRU.

The cause of this type of collision can be contributed to by many factors. The VRU may have been positioned in a place where they were not available to be seen by the driver through either glazed areas or mirrors. Alternatively, they may have been available to be seen during the build-up to the collision, but the driver may have detected their presence too late to avoid collision, or may have failed to detect their presence at all. This late detection, or failure to detect, could be a result of the driver failing to look, looking but failing to see, or seeing but failing to correctly judge the risk.

Elimination of this type of collision may consider action that mitigates many of these different causes. Other regulations have been introduced concurrently to enhance direct visibility, to use electronic sensing systems to detect a VRU in close proximity to the vehicle, to inform the driver of their presence via a low urgency information signal (e.g. light) and to provide a collision warning (e.g. audio-visual) when the situation becomes more critical.

2.2.5. Deployable Pedestrian Protection Systems

The UNECE Informal Working Group on Deployable Pedestrian Protection Systems (IWG DPPS) with significant contributions from BASt has made important steps towards the finalization of the test and assessment procedures as amendments to UN Regulation No. 127 und UN Global Technical Regulation No. 9. The prerequisites to account for the benefits provided by vehicles with DPPS (Figure 9) to the pedestrian’s head in case of an accident have been defined: a minimum protection below the deployment threshold must be demonstrated by headform tests at impact velocities equivalent to the vehicle speed. The FlexPLI has been evaluated as appropriate pedestrian surrogate for the sensing system of the DPPS. The boundaries of the area in which a pedestrian must be detected have been defined. A qualification procedure for human body models to be used for the determination of head impact times (HIT) has been evolved. The decisive factors for headform compliance testing of the DPPS, either statically in the deployed or undeployed state, or dynamically during its deployment, have been developed. For Contracting Parties opting to perform tests on the statically deployed system, a procedure for HIT determination by means of numerical simulations on the deployed DPPS has been developed in order to compare HIT with the total response time (TRT) of the system. For all cases where the HIT exceeds the TRT, headform compliance tests have to be performed dynamically. For the correct timing of headform firing and system deployment, additional numerical simulations are performed with the qualified models on the undeployed DPPS.

Since pure passive systems are expected to also provide some protection during accidents with impact speeds higher than 40km/h, and DPPS should provide at least the same level of protection, the deployment of DPPS should be at least initiated, or sufficient clearance be provided for energy absorption during headform tests at impact velocities higher than 35km/h. However, the IWG did not define specific requirements but will address it by including a corresponding wording within the preamble to UN Global Technical Regulation No. 9.
Furthermore, the generated clearance underneath the bonnet may be compromised due to the wrap around and loadings induced by the upper body of the pedestrian prior to head impact. A reasonable bonnet clearance will be required in the preamble to UN Global Technical Regulation No. 9.
The procedure for DPPS accounts for both, vehicle type approval as well as self-certification, providing the corresponding requirements.

A final draft will be submitted to GRSP at its May 2023 session. An adoption of the Global Technical Regulation No. 9 amendment by AC.3 is expected in November 2023. In a subsequent phase, provisions for HIT determination based on the vehicle geometry and using an empirical formula will be developed.

Figure 9. Vehicle with pop up bonnet as deployable pedestrian protection system (source: BASt)

2.2.6. Mitigation of thoracic pedestrian injuries

Current passive pedestrian test and assessment procedures comprise of component tests addressing injuries to head, pelvis and lower extremities of pedestrians during collisions with passenger cars. However, injuries to the upper body, in particular to the thorax which have been found in the German In Depth Accident Study GIDAS (Schick et al., IRCOBI 2021) are not specifically addressed. To account for thoracic pedestrian injuries, BASt has initiated a research project with the aim to establish a test procedure as follow up to the findings of the EU project SENIORS where a thorax injury prediction tool was developed and prototyped, see Figure 10 (Zander et al., ESV 2019). Both, a standalone procedure and an amendment to the existing procedures will be developed. A workshop with stakeholders is foreseen towards the end of the project in the course of 2023.

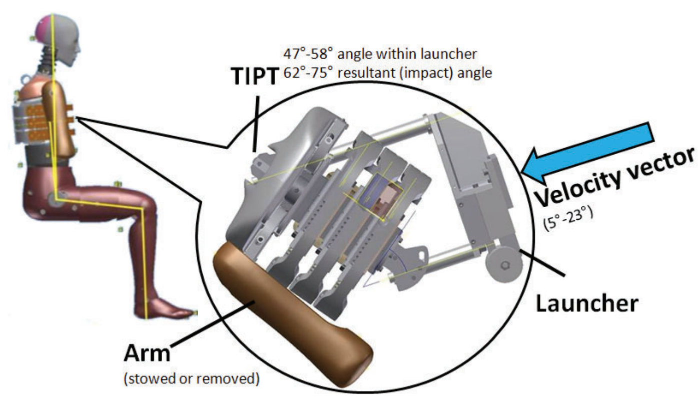

Figure 10. Test parameters for the thorax injury prediction tool (TIPT) (source: BASt).

2.2.7. Virtual Testing for crashworthiness assessment

Virtual Testing (VT) for vehicle safety crashworthiness assessment will be an important method to further improve the robustness of safety. Therefore, BASt is contributing to the development and evaluation of a VT methodology in Euro NCAP for the assessment of crashworthiness in a pilot case. The selected pilot case is the “Far-side” sled test. According to the proposed methodology the vehicle manufacturer will run simulations of additional sled test configurations to improve the level of protection.

Eventually, the rating will be based on a combination of physical and virtual test results. In a first step the method will be based on virtual tests with the WorldSID dummy. Requirements to certify the virtual simulation model of the dummy have been defined. The dummy-based Far-side VT procedure also includes a procedure to check the level of validation of the sled model that is used by the vehicle manufacturer for the VT assessment simulations. Validation acceptance criteria will be specified and evaluated in a pilot case. In a future step the validated sled model might be used for VT with human body models to further improve the robustness of safety assessment. 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), which continues to work on this topic. In addition to that BASt is also involved in several working groups of an international framework HBM4VT (Human Body Models 4 Virtual Testing), which was initiated by Euro NCAP to bring together international experts to jointly work on the most important questions and issues to be solved to enable a wider application of HBMs in VT based vehicle safety assessment.

2.2.8. Child Dummy Task Force for Mutual Resolution

BASt took the lead of a task force of the GRSP to implement the child dummy series “Q” in the Mutual Resolution 1 (M.R. 1). The M.R.1 defines test tools such as dummies for the use in UN-Regulations and can also be considered in Global Technical Regulations (GTR). The main objective of the Task Force is, to define the dummies of the Q-Series for use in UN Regulation No. 129. This requires a general description of the dummy design according to their specification in UN Regulation No. 129, assembly and disassembly, engineering drawings and certification procedures. All dummies (Q0, Q1, Q1.5, Q3, Q6, Q10) are checked and defined individually, starting with Q0 and Q1.

2.2.9. Improved frontal impact assessment procedures - New rotational brain injury criteria (Euro NCAP)

Brain injury is still one of the predominant injuries in frontal impact car accidents. Therefore, BASt was involved in the evaluation and introduction of a new brain injury criterion. More than 30 years brain injury assessment in all dummy-based vehicle safety assessment procedures was only considering linear head acceleration measurements. The Euro NCAP brain injury group evaluated several proposed alternative kinematic brain injury criteria which also consider rotational effects, because these are assumed to contribute to the risk of brain injury. BASt contributed to the group by evaluation of performance of various candidate criteria in MPDB crash tests as well as by simulation-based accident reconstruction studies using in-depth accident data and human body model simulation. The brain injury criterion DAMAGE was selected as a short-term kinematic criterion to be introduced to the Euro NCAP assessment protocol. BASt will continue to contribute to further research and evaluation to replace this kinematic criterion by a more advanced human model-based brain injury method in the future.

2.2.10. Further development of the in-depth collection of traffic accident data (GIDAS)

Since 1999, the Federal Highway Research Institute of Germany (BASt) and the Research Association of Automotive Technology (FAT) have been conducting a joint project for the interdisciplinary, in-depth investigation and documentation of randomly selected traffic accidents with personal injury (German In-Depth Accident Study – GIDAS; www.gidas.org). The scientific analyses of the reconstructed cases lead to findings on the cause, sequence and consequences of traffic accidents. This provides the opportunity to closely monitor accident occurrences and to identify negative developments at an early stage. Scientific evaluations of this accident data make it possible to identify safety problems and potential. Based on the findings, targeted measures can be derived and regulations can be drawn up or further developed at national and international level. The same applies in particular to investigations that become necessary in connection with the introduction of highly automated and connected vehicles.

Further development of GIDAS is set out in the German Road Safety Program 2021-2030 and is necessary for various reasons. Within the framework of the previous GIDAS project (GIDAS 3.0), possibilities for improving the collection, reconstruction and provision of the data have been discussed for several years. Furthermore, organizational and legal changes and improvements to GIDAS are necessary to ensure the future viability of the in-depth investigation and accident analysis.

Therefore, the current project is to be extended to include new survey content, including additional content from the areas of traffic infrastructure, human behaviour / psychology, and medicine, as well as the integration of sequential data - for example, time series of vehicle dynamics data. To ensure that the collection of new content is in line with the current state of science and technology, the BASt has launched a series of research projects whose results will serve as the basis for the further development of GIDAS leading to GIDAS 4.0. Finally, GIDAS 4.0 is going to be ramped-up in 2023.

2.2.11. Activities in the IWG EDR/DSSAD

By its Terms of References, the UNECE Informal Working Group (IWG) on Event Data Recorder / Data Storage System for Automated Driving (EDR/DSSAD) shall develop draft proposals for Event Data Recorder (EDR) for conventional vehicles and automated/autonomous vehicles and for Data Storage System for Automated Driving (DSSAD) for automated/autonomous vehicles. These categories shall be understood as systems collecting and storing a determined range of vehicle data, including:

a. Information related to collisions valuable for accident reconstruction (EDR);
b. The status of the automated/autonomous driving system and the status of the driver (DSSAD).

In particular, the IWG considers defining the categories of data recorded, the events triggering recording, as well as technical specifications in terms of mandatory performances of such systems.

The Federal Highway Research Institute of Germany (BASt) supports the Federal Ministry of Digital and Transport in this IWG since summer 2019 by providing technical and scientific input to the various discussions.

Specifically, current tasks of the IWG include the completion of EDR common performance elements for Contracting Parties to the 1958 and 1998 agreement in EDR Step#1 (UN Regulation No. 160, 01 series of amendments) and the consideration of additional technical provisions in EDR Step#2.
Additionally, the IWG develops a document of common technical elements for creation of a UN Regulation on EDR for heavy duty vehicles (trucks and busses) and will develop EDR performance elements for Automated Driving Systems.

Regarding DSSAD, the IWG has provided requirements to Automated Lane Keeping Systems (ALKS) in UN Regulation No. 157, builds up an inventory of best ADS storage practices and will harmonize on DSSAD performance elements for ADS for 1958/1998 Contracting Parties.

2.2.12. Safety evaluation of driver engagement in assisted and automated driving

Adapting the performance and design of assisted and automated driving systems to human capabilities and safety needs is an important requirement for a safe market introduction of new technologies in this field. A specific challenge is the correct level of engagement of the driver in the driving task. In assisted driving, a high level of driver engagement is necessary to ensure that drivers are able to monitor the system performance and to intervene immediately in system limit situations. In automated driving, it is important that drivers effectively and efficiently redevelop a sufficient driver engagement and situational awareness during takeover situations. One important aspect is that drivers perform as required by their individual role and responsibility, both in assisted and automated driving. However, effectiveness of current driver monitoring technologies to ensure driver engagement is rather limited. Therefore, the aim of the current research project is to go beyond driver monitoring and think about performance-based assessment procedures of driver engagement with a direct link to safety by focusing on concrete driver behaviour in system limit situations. It is assumed, that a system design influences driver behaviour in specific situations and that based on observed driver behaviour conclusions on a safe system design can be drawn. By doing so, design-neutral and innovative requirements on driver engagement can be described and assessed.

2.2.13. EU-Project Hi-Drive

The EU-Project Hi-Drive is co-funded by the European Union under Horizon 2020 research and innovation program and aims on pushing automated driving one step further towards higher automation. The ambition is to considerably extend the operational design domain (ODD) from the present situation, which frequently demands interventions from a human driver. The removal of fragmentation in the ODD is expected to give rise to a gradual transition from a conditional operation towards higher levels of automated driving. Hi-Drive focusses on testing, demonstrating and evaluating robust high automation functions in a large set of traffic environments on motorways, in cities and cross-border scenarios, with a specific attention to demanding, error-prone conditions. On this basis, important objectives of the project are to define und implement enabling technologies as well as targeting defragmentation and extension of the ODDs for different automated driving functions and traffic contexts.

In Hi-Drive, 40 partners from 13 different countries are involved. The consortium consists of OEMs, automotive suppliers, research institutes, associations, traffic engineering, deployment organizations and mobility clubs. BASt will participate with a study on situational awareness in takeover situations of SAE-L3 vehicles on motorways. It is common knowledge that a proper situational awareness of the human driver is highly relevant for traffic safety. Past studies have shown that drivers respond very quickly to take over requests when required to do so, but there are no findings in the special process of re-engaging situational awareness after taking over full vehicle control. The study will provide relevant insights into this process. Furthermore, BASt contributes to the analysis of teleoperator workplaces, the analysis of safety effects of higher levels of automated driving as well as the cooperation of different stakeholders (ITS experts, road operators etc.).

2.2.14. German project Validation and Verification Methods

The German project Validation & Verification Methods (VVM) is co-funded by the German Federal Ministry for Economic Affairs and Climate Action. The project aims to develop testing methods as well as a structured argumentation for the safety case of automated and autonomous vehicles for the use case of an urban intersection. Focus lies on the development of automated driving systems up to the complete automation of entire vehicles for SAE Levels 4 and 5.

VVM is part of the PEGASUS Family and the direct successor of the prolific PEGASUS Project, which delivered the well-known challenger model and the 6-Layer-Model for scenario-based testing. These results are utilized and built upon to extend the safety case and the argumentation for higher levels of automation and for more complex scenarios. An integral part of the project is to incorporate the safety case into the development process of components and subsystems in order to make their separate testability possible. This allows for individual testing of subsystems and for an arbitrary combination of components that meet the functional requirements.

In VVM, 23 different partners are involved ranging from OEMs and automotive suppliers over tech companies and evaluation authorities to science institutions with an overall budget of over 47 million Euros. The BASt contributes to the project as a node to international activities and regulation.

2.2.15. Research needs on Teleoperation

In July, 2022 the kick-off meeting of the working group for research needs on teleoperation took place at BASt. BASt is coordinating this action with experts from different departments. The term teleoperation describes techniques and methods for an external influence on vehicle control from a remote location. A teleoperator can for example remotely command a specific manoeuvre of an autonomous vehicle or even take over full (remote) vehicle control. Teleoperation is fundamentally different from the manual control of a vehicle and teleoperators are confronted with new tasks in a special working environment. Currently, more than 30 experts are part of the working group aiming on analysing the still basic state of research on a safe application of teleoperation and giving recommendations on future research needs.

2.2.16. EU-Project SUNRISE

Safety assurance of Cooperative, Connected, and Automated Mobility (CCAM) technologies and systems is a crucial factor for their successful adoption in society, yet it remains to be a significant challenge. CCAM must prove to be safe and reliable in every possible driving scenario. It is already acknowledged that for higher levels of automation the validation of these systems would be infeasible by conventional methods. Furthermore, certification initiatives worldwide struggle to define a harmonized approach to enable massive deployment of highly automated vehicles.

Building from the Horizon 2020-funded project HEADSTART and other initiatives, the SUNRISE (Safety assUraNce fRamework for connected, automated mobIlity SystEms) project, funded in the Horizon Europe framework program, will develop and demonstrate a commonly accepted, extensible Safety Assurance Framework for the test and safety validation of a varied scope of CCAM systems.

The project will define, implement and demonstrate the building blocks of this Safety Assurance Framework: harmonized and scalable safety assessment methodologies, procedures and metrics tailored for use cases, a European Scenario Database framework and its necessary data interfaces, a commonly agreed simulation framework including tools and interfaces. SUNRISE will work closely with CCAM stakeholders, such as policy makers, regulators, consumer testing, user associations.

BASt is responsible for the communication to vehicle safety bodies and contributes to the development of track testing methods and the scenario database framework. The project with more than 20 international partners is led by IDIADA and started on the 1st of September 2022 for a duration of 36 months.

2.2.17. V4SAFETY - Vehicles and VRU Virtual eValuation of Road Safety

The EU project “V4SAFETY - Vehicles and VRU Virtual eValuation of Road Safety“ is dedicated to the development of a harmonized framework for the assessment of safety measures for all kinds of road users. Such a framework has to deal with the rapidly changing road traffic system, including new technologies such as automated and connected vehicles, or a changing transport behaviour with an increase in cycling or the growing participation of older road users.

Therefore, V4SAFETY will use a Safe System approach and provide a prospective safety assessment framework that can handle a large variety of safety measures. This includes in-vehicle safety technology, new vehicle types, infrastructure solutions, and new regulations as well as a change in road user behaviour. To encourage intensive use of the framework, guidelines and examples will be provided on the use of the various simulation methods, driver and VRU models, and projection methods. A demonstration of use cases and a description of the validation and verification process aim to enhance broad acceptance of and trust in the framework. Thus, simulation-based safety assessment becomes more transparent and consistent, which leads to much-improved comparability and reliability of assessment conclusions. BASt is involved in the development of the framework, leading the task on the elaboration of the validation and verification process, there also physical testing of in-vehicle safety solutions will be performed. Further, BASt will analyse accident data on different aggregation levels – ranging from in-depth data of the GIDAS database to high-level databases like CARE – that will be used for modelling simulation baseline cases and the projection of the results on different areas of interest.

2.2.18. EU-Project MODI

The European Commission, through the Horizon Europe framework program, is funding a project to test and validate the implementation of CCAM solutions for real-logistics operations. The MODI project will demonstrate automated heavy-haul vehicles without safety drivers use cases on the motorway corridor from Rotterdam in the Netherlands to Moss in Norway, crossing four national borders and demonstrating terminal operations at four different harbours and terminals en route.

Automated transport will significantly contribute to improving European transport and logistic chains. The MODI research project will make substantial steps toward identifying and resolving barriers preventing this from coming true.

Even though the development of automated transport is accelerating, there are still many hindrances to overcome before we see a full-scale introduction of such transportation. These are related to the maturity of the technology itself but also to regulations, harmonisations, and social acceptance. The hindrances escalate when considering border-crossing transport. The project comprises five use cases, each describing a part of the logistics chain. It identifies what is required for automated driving level without human interaction (known as SAE level 4), and what is not possible yet.

BASt has an important role first in developing the safety requirements for the SAE L4 vehicles to be used in the project, and second to verify this during development and on-site in the Hamburg use case, where L4 heavy vehicles are set to travel from the surrounding highways through small city areas into the harbour, with special emphasis on ensuring the safety for vulnerable road users (section F1). BASt also contributes to the impact analysis for the project (F5) and to the definition of the required physical/digital infrastructure including (cooperative) intelligent transport systems (C-)ITS (V5). The project will be rolled out from October 2022 for 3.5 years.

2.2.19. Data for Road Safety (DFRS)

Data for Road Safety (DFRS) is a public-private partnership to improve road safety across the European Union by making vehicle-generated data on road safety related events and situations available for the creation of road hazard warnings.

European Transport Ministers of participating Member States, the European Commission, automotive industry partners as well as mobility data service providers established Data for Road Safety on the 15th of February 2017 in Amsterdam. In October 2020 a Multi-Party Agreement was signed, establishing the legal, organisational and partly also technical foundation. Since then, more partners have joined and more data is being made available via the DFRS data ecosystem: nine European States or their national road operators (Germany, Austria, Belgium, Denmark, Spain, Finland, Luxemburg, the Netherlands and England), five automotive manufacturers (BMW, Daimler, Volkswagen, Ford and Volvo) and five data service providers (GeoTab, INRIX, HERE, TomTom and NiraDynamics) are signatories of DFRS.

The Data Task Force was structured around 3 core principles:
a) Working together to make driving safer. Safer driving is a shared vision amongst government and industry stakeholders and is a key founding for this public-private partnership.
b) Safety without compromise. Vehicle-generated data has the potential to save lives. By making vehicle-generated data relevant for traffic safety a priority and share data across brands and across borders, we can maximize its usefulness and enhance road safety.
c) A fair and trusted partnership. The Data Task Force is a trusted partnership of government and industry stakeholders that enables trusted discussion and fair competition.

BASt has been supporting the Federal Ministry of Digital and Transport from the beginning of the initiative. From 2018 to 2021 BASt has led the Technical Group.

In 2023 BASt will manage the procurement, development and operation of a system that takes data from the DFRS data ecosystem and creates road hazard warnings for Germany, also using data from the legacy road traffic safety service (set up and run by the police in Germany together with traffic management centres of the main road operator and public broadcasting services). This additional and new data source has a proven potential to improve the quality of road hazard warnings: more data covering the whole road network is available, latency can be reduced compared to traditional data sources and additional data validation is possible. The created road hazard warnings will be made available at the National Access Point for traffic data in Germany (Mobilithek) so that service providers can inform road users via various end-user channels.

2.2.20. C-Roads Germany

C-Roads represents a European flagship initiative (co-funded by the Connecting Europe Facility) for piloting and deploying C-ITS services (https://www.c-roads.eu). It comprises of Member States driven pilots from 18 European countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden and UK). The key result of C-Roads is a catalogue of harmonised and tested specifications for C-ITS use cases and services (consisting of a bundle of use cases). C-Roads does not require institutions to deploy (although strongly encouraged) but to follow the agreed specifications when services are deployed. The specifications are harmonised across sectors (among road authorities/operators and with industry communication profile custodians such as the Basic System Profile of the Car2Car Communication Consortium). The catalogue gradually expands over time, driven by releases, so that the functionality of the services increases while at the same also extending the scope of the services. The first wave of pilots (with a focus on services for the motorway network) has ended in 2021. The achievements have been presented at the C-ITS roadshow (#saferoadstoday) in Brno in June 2021. The current state-of-play with regard to deployment is available at the European Commission's TENtec portal (C-ITS stations, https://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html). On national basis, Autobahn hosted an event with the Federal Minister for Digital and Transport in October 2022. The nationwide roll-out of the Road Works Warning service – the special fleet of 1,500 fully equipped roadworks safety trailers – will be completed until end 2023.

The second wave of C-ITS pilots which has started 2019 is targeting 50 European cities, aiming at providing the basis for urban C-ITS deployment. C-Roads Germany Urban Nodes extends the pilot locations to Hamburg, Kassel and Dresden, focussing on services such as Traffic Signal Priority, Emergency Vehicle Approaching, Green Light Optimal Speed Advisory and Vulnerable Road User Advise. The three cities have deployed until now 170 ITS stations (Road Side Units) and most of the services are already operational. In October 2022, the German cities have hosted a series of cross tests with pilot cities from other C-Roads countries and industry actors. The second wave comes to an end in 2023, or 2024 respectively. It is planned to broaden the wave of urban deployment with additional co-funding provided by the Connecting Europe Facility (project end: 2026).

The BASt roles are devoted to the national technical coordination of C-Roads 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, cross-testing and validation, evaluation and assessment of the pilots, urban C-ITS) of the C-Roads Platform. Especially, BASt chairs the task force on security aspects (Public Key Infrastructure) and co-chairs the task force on cross-testing and validation. BASt also supports the Federal Ministry for Digital and Transport at the Steering Committee.

2.2.21. FAME

FAME is a 23 partner-project coordinated by ERTICO, addressing the research and innovation needs as identified in the research coordination cluster of the CCAM Partnership. It has started in July 2022 and will run for three years, making use of a budget amounting to 5.7 MEUR. FAME will implement three key recommendations from the CCAM Platform (COM Expert Group, Final Report 2021), maintaining and enhancing the EU wide Knowledge Base on Connected and Automated Driving (which has been established by the predecessor project ARCADE), establishing an EU Common Evaluation Methodology (CEM) for CCAM testing and to provide a framework for sharing test data. A taxonomy tool as well as a legal and ethical framework will complement the European framework for CCAM testing. Besides that, FAME will foster the stakeholder engagement and organise key events such as the EU CAD Conference in Brussels (next forthcoming in May 2023).

BASt contributes to FAME with the following mission: to include the facts and findings from the BASt-hosted monitoring of CAD test fields (https://www.testfeldmonitor.de) in the EU wide Knowledge Base, to bring in methodological contributions for HMI research in the context of large scale demonstrations, to extend and accompany the Common Evaluation Methodology with a branch of impacts which are not directly based on test data but receive increasingly larger public attention (e.g. wider economic impacts, distributional impacts, land use) and to pilot CEM in synergy with large scale demo projects such as HiDrive and MODI. More information on FAME is available at https://www.connectedautomateddriving.eu/

2.2.22. Research program road safety

BASt has the task to carry out target-oriented planning and coordination of research in the area of road safety and to examine traffic safety improvements. Therefore, BASt elaborates research programs, addressing current and future road safety issues in order to provide scientifically proven information as a base for advice and support to the Federal Ministry of Digital and Transport (BMDV).

Among other topics, programs currently ongoing are dealing with the further development of the German In-Depth Accident Study (GIDAS) and with safe cycling on shared roads. A program dealing with cargo bikes is currently under development.

GOVERNMENT STATUS REPORT OF JAPAN

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1. Recent change of Traffic Accidents in Japan and the Government Targets

In 2021, the number of fatalities (those who died within 24 hours) in traffic accidents in Japan was 2,636.

This is a significant decrease from the previous year, down to about one-sixth of the 16,765 fatalities in 1970, when the number of fatalities peaked.

Further, the numbers of accidents with casualties and the number of injuries have both decreased for 17 consecutive years since 2004, the year they were the worst.

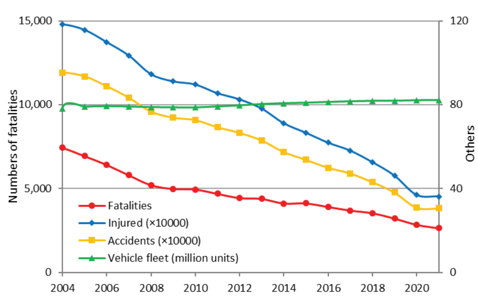

Figure 1. Recent trends in traffic accidents in Japan

As a further step, Japan announced in March 2021 the 11th Master Plan for Traffic Safety (2021-2025), which sets a new goal of reducing the number of fatalities (those who died within 24 hours) to less than 2,000 and the number of serious injuries to less than 22,000 by 2025.

Based on the 11th Master Plan for Traffic Safety, the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) announced on June 28 2021, the goals of reducing by 2030 the number of fatalities in traffic accidents within 30 days by 1,200 and the number of serious injuries by 11,000 compared to 2020 through vehicle safety measures.

In addition, MLIT set forth four priority areas as the directions for future vehicle safety efforts:

- Ensuring the safety of pedestrians, bicyclists and other road users
- Ensuring the safety of vehicle occupants
- Preventing certain types of serious accidents, which have become an important issue in light of the social background
- Promoting the creative and proper use of automated driving-related technologies

2. Effective Vehicle Safety Measures

The diffusion and development of active safety and other safety technologies require not only the update of the Safety Regulation but also a variety of rational measures.

These need to be examined after the

quantitative assessment of their effectiveness and performance.

MLIT is hence promoting vehicle safety measures by effectively linking safety regulations, the Advanced Safety Vehicle (ASV) project, and the New Car Assessment Program (NCAP).

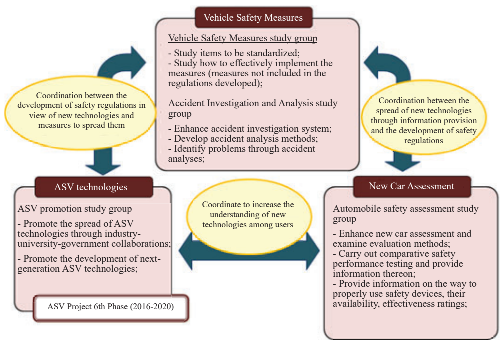

Figure 2. Vehicle safety measures promotion system

2.1 Enhancing the Safety Regulation

Regarding the enhancement of the Safety Regulation, MLIT has introduced UNRs and GTRs, focusing on advanced safety technologies, with the harmonization of international regulations in mind.

【Recent revisions of the Safety Regulation】
FY2022

- Enhanced the performance requirements for advanced emergency braking systems (AEBS) for heavy-duty vehicles
- Made mandatory the use of reverse warning sound systems for heavy-duty vehicles
- Expanded the regulation for automated driving systems (ADS)
- Enhanced performance requirements for pedestrian protection in the event of a collision

FY2021

- Made mandatory the use of devices (e.g., rearview cameras) to check immediately behind the vehicle when reversing
- Added requirements for AEBS for passenger cars, etc. (to protect bicyclists)
- Made mandatory the use of event data recorders (EDRs)
- Introduced regulation for risk mitigation functions (driver incapacity response systems)
- Improved regulation for battery electric vehicles
- Extension of the scope of frontal impact with focuson restraint systems

FY2020

- Introduced regulations for daytime running lights, etc. for motorcycles
- Introduced regulations for automated driving at Level 3 on expressways

FY2019

- Made mandatory the use of lateral collision warning systems
- Made mandatory the use of AEBS for passenger cars, etc.
- Introduced regulations for ADS
- Introduced regulations for cyber security software updates

Figure 3. Installation example of reverse warning sound systems

2.2. Advanced Safety Vehicle (ASV) Project

With regard to the ASV Project, which promotes the development and commercialization of advanced safety vehicles (ASV), MLIT worked on following during the 6th phase (FY2016-FY2020):

(i) Reviewed ASV design philosophy and Guideline principles ASV Technology Development with automated driving as a premise
(ii) Developed technical requirements of evolving emergency driving stop system for taking refuge on shoulder
(iii) Revised common definition and names of ASV technologies

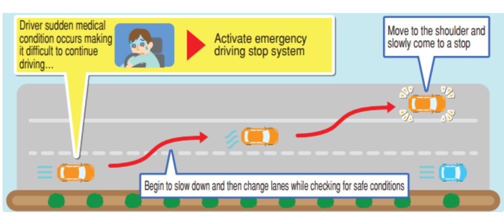

Figure 4. Technical requirements of evolving emergency driving stop system for taking refuge on shoulder

Into the 7th phase (FY2021-FY2025), we are working in four major areas, aiming to further promote ASVs for advanced automated driving.

(i) Helping people fully and correctly understand and use ASV, now a technology accessible to everyone, and diffusing them effectively on a solid strategy
(ii) Examining what safety technology should be that gives the system driving priority over the driver in certain situations.
(iii) Examining common specifications for the commercialization and dissemination of safety technologies using communications and mapping technologies
(iv) Exploring the scope and level of safety to be guaranteed to automated vehicles

In addition, for heavy-duty vehicles such as trucks and buses, MLIT is introducing advanced safety technologies such as Advanced Emergency Braking Systems (AEBS), Driver Incapacity Response Systems, and Lateral Collision Warning Systems through tax incentives and budget allocations.

2.3. Japan New Car Assessment Program (NCAP)

The Japan New Car Assessment Program (JNCAP), which assesses and publishes the safety performance of motor vehicles, has been in place since FY1995 to enable vehicle users to choose safer vehicles and to encourage automakers to develop such vehicles.

Since FY2011, the program has been assessing the performance of the vehicle both in occupant and pedestrian protection, and publishing the results with a one- to five-star rating of passive safety performance.

Meanwhile, the assessment of active safety performance such as AEBS has been conducted since FY2014, the scope of assessment being gradually broadened with an increasing number of systems tested.

In FY2018, the program added the assessment of Acceleration Control for Pedal Error (ACPE), and in FY2019, started that of AEBS that avoid collisions with pedestrians in unlit situations at night.

From FY2020, we integrated the assessment and result publication of passive safety performance and active safety performance, which had been conducted separately.

To further reduce the number of fatalities and injuries, we started assessing AEBS for bicycles in FY2022. Furthermore, from FY2024, we plan to assess AEBS for intersections.

To increase consumer awareness of JNCAP, we will continue disseminating knowledge and information in corporation with the National Agency for Automotive Safety and Victims' Aid (NASVA), district transport bureaus, and other parties concerned.

Figure 5. Assessing AEBS for bicycles

3. Efforts toward the Realization of Automated Driving

Automated driving is expected to be highly effective in solving problems by reducing traffic accidents, relieving traffic congestion, providing a means of mobility to the elderly, etc.

The Japanese government has set such goals as achieving automated driving at Level 4 on highway by FY2025 and unmanned automated mobility services with only remote monitoring by FY2022.

To achieve these goals, MLIT is working to (i) improve the environment (regulations and legal systems), (ii) promote development and deployment, and (iii) conduct field operational tests and social implementation toward the realization of automated driving.

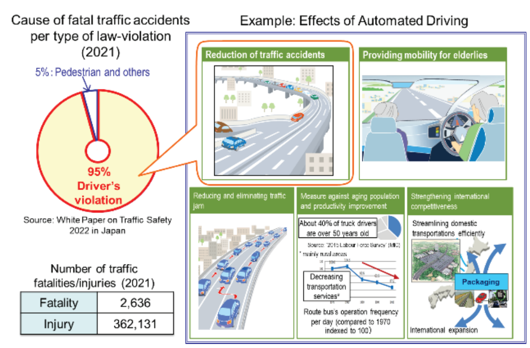

Figure 6. Importance of automated driving

3.1. Improving the environment for automated driving

Japan participates and plays an active role in discussions on international regulations for automated driving as a co-chair or vice-chair for various bodies at the UN ECE World Forum for

Harmonization of Vehicle Regulations (WP.29).

In June 2019, WP.29 agreed on a framework document on automated driving that outlines priority issues to be discussed and a schedule for the development of automated driving regulations.

Further, in June 2020, the Forum passed an international regulation for ADS, including automated lane keeping systems (ALKS) and cybersecurity measures.

In June 2022, it was also agreed to increase the upper speed limits for ALKS and add lane-change functions.

We will continue cooperating with other countries to discuss and establish international regulations for even more advanced automated driving.

At home, while taking into account of international discussions at WP.29, we established and enacted domestic regulations for ADS in April 2020.

Further, in November 2020, Japan became the first country in the world to grant a vehicle type approval for Level 3 automated driving.

Meanwhile, Acceleration Control for Pedal Error (ACPE), which is part of automated driving technologies, are expected to make a key issue in the future.

Japan is aging the fastest in the world and has seen accidents caused by elderly drivers become a serious social problem. By establishing international regulations for ACPE, which is already in widespread use in the country, we will promote its use to improve safety in many countries around the world, where the population is also rapidly aging.

3.2. Promoting the development and spreadof automated driving technology

To promote the development and deployment of automated driving technology, the government had set a new numerical target of increasing the percentage of newly registered passenger cars equipped with AEBS to 90% or more by 2020.

To achieve this target, MLIT has been promoting the spread of AEBS (as mentioned in 2.2).

In addition, in line with the international regulation established in WP.29, we made mandatory the installation of AEBS in new passenger cars (phased from September 2021).

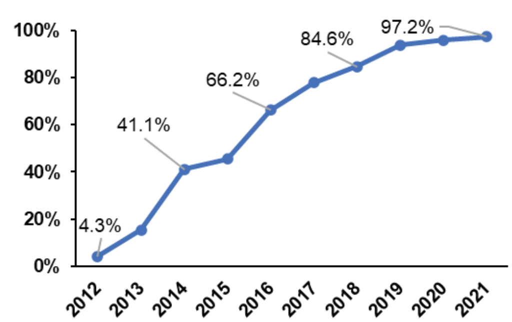

Figure 7. Percentage of newly registered passenger cars with AEBS

3.3. Field operational tests for automated and autonomous driving and their social

implementation

With regard to mobility services, the government realized Japan's first Level 3 unmanned automated mobility service in March 2021.

Currently, we are working to realize this mobility service at Level 4, and intend to use this experience to expand the unmanned automated mobility service nationwide in the future.

For logistics services, we realized in 2021 a platooning technology where trail trucks followed unmanned on expressways. Currently, we are studying how to run Level 4 automated trucks.

Figure 8. Unmanned automated mobility service and truck platooning

4. Promoting the International Harmonization of Vehicle Regulations in Cooperation with Other Countries

To help global distribution work smoothly, it is becoming more and more important to internationally harmonize vehicle regulations, which differ from country to country, and to promote mutual recognition of type approval between nations, by which they accept each other's certifications.

These activities are conducted by WP.29, the only world forum of its kind, and the Japan has been actively working there to promote the harmonization of vehicle regulations since the 1970s.

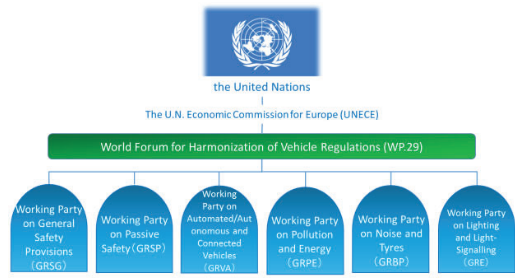

Figure 9. Structure of WP.29

4.1. Contributing to international discussions

In WP.29, MLIT, in cooperation with other countries, contributes to the development of international regulations on new technologies, such as automatic command, steering functions, AEBS, and other automated driving technologies, cybersecurity, and detection and warning systems for vulnerable road users in proximity.

In addition, MLIT contributes to the activities of WP.29 in terms of human resources, serving as vice-chair of various forums under WP.29 and working parties on automated driving-related technologies.

4.2. Promoting International Whole Vehicle Type Approval (IWVTA)

In 2017, WP.29 adopted an international regulation (UN R0), which entered into force in 2018.

In December 2019, Japan became the first country in the world to type-approve a vehicle under the IWVTA system.

Committed to the smooth operation of the IWVTA, MLIT promotes its active use.

Currently, the Informal Group on IWVTA under WP.29, chaired by Japan, is studying ways to further enhance the IWVTA in the future, including the expansion of the scope equipment concerned.

4.3. Promoting accession to UN Agreements in emerging countries

MLIT actively supports ASEAN and other emerging countries in joining UN agreements, participating in activities at WP.29, and introducing IWVTA.

In addition, building on its expertise and experience, MLIT helps these countries introduce appropriate traffic safety and environmental protection measures best suited to the traffic and environmental conditions of their own.

Conclusion

These are the measures being taken in Japan. In promoting them, MLIT collects and analyzes traffic data and runs PDCA cycles with the cooperation of various stakeholders.

Further, considering that motor vehicles are globally distributed products, it is essential, when considering and discussing regulations, to keep in mind the importance of international harmonization.

MLIT will continue actively making proposals based on technical evidence and help advance international discussions.

GOVERNMENT STATUS REPORT OF REPUBLIC OF KOREA

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Mobility and Motor Vehicles Bureau,
Ministry of Land, Infrastructure and Transport,
Republic of Korea

I. Overview of traffic accidents and relevant polices

1. Analysis of Road Traffic Accidents Statistics

The fatalities from road traffic accidents has been steadily decreased in Korea even though the number of vehicle registrations has been consistently increased over the past two decades through the Korean government's continuous efforts and the implementation of policies.
The number of motor vehicle registrations increased by 35% in 2021 to about 2,491 thousand compared to that in 2011, but the fatalities due to traffic accidents decreased by half to 2,916 for the first time in 2021 to less than 3,000.
The number of traffic fatalities per 100,000 people had also continued to decline since 2014, when it fell below 10 for the first time, and was halved to 5.6 in 2020, but as of 2019, it was 1.3 times higher than the OECD averaged of 5.2(6.5 in Korea) and ranked 29th out of 36 countries, therefore, it will be still requiring steady efforts.

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

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Fatalities	5,229	5,392	5,092	4,762	4,621	4,294	4,185	3,871	3,349	3,081	2,916
Fatalities per 100,000	10.5	10.8	10.1	9.4	9.1	8.5	8.1	7.3	6.5	6.0	5.6
Number of Car Registration (million unit)	18.44	18.87	19.40	20.12	20.99	21.80	22.53	23,20	23,68	24,37	24,91

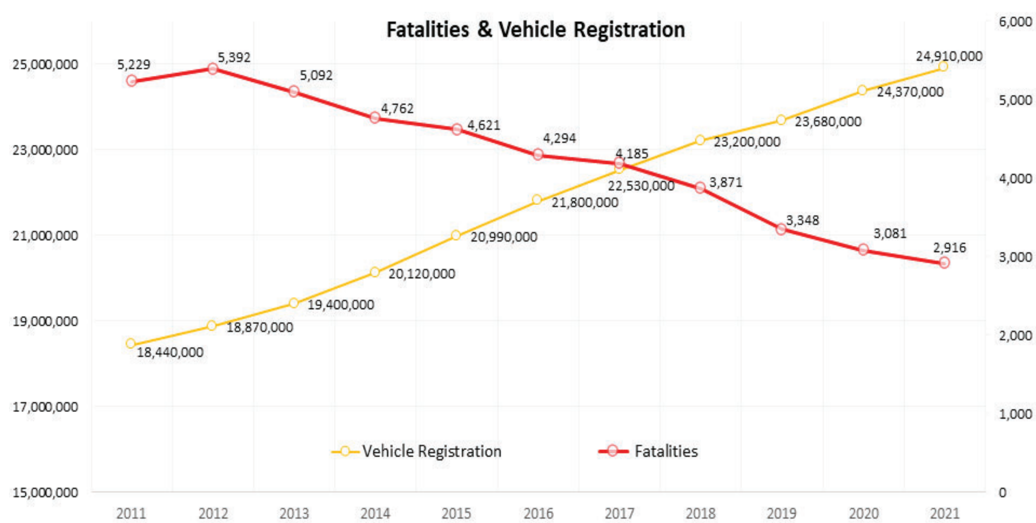

Figure 1. Road traffic fatalities

2. Overview of Traffic Safety Policies

The 9th National Transportation Safety Master Plan (2022-2026)

The Korean government establishes 'The National Transportation Safety Master Plan' every five years to improve road traffic safety, and according to the recently announced 9th Plan (2022 ~ 2026), it is actively implementing various government polices to improve traffic safety for vulnerable sectors such as pedestrians, the elderly, two-wheelers and freight vehicles with the goal of reducing the road deaths from 3,081 in 2020 to 50% by 2027.

The 3rd Vehicle Policy Framework Plan (2022~2026)

In addition, based on the 3rd Vehicle Policy Framework Plan (2022~2026) established in conjunction with the 9th National Transportation Safety Framework Plan, 4 strategies and 17 detailed implementation tasks have been set with the goal of realizing mobility in people's daily lives, improving safety management and consumer rights as shown in Figure 2, including 1) Completing the commercialization base for fully automated vehicles(Level 4), 2) Establishing an eco-friendly mobility safety system and fostering new industries, 3) Revitalizing the automotive aftermarket and 4) Strengthening the consumer protection and safety.

To briefly introduce the detailed implementation tasks of the fourth strategy, Korea will continue to reflect vehicle regulations into the Korea Motor Vehicle Safety Standard(KMVSS) and continuously improve the New Car Assessment Program to convert it to comprehensive assessment program that includes the Automotive Life Cycle Assessment(A-LCA), the assessment of vehicle interior air quality of new vehicles and Battery Management System and so on.

also, for quick and extensive consumer protection, Korea will take proactive measures by recommending manufacturers to expand voluntary recalls and public free repairs if necessary before forced recall and introduce a mediation system and arbitration services in the vehicle exchange and refund legal system.

In order to establish a tighter safety management system for in-use vehicles, Korea will strengthen the management and supervision of uninsured vehicles, rationalize maintenance fees to ease the burden on consumers, and expand livelihood support for accident victims. also the Korean government plans to make several management systems such as safety inspections, maintenance qualification systems, scrapping systems and enforcement measures to eliminate safety blind spots for two-wheelers.

Strategies	1 Completing the commercialization base for fully automated vehicles (Lv.4)
	2 Establishing an eco-friendly mobility safety system & fostering new industries
	3 Revitalizing the automotive aftermarket
	4 Enhancing the consumer protection & Safety

Figure 2. Strategies of the 3rd Vehicle Policy Framework Plan (2022-2026)

II. Measures for Ensuring Vehicle Safety

1. Overview of Korea Motor Vehicle Safety Standards (KMVSS)

The Korea Motor Vehicle Safety Standards (Hereafter, KMVSS) is based on the Motor Vehicle Management Act enacted to efficiently manage performance and safety of motor vehicles.

In detail, the KMVSS specifies requirements of vehicles and its parts and 7 items on the structure of vehicles, 21 items on the devices of vehicles, 12 items for vehicles' parts and detailed test methods to verify the performance of additional advanced devices.

Article 29, Motor Vehicle Management Act (Vehicle Structure and Devices)

Rules on the performance and standards of motor vehicles and its parts(KMVSS)

Vehicle Structure Standards[1)] (7 items)	Vehicle Devices Standards[2)] (21 items)	Vehicle Parts Standards[3)] (12 items)

1) Standards related to vehicle's dimension and weight for determining the road, lanes, tunnels and bridges for considering the traffic environment
2) Standards for vehicles or devices and accessories used or attached to vehicles can be classified safety and performance. and safety is further categorized into accident prevention, damage reduction and secondary accident prevention after an accident
3) Standards for determining strength, durability and performance, etc. of replacement part used in vehicles

Those who manufacture, assembles or import vehicles must self-certify the they have complied with the KMVSS and will be subject to corrective measures, fines and other penalties if the Korean government found non-compliance through the compliance test.

2. Activities in Harmonization of vehicle Regulations

Overview of Harmonization in Korea

The 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 The KMVSS.

Activities at UN ECE WP.29

In order to fulfill its responsible role as a contracting party of WP.29, The Korea is actively participating in the WP.29 Plenary Meetings and six expert group meetings(GR) and informal technical group meetings.

As of 2023, Korea has been serving as a Vice-Chairperson of Working Party on Passive Safety(GRSP) from 2014, the chair for the informal working group on Deployable Pedestrian Protection System (DPPS) to develop test procedures to mitigate pedestrian injury in pedestrian accidents and the co-chair of informal working group on Automotive Life Cycle

Assessment(A-LCA) and Vehicle Interior Air Quality Phase 3.

Korea also has been actively participating totally 13 informal working groups including Electric Vehicle Safety phase 2 and Hydrogen and Fuel Cell Vehicles (HFCV) phase 2.

The status of major amendments to the KMVSS

Korea has been continuously harmonizing with international Regulations since 2006 when it first introduced three UN regulations and one UN GTR into the KMVSS.

as of March 2023, 88 UN regulations and 16 UN GTRs were reflected in the KMVSS and about 91% of the KMVSS were harmonized with UN regulations and UN GTRs excluding Korea's own requirements in the KMVSS.

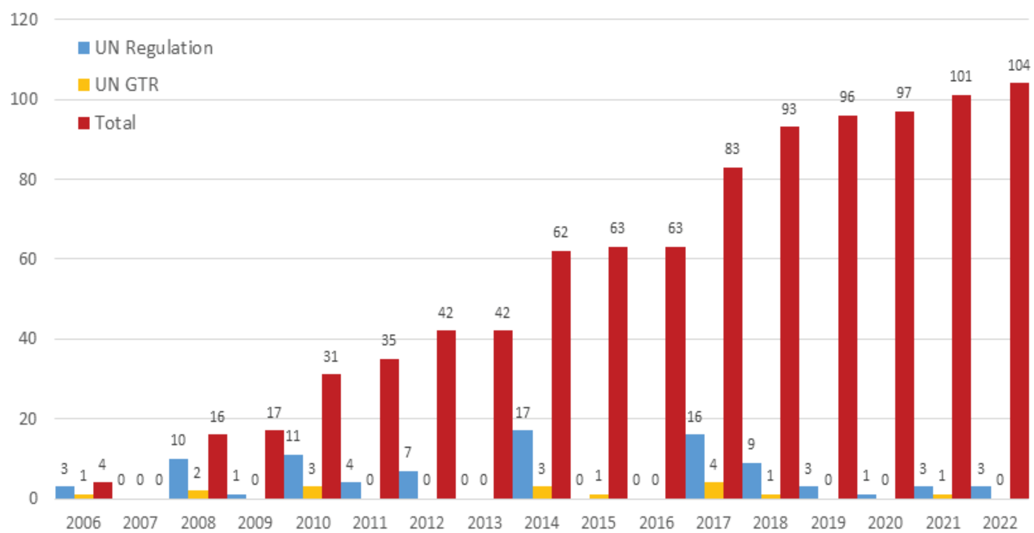

Figure 3. The number of introducing International regulations in the KMVSS

1) Introduction of UN R152 for Advanced Emergency Braking System(AEBS) for passenger vehicle (26.Oct. 2022)

Korea has steady mandated the installation of Advanced Emergency Braking System(AEBS) for large passenger vehicles, cargo and special vehicles with a gross vehicle weight of more than 3.5 tons to prevent heavy traffic accidents since 2017.

In addition, from 1. January. 2023, Passenger vehicles, cargo and special vehicles with weight 3.5 tons or less will be required to be installed in stages, and by 2027, all vehicles produced and imported in Korea should be installed as mandate requirements.

2) Reflection of revised international Regulations related to collision safety (26. Oct. 2022)

The amendments of UN regulations such as UN R94 and UN R95 on frontal collision, UN R95 on lateral collision were introduced into the KMVSS which are to enlarge applicable vehicles scope to passenger vehicles with weight of 3.5 tones or less and light trucks of a total permissible mass not exceeding 2.5 tons.

It is expected to significantly improve the collision safety of light trucks by applying frontal and lateral collision requirements and will take effect on 1. January. 2023 for new vehicles and 1. January. 2028 for existing vehicles.

3) Introduction of electrical safety of motorcycles (24. Dec. 2020)

Safety requirements of prevention of explosion and fire of traction batteries for electric motorcycles in the UN R136 in line with general electric vehicles were introduced into the KMVSS. it was come into effect on 24. December 2020.

Future plan for harmonization

Korea has been harmonized with international regulations according to mid-long term plan as a part of the 3rd Vehicle Policy Framework Plan.

In the process of establishing a mid-long term plan for the introduction of international regulations, we usually finalize decision to introduce which international regulations will be needed and proper time through technical researches and comprehensively reviews of domestic traffic conditions, policy priorities and opinions from vehicle manufacturers.

Currently, The Korea has launched several researches to introduce 10 UN regulations including simplified lighting regulations (UN R148, 149, 150), front and rear proximity alarm system for large passenger vehicles and trucks (UN R158, 159) and vehicle structure and seat strength for large passenger vehicles (UN R14, 16, 66, 80, 107).

in 2023, Korea plans to introduce international regulations that have still not been introduced such as conditions of operating stop lamp during regenerative braking and mandatory of automatically turn on headlamps and rear position lamps in the night time.

3. Korean New Car Assessment Program (KNCAP)

Korean New Car Assessment Program was introduced in 1999 with full frontal collision test of Hyundai Avante model. Since then, the number of assessment items and models have been continuously expanded, and as of 2022, the assessments of 21 items in the three areas of collision safety, pedestrian safety and accident prevention safety were conducted. and Korea plans to expand assessment system to the comprehensive assessment program in the future.

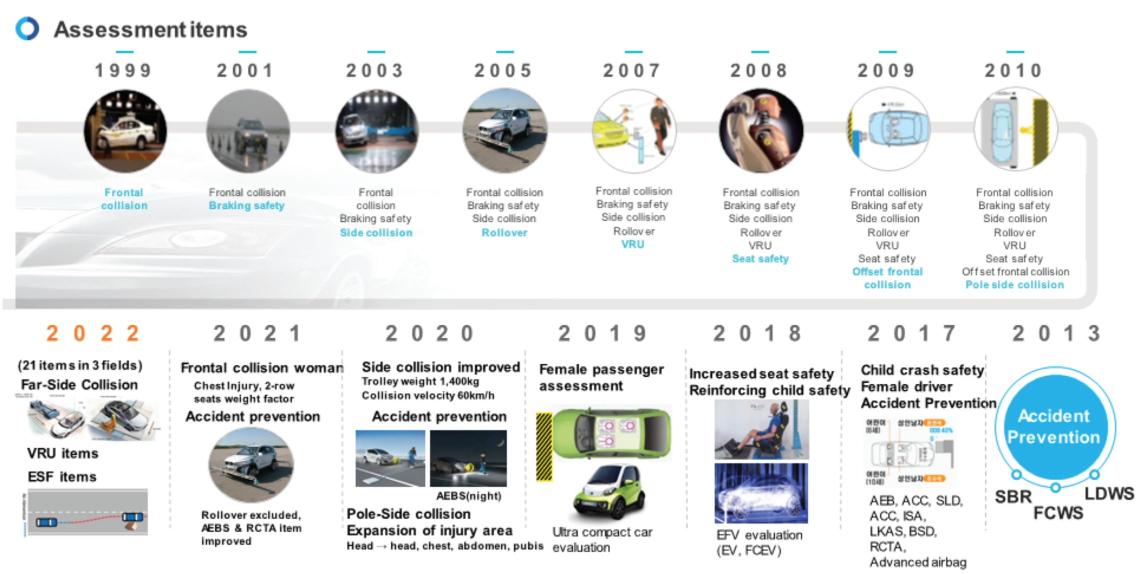

Figure 4. Expanding assessment items in KNCAP

In order to ensure the safety of vehicles in the event of an accident, as well as to strengthen accident prevention functions by installing real time monitoring system of traffic situation and actively accident prevention system, Rating adjustment method for accident prevention assessments was reflected in 2022 for the first time and the proportion of these assessments will be expanded continuously.

In addition, beyond the safety which evaluates the safety of vehicles, Green NCAP which evaluates the GHS of whole life cycle of vehicles from the point of view of vehicle manufacturing stages and fuels, and interior air quality of new vehicles will be introduced.

Also, evaluation methods for Battery Management System(BMS) to prevent fires of electric vehicles and C-ITS to accelerate the development of V2X infrastructure will be introduced into the comprehensive assessment program.

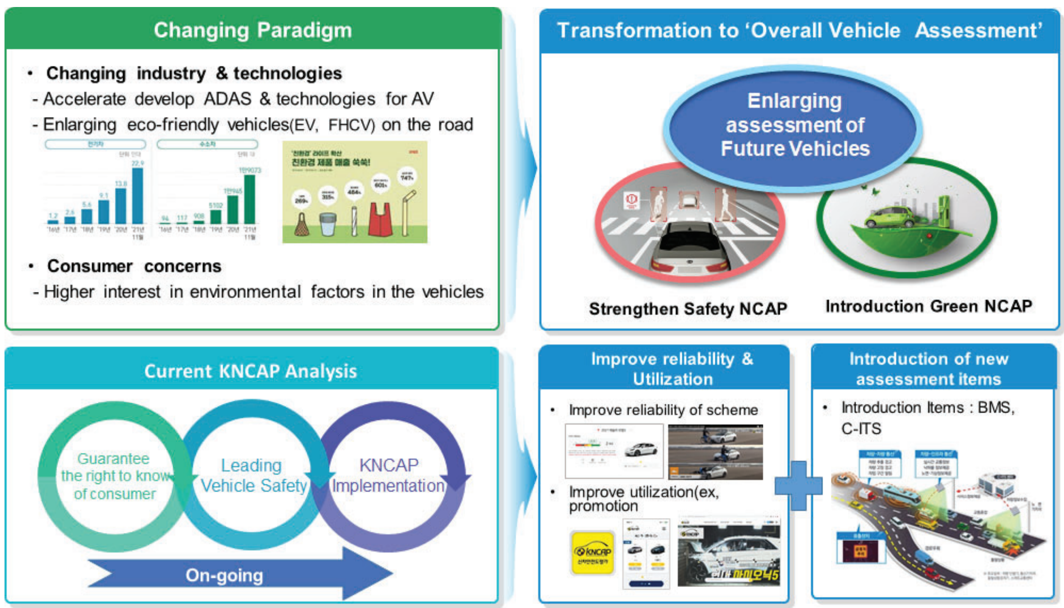

Figure 5. Policy direction for KNCAP

III. Conclusion

Korean Government has been making diverse efforts through improving the KMVSS to support the development and supply of vehicles to prepare the new mobility era, to actively participate international conferences to reduce trade barriers, trade friction and to harmonize with international regulations steadily according to the 9th National Transportation Safety Master Plan and the 3rd Vehicle Policy Framework Plan.

Also, KNCAP has been conducted to encourage to produce safer vehicles by manufacturers voluntarily. Korea now is preparing the upcoming future vehicle era by expanding KNCAP to the comprehensive assessment system.

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Government Status Report, 2023

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National Highway Traffic Safety Administration (NHTSA)

United States

Crash Incidence Status

For years, NHTSA celebrated success in the downward trend of motor vehicle-related fatalities on America's roadways. There was a relatively steady decline in fatalities from 43,510 in 2005, to 32,744 fatalities in 2014. A slight uptick, though, in 2015 introduced uncertainty in the trends in motor vehicle-related fatalities and a concerted effort to understand changes in trends and identify potential new agency priorities. The nation experienced the loss of 36,355 people in 2019 before the greatest upending of societal and cultural norms most generations experienced due to the Coronavirus Pandemic (COVID-19). The Pandemic that began in early 2020 introduced change in a multitude of areas including roadway transportation, most notably in driving behavior.

After the declaration of the public health emergency in March 2020, driving patterns and behaviors in the United States changed significantly . Of the drivers who remained on the roads, some exhibited riskier behavior, including speeding, failure to wear seat belts, and driving under the influence of alcohol or other drugs.

In 2020 there were an estimated 5,250,837 police-reported traffic crashes in which 38,824 people were killed and an estimated 2,282,015 people were injured. Compared to 2019, this was a 6.8-percent increase in fatalities, but a 16.7-percent decrease in the estimated number of people injured in 2020. The estimated number of police-reported crashes declined 22.3 percent from 2019 to 2020.

In 2020 there were 11,654 people killed in alcohol-impaired-driving crashes. Fatalities in alcohol-impaired-driving crashes increased by 14.3 percent from 2019 to 2020.

The number of speeding-related fatalities in 2020 increased by 17 percent from 2019, from 9,592 to 11,258.

The question became whether the increase in riskier behavior would continue? Would the return to more normal routines for individuals bring a return to expected behaviors and subsequently lower the number of fatalities on U.S. roads?

Projections for the number of fatalities in 2021 increased over 2020. The projections for the year show an estimated 42,915 people lost their lives in motor vehicle-related crashes. On top of the 6.8% increase from 2019 to 2020, the nation is expected to see an additional 10.5% increase in fatalities from 2020 to 2021, when the data are finalized.

Reaching into 2022, statistical projections of traffic fatalities for the first half of 2022 show that an estimated 20,175 people died in motor vehicle traffic crashes. This represents a marginal increase of about 0.5 percent as compared to 20,070 fatalities projected to have occurred in the first half of 2021. However, there is a hint of a potential turn or plateau in the data. The second quarter of 2022 represents the first decline in fatalities after seven consecutive quarters of year-to-year increases in fatalities, beginning with the third quarter of 2020.

Final data and analysis of crash characteristics and individuals involved in the crashes for 2021 are expected prior to the ESV Conference in April 2023 and will be included in the Global Focal Point presentation, along with more current projections for 2022. These additional data will better inform NHTSA and efforts into countermeasures and programs to reduce motor vehicle crashes and the deaths, injuries, and societal and economic impacts that result from those crashes.

BIL Implementation

On November 15, 2021, President Joe Biden signed the Infrastructure Investment and Jobs Act, also known as the Bipartisan Infrastructure Law or BIL, into law. BIL is the largest long-term investment in America's infrastructure and economy in the Nation's history. This commitment makes historic investments in the transportation sector by improving public safety and climate resilience, creating jobs, and delivering a more equitable transportation future.

Specific to NHTSA, BIL increased NHTSA's budget by more than 50 percent, allowing NHTSA to make its most historic and largest investment into vehicle and highway traffic safety. In addition to the funding increases, BIL included a number of provisions targeting improved roadway safety such as mandated research studies, new vehicle safety requirements, considerations of advanced vehicle technologies, and increased data collection efforts.

The following provides an overview of a selection of provisions included in the Bipartisan Infrastructure Law. Many of these areas involve activities that NHTSA has been focusing on in recent years through hazard identification, previous research, and data analysis.

<u>Crash Data</u>

- Revise the crash data collection system to include collection of data elements that distinguish personal conveyance vehicles such as scooters and bikes, from other vehicles involved in a crash.
- Change crash data collection systems to include collection of data elements relating to vulnerable road user safety.
- Coordinate with states to update the Model Minimum Uniform Crash Criteria.
- Coordinate with Centers for Disease Control and Prevention to develop and implement a plan for states to combine highway crash data with injury health data to produce a national database of pedestrian injuries and fatalities with demographic characteristics.
- Increase participation in the Electronic Data Transfer protocol via a new state grant program and internal investment.
- Expand the Crash Investigation Sampling System by adding sites, broadening the scope, and adopting on-scene investigation protocols.

<u>Risky Driving Behavior</u>

- Conduct research regarding the installation and use of driver monitoring systems on motor vehicles.
- Fund advanced drunk and impaired driving prevention technology research through 2025.
- Require states that have legalized marijuana to consider programs to educate people and reduce injuries and deaths resulting from marijuana-impaired driving.
- Allow states to use open container and repeat offender transfer funds for drug-impaired driving countermeasures.
- Identify all illegal passing laws in each state relating to school buses, as well as methods used by states to address school bus stop-arm violations and best practices to address illegal passing of school buses.
- Evaluate effectiveness of various technologies for enhancing school bus safety.

Child Safety

- Issue a final rule requiring all new passenger motor vehicles weighing less than 10,000 pounds gross vehicle weight to be equipped with a system to alert the operator to check rear-designated seating positions after the vehicle engine or motor is deactivated by the operator.
- Conduct a study on and report on:
    - The potential retrofitting of existing passenger motor vehicles with one or more technologies that may address the problem of children left in rear-designated seating positions after deactivation of the motor vehicles by an operator.
    - The potential benefits and burdens, logistical or economic, associated with widespread use of those technologies.
- Conduct a study to review the status of child car seat accessibility for low-income families and underserved populations, in coordination with other relevant federal agencies.
- Require states to use at least 10% of occupant protection grant funds for child restraint expenditures for low-income and underserved populations.

Vehicle Technologies

- Complete rulemakings that require the following on new passenger vehicles:
    - Lane departure warning
    - Lane keeping assist
    - Forward collision warning
    - Automatic emergency braking
- Work to issue a final rule prescribing an FMVSS that requires passenger motor vehicles, manufactured after the effective date of that standard, to be equipped with advanced drunk- and impaired-driving prevention technology.
- Complete a rulemaking to require automatic emergency braking on heavy vehicles subject to FMVSS 136 (electronic stability control systems). And complete a study on equipping vehicles not subject to FMVSS 136 with automatic emergency braking, including feasibility, benefits and costs.

Data Collection for Vehicles with Automation

In June 2021, NHTSA has issued a Standing General Order (SGO) requiring identified manufacturers and operators to report to the agency incidence of certain crashes involving vehicles equipped with Automated Driving Systems (SAE Levels 3-5) and Advanced Driver Assistance Systems (SAE Level 2). The SGO allows NHTSA to obtain timely and transparent notification of real-world crashes associated with ADS and Level 2 ADAS from manufacturers and operators. With these data, NHTSA can respond to crashes that may raise safety concerns about ADS and ADAS Level 2 systems through further investigation and enforcement.

Prior to the implementation of the SGO, NHTSA's sources of timely crash notifications were limited and generally inconsistent across manufacturers, including developers.

Reporting requirements are specific to the type of system in use. For ADS, entities in the SGO must report a crash if the ADS was in use at any time within 30 seconds of the crash and the crash resulted in property damage or injury. For ADAS Level 2 systems, entities in the SGO must report a crash if the ADAS Level 2 system was in use at any time within 30 seconds of the crash and the crash involved a vulnerable road user or resulted in a fatality, a vehicle tow-away, an air bag deployment, or any individual being transported to a hospital for medical treatment.

Summary incident report data submitted to NHTSA under the SGO are available for download. Publicly available information is updated on a monthly basis.

Advancing Equity

ADS Accessibility for All Road Users

NHTSA is currently conducting two projects examining accessibility and Automated Driving Systems – Dedicated Vehicles (ADS-DV). To improve mobility for all Americans, these vehicles are expected to be designed with usability in mind for a broad spectrum of travelers who need multiple means of expression, interaction, and engagement.

- *Considerations for Making ADS Vehicles Accessible for All Road Users.* Awarded in 2019, the goal is to develop knowledge about user needs for the design of ADS-DV with a particular focus on road users with disabilities and vulnerable road users (e.g., pedestrians, bicyclists).

- *Additional Considerations for Making ADS Vehicles Accessible for All Road Users.* Awarded in 2021, the goal is to understand how to establish situation awareness for travelers during unexpected events and identify needs for interface customization, standardization, and common configurations (for both the vehicle and individual devices).

Female Crash Safety Plan

In alignment with the Departmental Strategic Goal of Equity, NHTSA is working to address sex inequalities in crash safety outcomes. Although more male motor vehicle occupants are killed in motor vehicle crashes than females, recent studies suggest that female occupants have higher injury and fatality risk in comparable motor vehicle crashes.

NHTSA seeks to better understand the possible sex inequalities in crash safety outcomes, particularly those not addressed in vehicles with modern crashworthiness countermeasures. Further, NHTSA is interested in evaluating the potential benefits of improved female anthropomorphic test devices (ATDs), as well as finite element (FE) human body models (HBM), to provide the tools necessary to develop effective safety countermeasures. To do so, a comprehensive research plan has been developed. The primary objective of this research plan is to generate information to support overall knowledge on sex equity in crashworthiness and to support future agency decisions.

The plan identifies four core research areas:

- Field Data Analysis
- Advanced ATDs and Experimental Biomechanics
- Human Body Modeling
- Fleet Testing and Countermeasure Studies

Female Crash Risk Data Analysis

NHTSA recently updated the results of a 2013 study that compared relative fatality risk for females versus males. The update includes the most recent fatal crash data and found that the observed relative risk of fatality between females and males has been reduced, especially when considering newer vehicles. The incremental fatality risk for females relative to males for model year 2010-2020 vehicles was found to be 6.3 ± 5.4% and is statistically significantly less than for model year 1960-2009 vehicles (18.3 ± 1.2%). For model year 2015-2020 vehicles, the estimated difference in fatality risk between females and males appears further reduced to 2.9 ± 9.8% percent for the average of drivers and right-front passengers; however, due to data scarcity, this statistic will need further observation.

NHTSA is currently conducting a data analysis that compares the odds of female injury occurrence to males in motor vehicles. The two main question for this analysis are:

- Do female occupants of passenger vehicles have different serious injury risk (MAIS 2+ and MAIS 3+) than males as a result of motor vehicle crashes?
- Does female injury risk vary by body region?

While the full analysis and report are forthcoming, preliminary results show a mix of higher and lower injury odds for "All Crashes" and crash type specific models (frontal, near-side, far-side, rear-impact, and rollover). Overall, as compared to males, females see lower odds of injury for head, neck, and torso and higher for upper and lower extremities.

Disparities in Fatalities

In 2022, NHTSA published a report titled *Evaluating Disparities in Traffic Fatalities by Race, Ethnicity, and Income,* prompted by Executive Order 13985 on January 20, 2021, on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. In accordance with this Executive order, the study aimed to assess disparities with respect to traffic fatalities based on race, ethnicity, and income. The published report presents a summary of prior research, analysis, data and methodology, and the study's findings regarding the questions.

- Are there racial-ethnic disparities in travel outcomes?
- If so, have these disparities changed in recent years?
- What factors might be contributing to racial-ethnic disparities?
- Are there economic disparities in travel outcomes?

The findings from this study – too plentiful to be summarized here – can be found within the document with the aforementioned title and searchable document reference number DOT HS 813 188.

Key Research Programs

NHTSA's research programs are in alignment with the USDOT's strategic goals of safety, economic growth, equity, climate solutions, and transformation, as well as the Agency's safety mission to save lives, prevent injuries, and reduce economic costs due to road traffic crashes, through education, research, safety standards, and enforcement activity. NHTSA's research focuses heavily on safety -- prioritizing the reduction of death and injuries on our nation's roadways.

Vehicle Electronics and Cybersecurity

With the increasing proliferation of computer-based control systems, software, connectivity, and onboard data communication networks, modern vehicles need to consider additional failure modes, vulnerabilities, and threats. Additionally, connectivity and safety technologies that can intervene to assist drivers with control of their vehicle could also raise the cybersecurity stakes, and without proactive measures taken across the vehicle lifecycle, risks could rise accordingly. Identification of potential issues and proactive management of increased risks related to advanced electronic and software-controlled systems are essential to designing vehicle architectures that will respond safely even when there are electronic system failures, software errors, or malicious software attacks.

Advanced Safety Technology

Advanced Safety Technology research focuses on both traditional motor vehicle crash avoidance technologies (i.e., tires, brakes, lighting) and ADAS features (collectively SAE driving automation Levels 0-2) that assist drivers in avoiding crashes. The research program covers passenger vehicles, medium and large trucks, buses, motorcycles, and vulnerable road users.

Automated Driving Systems

Vehicles equipped with ADS continue to be progressed through the various stages of development, testing, and limited deployment. A vehicle equipped with ADS, when engaged, is expected to be capable of performing the full driving task without a driver. ADS-equipped vehicles hold the potential to improve safety substantially at their maturity; however, they also introduce complex challenges, including those that relate to their safety assurance. As a result, ADS research continues to be an important emphasis area for NHTSA.

Crashworthiness

Crashworthiness research focuses on vehicle safety countermeasures to better protect the occupants and crash partners in motor vehicle crashes. This research program is responsible for exploring test procedures for the assessment of motor vehicle crashworthiness safety, and for developing evaluation tools (e.g., crash test dummies and human body computer models) and appropriate injury metrics. Crashworthiness research encompasses new and improved vehicle designs, equipment, and safety countermeasures; biomechanics and injury causation; real-world field data collection and analysis of serious injury cases; and computer modeling-based research all aimed at enhancing outcomes for motor vehicle occupants and vulnerable road users.