The Future of Vehicle Safety for a Traffic Accident-Free Society

June 28, 2021

Automobile Traffic Subcommittee,
Land Transport Committee,
Council for Transport Policy

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Introduction

The motor vehicle is indispensable to our lives as a means of transportation and the basis of distribution, contributing greatly to the revitalization of society and economy and the improvement of our lives. At the same time, it is also a factor in various problems such as traffic accidents and environmental pollution. In response to traffic accidents, the government has studied necessary measures from the perspective of the three factors that cause accidents (*people*, *roads*, and *vehicles*), as well as emergency and lifesaving activities to mitigate the damage after accidents, established goals and measures in the form of the Road Safety Master Plan, which the entire government has promoted.

As Japan enters a period of full-scale population decline due to the declining birthrate and aging population, it is expected that the number of areas will increase that will find their public transportation services difficult to maintain and secure. In addition, the spread of Covid-19 pandemic is having a huge impact not only on human lives, but also on people's sense of values about the way they live and move around, as they take another look at their means of mobility.

On the other hand, if we look at technological innovation in motor vehicles, a major trend called CASE (Connected, Autonomous, Shared & Service, Electric) has emerged, and through global competition for development, motor vehicles are evolving beyond what we have ever imagined. Technological innovation is also making a significant contribution to improving motor vehicle safety and is the key to quickly solving the social issue of reducing traffic accidents by improving the performance and expanding the use of devices that support safe driving, such as advanced emergency braking systems (AEBS), and by promoting the commercialization of automated vehicles (AVs).

While expectations for these advanced technologies are rising, new accidents are also being reported due to overconfidence in and misunderstanding of these technologies. In addition, it is becoming more important than ever to properly maintain the functions of these technologies on in-use vehicles. To accelerate the progress toward reducing traffic accidents against this background, we need to study the ideal form of vehicle safety measures (VSMs) that will contribute to the reduction of traffic accidents in cooperation with industry, academia, and government.

To take measures from the perspective of *vehicles*, the Road Transport Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has been working on two fronts, by establishing a Comprehensive Safety Plan for Commercial Vehicles as intangible results while promoting VSMs as tangible results. The 2011 report *The Future of Vehicle Safety for a Traffic Accident-Free Society* (June 2011, the Automobile Traffic Subcommittee, the Land Transport Committee, the Council for Transport Policy), set the goal of "reducing the number of traffic fatalities within 30 days per year by 1,000 by 2020 (compared to 2010) through VSMs and implemented the measures accordingly. Having passed ten years since the report and five years since the interim report in which additional measures were examined and summarized, we have set up a Technology and Safety Working Group and discussed the issues.

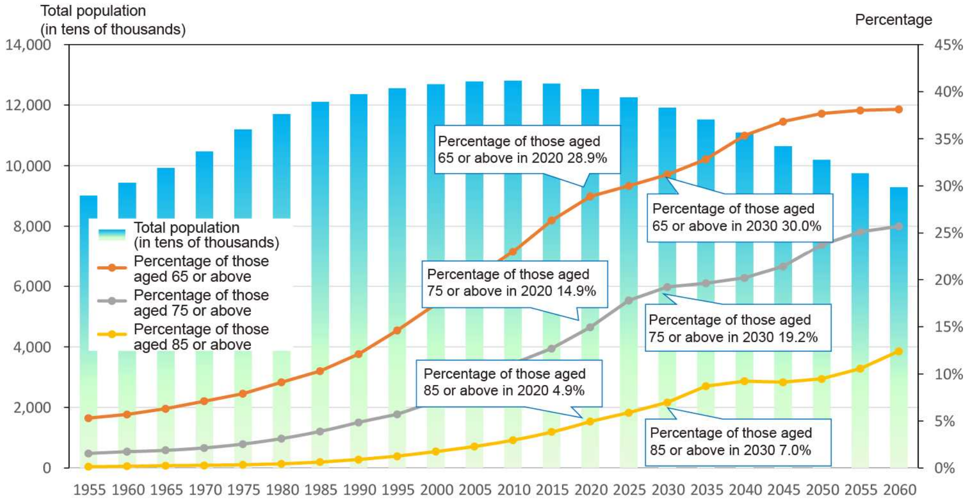
This report summarizes the evaluation of what we have achieved with the past reduction targets, new reduction targets set forth for the years to come, and what the safety measures should be in the future.

Chapter 1 Situation Surrounding VSMs

Section 1 Changes in Society

1. Acceleration of the aging society and the declining birthrate

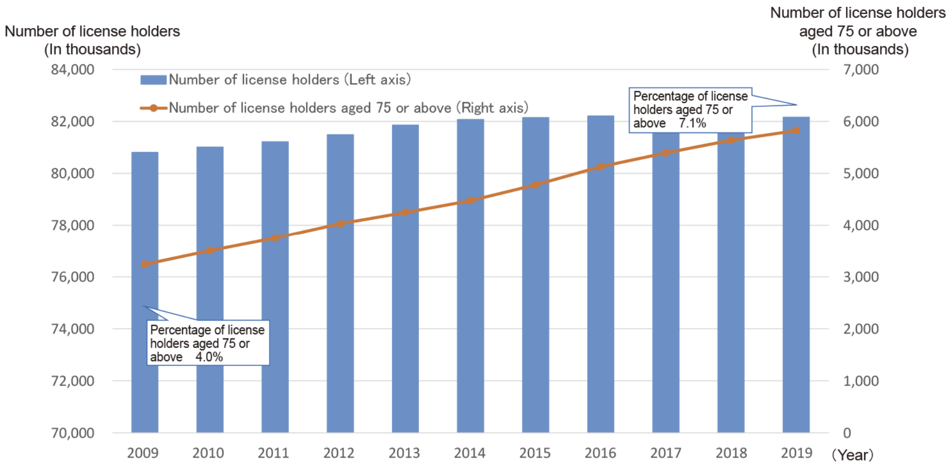
Japan's population began to decline after peaking in 2008, and the declining birthrate and aging population are accelerating. By 2030, the percentage of the elderly aged 65 or above is expected to reach 30% of the total population. In particular, the proportion of the elderly aged 75 or above is expected to increase from about 15% in 2020 to about 20% in 2030, in particular with baby boomers approaching this age group.



Source: Up to 2015: *National Census* by the Ministry of Internal Affairs and Communications
From 2020 onward: Calculated by the RTB based on the *Population Projections for Japan* (as of October 2017), according to the medium fertility and medium mortality assumptions, by the National Institute of Population and Social Security Research

Figure 1-1-1 Declining birthrate, aging population, and future projections

As a result of these changes in demographics and population composition, the percentage of the elderly including drivers, passengers, pedestrians, and bicyclists, in the road users as a whole is expected to increase. At the end of 2018, the number of people with driver's licenses aged 75 or above reached 5.64 million and, in the number of fatal accidents per 100,000 population with licenses, the percentage of drivers aged 75 or above ending up at fault is on the rise. All this makes promoting safety measures for elderly drivers an important task. At the same time, the proportion of the elderly among pedestrians, bicyclists, and other vulnerable road users is also expected to increase. Therefore, we need to ensure road safety in such a way to meet the needs of each group of road users, remembering the importance of protecting children, who will shape the nation’s future.



Source: Calculated by the RTB based on statistics on driving licenses

Figure 1-1-2 Changes in the number of driver's license holders

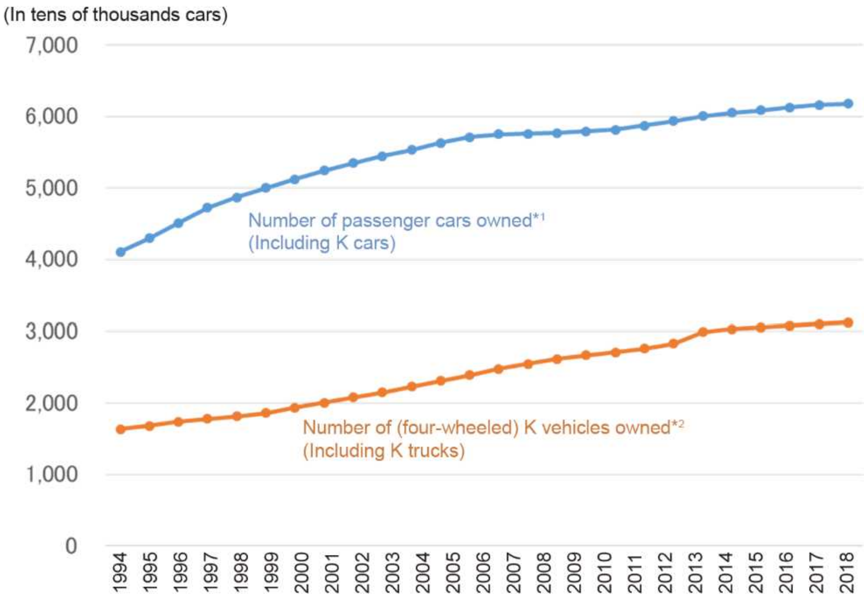
2. Changes in public transportation and mobility services

In urban areas, where there is a diversity of mobility needs and competition is viable among means of transportation, a variety of transportation services are provided, including public transportation. On the other hand, in rural areas, where depopulation and aging are often occurring simultaneously, more and more areas are finding it difficult to maintain and secure public transportation services. In addition, some transport operators are on the verge of losing their business due to a decrease in demand for transportation under stay-at-home advisories amid the Covid-19 pandemic or in response to large-scale disasters. Furthermore, as the aging of population and the decline of birthrate further progress and the number of elderly people unable to drive themselves increases, it will be difficult for them to maintain the lifestyle of using private cars as the primary means of mobility. We need to consider alternative means of private mobility and mobility services.

Based on this background, the Second Basic Plan on Transportation Policy (approved by the Cabinet on May 28, 2021) made it the primary policy to "maintain and secure means of mobility essential to residents' daily lives, allowing each of them to move around easily and with comfort, without having to drive themselves". What with new services that will appear using digital technologies, including shared mobility such as Mobility as a Service (MaaS), we will need to establish necessary safety measures in view of the changing forms of transportation services.

3. Changes in vehicle ownership and mobility needs

The number of passenger cars owned in Japan is approximately 61.77 million as of March 31, 2019. While the total population of Japan continues to decline, the number of passenger cars (including K cars and K trucks) owned is gradually increasing, with an average annual growth rate of about 0.8% over the past 10 years. The total distance traveled by passenger cars fluctuates from year to year, but is generally on an upward trend. Thus, passenger cars, along with public transportation, have taken root in people's daily lives as a means to move around freely. We need to develop further measures to ensure safety and security of their transportation.

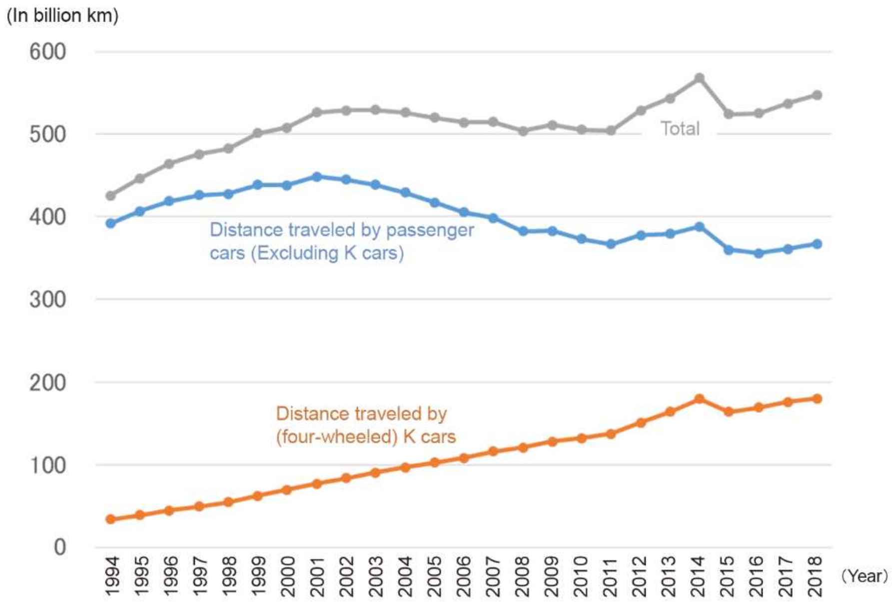


*1 "Number of passenger cars owned" includes K cars, but not trucks, buses, non-road special vehicles, powered two-wheelers (PTW), as counted at the end of March each year.

*2 "Number of (four-wheeled) K vehicles owned" includes K trucks. Compiled at the end of March up to 2013, but at the end of December from 2014 onward.

Source: The number of passenger cars provided by Automobile Inspection & Registration Information Association and the number of K vehicles by the Japan Light Motor Vehicle and Motorcycle Association.

Figure 1-1-3 Trends in the number of passenger cars owned



*"Passenger cars" don't include buses, non-road special vehicles, PTWs.

Source: Calculated by the RTB based on *Road Traffic Statistics* by ITARDA, *Motor Vehicle Transport Statistic Survey* (up to 2009) and *Motor Vehicle Fuel Consumption Survey* by MLIT (from 2010 onward).

Figure 1-1-4 Changes in the total distance traveled by passenger cars

Passenger cars are not only the primary means of mobility for people in Japan, but also the one to meet various mobility needs of foreign visitors to the country. In 2019, the number of foreign visitors to Japan reached a record high of 31.88 million and the use of motor vehicles such as rental cars are increasing. On the other hand, in 2020, the outbreak of a Covid-19 pandemic led to a decrease in the flow of people due to people refraining from going out and moving around unnecessarily and the drastic drop in the number of foreign visitors to Japan, which also affected the use of motor vehicles.

At the same time, means of mobility people own and use is changing as the number of elderly people increases, people's lifestyles change, and technology advances. In addition to passenger cars, including K cars, which have been the prevalent means of private mobility for the Japanese, a wide variety of other mobility devices are being used, including more compact, agile micro-mobility, or personal mobility devices such as electric kickboards.

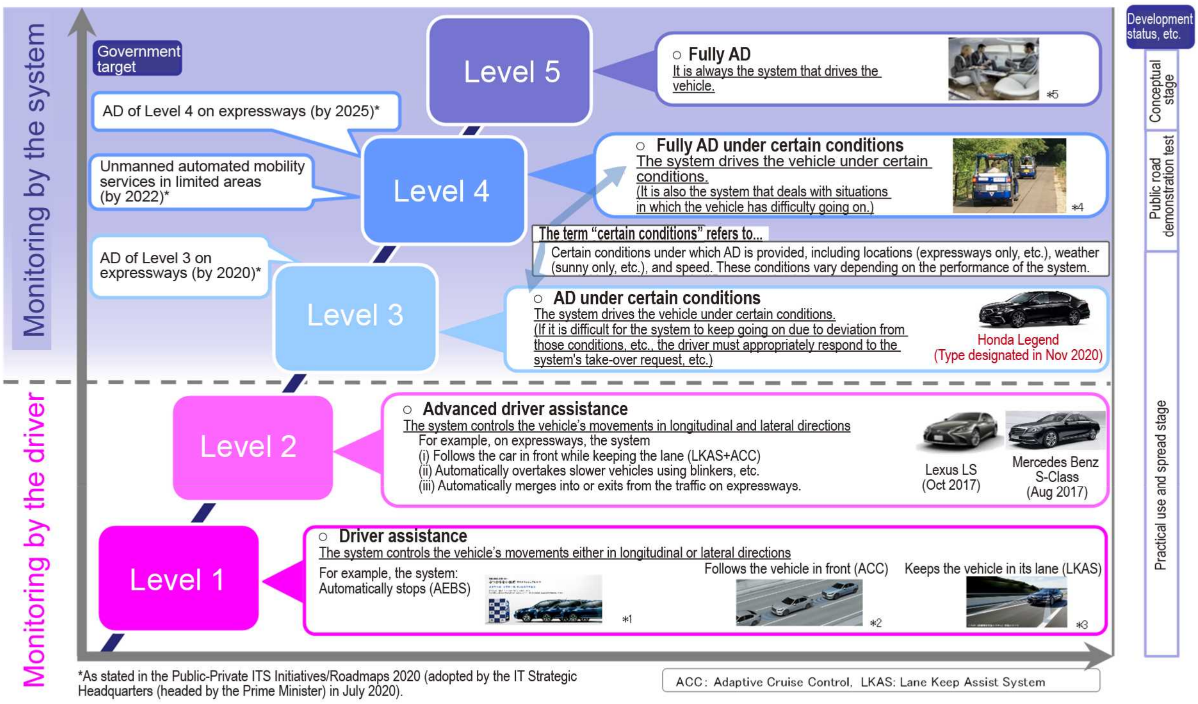
In recent years, many tragic accidents caused by elderly drivers, etc., and the efforts of the public and private sectors to promote the use of safe driving assistance cars, or *SuppoCars* as they are nicknamed, equipped with AEBS, etc. have raised the interest of motorists in vehicle safety. In addition, incentives are being provided to encourage motorists to purchase vehicles with advanced driver assistance systems (ADAS) and drive recorders, such as differentiation of insurance rates for voluntary insurance and *SuppoCar* subsidies to help them purchase such vehicles. These efforts are expected to raise the safety awareness of motorists and promote the replacement with safer vehicles.

Section 2 Development and Evolution of Technology

1. Development and evolution of technologies for AD

With the development of detection and information processing technologies, such as cameras, millimeter-wave radar, and lidar, the use of these technologies in motor vehicles is accelerating as we see in *advanced driver assistance systems (ADAS)*, i.e., systems that assist the driver in safe driving by preventing traffic accidents and mitigating damage or *technologies related to automated driving* (*AD)*, i.e., systems that support the driver by driving the vehicle under their supervision or driving the vehicle in their place. Further, AD technologies are evolving not only in Japan but all over the world as well through competition and collaboration among firms from different fields, i.e., not only traditional players from the automotive industry, but also tech companies and other new entrants into the field of new mobility.

Classified into *five levels of AD* by the Society of Automotive Engineers (SAE), AD technologies can be roughly broken up into two phases: the first comprised of ADAS up to Level 2, where the driver is required to monitor the driving, and the second of AD technologies of Levels 3 or higher, where the system drives the vehicle in place of the driver. *Level 1* technologies, each of which providing a single type of driving assistance such as AEBS, are already adopted by over 90% of new passenger cars in Japan. Vehicles with *Level 2* technologies, which provide advanced driving assistance such as automatic lane change with the driver still monitoring, are now on the market. The higher phase of AD technologies where the system drives the vehicle on behalf of the driver is comprised of AD technologies of: *Level 3*, where the AD system drives the vehicle under certain conditions, such as traffic jams on expressways, without the driver having to keep monitoring it, but hands over the control to the driver when keeping driving is difficult; *Level 4*, where the system does all the driving in certain areas and circumstances, handling even situations so far found difficult. AD technologies of *Level 3* and *Level 4* have been already commercialized. Ultimately, there will be fully AD of *Level 5*, where the system will always drive the vehicle without any restrictions as to areas or circumstances, but at present, the *Level 5* technology is still in the stage of concepts.



*1 Subaru Corporation website *2 Nissan Motor Co. website *3 Honda Motor Co. website
*4 Demonstration experiments in Eiheiji, Fukui *5 CNET JAPAN website

Figure 1-2-1 Levels of AD

Advanced Driver Assistance Systems (ADAS) (Up to Level 2):

ADAS are gradually spreading and penetrating the market through the expansion of their installation in new vehicles, while improving their performance and diversifying their types.

Specifically, in addition to AEBS, which are said to be highly effective in reducing the number of accidents, other technologies that have been commercialized include pedal misapplication prevention systems, systems to prevent lane departure and support lane keeping, and emergency driving stop systems to deal with sudden driver incapacity, etc. These technologies are being installed mainly in new vehicles one by one as the conditions are fulfilled for their introduction, such as technological evolution, cost reduction, and growing social needs, and are expected to further reduce accidents as vehicles in-use without them are replaced by new ones. In addition, detection systems and cognitive and decision processing technologies are also improving. For example, AEBS used to brake only when detecting a vehicle in front in certain speed ranges, but now they can detect pedestrians crossing the road, bicyclists, etc., and can respond to a variety of operating environments, such as at night and in wider speed ranges. In this way, a certain level of driving support is now possible even under conditions that were technically difficult for AEBS to cope with in the past, and this is thought to be contributing to the further reduction of traffic accidents.

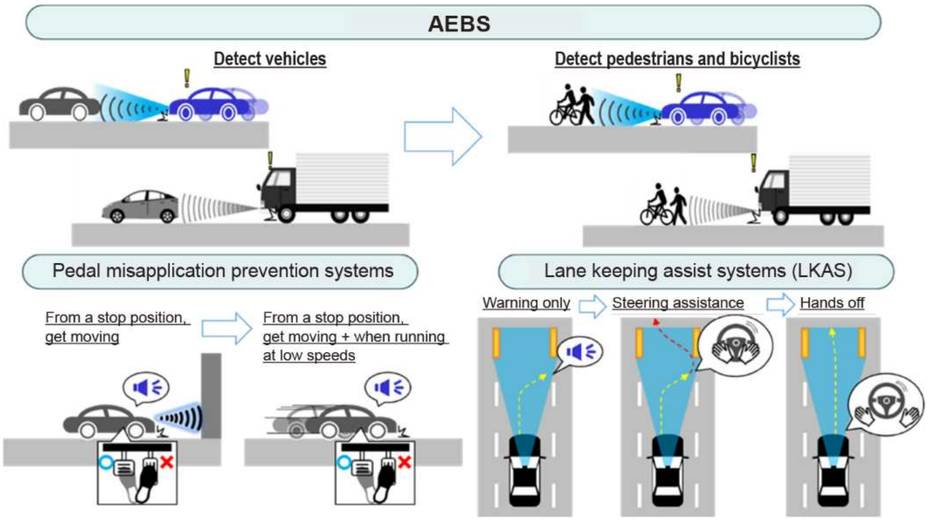


Figure 1-2-2 Examples of evolution and sophistication of ADAS

Accidental activation of ADAS such as AEBS can lead to serious accidents, so it is important that the functions of ADAS are reliably maintained during the course of use. Since ADAS are electronically controlled, there is a limit to what we can check such functions by using conventional methods such as visual check, with measuring instruments or inspection. For this reason, the Road Transport Bureau has conducted a systematic and technical study on a new inspection method using onboard diagnostic devices (OBD) and compiled the results in March 2019. To establish necessary systems and structures, the ministry revised the Road Transport Vehicle Act and other related laws and regulation in May 2019. It plans to start introducing OBD inspection in phases from October 2024.

- Recent years have seen **very rapid evolution and spread of AD technologies** such as automatic braking systems. Considering, however, that, if they once fail, these systems may lead to **malfunctions and serious accidents**, **it is vital to periodically make sure that they function properly through vehicle inspection, etc.**
- Current **periodic vehicle inspection (PTI),** which is conducted by checking functions visually or with measuring instruments, **is not designed to check the functions of electronic systems** used in AD technologies, etc.

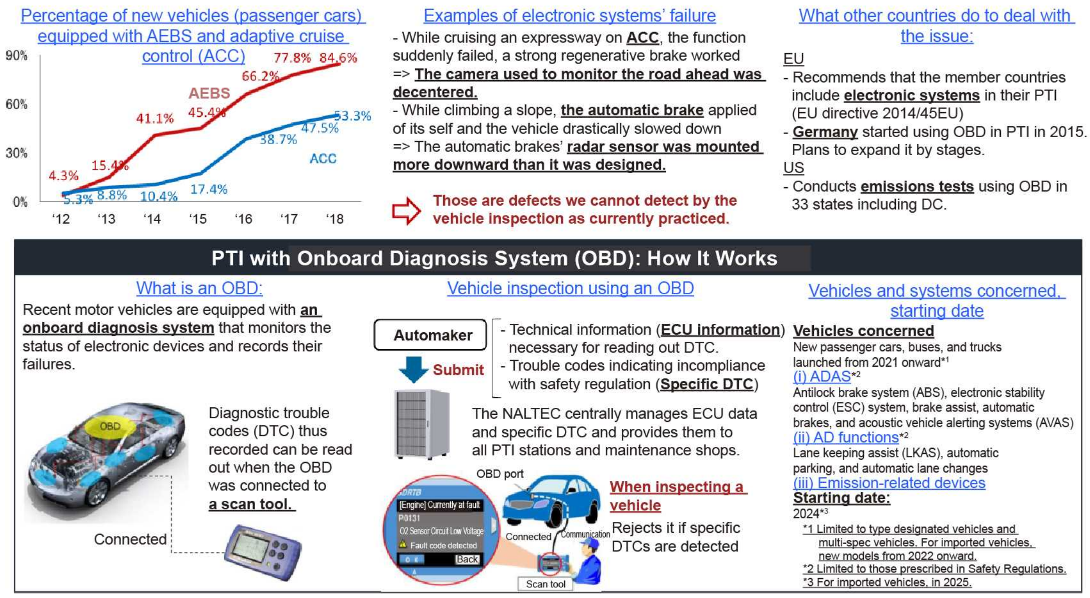


Figure 1-2-3 Report of the Study Group on How Vehicle Inspection Methods Using OBD Should Be (Summary)

On the other hand, as the use of ADAS spread widely we find cases where it was suspected that the driver’s overconfidence in or misunderstanding of the function of these devices might have led to accidents and where motorists experienced unexpected events, revealing the lack of understanding by the user of ADAS. For example, there are 100 or so reports per year of passenger car cases where the driver was suspected to have believed that AEBS would get activated no matter what the situation was. Further, the results of a questionnaire survey indicate that one in four drivers experienced an unexpected event caused by ADAS (Fig. 1-2-5). For drivers to fully get the benefits of ADAS and to avoid new accidents, it is necessary for them to correctly understand the functions and limitations of ADAS and to use them correctly and for vehicle manufacturers, etc. to develop ADAS that address those issues.

2017	2018	2019
72 cases	101 cases	113 cases

AEBS would not get activated when:

- The vehicle is running at a speed above that prescribed by the manufacturer.
- The camera cannot identify the object in the dark or against the light.
- A pedestrian, cyclist, or vehicle cuts in suddenly in front of the vehicle.
- You are in a rain, snow, or fog or other bad weather.
- The driver presses hard on the accelerator.

Figure 1-2-4 Cases in which accidents are suspected to have been caused by the driver’s overconfidence in the AEBS that it would work no matter what the situation was (passenger cars only)[1]

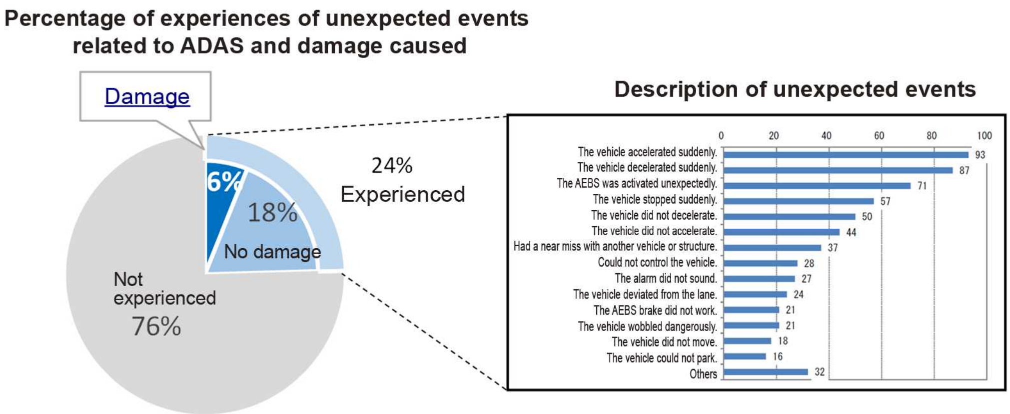


Figure 1-2-5 Percentage of experiences of unexpected events related to ADAS and their details[2]

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[1] Created by the RTB, MLIT based on defect reports made by vehicle manufacturers, motorists, and relevant ministries and agencies.

[2] Created by the RTB, MLIT, based on the results of questionnaire survey by the National Consumer Affairs Center.

AD technology (Level 3 or higher):

The AD technology consists in a machine or system performing such tasks as cognition, judgment, and operation that have so far been performed by humans. Based on information obtained from high-performance detection equipment, etc., the machine or system uses AI and other information processing methods to make driving decisions properly and perform acceleration, deceleration, and other controls on behalf of the driver. Given that 96% of fatal traffic accidents are currently caused by drivers violating laws and regulations, the commercialization of AD is expected to contribute greatly to improving road safety. What's more, the maintenance of a safe distance between vehicles and the appropriate management of speed through AD technology will lead to improved fuel efficiency and the elimination of economic losses due to traffic jam. Furthermore, it is also expected to provide a means of mobility for the elderly and other vulnerable road users, and to ensure the international competitiveness of the country in terms of motor vehicle-related technologies. With the aim of solving these social issues, the government has set targets in the fields of private motor vehicles, distribution services, and mobility services in the Public-Private ITS Roadmap for the marketing and merchandizing of AD technology.

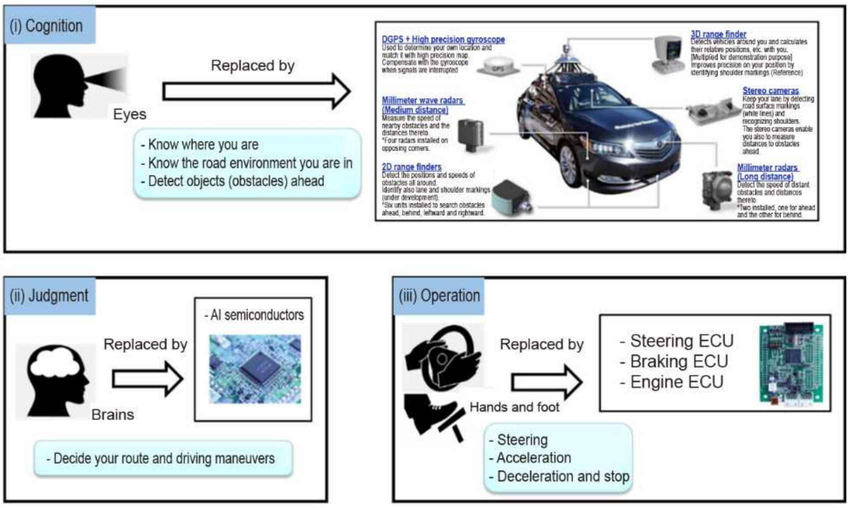


Figure 1-2-6 Cognition, judgment, and operation in AD systems

The development and commercialization of AD technology has progressed dramatically in the past few years. In May 2019, to pave the way for the commercialization of AD, the MLIT revised provisions in the Road Transport Vehicle Act and the Road Traffic Act for private passenger cars, which are the largest in terms of the number of vehicles owned and the size of the market, in order. In November 2020, it type-approved for the first time in the world a model vehicle with technologies for AD on expressways. The AD system (of Level 3) of the vehicle, which was put on the market in March 2021, is capable of performing driving operations in place of the driver under certain conditions, such as when traffic is congested on expressways, by recognizing the environment around the vehicle, recognizing the vehicle's own position, detecting the driver's status, and adding redundant functions, etc.

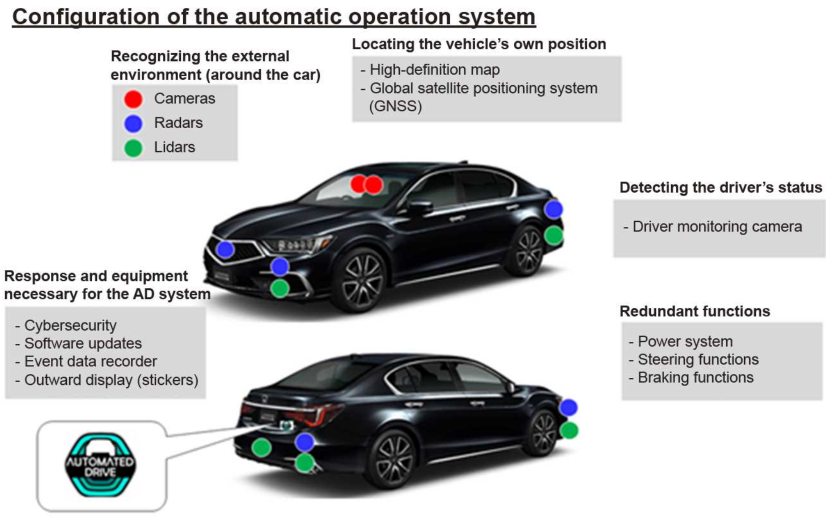


Figure 1-2-7 Configuration of the automatic operation system on Honda Legend

With regard to mobility and distribution services, demonstration tests are being conducted for unmanned AD services in limited areas and for truck platooning on expressways. For example, the last-mile automated mobility service, which connects the nearest station to one's destination to support the mobility of elderly people in rural areas, started demonstration tests in Eiheiji Town, Fukui Prefecture in 2017, followed by the launch of a one-to-three remote monitoring and operation type service in December 2020, and the nation's first Level-3 automated mobility service in March 2021. Further, the government began demonstrations of truck platooning on public roads in 2017, which will help solve the shortage of truck drivers, and in February 2021, achieved truck platooning on the New Tomei Expressway with unmanned trailing trucks. In this way, efforts are being made to implement AD-related technologies in vehicles other than passenger cars.

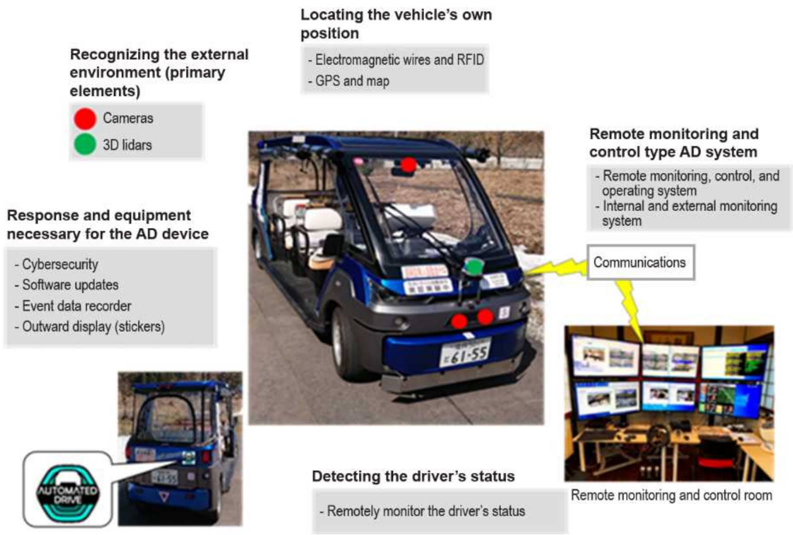


Figure 1-2-8 Configuration of the principal AD devices for the last-mile automated mobility service in Eiheiji Town, Fukui Prefecture

Figure 1-2-9 Truck platooning traveling on the Shin-Tomei Expressway

In the AD technology, it is essential to utilize not only the information gathered by the vehicle itself with its onboard sensors, etc., but also technologies to ensure road safety by coordinating with various elements of infrastructure, such as map information, information provision and communication (V2X) by the road infrastructure, and other road users. To make that occur by establishing technologies to coordinate with infrastructure, the public and private sectors are working together to commercialize technologies such as inter-vehicle communication, in which vehicles communicate with each other, and road-vehicle communication, in which infrastructure and vehicles communicate with each other and making other efforts for the advancement of AD.

2. Acceleration of electrification

Japan has been working to reduce greenhouse gas emissions as part of its efforts to protect the global environment. In particular, in the automotive sector, which accounts for about 16% of the country's total emissions, the government imposes fuel efficiency requirements on new vehicles under the Act on the Rationalization, etc. of Energy Use (Energy Conservation Act), gradually enhancing the requirements to reduce the carbon dioxide emissions from individual vehicles. As a result, the share of electric vehicles including hybrid vehicles (hybrid vehicles (HVs), plug-in hybrid vehicles (PHVs), electric vehicles (EVs), and fuel cell vehicles (FCVs)) in newly registered vehicles reached approximately 35% in 2019.

With regard to these electric vehicles, various companies, including new entrants into the market, are accelerating their investment in electric vehicles against the background of technological innovations such as improved energy density in batteries and changes in policies in major countries, etc., and their production and sales are increasing.

Further, in terms of hydrogen-fueled fuel cell vehicles, efforts are being made to expand the use of those systems in multiple passenger car models and to reduce the price of new vehicles, while developing infrastructure such as hydrogen stations and mass production of motorcoaches.

Source: Websites of Nissan Motors, Tesla Motors Japan, BMW Japan, and Honda Motor Company

Figure 1-2-10 Example of electric vehicles

3. Improvement of other vehicle safety technologies

In recent years, the focus of VSMs has been on *preventive safety technologies* such as ADAS, but, in the current driver-centered road traffic environment, many traffic accidents still occur due to human error, etc. Therefore, *passive safety technologies* are also important to reduce the damage to passengers, pedestrians, etc. in the event of a collision.

To improve collision safety technology, the government has expanded and enhanced mandatory standards (as part of the Safety Regulation) for the protection of the head and legs of pedestrians and for the protection of vehicle occupants. At the same time, it has conducted various evaluation tests on collision safety performance and made the results public in the New Car Assessment Program, which encourages vehicle manufacturers to develop safer motor vehicles and motorists to select such vehicles.

Furthermore, in addition to preventive safety and collision safety technologies, we have promoted the widespread installation of automatic collision notification systems and services that shorten the time necessary to start rescue and medical treatment as a measure to mitigate human injuries even after an accident has occurred.

In addition, onboard recording devices such as video drive recorders and event data recorders (EDRs), which store information before and after traffic accidents, are widely used. The accident data recorded by these devices are valuable for a wide range of purposes, including analysis of traffic accidents for VSMs, calculation of insurance premiums, clarification of liability in civil lawsuits between parties to traffic accidents, and investigation of traffic accidents.

4. Promotion of harmonization of international regulations

Motor vehicles are products that are distributed internationally and used in many countries around the world. This makes it possible to develop more advanced and specialized safety standards by having experts from various countries work together to develop regulations, harmonize motor vehicle regulations, and mutually approve each other’s certification. It makes it possible also to reduce administrative costs for certification, etc., and to reduce development and manufacturing costs through the common use of parts by multiple vehicle manufacturers, etc. In this way, harmonizing automotive safety and environmental regulations internationally will greatly contribute to the interests of the entire nation.

Japan is a Contracting Party to the 1958 Agreement for the mutual recognition between CPs of type approval of motor vehicles, etc. and the 1998 Agreement for the international harmonization of technical regulations. The United Nations World Forum for Harmonization of Vehicle Regulations (WP.29), which is composed of the member countries of these agreements, is working to promote international harmonization of vehicle regulations and mutual recognition of certification between the member countries. Currently, under WP.29, there are six working groups for respective fields of automotive equipment, and important issues that require more specialized knowledge are discussed in expert meetings set up under WP.29. Japan, which has a great deal of expertise on motor vehicles, has assumed important posts such as chair in many of the forums, and is leading international discussions.

The activities for the harmonization of international regulations at WP.29 have given birth to many international regulations that contribute to vehicle safety and environmental protection. Those include, for recent years, regulations for *acoustic vehicle alerting systems* for quiet hybrid vehicles, *AEBS* for passenger cars, and *automated lane keeping system* that keeps the vehicle in lane while in traffic jams on expressways, etc. It was Japan who proposed these regulations and led the international discussions for their adoption. In addition to these international regulations, it was also Japan who proposed the International Whole Vehicle Type Approval (IWVTA), which enables the mutual recognition of certification on the whole vehicle and was approved in July 2018.

Agreement concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of These United Nations Regulations (1958 Agreement)

1. Purpose
Adopted at United Nations in 1958, the multilateral Agreement aims to promote the spread of safe and environment-friendly motor vehicles and to facilitate the international distribution of motor vehicles by promoting the international harmonization of safety and environmental regulations and mutual recognition of type approval for individual vehicles, equipment, and parts.

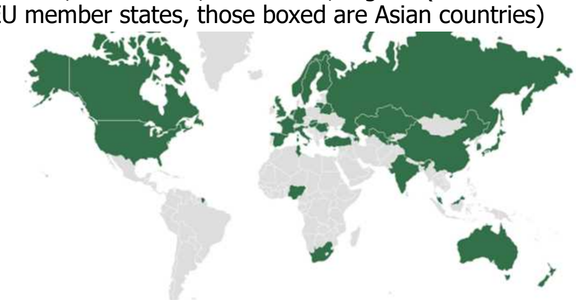
2. Contracting parties
As of January 2021, there were 53 countries and 1 region (EU) as Contracting Parties.
Japan joined on November 24, 1998.
Germany, France, Italy, Netherlands, Sweden, Belgium, Hungary, Czech Republic, Spain, Serbia, United Kingdom, Austria, Luxembourg, Switzerland, Norway, Finland, Denmark, Romania, Poland, Portugal, Russian Federation, Greece, Ireland*, Croatia, Slovenia, Slovakia, Belarus, Estonia, Bosnia and Herzegovina, Latvia, Bulgaria, Lithuania, Turkey, Azerbaijan, The Former Yugoslav Republic of Macedonia, European Union (EU), Japan, Australia, Ukraine, South Africa, New Zealand, Cyprus*, Malta*, Republic of Korea, Malaysia, Thailand, Montenegro, Tunisia, Kazakhstan, Albania, Egypt, Georgia, San Marino, Republic of Moldova, Armenia, Nigeria, Pakistan
(Underlined are EU member states, those boxed are Asian countries, those marked with * are not CPs but in which, as member of the EU, the Agreements are in force.)

3. Progress of rulemaking activities
As of January 2021, there were 159 United Nations Regulations (UNRs) already established.

Agreement Concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts Which Can Be Fitted and/or Be Used on Wheeled Vehicles (1998 Agreement)

1. Purpose
Drafted by the initiatives of Japan, the US, and the EU and adopted at the United Nations in 1998, the Agreement aims to promote the international harmonization of technical regulations for motor vehicles, equipment and parts by establishing such regulations for individual devices building on global expertise and introducing such regulations into regulations and national regulations and laws based on the 1958 Agreement, thereby improving the safety and environmental performance of motor vehicles, their equipment and parts, and making their international distribution smoother.

2. Contracting parties
As of January 2021, there were 37 countries and 1 region (EU) as Contracting Parties.
Japan joined on August 3, 1999.
Canada, United States, Japan, France, United Kingdom, European Union (EU), Germany, Russian Federation, China, Republic of Korea, Italy, South Africa, Finland, Hungary, Turkey, Slovenia, Slovakia, New Zealand, Netherlands, Azerbaijan, Spain, Romania, Sweden, Norway, Cyprus, Luxembourg, Malaysia, India, Lithuania, Republic of Moldova, Tunisia, Australia, Kazakhstan, Tajikistan, Belarus, San Marino, Uzbekistan, Nigeria (Underlined are EU member states, those boxed are Asian countries)



3. Progress of rulemaking activities
As of January 2021, there were 20 United Nations Global Technical Regulations (UN GTRs) already established.

Figure 1-2-11 Outline of the 1958 Agreement and the 1998 Agreement

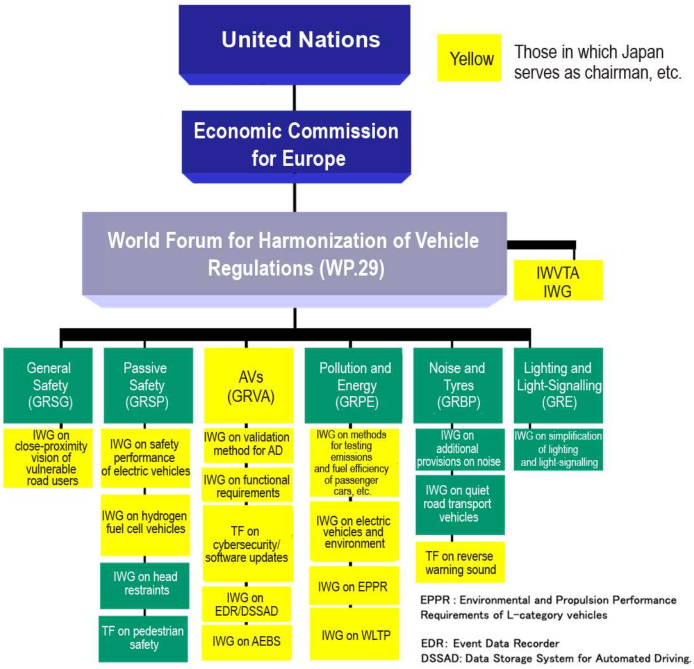


Figure 1-2-12 Structure of WP.29 and its working groups, etc.

- The previous mutual recognition system consisted in an automaker being exempted of examination for type approval of individual devices of a motor vehicle subject to the system of mutual recognition of approval in a contracting party by presenting the certificate of type approval for the same devices granted in another contracting party.
- Meanwhile, the IWVTA is a system that, aiming at expanding the scope of mutual recognition from *each of individual devices* to *the vehicle as a whole*, **puts basic safety and environmental performance criteria into one package**, thus enabling the automaker, upon the examination for type approval of a vehicle in a contracting party, **to be exempted from all examination by presenting the certificate of IWVTA** granted in another contracting party.
- Since the establishment of IWVTA in July 2018, the number of items subject to mutual recognition has increased steadily to 49 so far.

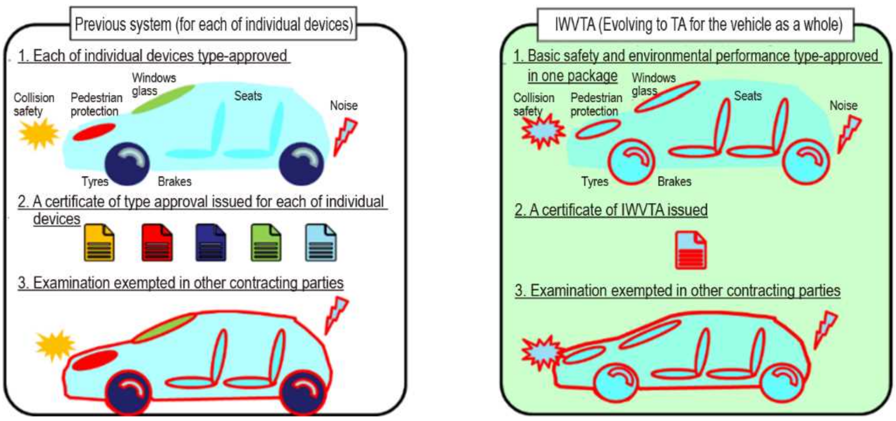


Figure 1-2-13 Overview of the International Whole Vehicle Type Approval (IWVTA)

Section 3 Status of Traffic Accidents

1. Overview

In recent years, the number of fatalities in traffic accidents has been on a downward trend, and in 2020, the number of fatalities within 24 hours[3] was 2,839 (a decrease of 376 persons, or 11.7%, from the previous year), which was the lowest in the postwar period for four consecutive years. The number of people seriously injured in traffic accidents totaled 27,774, a decrease of 4,251 (-13.3%) from the previous year. On the other hand, with regard to the targets set in the 10th Road Safety Master Plan (2,500 or fewer fatalities within 24 hours and 500,000 or fewer casualties), which was published in March 2016 and has been worked the government across the board, the target for the number of fatalities has not been achieved, although the target for the number of casualties has been achieved.

The downward trend in traffic accidents, etc. in recent years can be attributed to the government's concerted road safety efforts as well as the spread of motor vehicles equipped with advanced technologies such as AEBS.

In 2020, due to the outbreak of the Covid-19 pandemic, people refrained from going out and moving around unnecessarily, which affected the flow of people, and the increase in small-lot deliveries due to the expansion of e-commerce and other services affected distribution. In addition, the use of public transportation has decreased while the use of personal mobility such as bicycles has increased. These changes in mobility and transportation needs also have had a certain impact on the field of road safety.

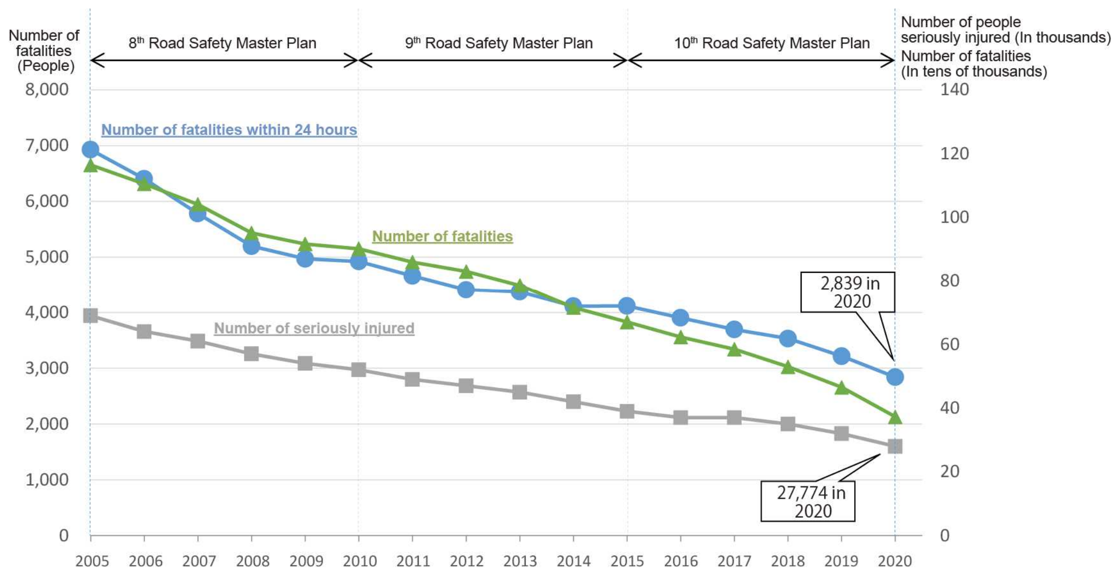


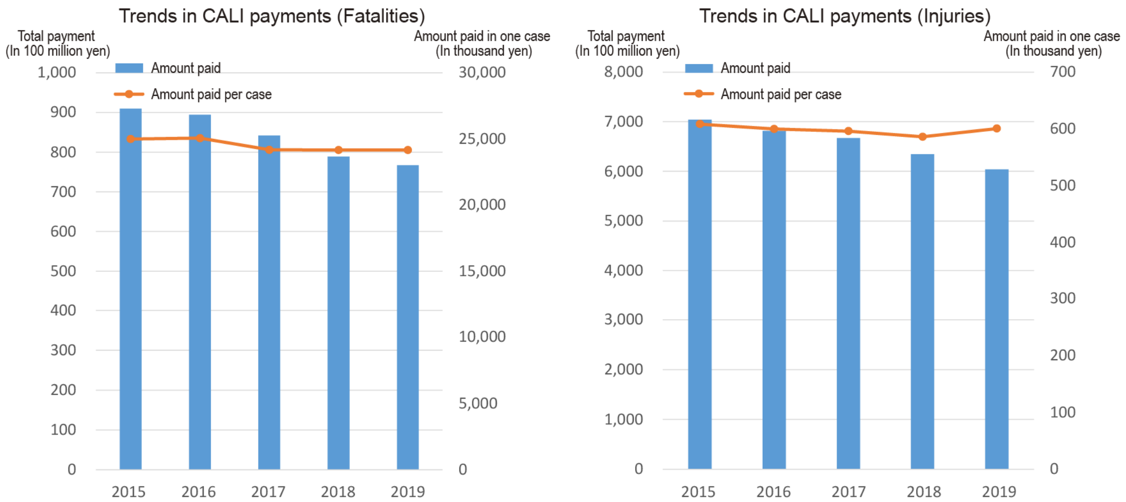
Figure 1-3-1 Changes in traffic accidents (Number of fatalities, serious injured, and casualties)

Traffic accidents produce a variety of economic losses. According to a survey conducted by the Cabinet Office, the economic loss due to traffic accidents is estimated to be approximately 14.76 trillion yen (March 2017), which is approximately 2.7% of Japan's GDP. These losses include human losses such as

[3] In this report, the number of fatalities refers to the number of fatalities within 24 hours unless otherwise stated.

medical expenses and damages for mental suffering, physical losses such as repairs to vehicles and structures, monetary losses such as emergency transport costs, police's accident handling costs, court costs, congestion loss costs, and other losses to various public institutions, as well as non-monetary losses calculated from pain and suffering caused by traffic accidents. Economic losses that are not included in the amount of such losses include losses related to traffic jam caused by traffic accidents (time losses, losses related to environmental impact).

In addition, in order to provide relief to victims of traffic accidents, there is the compulsory automobile liability insurance (CALI) that secures basic compensation for bodily injury. In recent years, the amount paid per accident has remained almost the same, but the total amount paid has been on a downward trend.



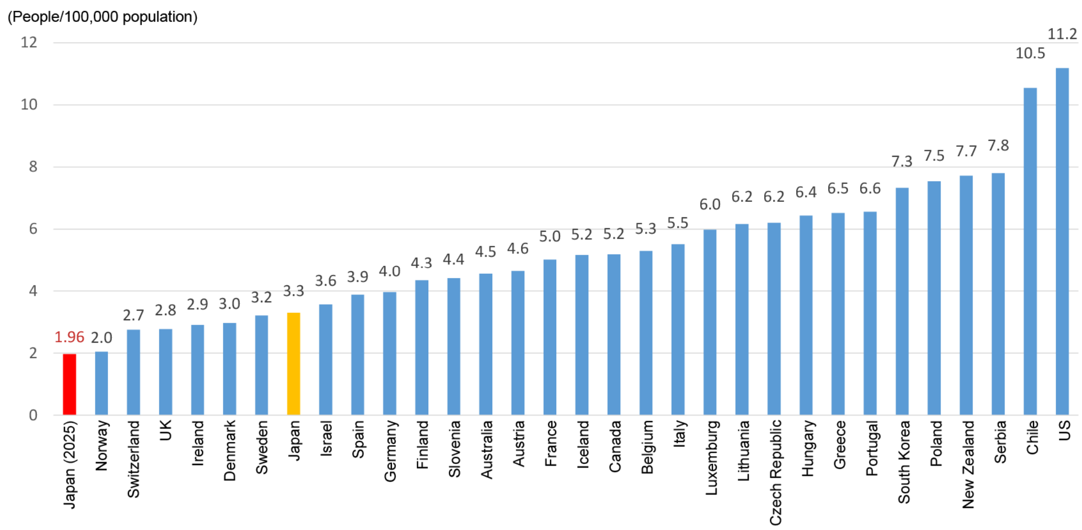
	2015	2016	2017	2018	2019
Number of claims paid (Fatalities)	3,639	3,568	3,481	3,264	3,173
Number of claims paid (Injuries)	1,157,050	1,136,174	1,119,111	1,082,458	1,006,272

Source: Created by the RTB based on the data provided by General Insurance Rating Organization of Japan

Figure 1-3-2 Trends in CALI payments

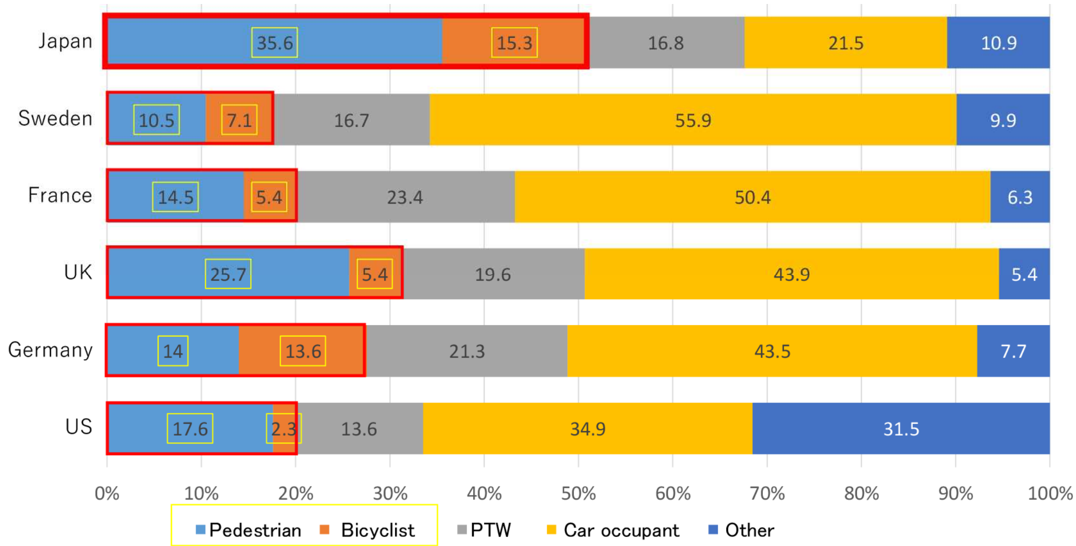
The number of fatalities within 30 days per 100,000 population in Japan is 3.3, which ranks 7th in the world (Fig. 1-3-3), when compared with other countries in the International Road Traffic and Accident Database (IRTAD).

Japan is characterized by a higher percentage of fatalities while walking and riding bicycles compared to other countries (Fig. 1-3-4). In major countries in Europe and the U.S., the percentage of people killed while walking or riding a bicycle is approximately 20% to 30%, but in Japan, the percentage is as high as 50%. Further, the ratio of fatalities (57.3%) to the elderly population (28.1%) is much higher in Japan than in other countries (Figure 1-3-5). This indicates that road safety measures for pedestrians and bicyclists as well as for the elderly are important issues to be addressed in Japan.



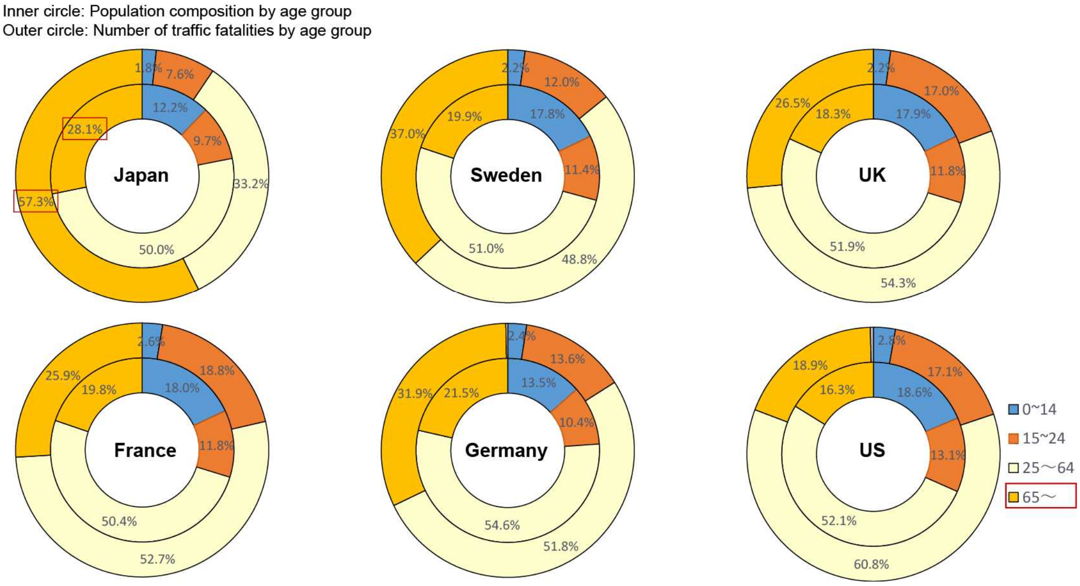
*The figures are all calculated from the data on the numbers of fatalities within 30 days.
Source: Created by the RTB based on the data provided by the International Road Traffic and Accident Database (IRTAD)

Figure 1-3-3 International comparison of the number of fatalities within 30 days per 100,000 population (2018)



* "Car occupant" includes those on buses and minibuses and "Other" those on trucks, non-road special vehicles, streetcars, and light vehicles.
Source: Created by the RTB based on the data provided by the International Road Traffic and Accident Database (IRTAD)

Figure 1-3-4 Percentage of deaths within 30 days in major countries by transport mode (2018)



Source: Created by the RTB based on the data provided by the International Road Traffic and Accident Database (IRTAD)

Figure 1-3-5 Composition of fatalities within 30 days by age group in major countries (2018)

The details of traffic accidents can be analyzed in terms of transport mode, age group, vehicle type, site of injury, etc. In this section, based on the data obtained from these viewpoints and to make this report easier for the readers to understand, we will divide the data into three categories: (i) traffic accidents involving vulnerable road users (pedestrians, bicyclists, etc.), (ii) traffic accidents involving vehicle occupants, and (iii) traffic accidents seen in light of social background and, from each viewpoint, sort out the trends and characteristics of traffic accidents today.

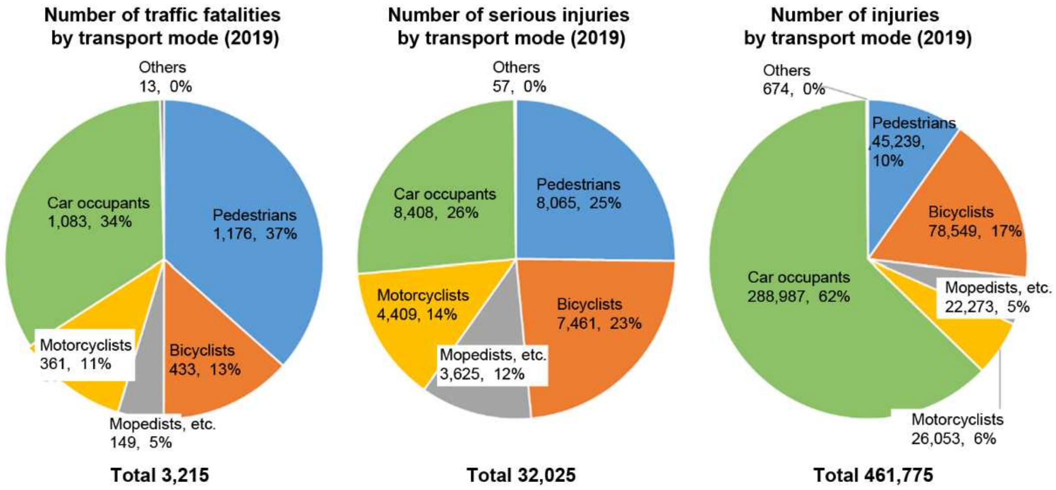
2. Traffic accidents involving vulnerable road users

(1) Characteristics by transport mode

Pedestrians and bicyclists, who are vulnerable road users, account for about half of all traffic accident fatalities in Japan. About 70% of the traffic fatalities involving *pedestrians* are seniors aged 65 or above. About half of all serious injuries were *pedestrians* and *bicyclists.*

It should be noted that the percentage of PTW* riders of all serious injuries is about 26%, much higher than their percentage of all fatalities, which is about 16%.

*Powered two-wheelers, such as motorcycles, mopeds, and scooters.

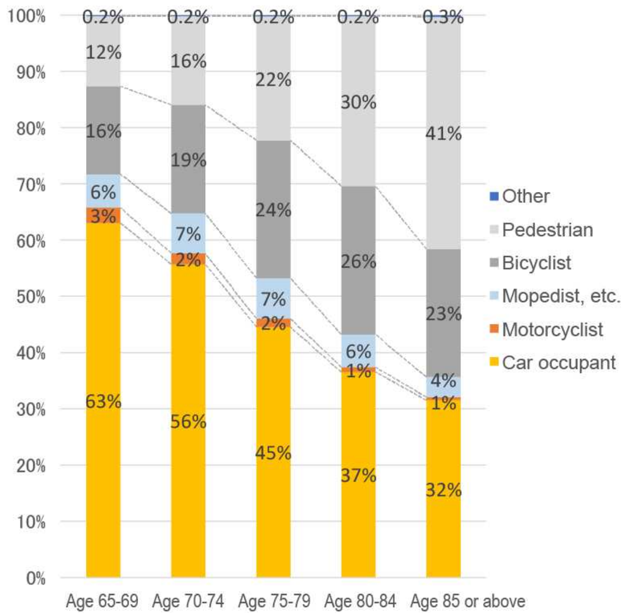


Source: Created by the RTB based on data provided by National Police Agency (NPA)

Figure 1-3-6 Percentage of traffic fatalities, serious injuries, and injuries by transport mode (2019)

(2) Characteristics by age group

Looking at the percentage of those killed or injured among *pedestrians* by age group, we see that the percentage of *pedestrians* of all casualties by all modes of transport increases as they get older. This is presumably attributable to decline in the elderly's cognitive and judgmental capacity and their tendency to depend on the other party (the driver) to act safely (Fig. 1-3-7). The same tendency is observed for *bicyclists*. With regard to children killed or injured on road, they are most frequently so among *pedestrians*, especially early graders who start walking to school.



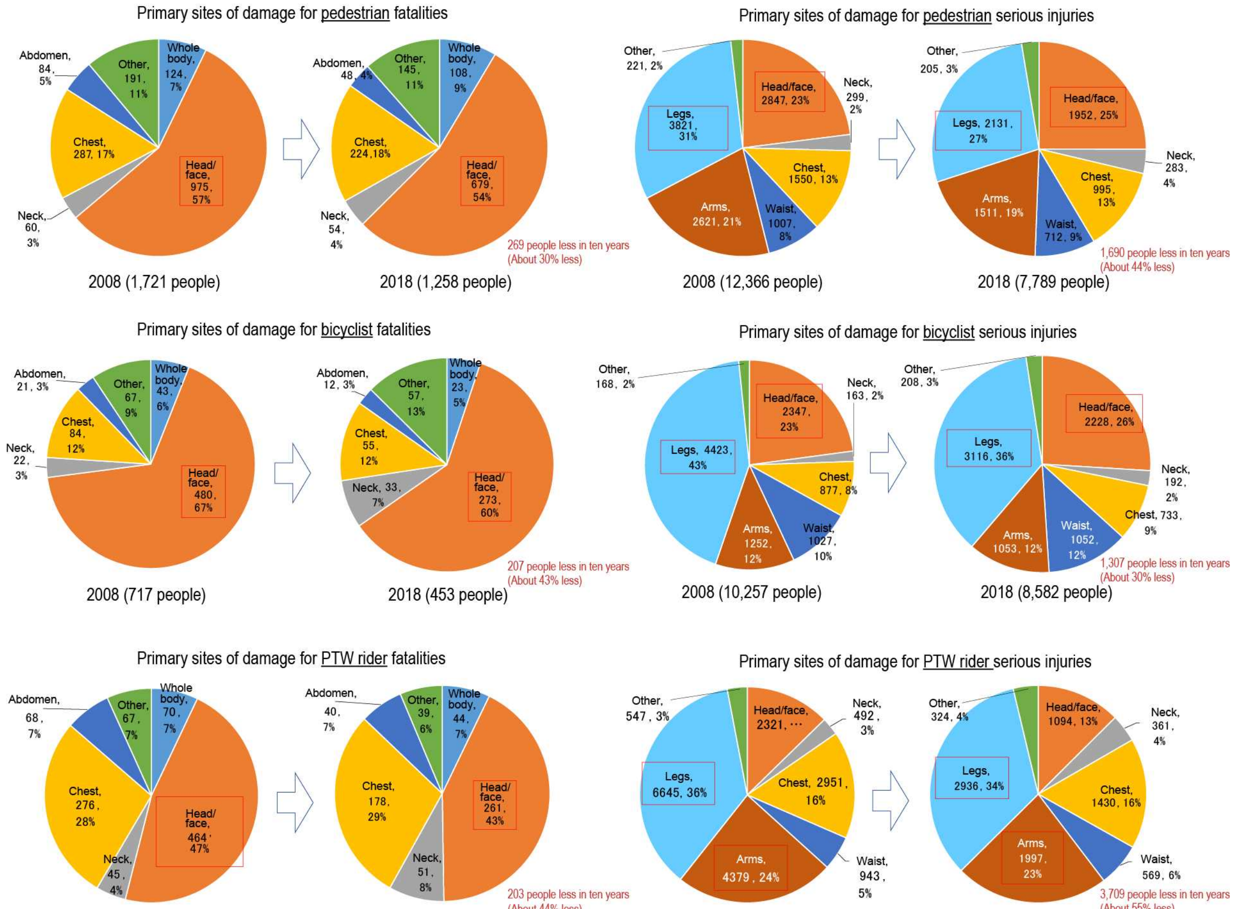
Source: Created by the RTB based on data provided by the NPA and ITARDA

Figure 1-3-7 Percentage of elderly casualties by transport mode (2019)

(3) Characteristics by site of damage

The absolute number of traffic fatalities among *pedestrians* and *bicyclists* has significantly decreased compared to a decade ago (2008). This is presumably attributable to a decrease in the number of accidents themselves as well as to the effects of various road safety measures implemented to help drivers avoid harming pedestrians through the improvement in their vehicles' pedestrian protection performance. That said, *head/face* injuries are still the prevalent cause of fatalities, which is presumably attributable to pedestrians and bicyclists' heads hitting the A-pillars or cowls of the vehicle as well as to their secondary collision with road surfaces.

For fatalities among PTWs riders, the head/face was the primary site of damage, accounting for more than 40% of all fatalities.



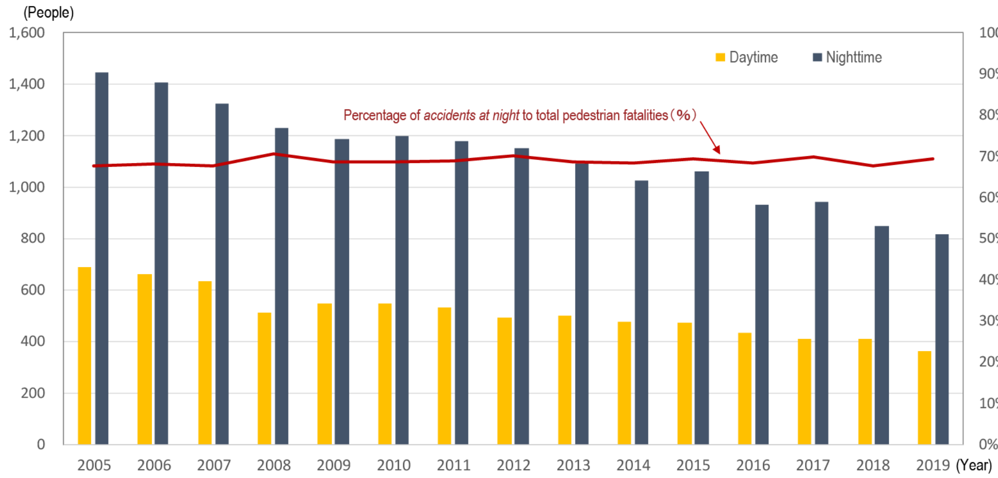
Source: Created by the RTB based on data provided by ITARDA

Figure 1-3-8 Percentage and changes in the primary sites of damage for fatalities (left) and serious injuries (right) by transport mode (2008/2018)

(4) Characteristics of fatal accidents involving *pedestrians*

Looking at *pedestrian* fatalities by accident type, we see that more than 90% of them occurred as a collision with a four-wheeled vehicle. The most frequent of those collisions (about 80%) are a collision with a *vehicle traveling straight ahead*, followed by a collision with a *vehicle turning right* (about 10%).

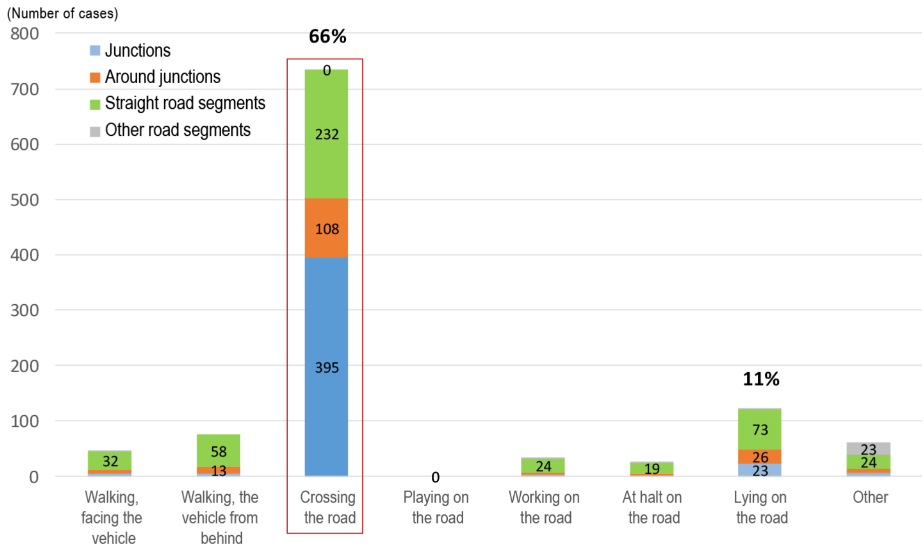
In terms of time zone, about 70% of *pedestrian* fatalities occurred *at night*. As shown in Fig. 1-3-9, the number of *pedestrian* fatalities has been decreasing year by year, but the percentage of accidents at night has remained almost the same without any change.



Source: Created by the RTB based on data provided by the NPA

Figure 1-3-9 Changes in the number of *pedestrian* fatalities by time zone

An analysis of pedestrian fatalities by accident type shows that the most frequent of all accident types was they were hit by a vehicle *while crossing the road* (around 70%), followed by *while lying on the road* (around 10%).

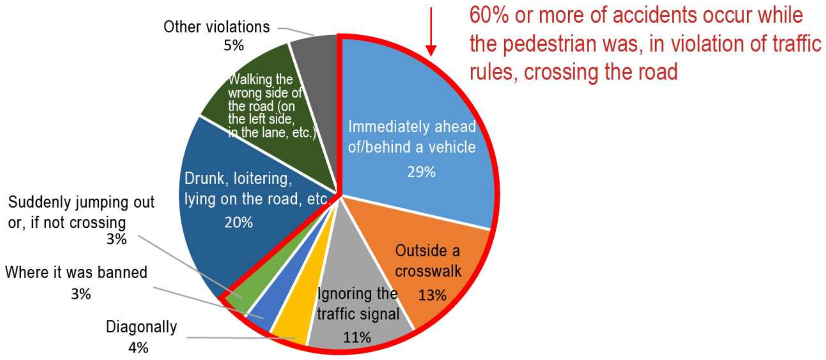


Source: Created by the RTB based on data provided by ITARDA

Figure 1-3-10 Number of pedestrian fatalities by circumstances and by road type (2019)

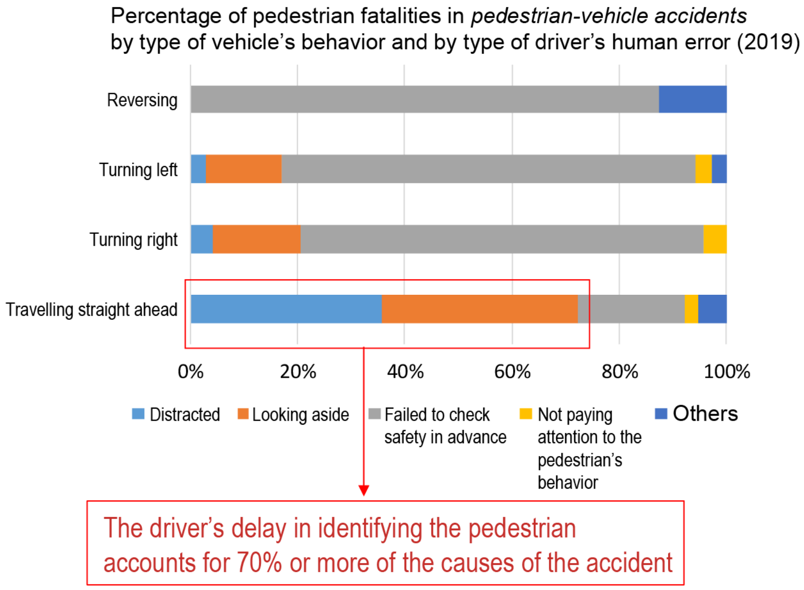
As shown above, fatal accidents between pedestrians and a motor vehicle most frequently occurred when *the vehicle was traveling straight ahead* and *the pedestrian crossing the road.* In this accident type, around 60% of cases where the pedestrian was at fault involve the pedestrian *violating traffic rules for when crossing a road* (immediately ahead of or behind the vehicle, outside a crosswalk, ignoring the traffic signal, etc.), whereas about 70% of cases where the vehicle driver ended up at fault involve *delay* *in identifying the pedestrian* (while distracted, looking aside) (Fig. 1-3-12).

Further, about 10% of all fatal accidents between pedestrians and vehicles occurred while the vehicle was *turning right*. Of these, about 80% of the accidents where the driver ended up at fault occurred after the driver *failed to check safety in advance* (Fig. 1-3-12).



Source: Created by the RTB based on ITARDA data

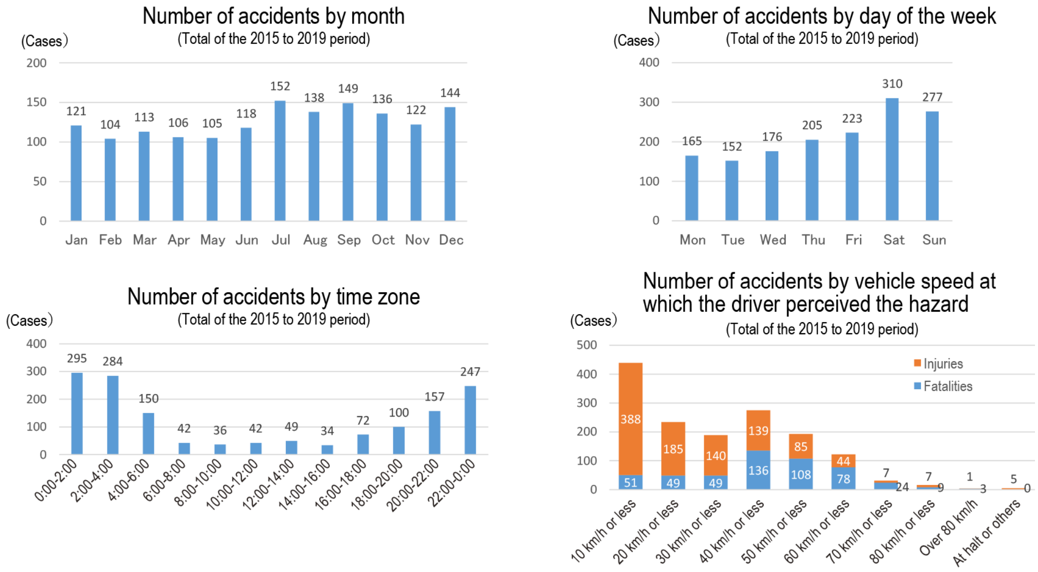
Figure 1-3-11 Percentage of pedestrian fatalities involving vehicles travelling straight ahead by type of pedestrian's legal violation (2019)



Source: Created by the RTB based on ITARDA data

Figure 1-3-12 Percentage of pedestrian fatalities in *pedestrian-vehicle* accidents by driver's human error (2019)

In 2019, there were 124 cases where pedestrians hit to death by a motor vehicle while lying down on the street. Fig. 1-3-13 shows the number of accidents involving pedestrians hit to death while lying down on the street over the past five years. Broken down by time zone, it indicates that many accidents occurred after dusk and before dawn (approx. 8:00 p.m. to 4:00 a.m.). Further, we see that, in terms of the vehicle speed at which the driver perceived the hazard, injuries are more common in the low speed range, but fatalities in the medium speed range (40 km/h to 60 km/h).



Source: Created by the RTB based on ITARDA data

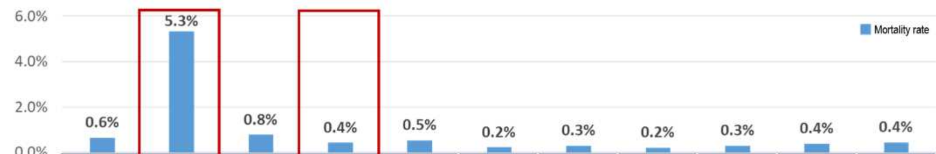
Figure 1-3-13 Characteristics of accidents involving people lying on the street (Total of the 2015 to 2019 period)

(5) Characteristics of fatal accidents involving *bicyclists*, etc.

Looking at fatal accidents involving bicyclists by accident type, we see that *collision at junctions** account for the largest accident type among bicyclists fatalities and serious injuries (FSI). In particular, as accident type, *collision at junctions* accounts for about 50% of bicyclist fatalities. Of these accidents, the most common are collisions between a bicyclist and a motor vehicle at junctions without traffic signals, presumably caused by the driver's failure to check safety in advance or the bicyclist's failure to stop once before entering the junction[4].

Accidents in which a bicyclist in motion is *rear-ended* by a vehicle from behind, don't result in a large number of casualties, but, once they happen, risk a remarkably high mortality rate (5.3%). Further, about 70% of the fatalities in these *rear-end collisions* occur *at night*.

*For the purpose of this report, *collision at junctions* as accident type doesn't include collision between a *vehicle turning right at a junction and a pedestrian or a PTW going straight through the junction,* which is also a *collision at junction but classified as an independent accident type for its high rate of occurrence.*

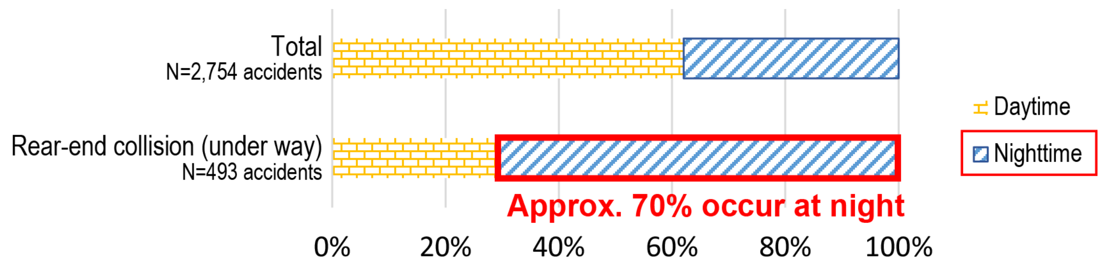


	Head-on collision	Rear-end collision (while in motion)	Rear-end collision (others)	Collision at junctions	While overtaking/ getting overtaken	While crossing each other	Vehicle turning left	Vehicle turning right (the vehicle turning right hitting the bicycle crossing the road)	Vehicle turning right (others)	Between vehicles (others)	Between vehicles (all)
Mortality rate	0.64%	5.35%	0.77%	0.42%	0.51%	0.21%	0.29%	0.20%	0.28%	0.38%	0.43%
Fatalities (people)	105	505	28	2,062	138	33	362	99	203	356	3,891
Serious injuries (people)	1,936	1,901	385	41,038	2,887	1,177	6,797	4,292	5,768	6,788	72,969
Slight injuries (people)	14,467	7,038	3,229	452,097	24,021	14,202	116,998	45,532	65,753	85,637	828,974
Casualties (people)	16,508	9,444	3,642	495,197	27,046	15,412	124,157	49,923	71,724	92,781	905,834

Source: Created by the RTB based on ITARDA data

Figure 1-3-14 Mortality rate and number of casualties involving bicyclists by accident type (Total of the period 2011 to 2019)

[4] Handout distributed at 15th Research Presentation Meeting of ITARDA (Analysis of Human Factors in Collisions between 4-Wheeled Vehicles and Bicycles at Unsignalized Junctions)



*Accident survey data is the total of the period 2011 to 2019
Source: Created by the RTB based on ITARDA data

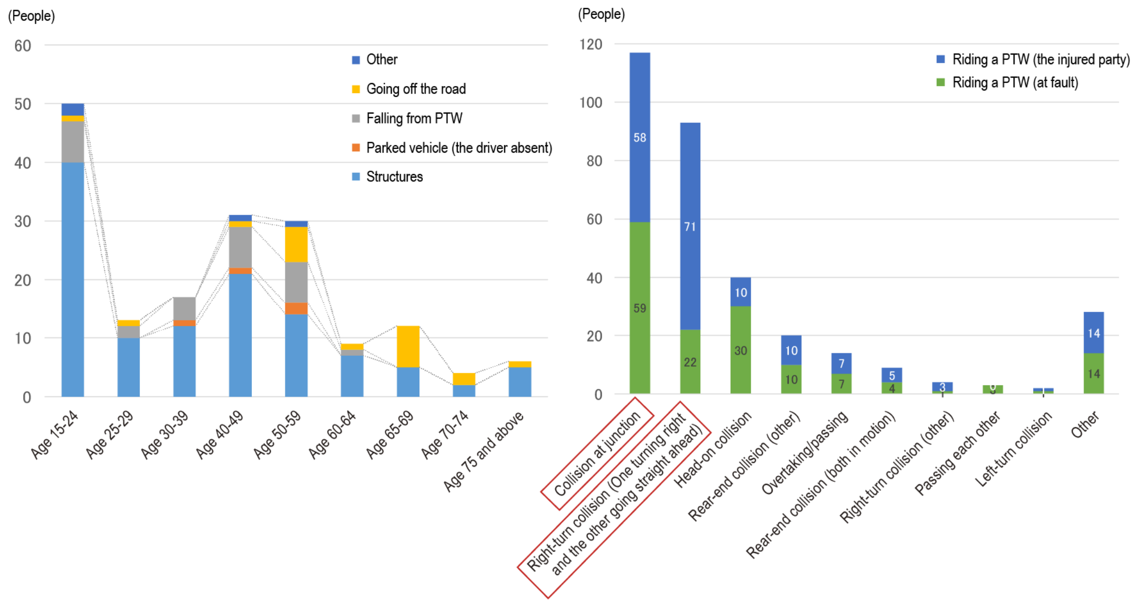
Figure 1-3-15 Percentage of bicyclist fatalities by time zone
(Total of the period 2011 to 2019)

(6) Characteristics of fatal accidents involving *PTWs*

Accidents involving PTWs can be roughly divided into two sub-types: those caused by a single PTW and those with other PTW(s) or vehicle(s).

Of fatal accidents involving a single PTW, around 67% were caused by their collision with *structures*. A relatively high percentage of PTW fatalities involving riders aged 65 or above occurred when they *went off-road*, while, for riders aged under 65, a high percentage of fatal accidents occur when they *fall from their PTW*.

In terms of PTW fatalities in accidents with other vehicles, the most common is *collision at junctions*, followed by *collision between a vehicle turning right and the other going straight ahead*, the top two accident types accounting for around 64% of all fatal PTW accidents with other vehicles. In particular, with right-turn collisions, the percentage of cases where the PTW is the victim is higher than in *collision at junctions*.



Source: Created by the RTB based on ITARDA data

Figure 1-3-16 Number of fatalities by accident type in single-vehicle accidents (SVA) (left) and vehicle-vehicle accident (right) (2019)

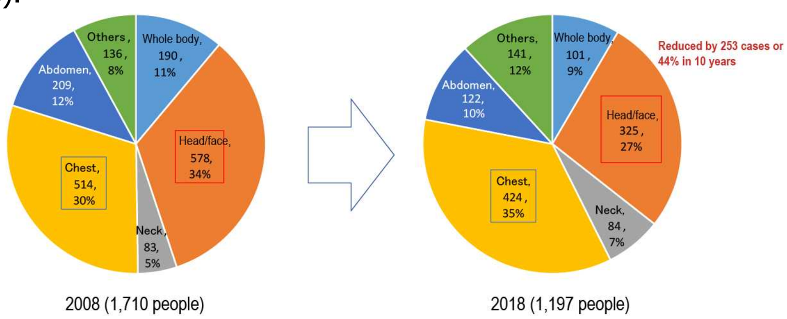
3. Traffic accidents involving vehicle occupants

(1) Characteristics by transport mode

With regard to accidents involving vehicle occupants (Fig. 1-3-6), the ratio of *vehicle occupants* to the total number of traffic fatalities was 34%, whereas the ratio of *vehicle occupants* to the total number of traffic injuries was 62%. In terms of accident type, the highest mortality rate for vehicle occupants is seen in *head-on collisions, etc*. between vehicles, whilst the highest number of accidents concerns *rear-end collisions*.

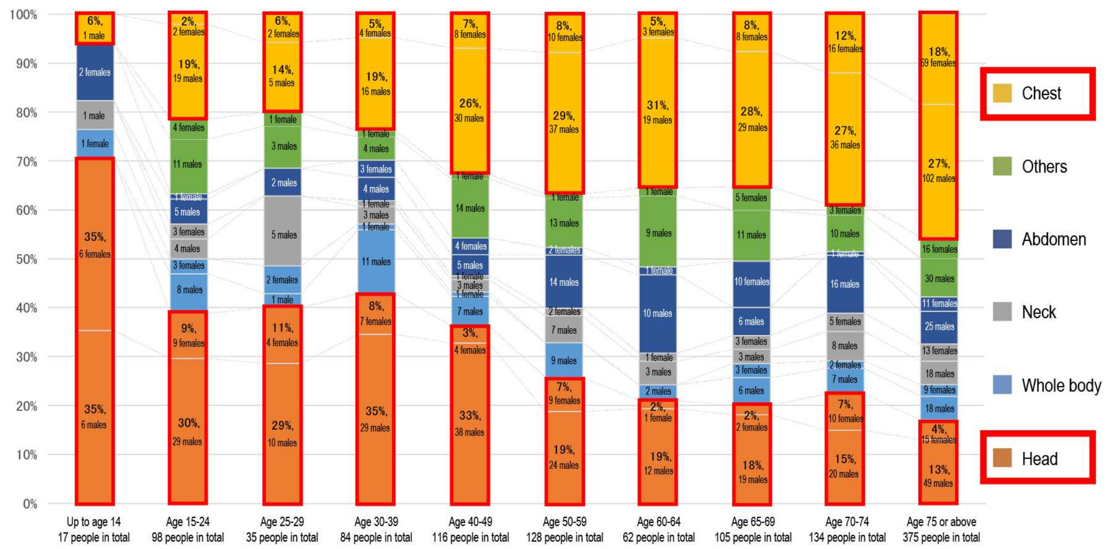
(2) Characteristics by age group and site of injury

The number of fatalities among vehicle occupants has decreased significantly over the past 10 years, but the primary site of injury in fatal accidents has shifted from *the head/face* to *the chest*. In 2008, 34% of primary injuries occurred in *the head/face* and 30% in *the chest*, but in 2018, *the chest* accounted for the highest ratio of 35% of all fatalities, followed by *the head/face* at 27% (Fig. 1-3-17). By age group, the ratio of *the head/face* decreased as the age increased, while the ratio of *the chest* tended to increase (Fig. 1-3-18).



Source: Created by the RTB based on ITARDA data

Figure 1-3-17 Ratio of and changes in the primary sites of injuries in fatal accidents involving vehicle occupants

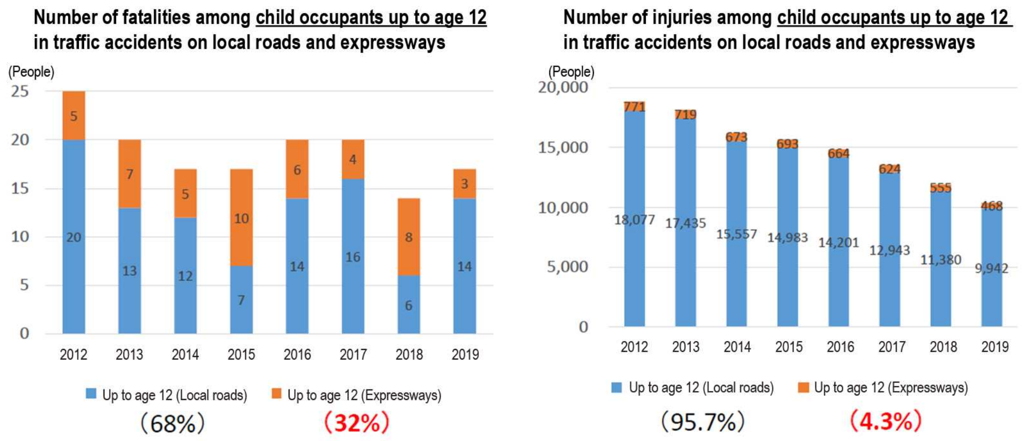


Source: Created by the RTB based on ITARDA data

Figure 1-3-18 Ratio of the primary sites of damage in fatal accidents involving vehicle occupants (by age group and gender) (2018)

(3) Characteristics of fatal accidents, etc. involving child occupants

The number of injuries to children (up to age 12) among vehicle occupants has been on a consistent downward trend, while the number of fatalities in the same category has remained almost unchanged, though with certain variations over the past few years (Fig. 1-3-19). The percentage of fatal accidents on expressways has been increasing for the same category, accounting for about 30% of all fatalities on average over the past eight years.



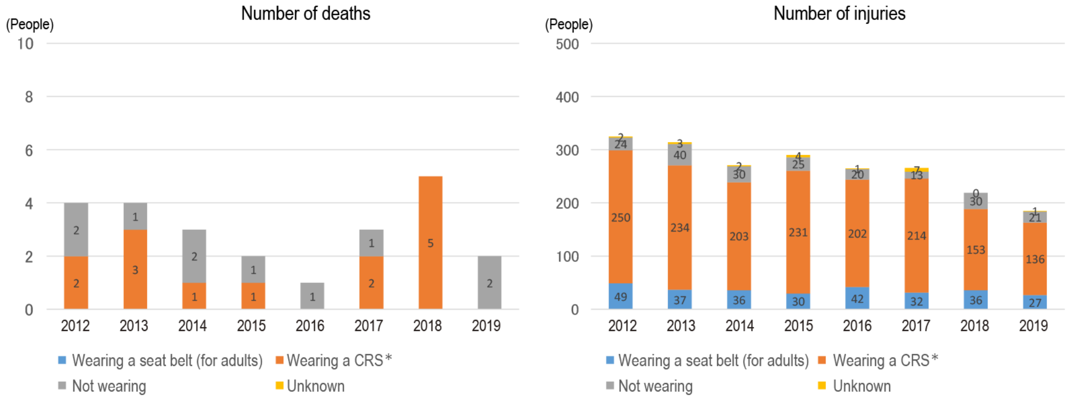
Source: Created by the RTB based on ITARDA data

Figure 1-3-19 Changes in the number of fatalities and injuries among child occupants up to age 12

Preschoolers (under age 6) account for a higher ratio in the fatalities and injuries among car occupants than school-age children (age 6 to 12). This is presumably because, in early childhood, children often travel by car with their parents or other caregivers and after entering elementary school they start to travel on foot or by bicycle.

Figure 1-3-20 shows statistics on accidents involving preschoolers in vehicle occupant on expressways in terms of their use of child restraint systems (CRS), etc. According to data on the use of CRS available in the statistics on fatalities and injuries, the ratio of use of CRS among preschoolers killed or injured while on a car is presumably about 70% to 80%, which is close to the ratio of use (70.5%) confirmed in a joint field survey by the NPA and the Japan Automobile Federation (JAF)[5]. Meanwhile, it has been confirmed that there are a certain number of cases where CRS are inappropriately used.

[5] Survey on the use of CRS (Joint survey by NPA and JAF in 2019)

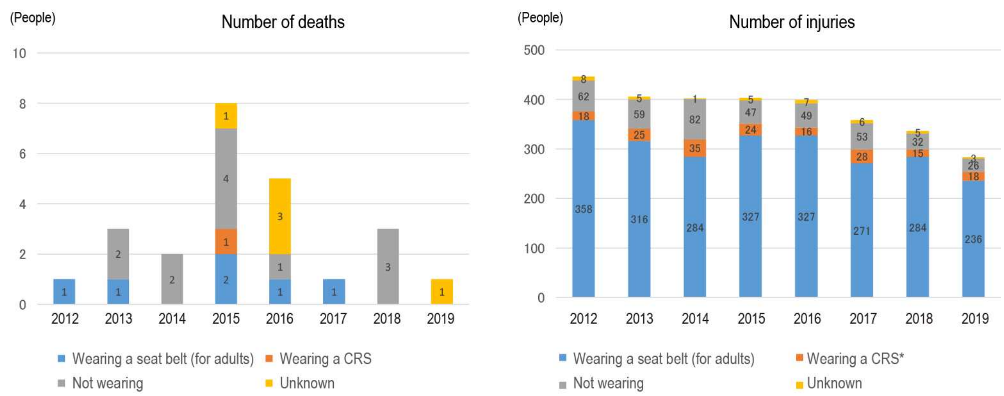


*CRS refer to seats for infants, toddlers/preschoolers, or school-age children.
*Among children wearing CRS under age 6, the number of cases of misuse was 1 in 2013, 1 in 2014, 2 in 2017 and 1 in 2018, respectively.

*CRS refer to seats for infants, toddlers/preschoolers, or school-age children.
*Among children wearing CRS under age 6, the number of cases of misuse was 16 in 2012, 18 in 2013, 10 in 2014, 11 in 2015, 11 in 2016, 14 in 2017, 7 in 2018, and 5 in 2019, respectively.

Figure 1-3-20 Changes in the number of preschoolers (under age 6) killed or injured in traffic accidents while in a vehicle on expressways

Next, Fig. 1-3-21 shows the changes in the number of school-age children (age 6 to 12) killed or injured in a vehicle in traffic accidents on expressways in terms of whether they wore or not CRS, etc. When we look at the use of CRS, etc., among school-age children killed or injured in those accidents, we find that the rate of use was about less than 10%, and that about 70% to 80% of them were wearing seat belts for adult. Further, we see that there were a certain number of school-age children killed or injured who were wearing CRS, etc. inappropriately.

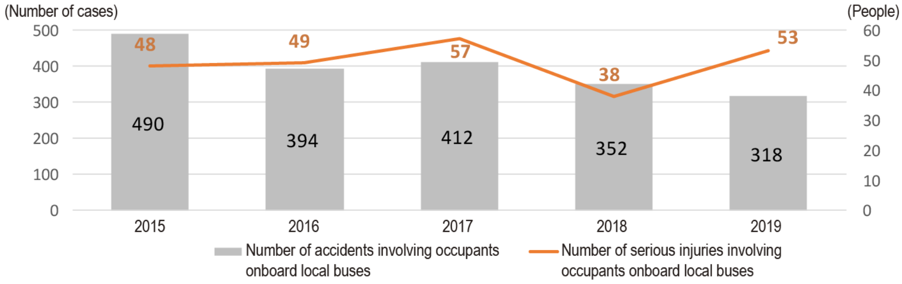


*CRS refer to seats for infants, toddlers/preschoolers, or school-age children.
*Among children wearing CRS of age 6 to 12, the number of cases of misuse was 1 in 2012, 3 in 2013, 1 in 2014, 2 in 2016, and 1 in 2017, respectively.
Source: Created by the RTB based on ITARDA data

Figure 1-3-21 Changes in the number of school-age children (age 6 to 12) killed or injured in a vehicle in traffic accidents on expressways

(4) Characteristics of onboard accidents involving occupants of local buses

The number of accidents on local buses in which passengers are killed or injured after they fell over, etc. upon sudden starting, braking, etc. of the bus (on-board accidents, including those in which the passenger is the secondary party at fault) has been decreasing in recent years, but the number of serious injuries has mostly remained unchanged (Fig. 1-3-22). Of these, about 40% occurred when the bus started moving.



Source: Created by the RTB based on ITARDA data

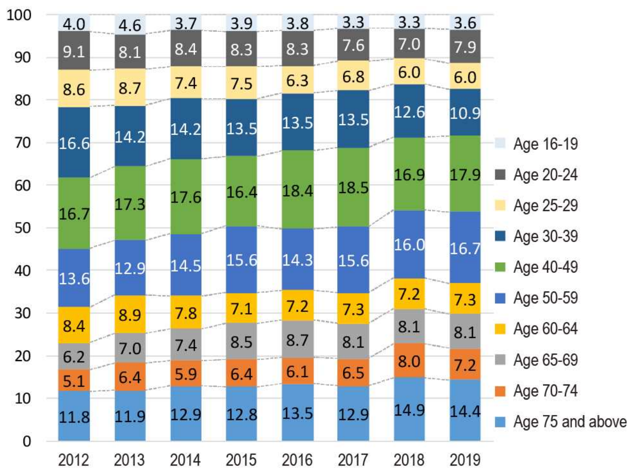
Figure 1-3-22 Changes in the number of accidents and serious injuries onboard local buses

4. Traffic accidents seen in light of social background

(1) Characteristics of accidents involving elderly drivers, etc.

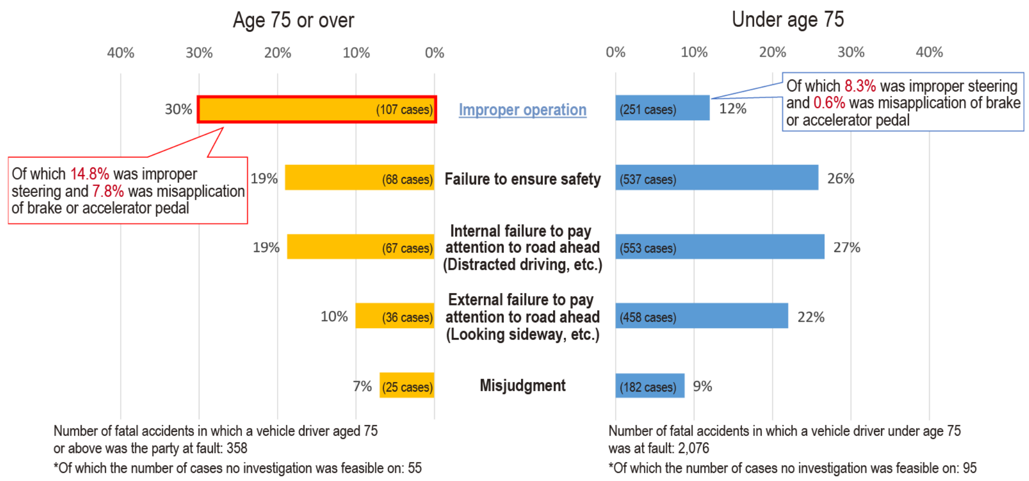
The number of fatal traffic accidents is on a downward trend in Japan, but, in fatal traffic accidents in which a vehicle driver was at fault, the ratio of such accidents caused by elderly drivers aged 65 or above has been on the increase (Fig. 1-3-23).

In fatal accidents caused by elderly drivers aged 75 and above, the percentage of those in which contributing human factor was their improper operation is 30%, much higher than the same percentage (12%) for drivers under age 75 (Fig. 1-3-24). Specifically, the percentage of fatal accidents in which the contributing human factor was improper steering was 8.3% for drivers under age 75, compared with 14.8% for drivers aged 75 or above. The percentage of accidents attributable to pedal misapplication was also 0.6% for drivers under 75, compared to 7.8% for drivers 75 or above.



* The term "the party at fault" refers, of the driver(s) of the vehicle(s) (including trains) or pedestrian(s) who were first involved in a traffic accident, to the party deemed more at fault for the accident than the other(s) or, if all parties are equally at fault, the party who is less seriously injured.
** The number of accidents is the one which concerns motor vehicles and PTWs.
Source: Created by the RTB based on NPA data

Figure 1-3-23 Changes in ratios of age groups to the parties at fault in fatal accidents year by year

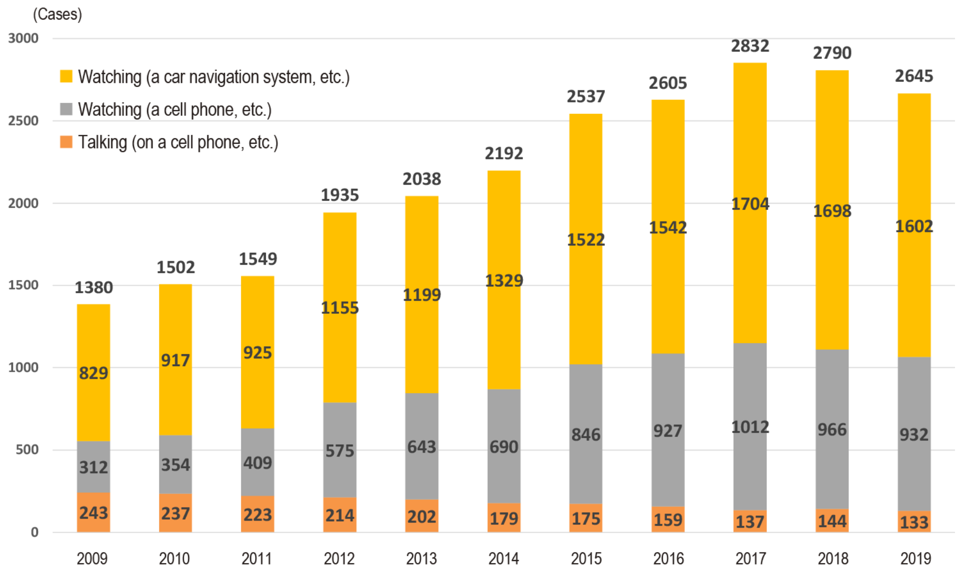


Source: Created by the RTB based on NPA data

Figure 1-3-24 Number of fatal accidents involving four-wheeled drivers (at fault) by contributing human factors (2019)

(2) Characteristics of accidents due to dangerous driving, etc.

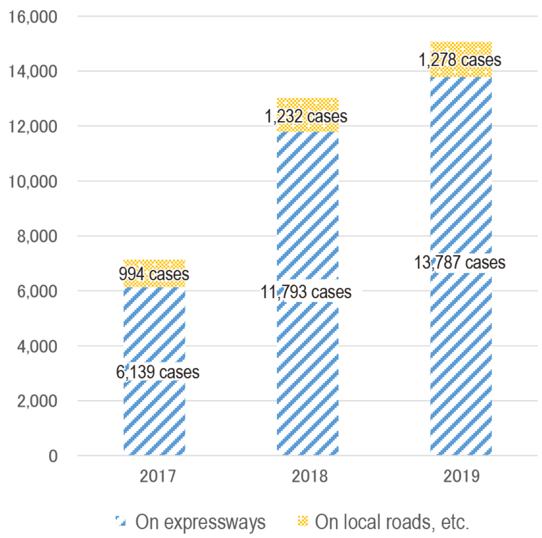
Figure 1-3-25 shows changes in the number of traffic accidents caused while the driver at the wheel was watching smartphones, etc., talking on the phone, or looking at car navigation systems, etc. The number of these traffic accidents had been on the increase until 2017, but then started to decrease due to the spread of road safety education and stricter penalties under the revised Road Traffic Act enacted in December 2019.



Source: Created by the RTB based on NPA site and ITARDA data

Figure 1-3-25 Changes in the number of traffic accidents due to cell phone use, etc. while driving by situation of use

There have also been incidents of dangerous driving, such as "tailgating" and other forms of obstructive driving, which have resulted in fatal traffic accidents. In the accident originating from a tailgating harassment on the Tomei Expressway in June 2017, a family's car long harassed and then blocked and forced to park on the expressway by the tailgater was rear-ended by a truck coming from behind, resulting in the tragic deaths of the parents. To deal with such malicious and dangerous driving behavior, strict traffic control measures are being taken, including the strict application of the Road Traffic Act and arresting tailgaters for the violation of safe distance rules, etc.

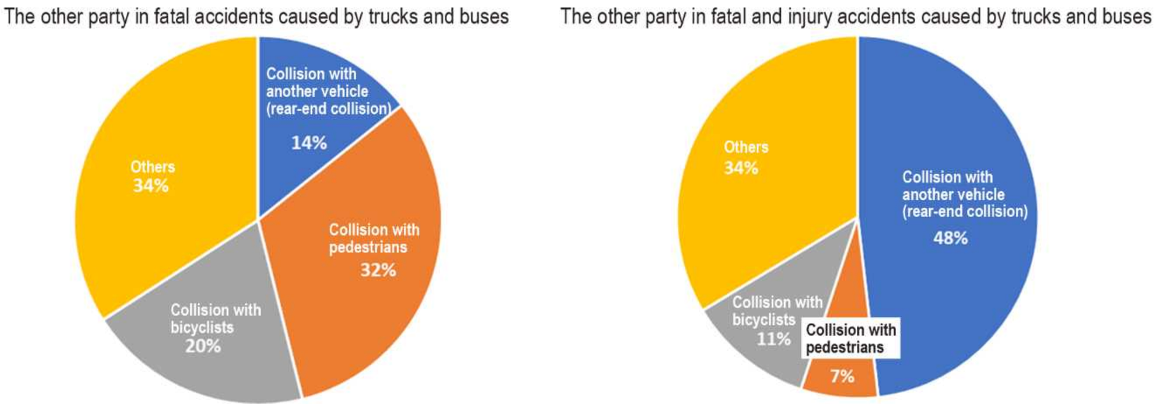


Source: Created by the RTB based on NPA data

Figure 1-3-26 Changes in the number of arrests made for violations of the obligation to keep safe distance

(3) Characteristics of accidents involving large vehicles, etc.

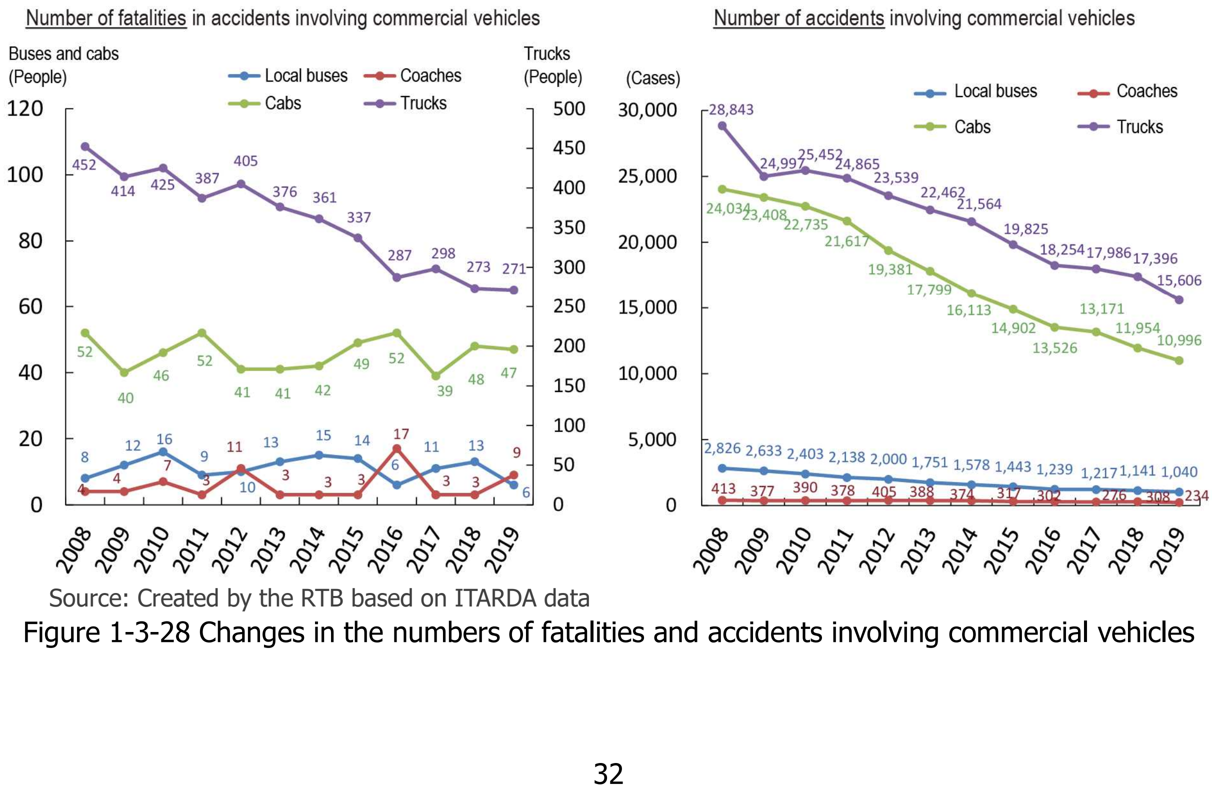
The rate of accidents resulting in fatalities (mortality rate) is high for accidents involving trucks and other large vehicles at fault. For example, while the ratio for a passenger car to be at fault in fatal accidents is 0.6%, that for a large truck is significantly higher 2.8%. Further, as shown in Fig. 1-3-27, about half of the victims from the fatal accidents caused by large vehicles (trucks and buses) are *pedestrians* and *bicyclists*, who are vulnerable road users. On the other hand, in terms of accident type, about half of all fatal and injury accidents caused by those vehicles are collision with another vehicle (rear-end collision).



Source: Created by the RTB based on ITARDA data

Figure 1-3-27 Percentage of the other parties in fatal and casualty accidents caused by trucks and buses by road user type (2016)

Safety measures for commercial vehicles such as trucks, buses, and cabs are implemented through operational management measures in the Comprehensive Safety Plan for Commercial Vehicles on one hand and VSMs on the other hand. As a result, the number of accidents involving commercial vehicles is on a downward trend, as shown in Figure 1-3-28. On the other hand, in terms of fatalities, the number of deaths from accidents involving commercial trucks is on a downward trend, while that for commercial buses, limousines, and cabs has remained almost the same.



Source: Created by the RTB based on ITARDA data

Figure 1-3-28 Changes in the numbers of fatalities and accidents involving commercial vehicles

Chapter 2 VSMs So Far Implemented

Section 1 How We Have Promoted VSMs and VSMs So Implemented

1. The system by which we have promoted VSMs

Vehicle safety measures (VSMs) have been implemented through the PDCA cycle, which, based on the analysis of actual accidents, sets targets for traffic accident reduction, implements measures, and evaluates the effects. The PDCA cycle is a long-term process, since the period from the time when VSMs are planned to the time vehicles provided with such safety measures are launched onto the market and spread across the country is generally long. For example, before a vehicle provided with safety measures is sold and distributed, there are processes of determining safety measures, developing relevant provisions of the Safety Regulation, designing the vehicle and equipment, and producing the vehicle and equipment, which take about five years. In addition, it will take another 5 to 10 years for these vehicles to fully spread across in the market.

The number of four-wheeled vehicles owned in Japan is about 78.42 million (as of December 2019), of which about 5.2 million were new vehicles sold the same year, accounting for about 7% of the total. Since the number of four-wheeled vehicles owned in recent years has remained almost constant, it will take about 15 years to replace all in-use vehicles with new ones. In reality, before all these in-use vehicles are replaced by new vehicles, even newer vehicles with even newer safety measures will be put into the market, so this replacement process will take place perpetually.

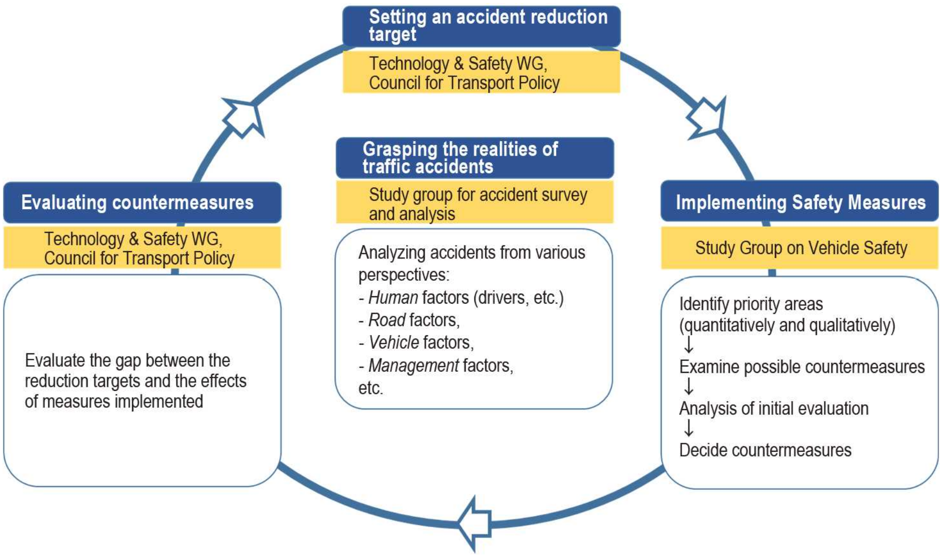
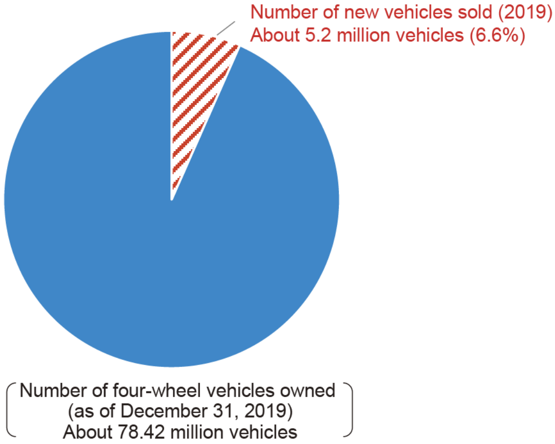


Figure 2-1-1 Cycle of a VSM



Source: Calculated based on JAMA, *Automotive Industry in Japan 2020*

Figure 2-1-2 Number of four-wheeled vehicles owned in Japan (as of December 31, 2019)

The Road Transport Bureau has implemented various measures for vehicle safety based on the four pillars of VSMs set forth in the report *The Future of Vehicle Safety for a Traffic Accident-Free Society* published in 2016, namely (i) safety measures for children and the elderly, (ii) safety measures for pedestrians and bicyclists, (iii) measures for serious accidents involving large vehicles, and (iv) response to new technologies such as automated driving (AD). At present, VSMs are based on a system that coordinates three measures: *expansion and enhancement of safety standards, etc.*, *Advanced Safety Vehicle (ASV) Promotion Plan*, and *new car assessment program (NCAP)*.

The purpose of VSMs is to ensure the safety of road traffic, but it is desirable that VSMs be implemented step by step as technology evolves and diffuse in a way not to hinder the competition among vehicle manufacturers and other private companies for technological development, while taking into account international trends such as activities for the harmonization of international regulations for vehicle standards, how far various ADAS have spread, etc. From this viewpoint, VSMs are required to be something that encourage the diffusion of such technologies across the market through appropriate implementation of policies in each stage (phase), from the birth of new technologies to their adoption as standard equipment.

Phase	Purpose of the measures	Measures
(i) Technological development	Develop an environment favorable for the introduction of new technologies	ASV Promotion Plan, establishment of technological guidelines
(ii) Technological competition	Promote technological competition on the market	NCAP (Compare performance among models and publish the results)
(iii) Spread and expansion	Give incentives to spread installation	Subsidies for *SuppoCars*, subsidies for ASVs, tax credits for ASV, etc.
	The government stamps new technologies with approval	System that certifies performance
(iv) Installation as standard equipment	Installed on all vehicles, the minimum performance ensured.	Development of safety regulations

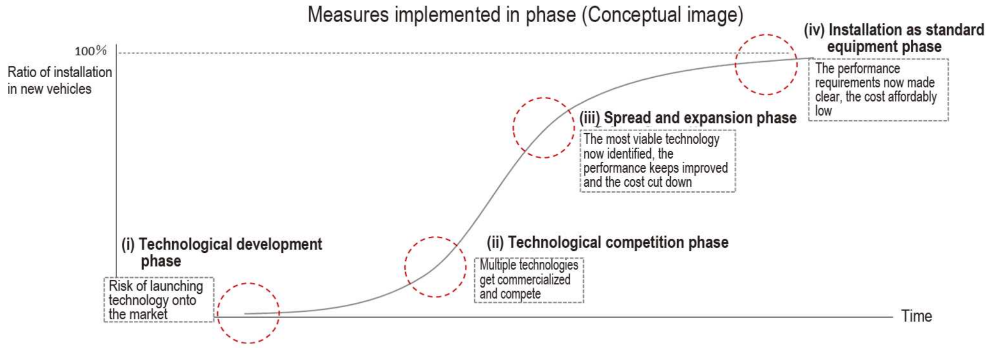


Figure 2-1-3 Phased implementation of VSMs

2. VSM so far implemented

So far, the Road Transport Bureau has worked on the reduction of traffic accidents by individual setting primary tasks that address the needs of the society, such as AD and measures for elderly drivers, based on the three basic measures of *expansion and enhancement of safety standards, etc.*, *ASV (Advanced Safety Vehicle) Promotion Plan*, and *New Car Assessment Program*.

(i) Expansion and enhancement of safety standards, etc.

The Road Transport Bureau establishes safety standards (Safety Regulation for Road Vehicles) with transparency, based on the results of traffic accident analysis and trends in technological development, etc. and through scientific discussions, and with an eye on the balance of its effects and burdens and the diversity of technologies. The safety standards are standards that set forth the technical requirements necessary to ensure and improve road safety and a mandate that requires manufacturers and motorists to comply with it, care should be taken not to make it something that inhibits the ingenuity of users and manufacturers in their technological development and product manufacturing. Based on this philosophy, since 2016 the RTB has taken the following measures in the direction indicated in a report published in the same year: made acoustic vehicle alerting systems mandatory for hybrid vehicles, etc., expanded the types of seats for which a seatbelt-reminder light is mandatory, made AEBS mandatory for passenger cars, etc. and introduced international regulations for automatic lane keeping systems.

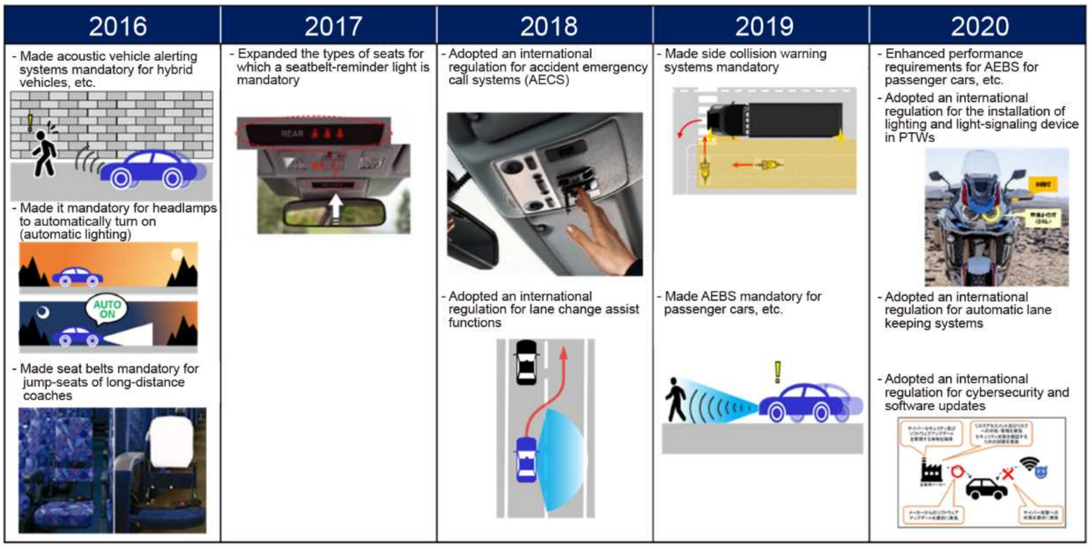


Figure 2-1-4 Major revisions to the Safety Regulation since 2016
(*The year of revision is based on the date the revision was promulgated.)

(ii) ASV Promotion Plan

The ASV (Advanced Safety Vehicle) Promotion Plan is a project aimed to promote the development, commercialization, and diffusion of advanced safety technologies. The ASV Promotion Study Group, in which industry, academia, and government participate, has been studying the technical requirements and basic design of new advanced safety technologies. In *the Sixth ASV Promotion Plan*, a five-year plan started in 2016 aimed basically at *promoting ASV for the realization of AD*, has studied specific requirements for technologies seeking the establishment of guidelines for the development and commercialization of advanced safety technologies necessary for the realization of AD. One of the results materialized as the Basic Design Guide to *Emergency Driving Stop Systems* (EDSS), which automatically stops the vehicle when the driver has suddenly fallen unable to continue driving due to illness, etc. The design guide was published in March 2016 ahead of other countries. Further, in August 2019, we established and published a design guide to advanced versions of this system, a system that automatically evacuates the vehicle to the shoulder of the road, avoiding stopping at junctions, etc. on local roads. Furthermore, we also established and published guidelines for *Intelligent Speed Assistance (ISA)* system, which reduces accidents involving excessive speeds, and *Unmanned Automated Mobility Services, etc.* during *the Sixth ASV Promotion Plan*.

Aside the development and publication of these guidelines, it is also important to take measures to promote the spread of ASV technologies. Financial incentives in the form of purchase subsidies and tax credits are provided to promote the replacement of in-use vehicles and create an environment that facilitates the purchase of vehicles with ASV devices, especially for large vehicles (trucks and buses), where new vehicles are expensive and represent a capital investment that requires significant financing and costs.

Figure 2-1-5 Overview of the Sixth ASV Promotion Plan

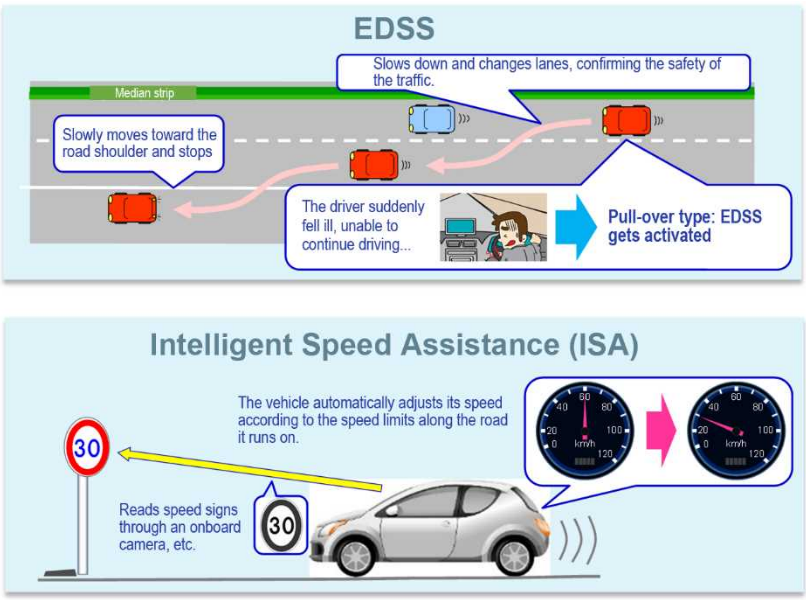


Figure 2-1-6 Overview of EDSS and ISA

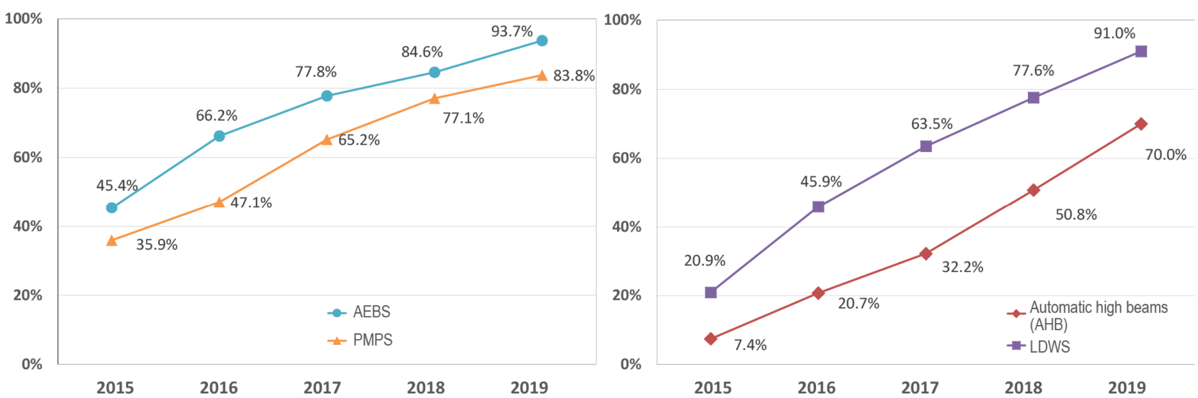


Figure 2-1-7 Percentage of new vehicles equipped with major ASV systems (Passenger cars)

(iii) New Car Assessment Program

The New Car Assessment Program (NCAP) is a measure to promote the spread of safer motor vehicles by creating an environment that facilitates motorists to choose safe cars while encouraging vehicle manufacturers to develop safer cars. As part of NCAP, safety performance comparison tests (frontal collision test and usability evaluation test) for CRS are also conducted.

After the introduction of the preventive safety performance assessment in 2014, the evaluation items were gradually expanded. The items thus added by 2020 include: rear vision monitors, AEBS for pedestrians (daytime, nighttime with/without street lights), lane departure warning systems (LDWS), advanced headlamps, and pedal misapplication prevention systems (PMPS). The evaluation of automatic collision notification system has been also started. In 2020, we integrated so far separated *collision safety performance evaluation* and *preventive safety performance evaluation* and introduced *vehicle safety performance evaluation* so that motorists can easily use it as an indicator in selecting safer vehicles.

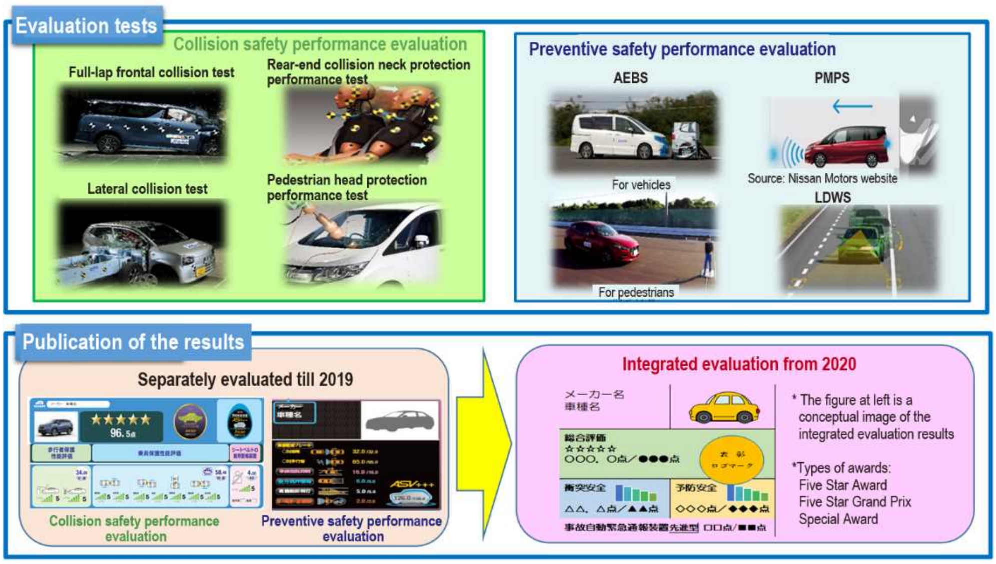


Figure 2-1-8 Overview of NCAP

(iv) Collaboration between medicine and engineering

To further reduce the number of traffic accident fatalities, it is important not only to focus on vehicles, but to consider solutions from a medical perspective as well, including the circumstances in which injuries were caused and the mechanism in which injuries occur in accidents. For this reason, we coordinate *a medical-engineering collaboration*, an initiative to clarify causes of injuries by integrating micro data on traffic accidents (engineering data), such as how the accident occurred and damage to the vehicle, and medical and first-aid data (medical data), such as how accident victim were transported and the extent of injuries.

We have analyzed traffic accidents based on data and conducted simulations to reproduce accidents in order to clarify the mechanism by which pedestrians develop injuries upon collision with vehicles. In addition, to promote the widespread use of automatic collision notification systems, we surveyed how airbags actually worked (which triggers the notification systems), surveyed the relationship between the sites of accidents and communication coverage, and verified the validity of injury prediction algorithm of the Advanced Automatic Collision Notification (AACN), which transmits also prediction information on injuries to vehicle occupants, etc. in the event of an accident. Through these activities, we conduct research that will contribute to the clarification of the mechanism by which injury occurs in accidents.

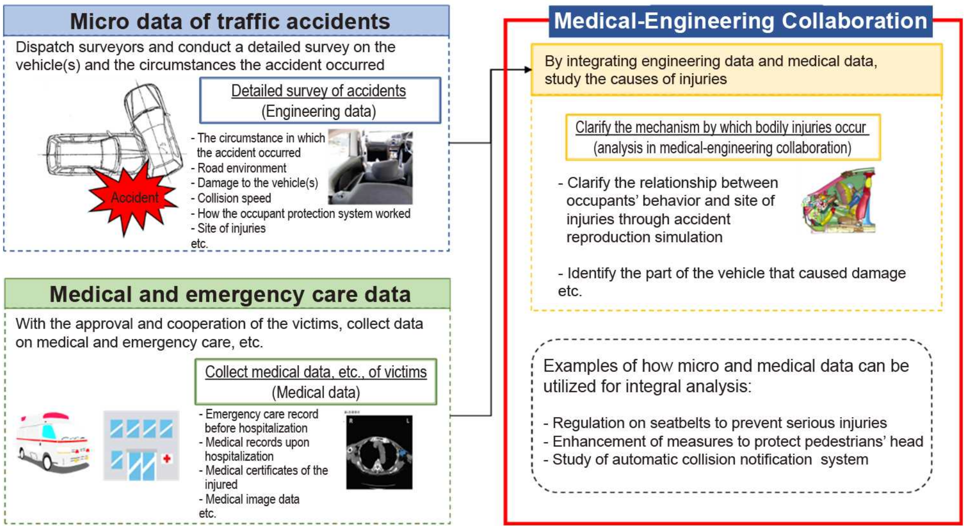


Figure 2-1-9 Overview of medical-engineering collaboration

(v) AD

AD is expected to have significant effects on solving various issues surrounding motor vehicles and road traffic, such as reducing traffic accidents, revitalizing regional public transportation, easing traffic jam, and enhancing the country's international competitiveness. To this end, the MLIT established an AD Strategy Headquarters of its own (headed by the Minister) in December 2016, and has pursued initiatives from three perspectives, namely, of *developing the environment for the realization of AD*, *developing and promoting AD technologies*, and *conducting demonstration tests and social implementation for the realization of AD*.

Of these, with regard to *the development of the environment for the realization of AD*, we are leading the international discussion at WP.29 as a co-chair or vice-chair of expert meetings that examine the regulations for AD. As a result of these efforts, the development of international vehicle regulations has been steadily progressing, as seen in the enactment in June 2020 of the international regulations on AD devices and cybersecurity for motor vehicles. At the same time, in Japan, there was a need to establish a system to ensure the safety of AVs, etc. in an integrated manner throughout the design and manufacturing stages to the in-use stage, while promoting the safe development, commercialization, and spread of AVs, etc. Therefore, pursuant to the enactment in May 2019 of the Act Partially Amending the Road Transport Vehicle Act, we established in March 2020 the safety standard for AD devices ahead of the rest of the world. Further, in November 2020, we granted type-designation to a vehicle (commonly known as Legend) applied for by Honda Motor Co. as the world's first vehicle equipped with an AD device based on an examination of its compliance with safety regulations.

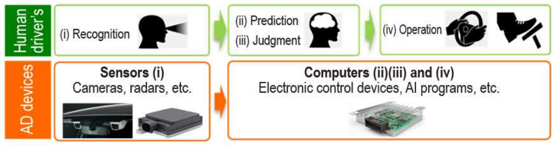
(1) Added AD devices to devices and systems subject to the Safety Regulation for Road Transport Vehicles

Current situation and issues:

- It is necessary to establish safety regulation (ministerial ordinance) to ensure the safety of AD systems (of Levels 3 and 4), but these systems are not deemed subject to the current Safety Regulation.
- Since AD systems (of Levels 3 and 4) are not expected to be at a technical level capable of ensuring safe AD anytime anywhere, we need to specify the requirements for the operating environment in which the AD system can be used (speed, routes, weather, time zones, etc.)

Amendment made:

- Added *AD devices* to systems and devices subject to the Safety Regulation for Road Transport Vehicles (Ministerial Ordinance)



- The Minister of LIT prescribes the requirements for the conditions under which the AD device concerned (operating environment) can be used.

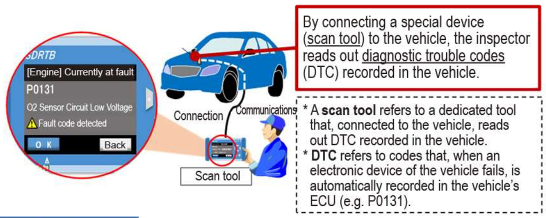
Examples of assumed operating conditions (combination of some of the following conditions):
- Road conditions (expressways/local roads, dedicated roads/mixed roads, number of lanes, presence or absence of lanes, etc.
- Geographical conditions (urban areas/depopulated areas, etc.)
- Environmental conditions (weather, daytime/nighttime, etc.)
- Other conditions (speed limits, restriction to prescribed routes, etc.)

For instance, in the early stage of introduction of AD devices, it may be prescribed that AVs run exclusively at daytime, on sunny days, on the main roadway of expressways, and at low speed (in time of congestions, etc.)

(2) Sorted out corporations to be in charge of the management of technical information necessary for the electronic inspection of motor vehicles

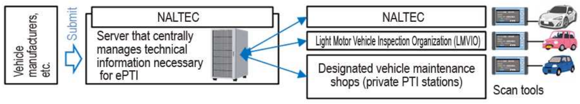
Current situation and issues:

- AD technologies such as AEBS have rapidly progressed recently, but a failure of such a system may lead to malfunction and an accident, so it is necessary to introduce electronic inspection into periodical vehicle inspection (PTI).
- To conduct electronic inspection, inspectors need technical information owned by vehicle manufacturers.



Amendment made:

- The National Agency for Automobile and Land Transport Technology (NALTEC) has been put in charge of the administrative work for the management of technical information necessary when examining the vehicle's compliance electronically in PTI, thereby providing an environment accessible to all technical services nationwide.



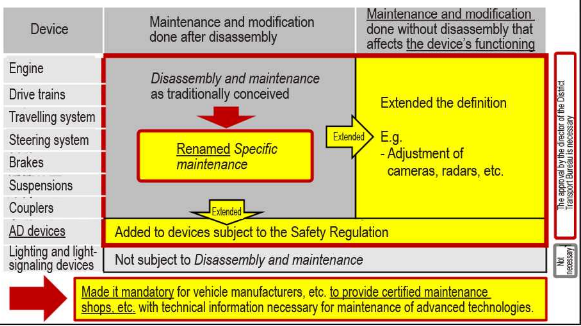
(3) Expanded the scope of disassembly and maintenance and made it mandatory for vehicle manufacturers to provide technical information necessary for maintenance

Current situation and issues:

- The maintenance and modification of high-tech devices are not included the scope of *disassembly and maintenance* to be certified when conducted as business, making it difficult to ensure safety. Hence, the above scope should be expanded.
- It is necessary to ensure that automotive technical information necessary to check and maintain high-tech devices be fully provided to maintenance shop operators, etc.

Amendment made:

- For *disassembly and maintenance*, a service that require certification, added AD devices to systems and devices subject to the Safety Regulation and expanded the definition of disassembly and maintenance to maintenance and modification that may affect the operation of the devices subject to the Regulation by renaming it *specified maintenance*.
- Made it mandatory for vehicle manufacturers, etc. to provide technical information specific to the types concerned to operators providing *specified maintenance services*.



(4) Created an approval system for the modification, etc. of an AD device, etc. through alternation of programs built in it

Current situation and issues:

- With the progress of automotive technologies in recent years, it is now made possible for vehicle manufacturers, etc. to modify the performance of or add functions to the AD device of an in-use vehicle (modification) by modifying programs built in ECUs of the vehicle through over-the-air updates.
- The current Road Transport Vehicle Act does not assume cases where vehicles are electronically modified through over-the-air communications. It is essential to ensure that modification be performed in an appropriate manner.

Amendment made:

- A provision has been added to the Safety Regulation to the effect that a person who intends to perform a modification of an AD device, etc. by modifying a program built therein that may, if inappropriately done, make the system no longer conform to the Safety Regulation by using telecommunication network, etc. (hereinafter referred to as "*specific modification, etc.*") must obtain an approval of the Minister of LIT in advance.
- Of the administrative work to be done before the approval, the task of technical examination will be assigned to the NALTEC.

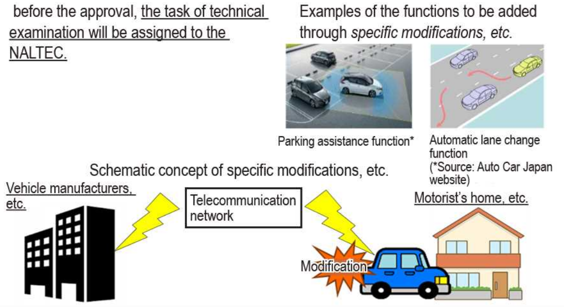
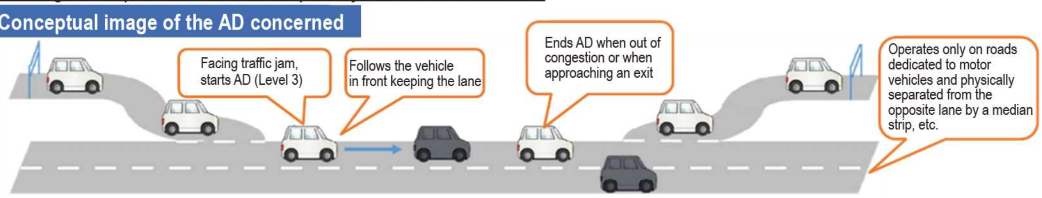


Figure 2-1-10 Act Partially Amending the Road Transport Vehicle Act (Summary)

Brief history

- In June 2019, the WP.29 session agreed upon a framework document for AD (an international guideline for AD and a schedule for development of relevant regulations).
- With the public and private sectors working as one, Japan led the international discussion as a co-chair, etc. of expert committees under WP.29.
- The regulation passed at the WP.29 plenary session in June 2020.

Conceptual image of the AD concerned



Main requirements

- The level of assurance of ADS must be equal to or higher than that of a competent and careful human driver in terms of, during its operation, not jeopardizing the safety of the occupants and other road users.
- When the system made a take-over request to the driver, it shall continue safe operation until the driver takes over the control and, if the driver does not, bring the vehicle to a stop safely.
- The system shall be equipped with a system that monitors the driver's condition to ensure that the driver is ready to take over the driving and other operating tasks.
- The system shall take measures to ensure cybersecurity to prevent unauthorized access, etc.
- The system shall have a device in place that records certain operational events such as the time it is activated or deactivated, the time a failure occurred, etc.
- Compliance with the above requirements shall be confirmed by a combination of simulation tests, test track tests, public road running tests, and written documents (e.g., Make sure that, in a situation where another vehicle may cut in front of it, the AV can avoid any collision deemed avoidable with the readiness and braking force of a careful and competent driver model).

Figure 2-1-11 Summary of the provisions of the Safety Regulation relevant to AD systems

(vi) Prevention of accidents involving elderly drivers, etc.

Elderly drivers are characterized by a high percentage of becoming at fault in fatal accidents and a high percentage of causing accidents due to operating errors such as pedal misapplication. One of such accidents occurred in October 2016 in Yokohama when a K truck driven by an 87-year-old driver plowed into a line of elementary school children on their way to school, killing one of the students. This attracted wide public attention to frequent fatal accidents being caused by elderly drivers in recent years, making them a big social issue. The government has since been taking concerted measures to prevent traffic accidents involving elderly drivers.

In January 2017, under the direction of the Prime Minister, a Vice Minister Meeting among Relevant Ministries for the Enhancement of Public Awareness of safe driving assistance cars was established to discuss the measures that should be taken immediately to prevent traffic accidents involving elderly drivers. After three rounds of discussions, the interim report released in March the same year proposed a concept of passenger cars with ADAS such as AEBS as safe driving assistance cars (or *SuppoCars*, as they were nicknamed). As part of the concerted efforts between the public and private sectors for public awareness activities, the RTB responded to requests from vehicle manufacturers, etc. and established in March 2018 a system that certifies that AEBS of qualified passenger cars have a certain level of performance.

Furthermore, in response to a traffic accident that occurred in Toshima Ward, Tokyo, in April, 2019, in which a parent and a child were killed by a runaway car, driven by an elderly aged 89, a Meeting among Relevant Ministries and Agencies on Road Safety Measures in Light of the Recent Accident Situation was held in May, 2019. Based on the Prime Minister's instructions given at the above meeting, a meeting of ministers from relevant ministerial held in June the same year proposed the Emergency Road Safety Measures regarding Preschoolers and Elderly Drivers. In this document, the RTB identified the following as urgent and priority measures to be taken and since has been working on them one by one:

(i) Establishment of a national regulation for AEBS
(ii) Introduction of a performance certification system for pedal misapplication prevention systems, etc.
(iii) Establishment of a performance certification system for retrofit pedal misapplication prevention systems in order to promote the use of retrofit ADAS in in-use vehicles.
(iv) Establishment of guidelines for technical requirements of ISA to promote the development of new ADAS technologies.

Furthermore, as part of the 2019 supplementary budget, the government created a *SuppCar Subsidy* to subsidize the purchase of vehicles equipped with *AEBS* and *PMPS* to help people aged 65 or above introduce these devices.

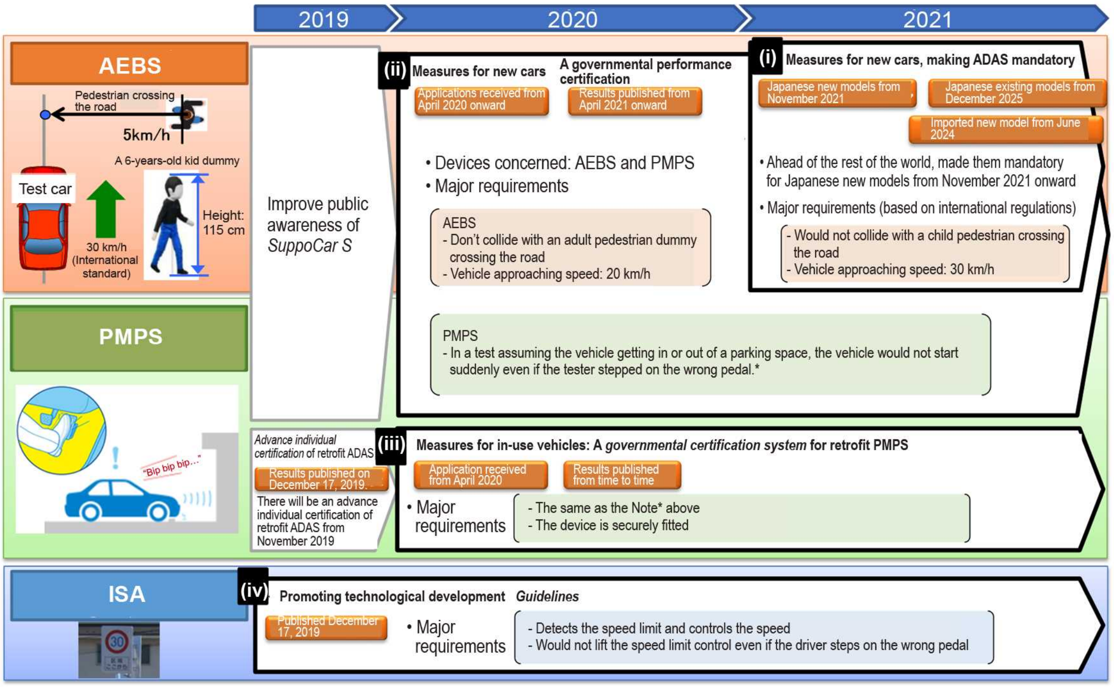


Figure 2-1-12 Overview of emergency road safety measures for preschoolers and elderly drivers (vehicle safety)

(vii) Other measures

Micro mobility, one or two-seater cars much smaller than compact cars, are extremely useful to get around small neighborhoods. In addition to contributing to energy saving and CO2 emission control efforts in road traffic areas, they are expected to offer a means of mobility to senior citizens and all other generations. The government has been promoting the widespread use of this new mobility while ensuring road safety in their circulation. In particular, based on the Micro Mobility Certification System established in January 2013, the government has been operating two-seater micro mobility in a limited number of areas and conducting surveys to determine needs for usage and driving conditions. In September 2020, based on a study of the vehicle safety requirements, we streamlined the safety standards for the type designation of micro mobility vehicles that can run freely on local roads other than expressways.

Furthermore, with the advancement of technologies, demand is growing for a great variety of means of mobility such as electric kickboards. In response to such demand, we have conducted studies on the ideal traffic rules for various road users.

Sources (left to right): from websites of Toyota Motor Corporation, Toyota Auto Body, and Kintone Co., Ltd.

Figure 2-1-13 Examples of micro mobility and electric kickboards

Section 2 Reduction Targets So Far Achieved Through VSMs

1. Traffic fatalities reduction targets set out in the 2011 report

The 2011 report *The Future of Vehicle Safety for a Traffic Accident-Free Society* set a target of *reducing the number of annual traffic accident fatalities within 30 days by 1,000 by 2020 (compared to 2010) through VSMs*. So far, the government has aimed at achieving this quantitative reduction target through VSMs and has taken necessary actions.

In a report published in 2016, in the middle of the target period, the government made an interim evaluation of how far it achieved the target. According to the report, by 2016, the number of annual traffic accident fatalities within 30 days was reduced by 735 (compared to 2010) through VSMs. The report noted that most of the reduction in fatalities was attributable to measures to mitigate the damage caused by collisions with vehicles and pedestrians, and that the effect of advanced safety technologies such as AEBS was limited.

2. Reduction targets so far achieved

In this report, to be published in the last year of the target period, we have evaluated the status of achievement of the reduction targets set in 2011 based on the latest traffic accident statistics (2019) (See Appendix 1 for the detail of the evaluation method.). To evaluate the effectiveness of preventive safety measures such as AEBS, we compared the number of accidents per 1,000 vehicles owned with and without these devices.

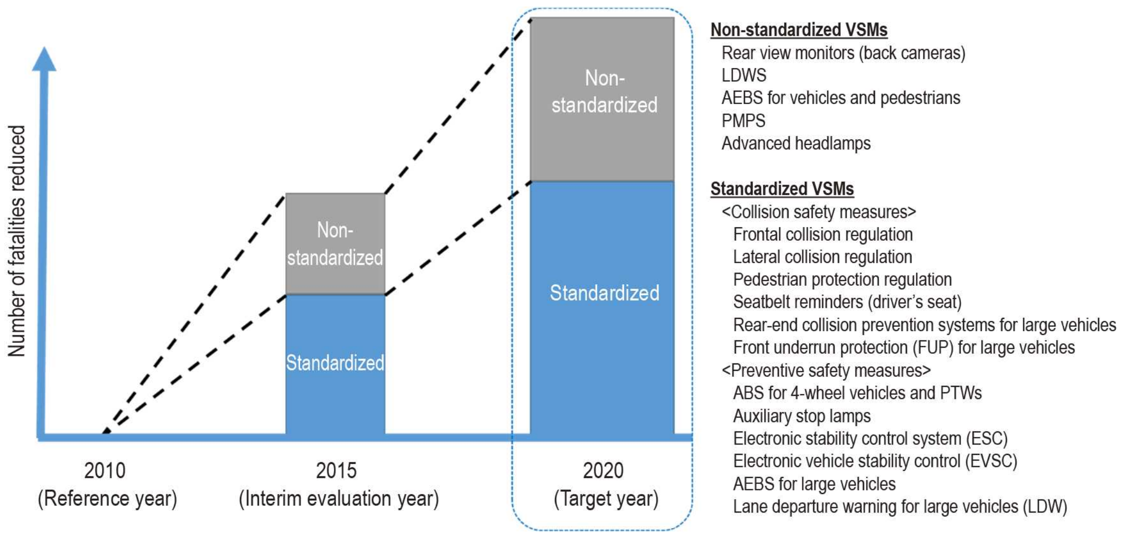


Figure 2-2-1 Approach to the evaluation of the effects of VSMs on the achievement of reduction targets

By calculating the effect of each VSM on reducing the number of fatalities and by fine-tuning the primary areas in which these effects overlap, we evaluated that **VSMs reduced the number of traffic accident fatalities within 30 days per year by 1,332 (compared to 2010)**. With regard to the countermeasures against frontal collision and countermeasures for pedestrians, which showed a significant reduction in the number of fatalities, measures to mitigate damage through enhanced collision safety regulations still account for a large proportion of the total, but the effect of AEBS in reducing the number of fatalities seems tangible to some extent. In addition, due to the promotion of road safety measures by the government across the board, the number of traffic accident fatalities within 30 days in 2019 decreased by 1,908 compared to 2010. Therefore, taking into account the reduction in fatalities through VSMs confirmed above, one could safely estimate that about 70% (1,332 fatalities) of this reduction was attributable to VSMs.

		Conducted in 2020	Subject accident types (Summary, conducted in 2020)	Subject vehicle types (Summary, conducted in 2020)
Measures against frontal collisions	Frontal collision	438	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
	AEBS		Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
Measures against rear-end collisions by large vehicles	AEBS for large vehicles	33	Between vehicles, single vehicle	Cars (10 or more occupants), trucks
	Front underrun protection for large vehicles (FUP)		Between vehicles (rear-end collision)	Trucks
Measures for pedestrians	Pedestrian protection	503	Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
	AEBS		Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
	Advanced headlamps		Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
Other safety measures	Lateral collision	100	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
	Rear-end underrun protection for large vehicles (RUP)	10	Between vehicles	Trucks
	FUP	71	Between vehicles (head-on collision)	Trucks
	Seatbelt reminders	9	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
	Auxiliary brake lamps	15	Between vehicles	Cars (including K cars), trucks (including K trucks)
	Anti-lock brakes (ABS)	4	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (10 or more occupants), trucks (including K trucks), PTWs
	Electronic static control (ESC)	65	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (including K cars)
	Electronic vehicle stability control (EVSC)	16	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (10 or more occupants), trucks (including K trucks)
	Lane departure warning (LDW) for large vehicles	3	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (10 or more occupants), trucks
	Rear view monitors (back cameras)	5	Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
	Lane departure warning /Lane departure prevention/Lane keeping assist (LDW/LDP/LKA)	60	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
	Pedal misapplication prevention systems (PMPS)	0*	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
	Total fatalities	1,332 people		

*The PMPS subject to the regulation are systems that prevent unintended sudden starting or acceleration after the acceleration pedal has been strongly misapplied. Their effect on the reduction of fatalities has so far been zero, but they are expected to reduce accidents by about 30%.

Figure 2-2-2 Ex-post evaluation of the effect of VSMs on the reduction of the number of fatalities (after fine-tuning calculation)

Chapter 3 VSMs in the Future

<The Eleventh Road Safety Master Plan>

The Eleventh Road Safety Master Plan, a government-wide plan established by the Central Road Safety Measure Council on March 29, 2021, sets the next target for road safety (which is to reduce the number of fatalities within 24 hours to 2,000 or less and the number of serious injuries to 22,000 or less by 2025, aiming to realize a safest road traffic in the world) from six perspectives and around eight pillars for VSMs. The six perspectives include those from the victims of accidents (i.e., (i) ensure the safety of the elderly and children and (ii) ensure the safety of pedestrians and bicyclists and help them develop their awareness of legal compliance), those from the parties at fault in the accidents (i.e., (ii) ensure the safety of pedestrians and bicyclists and help them develop their awareness of legal compliance), and those from a technological approach (i.e., (iv) promote the utilization of advanced technology). On the other hand, the eight pillars are each built in each field of safety measures and urges vehicle sides to improve safety measures such as (iv) ensure vehicle safety.

The Technology and Safety Working Group has studied future VSMs according to the Road Safety Master Plan as it was established as the government's across-the-board initiative. This time, too, the Group will promote measures as necessary in the field of vehicle safety, bearing in mind the purpose of the Eleventh Road Safety Master Plan and in coordination with measures in related fields such as lifesaving and emergency care in addition to the three elements of *people*, *roads*, and *vehicles*.

- Based on the Basic Act on the Road Safety Measures (Act No. 110 of 1970), the outline prescribes a comprehensive and long-term measures for road safety, etc.
- Period of the Plan: 2021 to 2025 (5 years)

The basic principles of the Plan

- Amid high expectations for a community that properly responds to issues posed by aging population and supports parenting families, we should present road safety measures that satisfy the essential needs of the times.
- Placing maximum priority on human life and keeping in mind the presence of victims of traffic accidents and a great social and economic loss we suffered from them, we seek a society free of traffic accidents. [Seeking a society free of traffic accidents]
- We need to ensure the safety of vulnerable road users such as the elderly, the disabled, and children. A society free of traffic accidents is one in which vulnerable road users can lead their lives with dignity and independently. Based on a road safety vision that puts *people first* before anything else, we will promote a variety of measures. [a road safety vision that puts people first before anything else]
- A society in which you can get around safe and secure, living your moments of life to the fullest in a symbiosis with everyone else regardless you are old or disabled. [develop a society in which you can get around safe and secure, no matter how old you get]

Road Traffic Safety

Objectives
(i) Reduce the annual number of fatalities within 24 hours to 2,000 or less (*)　　(*) Reduce the number of fatalities within 30 days to 2,400.
(ii) Reduce the number of serious injuries to 22,000 or less.

Perspectives:
1. Subjects to be addressed in priority to reduce victims to traffic accidents:
(i) Ensure safety of the elderly and children; (ii) Ensure the safety of pedestrians and bicyclists; (iii) Ensure safety of traffic on residential roads;
2. Subjects to be addressed in priority to develop an environment more immune to traffic accidents;
(i) Utilize and promote advanced technologies; (ii) Promote measures tailored to the realities of road traffic; (iii) Promote road safety measures involving all actors of the community;

Pillars:
(i) Develop the road traffic environment; (ii) Raise the public awareness of road safety; (iii) Ensure safe driving; (iv) Ensure vehicle safety; (v) Maintain order in road traffic; (vi) Enhance emergency and rescue services; (vii) Enhance the support to the victims' family; (viii) Enhance research and survey;

*In addition to those quoted above, the Plan addresses issues of railway traffic safety, level crossing safety, and marine and aviation traffic safety.

Figure 3-1-1 Overview of the Eleventh Road Safety Master Plan (Goals and Actions)

<Future Approach to Vehicle Safety>

The number of traffic fatalities has been on a downward trend in recent years, reaching a postwar low of 2,839 in 2020. However, to best reduce the social loss caused by traffic fatalities on one hand and considering the fact that there are still many accidents that cause serious injuries to victims, leave them permanently disable, and affect their daily lives on the other, it is essential to further reduce traffic accidents in the future. Further, accidents have been on the rise in recent years in which the victims were preschoolers, etc. or in which the party at fault was an elderly driver. This calls for our efforts to address such issues of tragic accidents that have received much attention in the social context such as declining birthrate and aging population.

Currently, drivers' human errors accounts for most of the causes of traffic accidents and theoretically can be eliminated by automated driving (AD), but it will take many years to make AD a daily reality and widely market it. On the other hand, ADAS have been installed in many new cars and their validity in reducing accidents have been already recognized. Further, the potential for safety measures utilizing vehicle technologies is expanding, as seen in efforts to encourage drivers to change their behaviors and help improve road safety using data recorded with onboard devices such as drive recorders. Therefore, to best reduce the number of tragic traffic accidents in the current driver-centered road traffic environment until the widespread use of AD technologies, we find it effective to actively utilize ADAS based on accident analysis. In addition to promoting the use of ADAS, it is important as well to ensure social acceptance of these technologies among pedestrians and other road users by helping them avoid overestimating and misunderstanding them, while teaching them how to use them the right way.

In light of the above, **to reduce traffic accidents in the short to medium term (3 to 5 years), we find it effective to take an approach that accelerates the development, commercialization, diffusion, and appropriate use of more advanced ADAS for situations of a high FSI risk.**

In parallel with these short- and medium-term approaches, it is also important to promote policies toward what we think is ideal vehicle safety in the long term. The Eleventh Road Safety Master Plan states that, placing the utmost priority on human life, its ultimate goal is to achieve the safest road traffic in the world, and to achieve a society without traffic accidents. Specifically, the report states that, based on the philosophy of road safety where people come first, it is necessary to promote various measures while actively taking in advanced technologies that contribute to ensuring road safety. In addition to the general idea of placing the utmost priority on human life, it is important as well to remember that a human life is never worth being lost in a traffic accident. To realize a traffic accident-free society, the ultimate goal of vehicle safety is to prevent the vehicle from causing an accident from its side, including those caused by driver error and avoiding accidents caused by other vehicles, etc. and to eliminate the risk of traffic accidents through vehicle technologies. This is the direction we should follow in the years to come.

On the other hand, some accidents, such as those caused by pedestrians suddenly jumping out in front of you from nowhere, are difficult to avoid even when driven by skilled drivers. For these accidents, it is estimated extremely difficult for the driver to reasonably predict the possibility of an accident occurring and to prevent such accidents, not only for vehicles equipped with ADAS but also for automated vehicles (AVs)[6]. Such problems cannot be solved through vehicle technology alone, but also in coordination with

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[6] The result of an accident analysis shows that, of all fatal and injury traffic accidents that occurred in Japan in 2018, 40% of the vehicles driven by the party at fault could not prevent the accident even if they were with certain ADAS and 10% of those vehicles could not, either, even if they were automated vehicle. (*Evaluation of the Effects of Automated Driving Systems and Advanced Driver Assistance Systems on the Reduction of Accidents,* Society of Automotive Engineers of Japan, Spring Meeting 2021).

other measures, such as the use of communication technology between vehicles, road infrastructure, and pedestrians, as well as the enhancement of awareness among road users of legal compliance.

Furthermore, it should be clearly noted that measures through vehicle technologies have their limitations, and, even when they are feasible, they may not be effective in all circumstances.

Based on the above, **as a long-term perspective on vehicle safety, we set an ambitious goal aiming at reducing fatal accidents caused by newly introduced vehicles on the market to zero by around 2035, to the extent that such reduction is possible through vehicle technologies**.

In doing so, it is important to expand the range of accidents that can be addressed through vehicle technologies, not only through vehicle technologies alone, but also through collaboration with other measures, such as communication technology (V2X) between vehicles, road traffic infrastructure, and pedestrians. Furthermore, for accidents that are difficult to respond to even using AD technologies, etc., and for accidents presumably unavoidable, such as when involved in an accident caused by other vehicles, measures to mitigate the damage caused by such accidents are necessary.
Therefore, it is necessary to take measures to increase the life-saving rate by further upgrading vehicle occupant protection technology and introducing vehicles capable of making a quick and accurate automatic emergency notification after an accident. At the same time, it is important to consider measures not only for new vehicles but also for in-use vehicles by the use of retrofit devices.

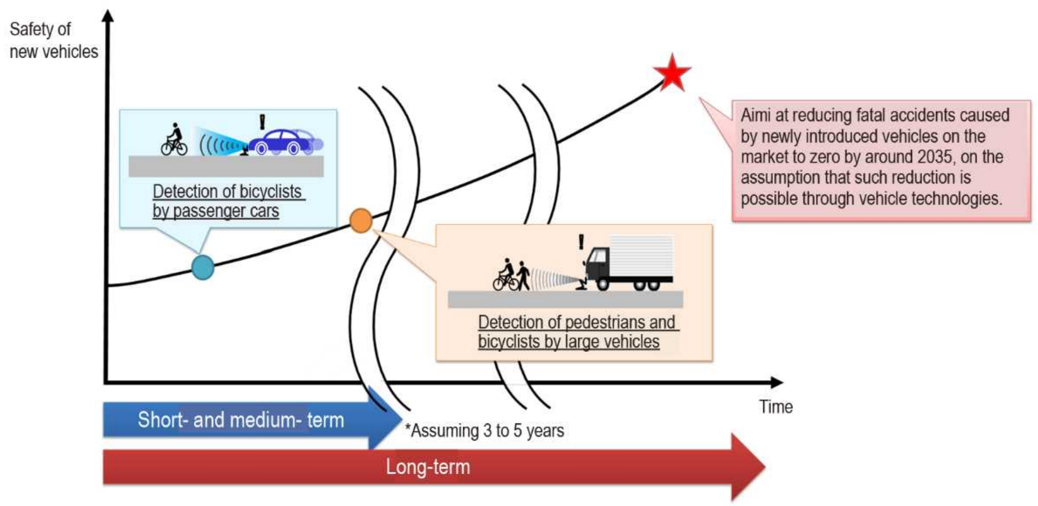

Figure 3-1-2 Conceptual image of vehicle safety in the future

<Setting priority issues for future VSMs>

This report aims to contribute to the realization of the world's safest road traffic by presenting strategic and systematic measures for the future in the field of vehicle safety, with a view to further reducing the number of traffic fatalities, etc. in the short and medium term, while keeping in mind the long-term perspective described above.

Specifically, we will prevent possible accidents and mitigate damage while considering changes in the composition of population due to the declining birthrate and aging population as well as the development and evolution of technology. Thus we will be required to take the following measures:

measures to protect vulnerable road users, such as pedestrians, bicyclists, who account for a large percentage of fatalities; measures to protect vulnerable occupants such as the elderly and children, whose human tissues are delicate and who are at high FSI risk; response to accidents caused by elder drivers who are at a high risk of accidents from operational error or health problems, or accidents in which the driver becomes the party at fault after violating law. Further, considering that the use of driver-centered ADAS will be the main measure for the time being, it is essential to promote advanced VSMs ahead of the rest of the world by making the transition to an AD society in a safe and strategic manner in cooperation with industry, academia, and government.

Moreover, to ensure the implementation of future VSMs, it is important that various stakeholders in industry, academia, and government (experts in preventive and collision safety and other related areas) clearly understand the nature of those measures and develop and compile them in such a manner that inspires people to take action and put the measures in place. In addition, it is important also not to forget cost-effectiveness and cost-benefit aspects so that we can effectively invest limited human and financial resources and maximize social benefits, including those of business operators and motorists, and all this while understanding that R&D time necessary for commercialization and dissemination of individual technologies varies from a safety measure to another.

Based on the above perspectives, we define the following priority areas for future VSMs to be promoted in the short and medium term.

Priority measures:

(1) **Ensure the safety of pedestrians, bicyclists, and other users**
Perspective: Aim at mitigating and reducing damage to vulnerable road users.

(2) **Ensure the safety of vehicle occupants**
Perspective: Aim at mitigating and reducing damage to vehicle occupants including children.

(3) **Prevent certain types of serious accidents in light of social background**
Perspective: Aim at mitigating and reducing damage to the victims of certain types of accidents to which a quick response is necessary from the social context.

(4) **Promote the effective and appropriate use of AD-related technologies**
Perspective: Aim at effectively using and promoting advanced technologies necessary to achieve the measures (1) to (3)

Section 1 Ensuring the Safety of Pedestrians, Bicyclists, and Other Users

1. Ensuring the safety of pedestrians

Pedestrians, including wheelchair users, are the most vulnerable of all road users, compared to other forms of mobility from vehicles to bicyclists. In an aging society with a declining birthrate, it is essential to prevent pedestrians, in particular children, who are the future of society but unable yet to protect themselves. Further, considering that an increasing percentage of elderly people are having accidents while walking and that many people now get around on various means of personal mobility such as electric wheelchairs, it is important, to further reduce the number of FSI, that safety measures take into account these various types of vulnerable road users.

The majority of fatal accidents involving pedestrians is those in which a pedestrian crossing the road collide with a vehicle. In this accident type, it has been confirmed that pedestrians often violate law by crossing the road immediately in front of or behind a vehicle, outside a crosswalk, etc. Therefore, further efforts are necessary to induce legal compliance among pedestrians. On the other hand, on the vehicle side, one of the factors contributing to accidents is the driver's delay in spotting them and most accidents resulting in pedestrian fatalities occurred at night while the car is travelling straight ahead. Therefore, the key to VSMs in the future will be to detect pedestrians as early as possible, including at night, and avoid collisions. Even when a collision proves unavoidable, how to reduce the collision speed is the key to the reduction of the degree of FSI.

To create a road traffic environment where pedestrians can move around safely and securely, we should, on one hand, take measures to let pedestrians know how important road safety is and, on the other hand, further develop ADAS technologies so they can deal with incidents in various situations such as nighttime, bad weather such as rain and snow, people sudden crossings or lying on the road. Furthermore, considering that the percentage of pedestrian fatalities is much higher in Japan than in advanced countries in Europe and North America, Japan needs to promote, ahead of other countries, VSMs that help ensure the safety of pedestrians.

Future measures:
○ **Promoting the sophistication and widespread use of AEBS for pedestrians on passenger cars, etc.**

About 70% of fatal accidents involving pedestrians occur at night. Current NCAP includes an evaluation of AEBS performance at night (with/without streetlights), thereby promoting AEBS through competition among vehicle manufacturers in technological development and the publication of performance evaluation results to motorists. To further reduce the number of FSI in traffic accidents, we should accelerate the improvement of nighttime detection technology and implement it in more vehicle models, while considering the enhancement of the safety regulation for AEBS, which are already made mandatory, so they work also at night.

Furthermore, the safety regulation for AEBS for pedestrians, which will be made mandatory in phases from November 2021 ahead of other countries, uses a six-year-old child dummy (of 115 cm in height) for testing. In the future, as we fully enter the aging society with fewer children, it will be necessary for the government to sophisticate detection technology so vehicles can have pedestrians, including preschoolers and wheelchair users, in their range of detection.

○ **Enhancing the performance of and spreading the use of AEBS for pedestrians in large vehicles**

For large vehicles such as trucks, which shows a high mortality rate in accidents, the FSI risk for pedestrians is particularly high when involving pedestrians, so we should give top priority to measures to ensure safety of pedestrians. In light of the characteristics of large vehicles, consideration should be given to the enhancement of the Safety Regulations for AEBS for large vehicles so that the regulation includes pedestrians and that the element technology developed for passenger cars, for which AEBS for pedestrians has already been made mandatory, can be applied and implemented as soon as possible.

○ **Improving detection, warning, and braking technologies for vehicles to protect pedestrians at junctions and other situations of high accident risk**

Pedestrian fatalities occur most frequently when, while crossing a road, they collide with a vehicle travelling straight ahead. The next most common situation is when the vehicle turns right at an intersection and hits a pedestrian walking the crosswalk ahead, followed by when the vehicle turns left in the same situation. In general, when a vehicle turns right, the driver is often distracted by the traffic signal, checking for oncoming traffic, etc. and fails to identify a pedestrian walking the crosswalk ahead. To prevent such accidents, it is essential to improve technologies for detecting pedestrians, etc. when turning right at intersections, where the risk of accident is particularly high, and accelerate the implementation of such technologies.

Further, in avoiding collisions with a pedestrian at junctions of poor visibility or with people lying on the road, technologies have their limits and we cannot expect vehicles to find them on their own. We should hence keep making long-term effort to explore ways to prevent such accidents such as coordination between vehicles and infrastructure and communications between vehicles and pedestrians.

○ **Expanding and promoting the use of advanced headlamps that improve visibility of pedestrians at night**

Drivers often face road traffic environments of poor visibility such as nighttime, rain, and bends. Further, some accidents occur when the driver was dazzled by the headlamps of oncoming and following vehicles and found a pedestrian too late. It is important to ensure good visibility and conspicuity for all road users, including pedestrians, so it is essential to keep expanding the use of advanced headlamps, such as automatic high beams (AHB) and adaptive driving beams (ADB) and promoting the use of *SuppoCar S* (Wide) fitted with such lights.

It is also important to ensure the visibility for drivers at twilight zone, when accidents tend to occur more often. In addition to making it mandatory to automatically turn on the headlamps (automatic lighting), which has already started in phases, the government should consider enhancing the Safety Regulations for auto-leveling systems that automatically prevent the cutoff line from turning upward when the vehicle body tilts for loading or other reasons. Further, since we need to ensure the visibility of vehicles for pedestrians, too, we should take measures such as promoting the installation of daytime running lights (DRLs).

In addition, it is said that elderly people tend to feel dazzled more easily as the lens of their eyes become cloudy with age. As the number of elderly drivers will increase in the future, we need to continue research on the effects of aging on glare to ensure the elderly appropriate visibility and consider long term measures based on the research results.

○ **Enhancing measures to protect pedestrian's head and legs upon a collision**

In addition to preventive safety measures such as AEBS, measures to mitigate damage to pedestrians upon a collision with a vehicle. Since the head and face remain the primary site of injury in fatal accidents with pedestrians, consideration should be given to enhancing the safety standards by extending the pedestrian head protection area to the front windshield and thus reducing the risk of injury. Another possible solution is a measure to mitigate the impact of pedestrian airbags, but we need to improve head and face protection technologies while carefully assessing their effectiveness in actual accidents, including the risk of head injury upon a collision with the ground.

At the same time, it is important to take measures to reduce the risk of inflicting serious injuries to pedestrians. In general, a collision with a car is said to often leave serious injury to the pedestrian's legs, sometimes as permanent disability. Further research hence should be conducted to develop pedestrian leg protection technology.

○ **Enhancing safety standards to ensure fields of vision, etc. effective in preventing accidents with pedestrians, etc. in close proximity**

Residential roads, parking lots, etc. are places where pedestrians and motor vehicles circulate side-by-side in road spaces. In such places, drivers are strictly required to respect traffic regulations, such as speed limits and pause before junctions, as well as to prevent maneuvering and other human errors. It will be hence effective to support drivers with ADAS in detecting speed limits and stop signs and preventing sudden starting after possible pedal misapplication. On the other hand, it is also important to ensure a good field of vision for the driver so they can identify any pedestrians or children there are, either by themselves or through systems. Therefore, consideration should be given to enhancing safety standard to ensure good field of vision for the driver around and behind the vehicle or detection of any obstacle therein.

2. Ensuring the safety of bicyclists, etc.

In Japan, aside pedestrians, bicyclists also account for a high percentage of FSI. Of all fatal accidents involving bicyclists, they were in violation of law in about 80% and the head or face were the primary site of injury in about 60%. Therefore, in our efforts to prevent accidents and reduce the damage involving bicyclists, we must continue heightening their awareness of legal compliance and of the importance of wear helmets. At the same time, it is also important to take measures on the vehicle side to reduce the number of accidents with bicyclists, including rear-end collisions, where the mortality rate is overwhelmingly high, or collisions at junctions, which are most frequent, since there are many legal violations on the part of motorists, too, such as delay in spotting bicyclists.

With recent technological advances, demand for personal mobility devices such as electric kickboards is expected to increase. In addition, demand for commuting and delivery by bicycle is increasing under the influence of Covid-19, changes in people's lifestyles, and the spread of sharing services. Thus, to prevent traffic accidents involving bicyclists, etc., which are expected to increase, it is necessary to create a road traffic environment that separates bicycles, etc. and vehicles and to consider measures to ensure safety from the vehicle side.

Future measures:

○ **Sophisticating and spreading the use of AEBS for bicyclists in passenger cars, etc.**

To reduce the number of FSI of bicyclists, we need to enhance measures particularly against rear-end collisions and collisions at junctions. Compared to pedestrians, bicycles have characteristics of being fast in crossing the road and traveling aside vehicles. Considering these characteristics as well as the spreads of AEBS for bicyclists that are expected to detect bicyclists early, avoid collisions, and thus reduce damage to bicyclists, the government should consider enhancing the performance of those ABES by introducing them into NCAP assessment while enhancing the Safety Regulations with this regard, too.

In addition to bicycles, the use of electric kickboards and other mobility devices is expected to increase as people's lifestyles change with the Covid-19 pandemic, the cost of those mobility decreases through mass production, and diversify means of mobility in the road traffic environment. For new means of mobility such as electric kickboards, discussions are underway on how their traffic rules should be. In addition to understanding their operating characteristics and patterns in traffic flow, we should work on improving detection technologies to protect the users of diversifying new means of mobility.

○ **Enhancing the performance and promoting the widespread use of AEBS for bicycles in large vehicles**

Measures against accidents with bicyclists are also important for trucks and other large vehicles, which have a high mortality rate when involved in accidents. For large vehicles, which have more blind spots especially when turning left due to their structure, we have so far taken such physical measures as rear-view mirrors, lights, and side guards. We find it appropriate now to upgrade our measures by making lateral collision warning (LCW) systems that detect bicyclists and alert the driver mandatory for all new vehicles by May 2024 ahead of other countries.

Meanwhile, there are still many accidents with bicyclists caused by large vehicles. Some manufacturers have already installed AEBS for bicycles in some large vehicles. It is necessary to improve the performance and promote the widespread of those AEBS, while considering the enhancement of part of the Safety Regulation for AEBS on large vehicles so they work with bicyclists, too.

○ **Improving technologies to detect, give alert, and brake when bicycles, etc. approach in high-risk situations**

Motor vehicles have their limits in detecting bicyclists on their own, considering that bicyclists travel relatively fast, move often irregularly, and are prone to collisions at junctions with poor visibility. Therefore, in the long term, consideration should be given to measures to prevent accidents involving bicyclists by coordinating bicycles and motor vehicles through communication infrastructure technology.

In accidents between PTWs and motor vehicles, the most common accident types are collisions at junctions and in particular collisions between a vehicle turning right and a PTW passing through the junction. For four-wheeled vehicles, detecting PTWs and judging distance, etc. is said to be technically more difficult than pedestrians or bicyclists because they move much faster and look much smaller as a detection target from a distance. To deal with these accidents, we should develop AEBS by improving technologies to detect PTWs on the vehicle side, while, in the long term, considering developing safety measures using communications technologies.

○ **Promoting VSMs to ensure the safety of occupants of various means of mobility**

In recent years, a variety of means of mobility, such as electric kickboards, onboard micro mobility, and automated delivery robots, have been available for use as new means of mobility and transport for people. The NPA is currently studying traffic rules for various types of mobility with experts. In the future, we should study issues of how we can ensure the visibility of various means of mobility, what kind of safety devices are necessary, etc., taking into account the results of the study of traffic laws, usage and needs of such mobility and cooperating with relevant ministries and agencies.

Section 2 Ensuring the Safety of Vehicle Occupants

1. Ensuring the safety of children

In a society with a declining birthrate and an aging population, ensuring the safety of children is a top priority. Children are the future of the nation and we can't afford losing their lives in traffic accidents. In particular, the majority of fatal and injury accidents involving preschoolers occur while they are *vehicle occupants.* It is difficult for this age group to protect themselves, and there are still many cases where CRS are misused or simply not used. To reduce the number of and mitigate accidents involving children in a vehicle, it is necessary for parents to ensure the safety of their children on one hand and for society as a whole to increase its awareness of road safety on the other. Combining these efforts on two fronts, we should develop and deploy VSMs that help realize a road traffic environment where children travel safely and securely.

The percentage is also increasing for school-age children involved in traffic accidents while in cars, where the misuse or non-use of booster seats is still common. With this in mind, we should deploy VSMs aiming to improve the substantive performance in occupant protection and enhance the public awareness of road safety while promoting the spread and proper use of booster seats, etc.

Future measures:
○ **Developing and promoting CRS, etc. that are highly safe and usable**

Most of the CRS currently sold and used in the market comply with UN Regulation No. 44. To further improve their safety performance, however, it is essential to improve the performance of products to be introduced in the market. In the future, we need to develop technology that conforms to the UNR 129, which has enhanced the requirements for shock absorption performance in the event of a side collision and promote the introduction of products that conform to its safety standards.

Meanwhile, there are still many cases of misuse by motorists, who insufficiently tighten the waist belt when installing the device and not properly fastened the harness when seating the child. At present, about half of the all CRS on the market are ISO-FIX compatible products[7], but to reduce the occurrence of misuse itself, including booster seats, we need to further increase the percentage of sales of ISO-FIX compatible products that have better usability.

Further, considering that there are cases where low-priced CRS, etc. are sold on the Internet, etc. that do not meet the safety standards, we need to continue our efforts to eliminate those non-compliant products from the market. It is also important to improve the safety and usability of CRS through NCAP and to promote the spread of safer and more usable CRS by providing motorists with relevant information.

○ **Promoting the proper use of CRS, etc.**
Since 2000, it has been made mandatory to put children age 6 or less in CRS, but there are surveys that, even today, about 30% of children aren't and if they are, in many cases not in a right way, with the waist belt not firmly fastened, etc. In addition, there are many cases of misuse or non-use of booster seats observed among fast-growing children age 6 or above. In light of this, to reduce the number of

[7] Based on 2020 shipments by the members of the Japan Auto Parts Industries Association (JAPIA).

unused and misused CRS and booster seats, we will promote the spread of ISO-FIX and i-size compatible devices by conducting usability tests as part of NCAP and increase the awareness of road safety and the proper use of CRS and booster seats among the nation, including motorists.

○ **Enhancing information provision tailored to motorists' needs**

So far it was various industries such as car manufacturers, car dealers, and parts manufacturers who provided information on the safety and usage of CRS and booster seats. On the other hand, necessary information constantly changes according to the growth stage of children and presumably there has not been much information provided to satisfy such needs. We should hence explore ways to spread information to promote the proper use of CRS, etc. tailored to motorists' needs.

2. Ensuring the safety of the elderly, etc.

Currently, people aged 65 or above account for 60 or so percent of all traffic accident fatalities. Since the strength of human tissues generally decreases with age, the FSI risk increases for the elderly when involved in traffic accidents. It has also been confirmed that, for car occupants killed or injured, the sites of their damage shift more and more from the head and face to the chest as their age goes up. Thus, in developing road safety measures to protect vehicle occupants, it is essential to take into account the characteristics of elderly people, such as the decline in the strength of human tissues.

Future measures:
○ **Improving occupant protection performance for the elderly, etc.**

Among the elderly, the percentage of fatalities from chest injuries in collisions is on the rise. To reduce the FSI risk of elderly occupants from chest injuries upon collision, it is appropriate to develop safety standards that enhance requirements for chest injury values (chest deflection) in frontal collisions of cars and trucks and enhance occupant protection performance of vehicles by applying such standards starting with new vehicles.

3. Upgrading occupant protection measures

To further reduce the number of fatalities and injuries in traffic accidents in the future, we need not only to improve conventional collision safety technologies, but also to explore the possibility of improving occupant protection from a new perspective. At present, collision safety tests are conducted in the representative forms of full-lap, offset, and side impact collisions, but, considering that actual collisions are occurring under a variety of conditions, it is vital to explore ideal forms of collision tests and introduce them into NCAP, etc. in phases.

In addition, approximately 60% of all traffic accident injuries occur while the victim is in a car, and of these, one of the most common accident types is a rear-end collision. To reduce the number of fatalities and injuries among elder and other vehicle occupants in the future, it will be essential on the one hand to utilize preventive safety devices and avoid rear-end collisions with AEBS, lane departure with LDW, etc. and, on the other hand, to take further occupant protection measures, including impact mitigation and post-crash measures.

In the future, it is expected that AVs driven by systems will gradually spread. For passenger cars, an automated car of level-3 has already been launched onto the market. It is expected that the occupants' seating positions will change drastically as they get relaxed under AD. Demonstration tests on level-4 mobility services are being conducted across the country. We assume that some of these AVs will be used for services such as mobile offices in the future. Hence it is also necessary to study how to protect occupants in such a variety of ways AVs may be used.

Future measures:

○ **Improving occupant protection performance upon a collision through NCAP and enhancing safety standards**

Most of the actual collisions are between vehicles of different sizes and weights, so it is important to evaluate collision safety also from the perspective of to what extent the vehicle damages the other vehicle in a collision.
In the future, it is important to consider, as part of NCAP, evaluating collision safety using MPDB (Mobile Progressive Deformable Barrier) from the viewpoint of to what extent the vehicle damages the other vehicle upon a collision.

One of the most common forms of accidents between vehicles is rear-end collisions. To reduce the number of accidents resulting in serious injuries, including permanent disabilities caused by whiplash, it is essential to enhance measures through technological improvements of seat frame structures, etc. To reduce the number of accidents resulting in FSI due to neck injuries, we need to enhance safety standards on headrests.

○ **Promoting research on occupant protection measures based on actual collisions**

The ways vehicles actually collide with each other differ from the ways they are supposed to in legally prescribed test conditions (full-lap test, offset test, etc.). Specifically, in addition to the fact that vehicles actually collide with each other at various collision angles, as seen when turning right at an intersection or in a small-overlap collision, the size and weight of the vehicle is different between the two vehicles. Furthermore, attention should be paid to occupants' behavior during the collision. For example, in cases where the driver was driving with his/her seat pushed too forward or sitting on the edge of the seat, where occupants' behavior immediately before the collision greatly differed from what is supposed in legally prescribed test conditions because AEBS had worked and the vehicle had suddenly slowed down, or where the driver was unable to take the right position for safe driving, etc., the vehicle's occupant protection performance may be negatively affected by such factors as steering interference, airbag deployment, etc. Therefore, over the long term, consideration should be given to exploring how we can ideally revise safety standards by studying how we can ensure occupant protection based on various seat positions the driver may possibly take, the ways accidents have actually occurred, etc.

○ **Promoting research on mechanisms by which occupant get injured through collaboration between medicine and engineering**

It is important to, based on engineering and medical data gathered from actual collisions, verify the ways collisions occurred from the viewpoint of the mechanism by which human injury occurs. It is necessary, on one hand, to continue research in the future on occupant injury mechanisms in collisions and, on the other hand, to verify the effects of automatic collision notification systems currently being widespread through the collection and analysis of data on actual traffic accidents in which they activated.

○ **Promoting research on occupant protection for AVs**

In the future, as the area of use expands for AVs, we assume that the ways people want to use their seats will be diversified, using them constantly reclined, turning them backward, etc. Generally, it has been said that using a seat reclined presents a certain risk for the occupant, because the seatbelt then isn't properly applied to their pelvis and shoulders. Meanwhile, AVs will be used not only to get around the neighborhood, but for a wide variety of other purposes as well, such as home or office you can get around with, as a *movable immovable*, so to speak. In view of these diversifying needs, study should be done in the long term on how safety measures and standards on AVs should be on these issues by surveying, through international collaboration, how we can best protect occupants in AVs.

Section 3 Preventing Certain Types of Serious Accidents in Light of Social Background

1. Preventing accidents caused by elderly drivers, etc. for operating errors or incapacity.

A relatively large number of fatal accidents involving elderly drivers are caused for driving errors, such as wrong steering or pedal misapplication. With the number of elderly drivers in the public transportation and distribution sectors assumed to increase in the future, there is concern that the number of accidents will increase. To deal with this problem, it is essential to combine two types of initiatives: the first is efforts under the revised Road Traffic Act that requires drivers aged 75 or above with certain violation record to take a driving skills test (on actual vehicle) and the second is measures that prevent their driving errors based on studies on elder drivers' driving behavioral patterns, such as what triggers their errors, and measures that encourage elderly drivers to change their driving behavior based on AI and other data analysis, etc. We also need to improve technologies to detect driving errors per se and to take measures to reduce the damage caused by accidents.

Meanwhile, we need to renew our response to traffic accidents caused by health-related factors (epilepsy, heart attack, cerebrovascular disorders, etc.), which we currently see 200 to 300 times per year, because the population keep aging further. To prevent accidents caused by health-related factors of drivers of commercial vehicles, we request employers to help them improve their working practice, i.e., regular health check, pre- boarding health check, etc.
Since the above practice obviously do not prevent all health-related accidents, and it is difficult to impose such practice to private vehicles, it is necessary also to take measures on the vehicle (physical) side from both a preventive and post-accident perspective.

Future measures:
○ **Improving technologies and spreading devices that help prevent accidents caused for driving errors**

Most of the pedal misapplication prevention systems currently used widely in new and in-use vehicles are designed to detect wrong operation at low speed ranges, such as in parking lots, by detecting obstacles in front and behind using sonars, etc. Meanwhile, recently there has been technologies being implemented that use AI, etc. to monitor driving behaviors and determine whether there is steering or pedal misapplication errors. Therefore, while promoting further spread of pedal misapplication prevention systems, consideration should be given, on one hand, to promoting the spread of devices that prevent sudden acceleration after pedal misapplication on local roads, too, and, on the other hand, to developing and enhancing safety standards to that effect.

○ **Promoting the spread of EDSS**

To respond to the driver's sudden incapacity, etc. of continue driving, Japan established a guideline for Emergency Driving Stop Systems for the first time in the world in 2016. EDSS are devices that detect the driver's incapacity, etc. and stop the vehicle safely. The basic, push-button, simple stop type system is now being installed as standard equipment mainly in large buses that carry many passengers and may cause a lot of damage once involved in an accident. Efforts should be made in the years to come to improve the accuracy of detection, reduce the cost, etc. in judging the driver's incapacity to accelerate their implementation of those systems, especially in buses and cabs, while considering the development and establishment of safety standards.

Meanwhile, in promoting the spread of EDSS, it is essential to increase their social acceptance so that the system does not negatively affect other road traffic users when it is activated.

○ **Helping drivers changes their behaviors by promoting video drive recorders, etc.**

Under the Road Traffic Act, drivers are held responsible for driving safely and, therefore, held liable for any accident they cause while driving. Meanwhile, in ensuring the safety of elderly drivers, it is essential not only to help them take care of themselves, but also for their family and community to help them drive safely in the spirit of mutual aid. For example, a monitoring service is being studied in which a video drive recorder watches over elderly drivers, have artificial intelligence analyze their driving patterns and characteristics, and use the results to help them improve their driving behaviors and prevent accidents. This way, it is necessary to consider developing preventive measures that help elderly drivers change their behaviors by utilizing data recorded by onboard devices, etc.

○ **Promoting research on the driving patterns, etc. of elderly drivers**

At present, approximately 30% of the parties at fault in the traffic fatalities are people aged 65 or above. In particular, among the parties at fault in accidents involving driving errors such as improper steering and pedal misapplication, the percentage of drivers aged 75 or above is significantly higher than that of those under 75. It is generally believed that motor and cognitive abilities among humans decline as they get older, but the causal relationship between this and the causes of accidents presumably more common among elderly drivers has not been clarified. Since the number of elderly drivers is expected to increase in the future in our aging society, we should promote research on the driving characteristics of elderly drivers ahead of other countries through collaboration between medicine and engineering experts, and consider developing measures from the vehicle side.

2. Preventing dangerous driving

Looking at a smartphone, etc. while driving is an extremely dangerous act leading to distraction and accidents, but there are still no end to this kind of accidents. To prevent such driving behavior, it is important to raise awareness of road safety rules among drivers, such as giving priority to pedestrians and observing speed limits. So far, these activities have taken the form of road safety education and campaigns to raise public awareness by the national government, local public authorities, and relevant organizations. Meanwhile, advancement in motor vehicle technology has made it possible for vehicles to detect everything from the status of surrounding traffic to the driver's driving behavior. We find it possible that, by utilizing such detection technology and alerting the driver to the danger of such behavior as watching at a smartphone, to help drivers drive safely and reduce the risk of ending up the party at fault harming other people in the event of an accident. To inspire drivers to legal compliance from the vehicle, too, we need technological assistance such as information alerts, warnings, and braking control from the vehicle side that help drivers observe speed limits, stop at stop signs on residential streets, etc. which so far has been difficult from the vehicle side, while paying attention to acceptability among drivers.

In addition to dangerous driving behaviors, it is important to take measures to reduce the risk of harm to the other vehicle *after* a collision, through measures such as test evaluation by the MPDB[8] that takes into account the risk of harm to the other vehicle.

So-called tailgating and other types of dangerous driving is an extremely malicious driving behavior that can lead to serious accidents. To deal with such an abnormal driving behavior and resulting accidents, it is necessary on one hand to impose strict penalties as provided in the revised Road Traffic Act (enacted in June 2020) and the revised Act on Punishment for Acts of Harming People by Driving a Car[9] (enacted in July 2020), while, on the other hand, keeping promoting the use of video drive recorders to record accidents and provide evidence on the vehicle side.

Future measures:

○ **Promoting the spread of alerts to speed limits and other road signs, etc.**

To reduce the FSI risk in traffic accidents, it is essential to curb violations of law, such as excess speeds, and to encourage drivers to always drive safely. What is vital for this purpose is to raise awareness of road safety among drivers through educational campaigns, traffic control, etc. A device that detects road signs such as speed limits, stop signs, and wrong way signs and alert drivers deems to be one of the valid measures that are available on the vehicle side and now spreading in passenger cars. In the future, we will need to <u>spread these devices that alert drivers to road signs, etc.</u> by letting drivers know road sign detection technology and their validity, etc., while <u>improving the social acceptance of these devices</u>.

○ **Promoting the commercialization of ISA**

In addition to the promotion and spread of road sign alerting devices, etc., another way to inspire drivers to more readily observe speed limits is to spread and implement devices that automatically control the vehicle speed when it exceeds prescribed speed limits. Regarding intelligent speed adaptation devices (ISAs) that curb excessive speeds from the driver's distraction, etc., we established guidelines in December 2019, but there remain issues to be resolved in terms of technical issues and social acceptability. In the future, <u>consideration should be given to the early commercialization of ISA by limiting the zone of usage to residential roads (e.g., Zone 30) to improve social acceptability</u>.

○ **Promoting analysis and preventive measures through the use of onboard devices**

Under the Road Traffic Act, drivers are held responsible for driving safely and, therefore, held liable for any accident they cause while driving. Meanwhile, in ensuring the safety of elderly drivers, it is essential not only to help them take care of themselves, but also for their family and community to help them drive safely in the spirit of mutual aid. For example, a monitoring service is available in which a video drive recorder watches over elderly drivers, have artificial intelligence analyze their driving patterns and characteristics, and use the results to help them improve their driving behaviors and prevent accidents. This way, it is necessary to <u>promote preventive measures that help elderly drivers change their behaviors by utilizing data recorded by onboard devices</u>. [Reminder]

○ **Promoting the spread and proper use of video drive recorders, etc., as a measure against tailgating harassment**

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[8] Mobile Progressive Deformable Barrier.

[9] The Act on Punishment of Acts Inflicting Death or Injury on Others by Driving a Motor Vehicle, etc. (Act No. 86 of 2013).

Recording devices such as video drive recorders have a variety of usages, not only in raising the driver's safety awareness but also in deterring other road users from tailgating by clearly telling them the vehicle is so equipped, and in using the record as evidence in the event of a traffic accident. Meanwhile, there are points to keep in mind when using those video drive recorders, such as making sure that the SD card is not defective and won't fail to record, that the recorder is mounted an appropriate position so it does not block the fields of vision prescribed by the Safety Regulation. We should continue promoting the proper use of video drive recorders, which are expected to have a deterrent effect on tailgating, etc. through educational presentations with videos, etc., while promote their installation in vehicles.

In addition, a private sector service that uses an automatic collision notification device to provide an emergency notification to the police when a driver is in imminent danger, such as tailgating, is currently available. It is desirable to promote the spread of such private sector services.

3. Preventing accidents involving large vehicles

Large vehicles, which play an important role in logistics, public transportation, and other transportation services, are indispensable to modern society. On the other hand, run on a huge amount of kinetic energy, they show a relatively higher mortality rate once involved in a collision and gives a large impact on society. This is why the government needs to enhance its measures for operators of commercial vehicles so they enhance their operation management based on *the Comprehensive Commercial Vehicles Safety Plan 2025*. The safety measures for large vehicles should be promoted in parallel with their operation management like two wheels of a cart.

With regard to the safety measures for large vehicles, measures should be taken, in addition to continued promotion of seatbelt use in large buses, to prevent accidents or reduce damage by assisting drivers with advanced driver assistance systems (ADAS). Further, considering that the shortage and aging of drivers of commercial vehicles are becoming increasingly serious, it is vital to take measures to prevent accidents caused by drivers' fatigue and health conditions. Moreover, along with the moves of digital transformation (DX) that transport companies undergo, it is important that the government studies measures that could transform the driver's driving behavior by utilizing digital data collected from the vehicle side, such as the driver's driving behavior and characteristics.

On the other hand, many bus and truck operators are small and medium-sized companies and are not only facing rising vehicle prices but, amid Covid-19 pandemic, having difficulty purchasing new vehicles with safer equipment. As the average age of vehicles is expected to increase gradually in the future, it is important to maintain policies to promote the replacement of vehicles while implementing safety measures for in-use vehicles.

Future measures:
○ **Enhancing the performance and promote the spread of AEBS for pedestrians in large vehicles**

For large vehicles such as trucks, which have a high mortality rate in accidents, we should consider, in view of international discussions, expanding and enhancing the part of the Safety Regulations on AEBS for vehicles, pedestrians, and bicyclists, while continuing activities for the harmonization of international regulations at WP.29 [Reminder].

○ **Accelerating the compulsory installation of systems to detect and warn against pedestrians and vehicles in blind spots for situations of high accident risks**

Large vehicles have the characteristics, for their own structure, of having more blind spots than passenger cars and running often at different speeds from passenger cars when traveling on expressways. This is why they often have accidents involving pedestrians when turning right or left at junctions and get rear-ended while changing lanes by vehicles coming from diagonally behind on expressways, etc. Therefore, we need to develop and implement ADAS for large vehicles for such situations of high accident risk. In the future, in addition to technologies for those vehicles to detect and alert to pedestrians and bicyclists when turning left at junctions, we should improve, on one hand, the same technologies for when turning right as well as technologies to detect and alert to vehicles from behind while changing lanes, each of which being a situation of a particularly high accident risk, while, on the other hand, promoting the spread of those devices in large vehicles to reduce the number of accidents caused by large vehicles.

○ **Enhancing safety standards to ensure fields of vision that enable drivers to prevent accidents involving pedestrians, etc. in close proximity**

To ensure safety on residential roads and in parking lots, etc., consideration should be given to the development and enhancement of safety standards to ensure the driver backward field of vision and for devices to detect pedestrians, etc. in close proximity. [Reminder]

Further, consideration should be given to the introduction and enhancement of safety standards for reverse warning sounds, taking into account how appropriate ways to give audible warning to road users should be.

○ **Ensuring the safety of the crew and passengers of large buses**

Large buses are required to protect their crew and passengers in case of emergency braking and accidents. In particular, there yet remains a challenge of getting all passengers to wear seatbelts. Therefore, it is essential to explore and promote measures to help increase the ratio of passengers wearing seatbelts, such as considering safety standards to expand the provision of seatbelt reminders for passengers.

○ **Ensuring the safety and security of passengers on local buses**

As a public transportation system, it is essential to ensure the safety and security of various types of passengers, including the elderly and physically disabled. To cope with the risk of accidents such as passengers falling onboard, it is necessary to promote measures such as the use of advanced devices that enable the driver to easily grasp how passengers are seated or moving onboard. Further, the safety and security of passengers should be ensured through detailed accident analysis to identify accident risks, consideration of vehicle mechanisms that reduce impact and sudden acceleration at the time of departure, further improvement of the vehicle to make it more barrier-free, etc.

○ **Promoting the replacement of in-use vehicles with vehicles equipped with advanced safety technologies**

For large vehicles, a vital factor of transportation and distribution infrastructure, it is essential to control the risk of aging vehicles. However, most of the bus and truck operators are small and medium-sized companies. With rising vehicle prices, purchasing new vehicles is a big challenge for them. Therefore, consideration should be given to promoting further replacement of existing vehicles with new vehicles with ADAS technologies.

Section 4 Promoting the Effective and Appropriate Use of AD-Related Technologies

1. Accelerating the installation and improving the performance of ADAS, etc.

In the future, it is expected that technologies for AVs controlled by a system will be developed and implemented, but it will take some time until AVs will widely spread. Meanwhile, majority of vehicles will be driven by human drivers. Hence, to reduce traffic accidents in the short and medium term, it is essential to promote the development, commercialization, and widespread and proper use of more advanced ADAS technologies that operate under the driver's responsibility.

To ensure further road safety that will help reduce the number of traffic FSI, we need to give quick response to improve the performance of AEBS, which have proved highly effective in reducing accidents, and to develop and expand the use of ADAS that effectively work in situations of high accident risk, while taking into account the cost burden and the acceptability among drivers. In this regard, Japan should aim to enhance its international competitiveness in such advanced technologies by improving the accuracy of perception, judgment, and operation through the use of advanced detection and information processing technologies on the vehicle side.

To further reduce the number of traffic accidents, it is also important to improve the surrounding environment so that more accurate and precise decisions can be made not only by vehicles but also by infrastructure such as road signs and map information coordinating with road users. Also, after a collision, it is necessary to improve measures for the vehicle side to create an environment that enables early and appropriate treatment of the injured in cooperation with emergency medical services.

Future measures:
○ **Promoting advanced and widespread use of AEBS capable of detecting nighttime pedestrians and bicyclists**

AEBS are highly effective in reducing accidents, as shown by the fact that there is a difference of more than 80% in the accident rate between the same number of vehicles with or without AEBS. Therefore, we have established a safety standard for passenger cars for the use of AEBS against vehicles and pedestrians and they will be made mandatory for new cars in phases from November 2021 onward. For large vehicles, which are more vulnerable to accidents, we will first establish safety standard for AEBS against vehicles on expressways and then gradually extend the range of application, until all new vehicles will be subject to compulsory installation in November 2021.

In the future, efforts should be made to extend AEBS' scope of detection to bicyclists, etc., improve their performance so they work even at night, expand the assessment of AEBS in NCAP, and consider the extension and enhancement of the safety standard, all the while dispelling overconfidence and misunderstandings about this technology. At the same time, it is essential to improve detection technology for such pedestrians as low-profile preschoolers and wheelchair users, in response to the aging society with fewer children. [Reminder]

○ **Improving the performance of LKA and LCA systems and extending the vehicle models subject to compulsory installation**

About half of all fatal accidents involving vehicle occupants occur after lane departure (of a single vehicle or two vehicles colliding head-on), which is the most common type of accident. Accidents resulting from lane departure have an extremely high mortality rate compared to other accident types and most of these accidents occur in the low to medium speed ranges (20 km/h to 50 km/h). Most of the lane departure warning systems (LDWS) installed on most new vehicles operate in the high-speed range, so there remain issues to be solved before they can be used in the low-speed and medium-speed ranges, typically on local roads where vehicles frequently change lanes to avoid cars parked or at halt. In the future, to prevent lane departure accidents, we should further promote the spread of LDWS and lane keeping assist systems (LKAS), promote their use through *SuppoCar S (Wide)* awareness campaigns, and continue examining whether to use them in the low- to middle-speed ranges.

As to traffic accidents that occur when changing lanes to a different traffic flowing at a different speed, it is important to take measures to reduce the number of those accidents, because they may lead to serious accidents if happened on expressways. For lane change assist (LCA) systems that assist drivers by detecting blind spots behind the vehicle and the behavior of surrounding vehicles, we need to promote their spread by increasing the number of vehicles fitted with those systems.

○ **Promoting the development and implementation of various advanced technologies**

In the future, the use of AI and IoT technologies in motor vehicles will make it possible to introduce safety systems that could not be in the past. Improvements in the accuracy of recognition of everything around the vehicle using cameras, etc. are making it possible to detect not only road signs, but also the color of traffic signals and even vehicles reflected in traffic mirrors installed at junctions and curves with poor visibility. In addition, with the progress of augmented reality (AR) technology, devices that project virtual information onto the windshield and provide it to the driver are being implemented in addition to existing head-up displays (HUDs). Thus, we should promote the development of advanced ADAS that utilize image recognition technology (technology to recognize road signs, traffic signals, images reflected in traffic mirrors, etc.) and AR and install them in motor vehicles.

○ **Spreading the use and improving their performance of automatic collision notification systems**

To reduce the FSI risk after a traffic accident, it is essential to shorten the time necessary for rescue and treatment to begin. Regarding automatic collision notification systems (ACN) that automatically notify competent authorities of an accident, we have promoted the spread of models that satisfy a certain level of performance requirements by adding evaluation tests to NCAP and introducing safety standards in 2018. At present, the number of new cars with ACN is increasing, but, to keep the ACN services available, there remain issues to be solved, such as running costs often proved higher than expected, the competence and quality of the call center staff who sorts out and relays calls to right services. In light of the above, actions should be taken to promote the spread and improve the awareness among the public of the system in cooperation with the relevant ministries and agencies and the motor vehicle industry, while working to resolve those issues so that accident victims can truly benefit from the use of ACN system.

Another issue is that ACN systems currently used target the driver and other front seat passengers, but expanding the targets to include rear seat passengers, pedestrians, and other road users, and informing the center of the more specific and accurate details of the accident will help further reduce the FSI risk of victims. In the long term, we need to improve the performance of ACN systems, conduct research on how we could expand the targets to injured rear seat passengers and pedestrians, etc., and to consider the development of safety standards based on the results of such research.

2. Promoting the development of AVs and ensuring their safety

To reduce traffic accidents in the short and medium term, the development, commercialization, spread, and proper use of ADAS driven by the driver will be central to the measures to be taken, as stated earlier in *Phased implementation of VSMs*. At the same time, efforts to promote research and development as well as commercialization of AD technology, in which the system drives itself, are indispensable in implementing effective VSMs in the long-term. In March 2021, the world's first passenger car with an AD system that operates under certain conditions, such as traffic jam on expressways, was put on the market. In the future, it is expected that operational design domains (ODD), under which AD is possible, will be expanded and the social implementation of unmanned automated mobility services will advance. We need to study how to ensure safety of AVs in response to those trends.

In addition, the Public-Private ITS Roadmap aims to commercialize Level 4 on expressways by 2025. Level 4 AVs do not necessarily require the presence of a driver, as long as they are driving appropriately within the ODD. To realize this type of AD, it is necessary to work in cooperation with the relevant ministries and agencies, as there remain issues to be addressed, such as the nature of the certification and examination systems to ensure safety in an integral manner from the design to manufacture and to in-use stages of AVs and the concept of safe driving obligations to be imposed on drivers.

Future measures:

○ **Developing safety standards for advanced AD functions**

In March 2020, Japan introduced the world's first safety standard for AD systems with lane keeping functions that operate at 60 km/h or less on expressways, etc. and in December the same year, introduced the international regulation. In the future, with the development of AD technology, we should establish safety standards for more advanced AD functions for high-speed areas, etc., under international collaboration.

○ **Examining the certification and examination methods for AVs**

In the future, AD technologies we will see implemented will be more and more advanced. To deal with the tasks, we need to clarify performance requirements for AVs and establish a highly reliable evaluation method that combines public road tests, test course tests, and simulations. To achieve this goal, the government should study, under international collaboration, methods for examining safety management systems, methods for verifying vehicle safety using simulations, etc. and methods for certifying and examining AVs by monitoring the operation of in-use AD systems, etc.

○ **Improving detection technology for AVs**

AVs are required to respond to various incidents as they move around autonomously. The general requirement for AD so far made under an international regulation (automated lane keeping systems or ALKS) is that there should be no reasonably foreseeable and preventable accidents involving human injuries caused by the AD system in ODD. On the other hand, to ensure the reliability of AD technologies and improve their performance, presumably they will be required to respond to such incidents as rain, wind, snow, and other bad weather conditions and to detect people lying on the road or falling objects and avoid colliding with them. In the long term, we need to improve detection technology on the vehicle side while promoting safety measures using external information such as map data and road infrastructure.

○ **Promoting safety measures through collection and analysis of automated vehicle-related data**

What is essential to accurately assess the safety of AVs is to clarify requirements for their performance and what is useful to do that is to collect and analyze data on their operation by skilled drivers. To commercialize more advanced AVs, it will be necessary to verify their safety while running on public roads and in the event of unlikely accidents, to investigate the cause of possible accidents, etc. Therefore, consideration should be given to expanding safety standards such as event data recorders (EDRs) for AVs and data storage systems for AD (DSSADs) for AD systems that will contribute to achieving those tasks. Further, it is necessary to work with the NPA to investigate the causes of possible accidents without delay and prevent recurrence through the AD Accident Investigation Committee, which is in charge of investigation and analysis of the causes of accidents.

○ **Socially implementing unmanned automated mobility services**

Regarding unmanned automated mobility services that help elderly people in rural areas easily move around, the government should take initiatives to conduct demonstration tests and establish technical requirements to promote the development of safe vehicles as part of its objective to *realize automated mobility services controlled only by remote monitors (Level 4) in limited areas by 2022* and their deployment across the country.

3. Improving the social acceptability of AD-related technologies, etc.

To prevent traffic accidents from occurring, it is essential that all drivers correctly understand the purposes and limitations of ADAS and use them appropriately. As the use of ADAS spreads widely, there have been reports of cases in which drivers seemingly put too much trust in activation of AEBS and had accidents, and cases in which they experienced unexpected events such as sudden acceleration/deceleration or stopping under ADAS. The performance of ADAS is expected to be improved and diversified in the future, but it is necessary for these systems to become something easy to understand and use for all drivers, including young people, the elderly, and tourists to Japan. Further, we should aim to develop and implement technologies for ADAS that would enable drivers to drive the vehicle properly while communicating with it smoothly. Moreover, we need to ensure social acceptability of ADAS among drivers and all other road users, so that there will be no overconfidence or misunderstanding in them leading to new accidents.

In the future, as AD technologies develop further, AVs will be implemented in society in stages, though with limitations to ODDs and operation areas at each stage. As AVs spread widely, their speeds and behavior may prove much different from those of conventional road users and the risk of accidents from such a gap has been pointed out. In addition, since they are driven by a system, it is necessary to secure the trust of society in the safety of these vehicles, such as electronic control, and to ensure the cybersecurity of vehicles themselves and cyberspace. Thus, it is necessary to consider various issues and take measures to improve social acceptance of AVs while promoting the development of AVs themselves and ensuring their safety.

Future measures:

○ **Preventing overconfidence in and misunderstanding of AD-related technologies and promoting their proper use**

It is expected that, as the performance of AD-related technologies improves and diversifies, a great variety of advanced safety functions will be installed in new vehicles in the future. The functions and limitations of such AD-related technologies must be properly understood by each segment of those who use them, including the youth, the elderly, and tourists to Japan. This makes it essential not only to implement measures to promote the widespread use of AD-related technologies, but also to conduct educational activities for drivers and all other road users. In promoting the ASV Promotion Plan, etc. in the future, it is important to conduct public awareness and educational activities to ensure the correct understanding and use of AD-related technologies. In this regard, it is important to effectively deploy activities aimed to prevent overconfidence in and misunderstanding of these technologies while promoting the proper use of AD-related technologies by disseminating information through videos and publishing the results of demonstration tests, while ensuring division of roles between the public and private sectors. In doing so, it is also necessary to consider measures for when people drive unfamiliar vehicles, considering the spread of car sharing services, etc.

Meanwhile, some vehicles with advanced automatically commanded steering functions (ACSF) are also with a driver monitoring system that supports the driver in safe driving by monitoring them and detecting them looking away or getting drowsy. In the future, consideration should be given to the development of human machine interface (HMI) technology that constantly help the driver properly use AD-related technologies and to the expansion of vehicle models with such technology, while taking into account the safety effects of such devices and the availability of the technology.

○ **Studying measures to improve the social acceptability of AVs**

Since March 2020, vehicles with AD systems (level-3 passenger cars) have been requested to have a sticker on their body to indicate to surrounding road users that they are automatically driven. On the other hand, the presence of AVs in road traffic is expected to increase in the near future, when the driving environment conditions (ODD) that will enable AD are expanded and unmanned AD service vehicles are implemented in society. In the future, in cooperation with the relevant ministries and agencies, consideration should be given to safety requirements such as the outward communication (HMI: Human Machine Interface) functions required of AVs, while taking into account discussions such as the priority rights of pedestrians over AVs.

Further, to harmonize AVs with existing traffic, it is important to examine what surrounding road users should pay attention to and what driving behavior is required of AVs. Moreover, for AVs of Level 3, where the driver takes over the control from the system when it reaches its functional limit, the driver is required to respond immediately, even upon a sudden take-over request. In the long term, we need to study how we could build up an environment in which AVs are socially accepted through the collection of data on driving characteristics through actual vehicle tests, analysis of traffic accident precedents, and research on how the control should be handed over to the driver.

○ **Ensuring cybersecurity in AVs, etc.**

AVs will use technologies to communicate with outside and to update their software over-the-air (OTA), but there are concerns about the risk of accidents caused by unauthorized access to their control system. To deal with such concerns, it is essential to build up systems that ensure that the latest measures are always taken for OTA and cybersecurity to prevent unauthorized access to vehicle control systems.

○ **Letting known to the public the accident reduction effects of ADAS**

ADAS such as AEBS can greatly help drivers prevent serious accidents caused by human errors and mitigate damage, to the extent that drivers understand their functional limitations and use them correctly. In general, the installation of ADAS requires an initial cost, which investment being recovered through the reduction of accident risk through their service life, but consumers may hesitate about the installation of such expensive ADAS. Insurance companies are already offering incentives such as discounts on voluntary insurance premiums for vehicles with ADAS deemed highly effective in reducing accidents, which is a good example of effective use of their accident-reducing effect. In this way, the benefits of ADAS, such as their accident-reducing effects, should be let well known to the public, and efforts should be made in cooperation with the public and private sectors to help consumers understand them and encourage their behavioral changes, such as the active selection of such systems.

Section 5 The System by Which to Promote VSMs

In the past, the Vehicle Safety Bureau set up *the ASV Promotion Study Group* and *the NCAP Study Group* under *the Vehicle Safety Study Group* to discuss VSMs from a bird's eye view while keeping abreast of various changes in social conditions, and built up a system to promote VSMs in an integrated manner. The evolution of technologies in recent years accelerated the advancement of technologies installed in vehicles, making it more important than ever to coordinate between various measures such as the expansion and enhancement of safety standards in response to the introduction and spread of motor vehicle technologies, the ASV Promotion Plan, and NCAP.

Speaking of the expansion and enhancement of safety standards, the structure and systems of motor vehicles have become extremely complex due to the advancement of motor vehicle technology, and the study of safety standards now requires a quite high-level of specialized knowledge and judgment as well as an enormous amount of work, including the verification of evaluation tests. It is hence essential to collaborate with other countries and share the work through activities at WP.29 for the harmonization of international vehicle regulations.

It is also necessary to make use of the knowledge gained through many demonstration tests on AD being conducted across the country. Furthermore, as we go through demographic changes and the aging society with declining birthrate, that we experience first in the world, it is important to explore solutions to issues that surface in different situations from an interdisciplinary perspective to prevent accidents caused by elderly drivers, etc.

In the future, to ensure the achievement of the priority measures (Sections 1 to 4) from a long-term perspective, it is desirable for each study group and working group to conduct studies and discussions based on the following agenda.

Future direction:
○ **Enhancing coordinated efforts for VSMs, etc.**

To improve VSMs, it is important to implement effective and efficient measures. For example, the ASV Promotion Plan, which encourages the development and commercialization of advanced technologies, will support the introduction of new devices to the market, and the vehicle manufacturers will be encouraged to develop technologies and install safety technologies through NCAP to disseminate and improve the performance of new safety technologies that have not yet become safety standards. At the same time, the assessment will provide motorists with information necessary for selecting safer vehicles. Thereafter, for those of safety technologies that have been well commercialized, consideration should be given to the expansion and enhancement of safety standards, taking into account their cost-effectiveness, etc. Based on these perspectives, the VSMs Study Group should continue examining overall VSMs from a bird's eye view to further promote coordination among policies, such as the ASV Promotion Plan, NCAP, the expansion and enhancement safety standards, and achieve an effective and efficient promotion system. When expanding and enhancing safety standards, etc., it is essential to further promote the activities for harmonization of international regulations at WP.29 under international collaboration with major countries, while taking into account circumstances leading to traffic accidents in Japan, cost effectiveness, etc.

○ **Further expanding of NCAP**

With regard to NCAP, further expansion and evolution of the integrated safety performance assessment will be promoted. Specifically, in addition to the introduction of advanced Pedestrian Legform Impactor (aPLI), consideration should be given to the expansion of collision safety performance assessment that takes into account to what extent the driver will be held at fault upon a collision, such as MPDB (Mobile Progressive Deformable Barrier). Further, it is necessary to expand preventive safety performance evaluations, such as those for bicyclists and AEBS for junctions, while initiating studies with a view to performance evaluations of AD technology and V2X.

○ **Accelerating the ASV Promotion Plan**

With regard to the ASV Promotion Plan, it is necessary to study the technical requirements for individual devices with the aim of improving the elemental technologies that support AD so as to contribute to the realization of a safe and secure AD society. Further, studies should be conducted on the scope and conditions to which for the vehicle to respond (e.g., conditions under which it is safer for the system to get activated on its own (override)), and the scope of tasks the vehicle is in charge, with a view to further sophisticate AD. Furthermore, to promote the spread of ASVs on the assumption that motorists understand and use them appropriately, it is necessary to promote efforts to foster understanding of advanced technologies.

○ **Enhancing systems to implement demonstration tests of AVs, etc. on public roads**

Many demonstrations of AVs and automated delivery robots have been conducted based on standards relaxed assuming that alternative safety measures are taken. In the future, there will continue to be needs from a large number of business operators for demonstrations of AD under a variety of operating environments. To ensure the safe and smooth implementation of demonstration experiments, we should enhance the system for studying the operation of AVs on public roads with a view to publishing best practices such as appropriate safety assurance measures and developing future safety standards based on past results of standard relaxation. In doing so, consideration should be given to ensuring the rights of applicants for demonstration experiments and care should be taken to maintain a fair competitive environment.

○ **Promoting interdisciplinary research on elderly drivers**

The number of elderly drivers is expected to increase in the future. Interdisciplinary research on their driving characteristics should be conducted aimed at solving their problems. At present, about 30% of parties at fault in the traffic fatalities are people aged 65 or above, and many of these accidents are caused by driving errors, such as inappropriate steering and pedal misapplication. It is generally believed that motor, cognitive, and judgment abilities among humans decline as they get older, but the causal relationship between this and the causes of accidents presumably more common among elderly drivers has not been clarified. Consideration should be given to promoting research on the driving characteristics of elderly drivers ahead of other countries through collaboration between industry, academia, and government.

○ **Studying measures to utilize vehicle data from accident analysis, etc.**

In recent years, onboard recording devices such as EDRs and video drive recorders have spread widely and data on traffic accidents, etc. is now recorded and stored. In addition to traffic accident analysis to improve vehicle safety, this data has been used in a wide range of fields, such as clarification of where responsibility lies in traffic accidents, a part of insurance process to calculate compensation amounts and investigation of traffic accident by the police. Further, we will be able to further improve VSMs through the analysis of traffic accidents by utilizing the data from onboard recording devices in conjunction with various data related to vehicles, from vehicle examination and certification to registration and vehicle inspection. We should continue examining the possibility of utilizing macro data of traffic accidents and micro data from onboard recording devices aimed at implementing effective VSMs based on the results of analysis of actual accidents, while taking into account social acceptability from the viewpoint of personal information protection. In doing so, it is important to consider the possibility of utilizing data obtained through automatic collision notification systems in cooperation with related parties. It is also necessary to consider the utilization of data obtained from video drive recorders, etc., for driver management and driver education.

Section 6 Other VSMs, etc.

To promote road safety measures and truly reduce traffic accidents, it is necessary not only to take measures for new vehicles, but also to take various measures such as appropriate maintenance and management of in-use vehicles, and to promote safety measures for increasingly diversifying electric vehicles. In addition to safety measures for individual vehicles, it is also essential to promote cross-sectoral measures in cooperation with relevant ministries and agencies that link the three elements of *people*, *roads*, and *vehicles* as well as *emergency and life-saving activities*.

Japan has held many key positions such as chairperson working groups under WP.29 for the harmonization of international regulations and is one of the major countries that submit technical proposals. To make international proposals for technical requirements based on the knowledge obtained in Japan and to lead the discussion in the world, analysis based on objective data on vehicle safety is indispensable. Further, to implement effective VSMs, it is necessary to ensure safety throughout the entire lifecycle of a vehicle, from the examination and certification of new vehicles to in-use vehicles. On the other hand, with the advancement of IT in the automotive industry, the possibility is growing for the use of onboard recording devices such as video drive recorders and EDRs, probe data and OBD information. It is also important to keep developing an environment in which data related to vehicle safety can be mutually utilized by government agencies, vehicle manufacturers, private companies, and research institutes related to road safety, while giving maximum consideration to personal information.

1. Other VSMs

In the future, it is desirable to take the following measures for in-use vehicles and the utilization of vehicle safety data.

Future measures:
○ **Promoting the maintenance of ADAS functions of in-use vehicles (for OBD inspection)**

With the installation and spread of ADAS in new vehicles underway, it is essential to maintain their functions on in-use vehicles as VSMs. The government hence plans to introduce an inspection method using onboard diagnostic devices (OBD) from October 2024 onward, currently preparations are underway mainly by the National Agency Automobile and Land Transport Technology (NALTEC). In introducing the inspection, we should study issues making sure that those inspections can be carried out appropriately at inspection stations across the country, including designated maintenance shops. Specifically, in addition to creating an environment in which scan tools are available early and at low cost, we need to identify issues and coordinate parties concerned so that inspections can be conducted safely and easily, taking into account safety standards such as cybersecurity for vehicles.

Further, the acceptance/rejection judgment in OBD inspection is based on the *specific diagnostic trouble codes* (DTC) information submitted by vehicle manufacturers from the viewpoint of ensuring diversity of technology and not hindering its development. On the other hand, due to differences in the design concept and technology among vehicle manufacturers, the submitted *specific DTC information*, the location of the OBD port for connecting the vehicle to the scan tool, and the equipment required for maintenance differ. Therefore, from the viewpoint of vehicle serviceability (ease of maintenance) and vehicle safety, it is desirable that *specific DTCs* be detected in uniform failure patterns, and that the location of OBD ports and maintenance equipment be standardized. Further, if the way OBD inspection is conducted is not uniform and varies from a country to another, we will need to provide different technical information to each country, which will be a heavy burden on vehicle manufacturers. In the future, while taking into account the balance between convenience for and burden on those involved in maintenance and inspection services, efforts should be made to study safety standards for OBDs, design and develop vehicles easy to inspect and maintain, and promote the common use of maintenance equipment through international cooperation under WP.29.

Furthermore, with the sophistication of vehicle technologies, we need to continue studying various issues, such as whether there are any new devices to be inspect with OBDs, and whether we should ensure software update confirmation in the inspection, based on whether or how these issues are being handled and studied overseas, to what extent technologies have spread, and to what extent standards have been developed. It is also important to properly manage the data accumulated through OBD inspections, keeping in mind the possibility that ways that help increase user convenience and in-use vehicle safety may be proposed.

○ **Enhancing measures for the proper use of vehicle tires**

To ensure safety while driving and prevent accidents such as punctures, slips, and wheel fall-offs, the government should continue promoting the proper use of vehicle tires to motorists, in cooperation with related organizations, by raising their awareness of tire use limits and the need to check the fastening of wheels, bolts, and nuts when changing tires. It is also appropriate to educate the public on the proper use of winter tires and carrying and fitting chains to prevent getting stuck in snow.

Further, it is necessary to accelerate the installation of tire pressure monitoring systems (TPMS), which are systems that notify drivers of insufficient tire pressure.

In recent years, the number of accidents involving large vehicles whose wheels fell off has been increasing. The reasons for this are thought to be the concentration of work to replace winter tires in a short period of time, inadequate work due to workers' lack of understanding of how to replace them correctly, and inadequate maintenance and management after replacement. However, tire replacement work involves human intervention and human error is not 100-percent avoidable. According to this philosophy, vehicle manufacturers should take the initiative in studying ways to eliminate wheel drop-off accidents with some hardware.

○ **Enhancing safety measures for electric vehicles, etc.**

The sales of electric vehicles (EVs and PHVs) on the market are expected to be boosted with the enhancement of environmental regulations and the promotion of favorable policies in countries around the world. In Japan as well, to address climate change in line with the concept of green growth, the government has announced a policy aimed at making all new vehicles electrically driven by 2035. On the other hand, as the energy density of batteries in electric vehicles continues to increase, and the shapes of batteries, how they are placed in vehicles, how they are managed, etc. become more and more diverse, we need to find a way to evaluate these factors appropriately. Further, batteries deteriorate in the process of use, and there has been reports of self-ignition accidents in in-use electric vehicles in other countries. In light of this, the following safety measures should be enhanced:

- Further development and enhancement of safety standards for electric vehicles, including thermal chain test methods, vibration test methods, water damage test methods, gaseous properties at the time of ignition, and high voltage safety test methods, through international cooperation.

- In the long term, research on the potential impact of battery degradation on vehicle safety in the course of use. In addition, based on the knowledge and data obtained in Japan and through international discussions, establish a method for evaluating the safety of batteries in terms of their life cycle.

○ **Promoting safety measures for fuel cell vehicles**

With regard to safety measures for fuel cell vehicles, Japan has taken the lead in developing international safety standards and introduced the UN regulation 134 into the national legislation. With the number of models for fuel cell vehicles expected to increase in the future, the shape and location of hydrogen tanks are destined to diversify. It is necessary to consider expanding the safety standards to meet these trends and promote further VSMs.

○ **Promoting VSMs for in-use vehicles**

To improve the safety of in-use vehicles, it is important to promote the use of retrofit devices, such as pedal misapplication prevention systems (PMPS), which are expected to be effective in preventing accidents. The Road Transport Bureau, MLIT, has created a certification system for retrofit PMPS (a system by which the government, upon requests from manufacturers, certify that a PMPS has a certain level of performance and function and that a system by which the manufacturer provides explanation to users and to install the device) and announce certified devices on its website, thereby promoting the spread of quality products. In the future, it will be necessary to consider the expansion and enhancement of safety measures for in-use vehicles based on how far these devices have been developed and what are the needs of motorists.

○ **Enriching and enhancing the recall system**

As the commonization and modularization of devices across vehicle manufacturers progress in recent years, multiple vehicle manufacturers are making large-scale recalls. To properly respond to this situation and help them conduct recalls faster and more reliably, the government should further enhance its efforts to gather information from vehicle manufacturers. Further, for vehicles of which safety and environmental performance is questionable, the National Agency for Automobile and Land Transport Technology (NALTEC) should conduct technical verification on actual vehicles, etc. Further, to make recalls in line with motorist demand, the government should promote the collection of defect reports from motorists and enhance information provision on recalls to raise awareness of motor vehicle defects among motorists.

○ **Promoting evidence-based VSMs**

Regarding video drive recorders, we need to expand their use by letting well known to motorists their benefits, including monitoring of elderly drivers, deterrent effects against tailgaters, their utilization in accident analysis. [Reminder]

Event Data Recorders (EDRs), which record data such as changes in collision speed and whether or not seatbelts are worn in an accident, are very effective when used to analyze traffic accidents and eventually help improve VSMs, to clarify the situation in which the accident occurred, clarify which party was at fault, etc. In 2018, the RTB established the technical requirements for EDR in passenger cars, etc. thereby improving the technical level and accuracy of what was recorded and expanding the number of models with EDR. In the future, we need to develop and enhance safety standards for EDRs, including those for large vehicles, through international discussions.

○ **Promoting safety measures for micro mobility**

One-seater and two-seater ultra-compact vehicles called *micro mobility* are used to provide all generations, including the elderly, with a daily means of mobility. Particularly for two-seater micro mobility, in addition to the operation of the Micro Mobility Certification System, safety standards have been developed for the type designation of micro mobility vehicles that can travel freely on general roads except for expressways. In the future, it will be necessary to continue to study the collision safety (occupant protection and pedestrian injury in the event of a collision) based on the actual situation of traffic accidents, in addition to the needs and phases of use of these vehicles.

2. Taking measures in coordination with other fields of road safety

As to measures to be taken in coordination with other fields of road safety, it is recommended that the following measures be promoted:

Future measures:
○ **Reducing FSI risk through the use of ACN systems**

It is important to reduce the FSI risk in traffic accidents through the use of automatic collision notification (ACN) systems. At present, the number of new cars with ACN is increasing, but, to keep the ACN services available, there remain issues to be solved, such as running costs often proved higher than expected, the competence and quality of the call center staff who triage and relays calls to right destinations. In light of the above, actions should be taken to solve these issues in cooperation with the relevant ministries and agencies and the motor vehicle industry and promote the spread the installation of ACN systems so that victims can truly benefit from them. [Reminder]

○ **Promoting measures to prevent unintended moving of vehicles**

Though the number of casualties from unintended moving of vehicles (where the vehicle started moving without the driver's driving action) is small, at around 200 per year, the number of deaths has been on the rise in recent years. Most parking brakes are hand- or foot-operated, and accidents occur when drivers forget to apply them when parking or stopping. On the other hand, in recent years, more and more vehicles have electric parking brakes, and a function that automatically applies the brake when the vehicle is shifted to parking has been implemented. In the future, in addition to promoting such measures on the vehicle side, actions should be taken to raise the public awareness for prevention in cooperation with relevant ministries and agencies, since unintended moving of vehicles is mostly caused by drivers' improper braking action.

○ **Promoting measures against drunk driving**

The number of accidents involving drunk drivers is on the decrease due to measures taken to toughen penalties and sanctions, but there were still 2,522 cases in 2020. Solutions on the vehicle side include alcohol interlock devices, but they have room for improvements in terms of prices and actual effect. In light of these issues, steps should be taken to study effective use of alcohol interlock devices in cooperation with related measures such as operation management, road safety education, toughened penalties, and measures against alcoholism.

○ **Promoting safety measures using communication technologies and data**

Technological advancement has made it possible to generate a variety of data in real time from onboard devices, and the potential is increasing for safety measures using such a data for communication with motor vehicles (V2X) and communication systems between people, roads, and motor vehicles (ITS). Further, communication technologies such as 5G not only ensure stable communications and accurate positioning, but also enable mutual communication. So, it will be soon possible for vehicles to give pedestrians and bicyclists warning, etc. On the other hand, there are issues of how to deal with the introduction of devices to send and receive information and the cost of such devices. In the future, by using those communication technologies, long-term safety measures should be taken expanding the range of detection and enabling vehicles to communicate with other vehicles and road infrastructure through V2X and ITS technologies. Further, actions should be taken to study how to utilize this data to analyze the safety of vehicles, including those in use, by linking traffic and vehicle-related data such as probe data.

○ **Promoting safety measures for various types of mobility**

In the future, the use of personal mobility such as electric kickboards and automated delivery robots is expected to increase. Small and of short cruising distance, these means of mobility will be best used for moving around urban neighborhood. In the future, it is important to study measures to ensure the safety of the mobility's body in cooperation with relevant ministries and agencies, as well as measures to ensure their safety when mixed with existing traffic, taking into account traffic regulation and urban planning.

○ **Cooperating with other stakeholders in raising the public awareness of road safety**

Ensuring the safety of pedestrians and bicyclists, etc. requires, in addition to VSMs aimed to improve vehicles' detection capacity and to instill drivers' legal compliance, that pedestrians and bicyclists too meet their legal compliance. In particular, considering that head injuries still account for a high percentage of traffic fatalities among bicyclists and motorcyclists, it is vital to promote safety measures to get them to wear helmets. Further, considering that many fatal accidents involving bicyclists occur at dusk and night, actions should be taken to encourage bicyclists to turn on their lights early and properly and to use reflective materials to improve their visibility to other road users. Based on the above, the government should do its best to raise awareness of road safety among various road users in cooperation with relevant ministries and agencies and organizations.

Section 7 Setting New Reduction Targets for VSMs

1. Targets of the Eleventh Road Safety Master Plan

The future road traffic situation in Japan will be influenced by various factors such as economic and social trends, the impact of the Covid-19, and changes in people's means of mobility. In the Eleventh Road Safety Master Plan, targets are set based on projections of the number of traffic fatalities, etc. in the future.

Targets in the Eleventh Road Safety Master Plan:

(i) Reduce the number of fatalities within 24 hours[10] to 2,000 or less by 2025*, with the aim of realizing the safest road traffic in the world.
(* Multiplying this 2,000 by the average (1.20) of the ratio of the number of fatalities in 24 hours to the number of fatalities within 30 days[11] between 2016 and 2019 gives a result of 2,400.)
(ii) Reduce the number of the seriously injured[12] to 22,000 or less by 2025.

2. New reduction targets for VSMs

Based on the targets set in the Eleventh Road Safety Master Plan, this report also sets reduction targets for vehicle safety in terms of the PDCA cycle, i.e., systematic and effective implementation of future VSMs and verification of their effectiveness after the fact.

(1) Philosophy on reduction effect by VSMs

Concept of the target year:
In consideration of the following factors, the target year is set to 2030.
(Factors to be considered)
- Time necessary for planning, design and development, and installation in new vehicles (about 5 years)
- Actual conditions of the Japanese market (e.g., average vehicle age: approx. 13 years (for passenger cars), average turnover rate of vehicles owned: approx. 15 years)
- Recovery of cost for R&D investment in the private sector over the medium- to long-term

Concept of the target values:
In the Eleventh Road Safety Master Plan, in addition to the number of fatalities within 24 hours, a target has been set for the number of the seriously injured, who are high-priority, life-threatened victims, because efforts to prevent accidents leading to serious injuries will also lead to decreasing the number of fatalities. In the area of VSMs, measures are being taken to prevent serious injuries, such as leg protection technology for pedestrians and neck protection technology for vehicle occupants, while cross-

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[10] The term *fatalities within 24 hours* refers to those who die within 24 hours of a traffic accident.
[11] The term *fatalities within 30 days* refers to those who die within 30 days of a traffic accident (the first day being the date of accident).
[12] The term *seriously injured* refers to those who are injured in a traffic accident and require treatment for one month (30 days) or more.

sectoral measures being adopted to prevent fatalities through coordination with emergency and lifesaving services. Further, the number of fatalities within 30 days has long been used as an international indicator as shown in the 2011 report that set the number of fatalities within 30 days as a target value. In consideration of the above, targets for VSMs will be the number of *fatalities within 30 days* and that of *serious injuries*.

In setting targets for VSMs, there are various factors to be taken into account, such as the speed of vehicle replacement in the market in the future, the status of technological development and their adoption in vehicles by vehicle manufacturers, trends in vehicle safety policies, and the impact of Covid-19, etc. on the field of road safety. In particular, it should be noted that the actual traffic accident situation in 2020 was affected by the outbreak of the Covid-19. Therefore, on the premise that it is extremely difficult to make accurate future predictions based on the actual traffic accident situation in 2020, the baseline year, we envision the following VSMs based on feasible or foreseeable technologies based on the specific measures described in Chapter 3, Future VSMs. Specifically, they will be (1) the reduction effects of vehicle safety devices already in place (e.g., standard equipment) due to their widespread use in the market (e.g., AEBS for vehicles and pedestrians in passenger cars, etc.), (2) the reduction effects of vehicle safety devices expected to be newly in place onboard in the future (e.g., AEBS for bicyclists in passenger cars, etc.)

(2) New reduction targets through VSMs

In view of the above, and based on the direction of future VSMs and their specific terms, the following new targets are set to achieve the targets set in the Eleventh Road Safety Master Plan and to lead the improvement of road safety in the future from the *vehicle* side.

By 2030, through VSMs, reduce the number of fatalities within 30 days and serious injuries in traffic accidents by 1,200 and 11,000, respectively, compared to 2020.

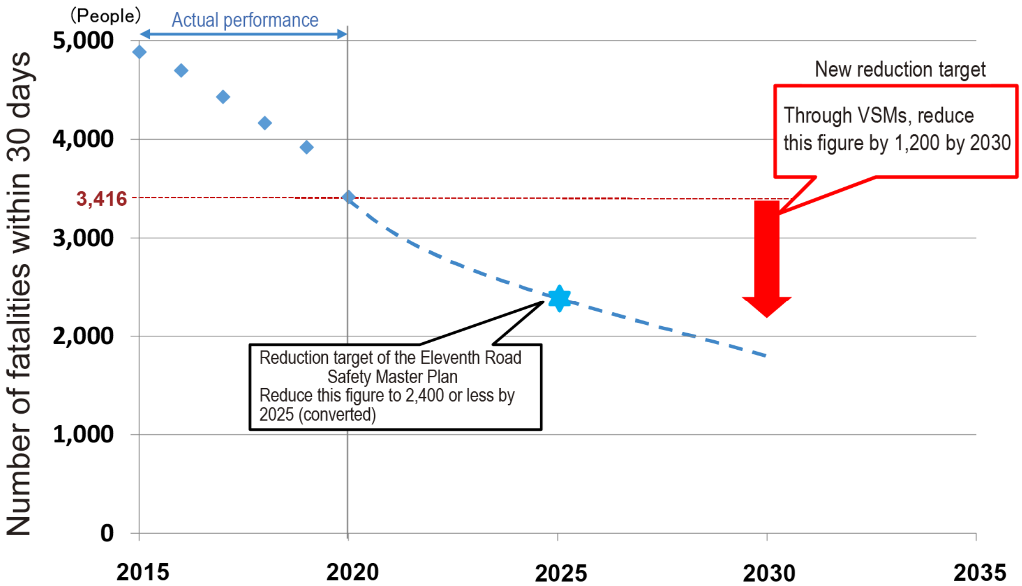


Figure 3-7-1 Schematic concept of new reduction targets for vehicle safety (Number of fatalities within 30 days in traffic accidents)

In Closing

To further ensure road safety, this report summarizes the direction of measures using automotive technologies and reduction targets for VSMs, including collision safety and preventive safety technologies and cross-sectoral measures including those other than VSMs. Further, by setting forth a clear long-term perspective on vehicle safety, we have confirmed the direction we should take and will further promote efforts in cooperation with industry, academia, and government.

The number of traffic accidents in Japan has been steadily decreasing thanks to the efforts of the government, the private sector, and the public over the years. In recent years, the performance of preventive safety technologies, such as AEBS, as well as the performance of collision safety technologies, which have been developed over the years, have improved and their installation expanded significantly. In particular, we assume that the spread of vehicles with ADAS has largely contributed to the reduction of traffic accidents.

On the other hand, in the deliberations of the Technology and Safety Working Group, which conducted the discussions to compile this report, there were many discussions on the role vehicle technologies should play in Japanese society by viewing them from the perspective of drivers and other road users and society as a whole. Even if the vehicle features the latest technologies, the fact remains that the driver and other road users around are all *humans*, so it is essential that the *human* driver correctly understand how these technologies work and what are their limitations, use them properly and get along with other road users in the same traffic environment. To achieve true road safety, it is necessary not only to promote the adoption of these technologies in vehicles, but also to help *humans* users understand them correctly and to ensure their acceptability among *them*.

Further, the Technology and Safety Working Group discussed not only VSMs, but also legal compliance of road users in general, including pedestrians and bicyclists, and changes in society. To maximize the effectiveness of VSMs in the future, it is necessary not only to promote efforts in the field of vehicle safety, but also to encourage all road users to enhance their compliance through road safety awareness campaigns, etc.

The Technology and Safety Working Group was held in the midst of the Covid-19 pandemic that was having a significant impact on our daily lives. In addition to the impact of the Covid-19 infection, there have been major changes in the ways people and goods move around Japanese society under the declining birthrate, aging population, and diversification of personal mobility. In the field of vehicle safety, too, we must respond appropriately to these changes.

AD technologies will be extremely important in achieving the goal of reducing traffic accidents caused by vehicles to zero, but they are still at the early stages. To improve the performance and implementation of these technologies consistently, it is essential that all road users are aware of their role as participants in this work, and that society as a whole helps improve these technologies, rather than leaving it to the MLIT and vehicle manufacturers. Through efforts to improve vehicle technology, including AD technology, it is hoped that we can prevent tragic traffic accidents to the extent possible and contribute to ensuring safety and security in the lives of the people and improving their quality of life by enhancing the potential social value of motor vehicles as a highly convenient means of mobility and transport.

References

Appendix 1: Evaluation of the Effects of VSMs on the Targeted Reduction of the Number of Fatalities in Accidents

1. Background and objectives

The 2011 report of the Automobile Traffic Subcommittee, the Land Transport Committee, the Council for Transport Policy set the goal of *reducing the number of traffic accident fatalities by 1,000 (compared to 2010) through vehicle safety measures by 2020.* To ascertain the extent to which the target has been achieved in the final year of the plan, 2020, an ex-post evaluation was conducted of the effectiveness of the VSMs so far implemented in reducing the number of fatalities based on the most recent traffic accident statistics (2019).

The ex-post evaluation was conducted on two types of safety measures: the VSMs that have been implemented and standardized over decades and the VSMs for safety performance, which have not been standardized but assessed as part of NCAP. The effects of the different types of safety measures were assessed by estimating how they have been effective in reducing the number of fatalities since 2010, the base year. The reason for including non-standardized VSMs as an evaluation item in NCAP was that it will promote the spread of safer vehicles, and as a result, it is expected to have the same effect as standardized VSMs. Since there is overlap in the effects of reducing the number of fatalities among the measures, the main overlap is taken into account in the final evaluation.

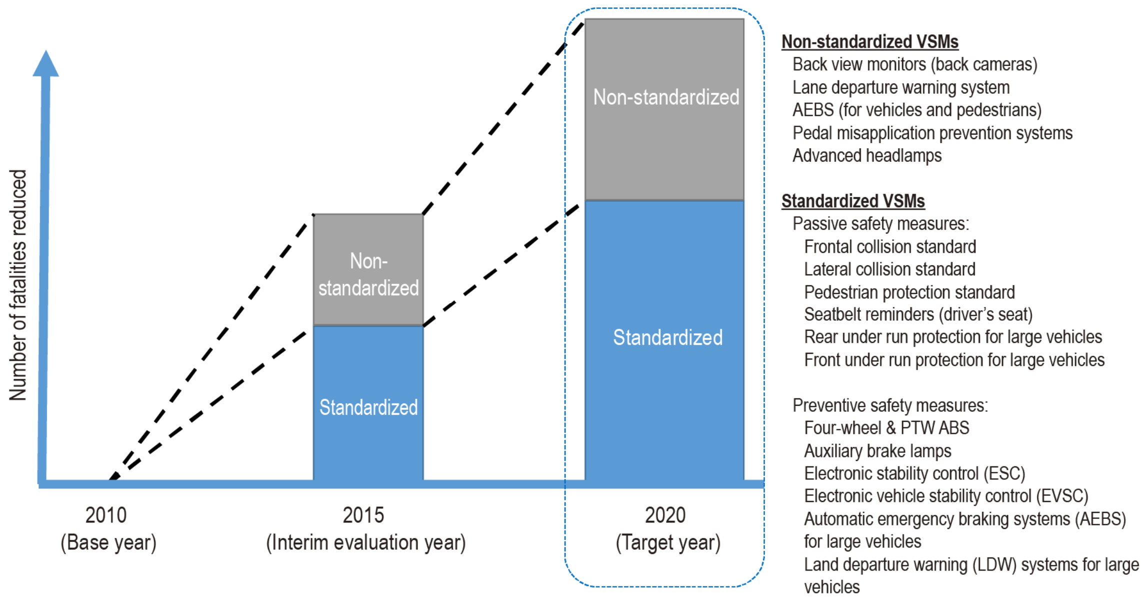


Figure 1 Schematic concept of the reduction target in the number of fatalities and ex-post evaluation of the effect

2. Safety measures to be evaluated

Ex-post evaluation was made of twelve *standardized VSMs* (six damage mitigation measures and six preventive safety measures) and five *non-standardized VSMs.* The list of items subject to ex-post effect evaluation is shown in Table 1.

Table 1 List of safety devices subject to the ex-post evaluation of the effects

Safety measures			Accident types (Outline, 2020)	Vehicle types (Outline, 2020)
Standardized VSMs	Damage mitigation measures:	Frontal collision standard	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
		Lateral collision standard	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
		Pedestrian protection standard	Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
		Rear under run protection (RUP) for large vehicles	Between vehicles	Trucks
		Front under run protection (FUP) for large vehicles	Between vehicles	Trucks
		Seatbelt reminders	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)
	Preventive safety measures:	Auxiliary brake lamps	Between vehicles	Cars (including K cars), trucks (including K trucks)
		Anti-lock brakes (ABS)	Between vehicles, single vehicle, pedestrian vs vehicles	Cars (10 or more occupants), trucks (including K trucks), PTWs
		Electronic stability control (ESC)	Between vehicles, single vehicle, pedestrian vs vehicles	Cars (including K cars)
		Electronic vehicle stability control (EVSC)	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (10 or more occupants), trucks (including K trucks)
		Automatic emergency braking systems (AEBS) for large vehicles	Between vehicles, single vehicle	Cars (10 or more occupants), trucks
		Land departure warning (LDW) systems for large vehicles	Between vehicles, single vehicle, pedestrian vs vehicles	Cars (10 or more occupants), trucks
Non-standardized VSMs		Back view monitors (back cameras)	Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
		Lane departure warning system (LDW/LDP/LKA)	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
		Automatic emergency braking systems (AEBS)	Between vehicles, single vehicle, pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
		Advanced headlamps (AHB, ADB)	Pedestrian vs vehicle	Cars (including K cars), trucks (including K trucks)
		Pedal misapplication prevention systems	Between vehicles, single vehicle	Cars (including K cars), trucks (including K trucks)

3. Concept of the ex-post evaluation of the effects

The ex-post evaluation of the effects of ADAS was conducted by analyzing data provided by the Comprehensive Database on Traffic Accidents of the ITARDA following the steps shown in Fig. 2.

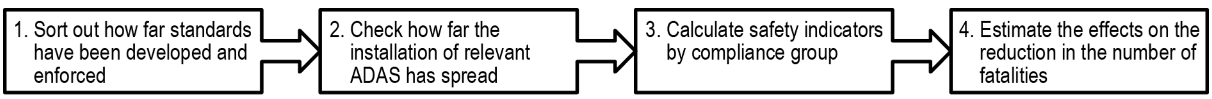
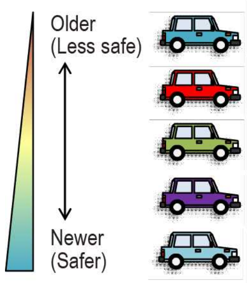


Figure 2 Work flow of the ex-post evaluation of the effects

(1) Sorting out how far standards have been developed and enforced

Based on the data on the vehicle types subject to the standards and the start date of the standards' application, how those vehicles comply with the standards has been classified into compliant vehicle group, non-compliant vehicle group and mixed vehicle group based on the month of first registration. Figure 3 shows how vehicles are sorted out in terms of how they comply with the front collision standard. In this case, the compliant vehicle group is defined as vehicles continuously produced or imported that were first registered in a month after the date of application of the relevant standard, whichever comes later; the non-compliant group as vehicles first registered in a month preceding the date of application of the relevant standard to newly type-designated vehicles; and the mixed group as vehicles first registered in a month between the two dates of application.



Compliance	Period	Full lap standard	Offset standard
Full lap*, Non-compliant Offset**, Non-compliant	- Mar '94	Before application to newly type-designated vehicles	Before application to newly type-designated vehicles
Full lap, Mixed Offset, Non-compliant	Apr '94 to Mar '99	After application to newly type-designated vehicles Before application to imported vehicles	Before application to newly type-designated vehicles
Full lap, Compliant Offset, Non-compliant	Apr '99 to Aug '07	After application to imported vehicles	Before application to newly type-designated vehicles
Full lap, Compliant Offset, Mixed	Sep '07 to Aug '09	After application to imported vehicles	After application to newly type-designated vehicles Before application to continuously produced vehicles
Full lap, Compliant Offset, Compliant	Sep '09 -	After application to imported vehicles	After application to continuously produced vehicles

*Refers to *full-lap frontal collision safety performance standard*
**Refers to *offset frontal collision safety performance standard*

Plus

Month in which they were first registered

According to the above criteria, vehicles were classified into a *compliant vehicle group*, a *non-compliant vehicle group*, and a *mixed group*.

For example, a vehicle first registered in March 1994 or earlier was classified into the non-compliant group both in terms of the full lap frontal collision safety performance standard and the offset frontal collision safety performance standard.

A vehicle first registered in January 2009 into the compliant group in terms of the full lap frontal collision safety performance standard but into the mixed group in terms of the offset frontal collision safety performance standard.

Figure 3 Schematic concept of how cars were sorted out in terms how they comply with two frontal collision standards

(2) Checking how far the installation of individual ADAS has spread

From the statistics on the number of vehicles owned, the spread of devices by each compliance group in the base year of the ex-post effect evaluation (2010) and in the year of the evaluation (2019), based on the information on their month of first registration, will be checked from changes in percentage of each vehicle group. In other words, with the percentage of non-compliant group decreasing and that of the compliant group increasing, we can confirm that safer vehicles that comply with the two standards have spread.

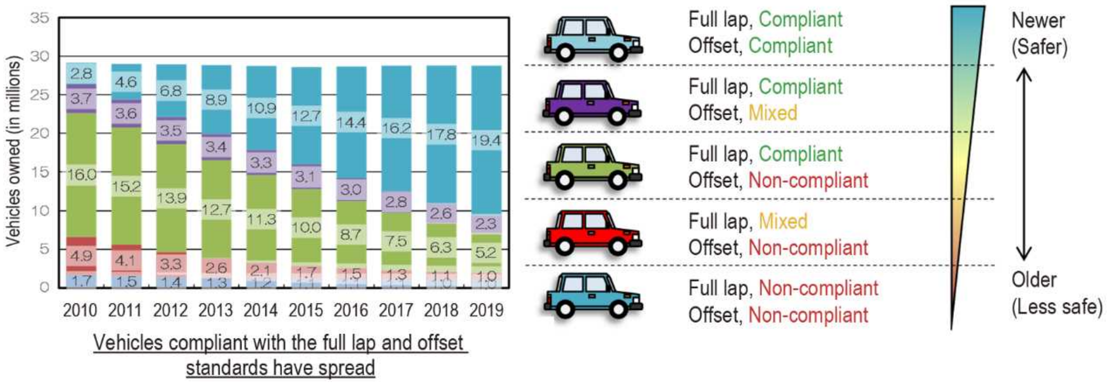


Figure 4 Spread of each compliance group in terms of the frontal collision standards

(3) Calculating safety indicators by compliance group

In the initial stage of safety measures, the non-compliant group accounted for many accidents because the compliant group had hardly spread in the market. In the spread stage, the percentage of the compliant group increased.

In conducting the ex-post evaluation, the safety indicators of the two groups were compared during the period when the compliant and non-compliant groups were mixed.

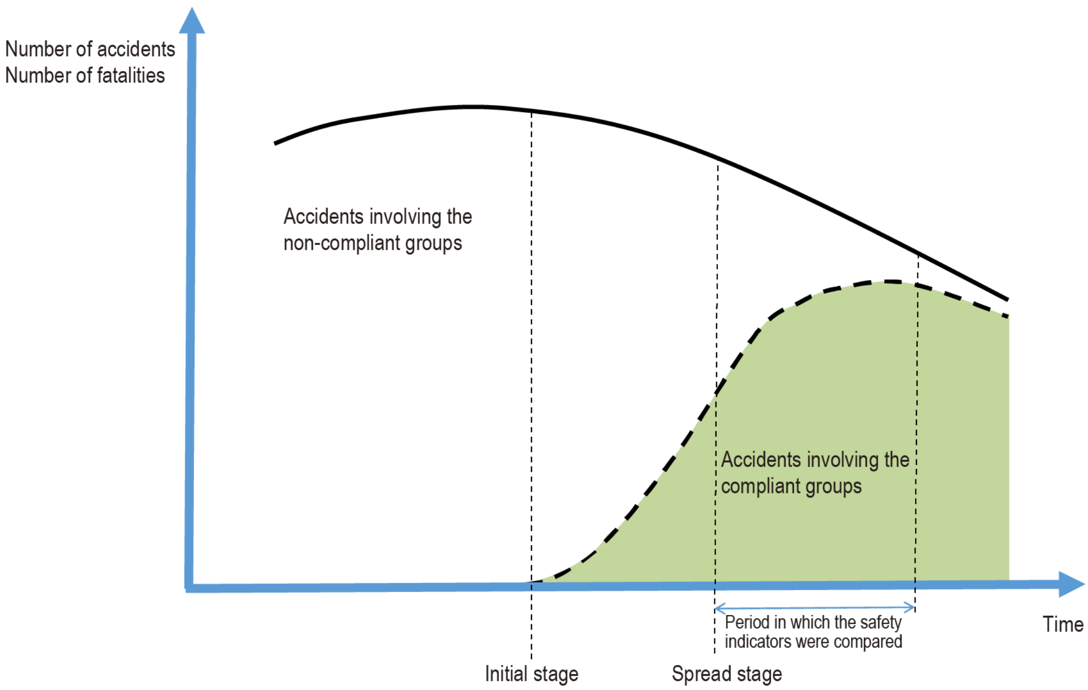


Figure 5 Safety indicator comparison period (Schematic concept)

As safety indicators, the mortality rate was used for damage mitigation measures and the accident rate (the ratio of the number of accidents to the number of vehicles owned) for preventive safety measures. The accident data to be used in the calculation of the safety indicators were collected by first selecting the accident types and target vehicles for which respective safety measures deemed effective and then extracting only accident data that meet the conditions selected above from the Comprehensive Database on Traffic Accidents. The mortality rate and accident rate were defined as shown below. In general, the mortality rate is calculated as the ratio of the number of fatalities to the number of injuries, but in this survey, the denominator includes uninjured people.

$$\text{Mortality rate} = \frac{(\text{Number of fatalities})}{(\text{Number of fatalities + Number of the seriously injured + Number of the slightly injured + Number of the uninjured})}$$

$$\text{Accident rate} = \frac{(\text{Number of accidents})}{(\text{Number of vehicles owned})}$$

By comparing the calculated safety indicators for the compliance groups, the degree of effectiveness of the safety measures in question was confirmed. If the indicator for the compliant vehicle group is smaller than the indicator for the non-compliant vehicle group, it can be said that the measures were effective.

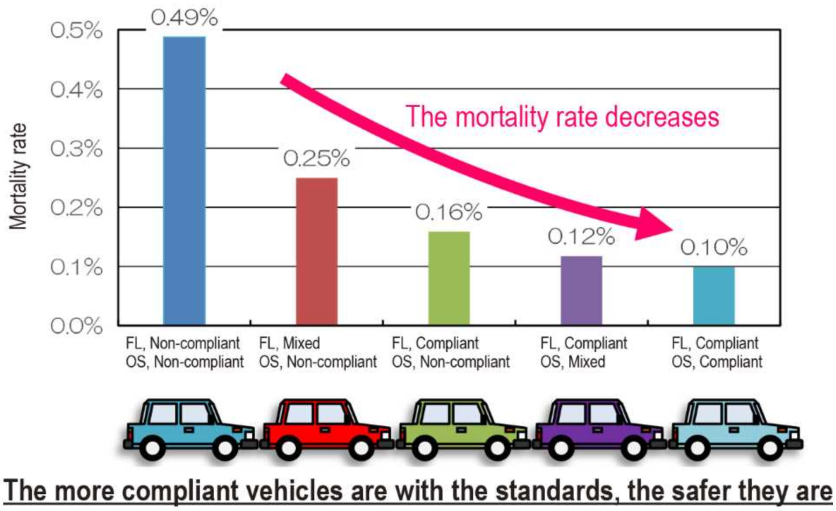


Figure 6 Safety indicators for respective compliance groups in terms of the frontal collision standards

(4) Estimating the effect of ADAS on reducing the number of fatalities

The effect of ADAS on the reduction of the number of fatalities was defined as the difference between the estimated number of fatalities and the actual number of fatalities, assuming that the ratio of vehicles in each compliance group in 2019, the evaluation year, did not changed from 2010, the base year.
The estimated number of fatalities was calculated using the number of fatalities per number of vehicles owned by each compliance group, regardless of whether damage mitigation measures or preventive safety measures had been taken. In the evaluation of VSMs, calculations were made on the assumption that conditions other than the presence or absence of measures (driving characteristics, driving distance, etc.) were the same.

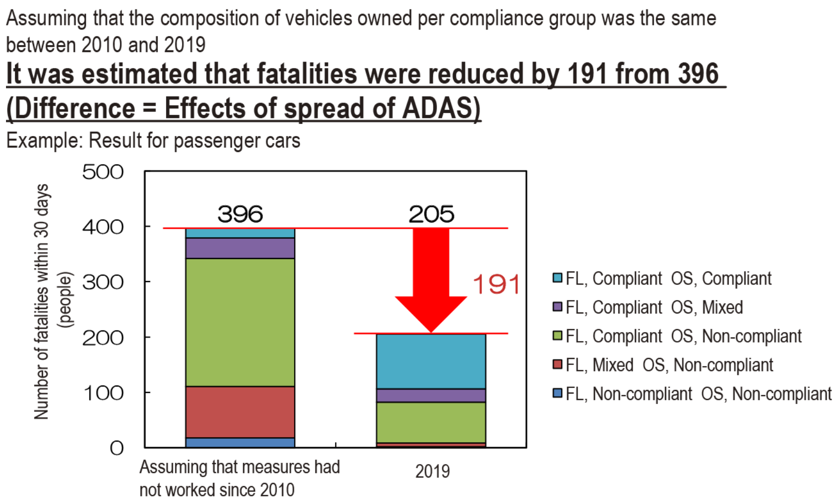


Figure 7 Estimation of the effect of ADAS on the reduction of the number of fatalities

(5) Procedure for the ex-post evaluation of standardized VSMs

Figure 8 below shows the flowchart of the ex-post evaluation steps (1) to (4) above.

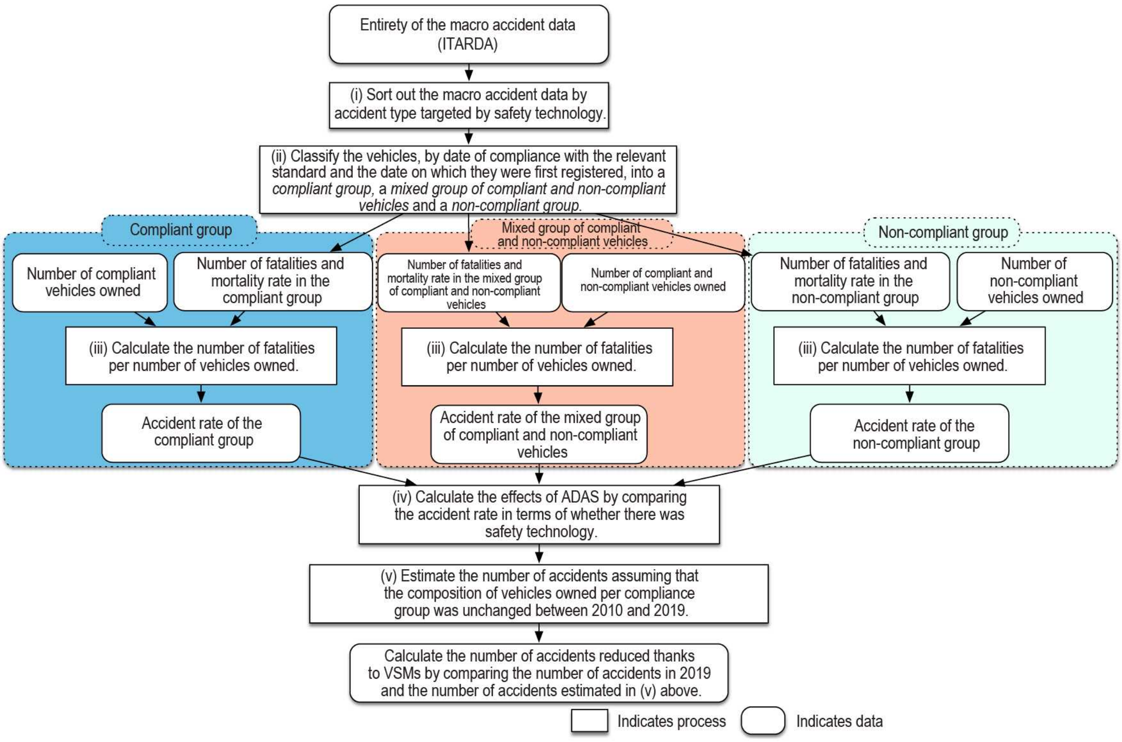


Figure 8 Flowchart of the ex-post evaluation

4. VSMs other than standardization

When evaluating the effectiveness of vehicle safety efforts such as NCAP, it is difficult to classify vehicles into those for which measures are underway and those they aren't. In this study, vehicles were classified on a trial basis by using vehicle type in designation of target vehicle types as in NCAP. In reality, strict classification is not possible, because even if two vehicles are of the same vehicle type, they might be either with or without a device if the device is optional.

Safety indicators were calculated using the same method as in the case of standardized VSMs, distinguishing between the compliant group for vehicles subject to NCAP and the non-compliance group for vehicles not subject to NCAP, according to whether they are with or without the device. As in the case of standardized VSMs, the effect of ADAS on the reduction of the number of fatalities was defined as the difference between the estimated number of fatalities and the actual number of fatalities, assuming that the composition of vehicles owned per compliance group in 2019, the year of assessment, had not changed from 2010, the base year.

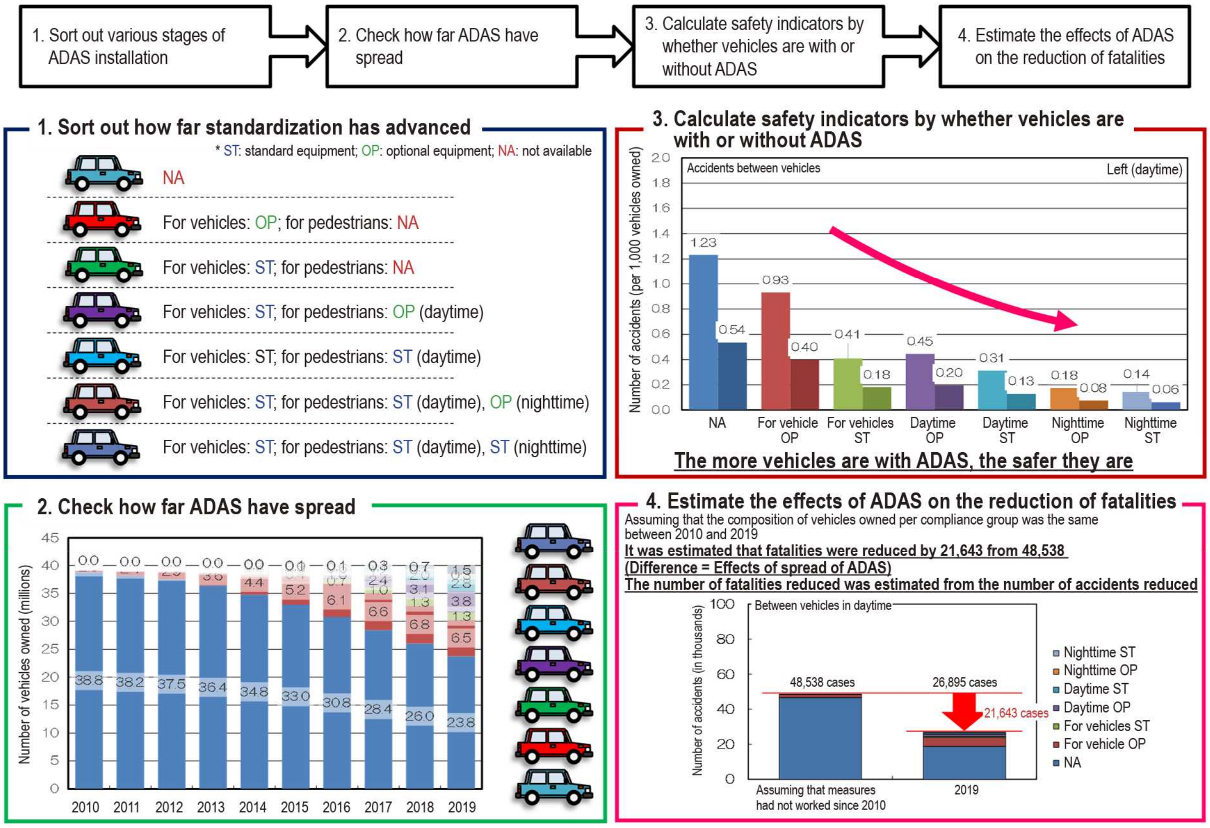


Figure 9 Ex-post evaluation of the effect of VSMs other than standardization
(Example of passenger car AEBS)

Appendix 2: Vehicle safety policies in other countries

I. VSMs in Europe

The European Commission has compiled and published *Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero"*, which sets how Europe plans to reduce the number of fatalities and serious injuries (FSI) in road accidents between 2021 and 2030. The main points are as follows.

1. Targets

- Medium-term target
Reduce the number of FSI in traffic accidents by 50% by 2030 compared to 2020

- Long-term target
Reduce the number of traffic FSI to near zero by 2050

2. Themes for achieving road safety

Based on the advice of various experts and stakeholders, identified four themes for achieving road safety, and set KPI for each.

(a) Infrastructure safety (roads and roadside areas)
KPI: Percentage of distance traveled on roads that meet the new EU safety standards to be developed.

(b) Vehicle safety
KPI: Percentage of new vehicles (passenger cars) meeting Euro NCAP four-star or higher safety standards.

(c) Use of safe roads
KPI: (i) Percentage of vehicles that travel within speed limits
(ii) Percentage of drivers who drive with a blood alcohol level below the legal limit
(iii) Percentage of drivers who do not use mobile phones
(iv) Percentage of vehicle occupants who use seatbelts and CRS
(v) Percentage of motorcyclists and bicyclists wearing helmets

(d) Prompt response to emergencies
KPI: Elapsed time from collision to arrival of emergency services at the accident site.

II. VSMs in the United States

The National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation (DOT) has developed *THE ROAD AHEAD: National Highway Traffic Safety Administration Strategic Plan 2016-2020* announcing the future direction of the actions it takes to improve road safety and reduce the number of fatalities and injuries on U.S. roadways. The main points are as follows:

1. General road safety
- Reduce deaths and injuries by eliminating drunk driving and improving the rate of seatbelt use
- Improve the survival rate from crashes by enhancing the infrastructure for 911 calls, enhancing emergency medical services, etc.
- Reduce economic costs by continuously updating fuel efficiency standards, etc.

2. Preventive safety of vehicles
- Enhance and promote preventive safety
- Improve recall completion rate
- Provide information to consumers
- Harmonize international vehicle regulations

3. AVs
- Deploy safe and advanced AVs in a safe manner
- Deploy V2V communication securely through centralized monitoring of license registration, inspection, etc.
- Establish a strong cybersecurity environment

4. Human behavior
- Improve behavioral safety measures
- Improve the effectiveness of DWI (Driving While Intoxicated) courts