AUTOMOBILES AND SAFETY

1 Introduction

In 2018, the number of injuries due to traffic accidents fell for a thirteenth consecutive year since 2006 and the number of traffic accident fatalities (within 24 hours of the accident) was 3,532 people, which is lower the total of the previous year (2017), which had been the lowest total since the National Police Agency started recording statistics in 1948. Nevertheless, the outlook on achieving the government target of reducing fatalities to 2,500 or less by 2020 remains bleak. Achieving the target will require cooperation between the public and private sectors, as well faster adoption of integrated three-part measures that incorporate pedestrians, drivers, and society. The explanations below focus on driver-related measures.

2 Traffic Accident Trends and Measures

2. 1. Traffic Accident Trends

The number of traffic accidents and traffic accident injuries has fallen since reaching a peak in 2004. In 2018, the number or traffic accidents was 430,601, 8.8% less than in the previous year, and the number of injuries was 525,846, 9.5% less than in the previous year. These numbers are at the same level as those of the late 1960s.

The number of traffic accident fatalities peaked at 16,765 in 1970, before falling to 8,466 in 1979 due to the development of road traffic infrastructure such as traffic lights and guardrails. Higher cruising speeds and the deterioration of driving environments due to the popularization of vehicles caused the number of traffic accident fatalities to rise again and reach 11,452 in 1992. Until 1985, only drivers were required to wear seat belts. Since 1985, traffic rules were reinforced with provisions such making the wearing of seat belts mandatory in passenger seats, prompting a decrease in the number of traffic accident fatalities. As vehicle safety performance improved, drivers started respecting traffic rules more closely, and regulations became stricter, the number of fatalities since 2000 fell gradually year after year, dropping to 4,113 in 2014. In 2015, the number of fatalities rose to 4,117, the first increase in 15 years. However, in 2016, that number decreased to 3,904. In 2018, the number of fatalities dropped to 3,532, which is lower than the total of the previous year, which had been the lowest total since the National Police Agency started recording statistics in 1948 (Fig. 1)[1].

The following sections outline the salient characteristics of fatal accidents in 2018.

2. 1. 1. Number of Fatalities per Road User Status

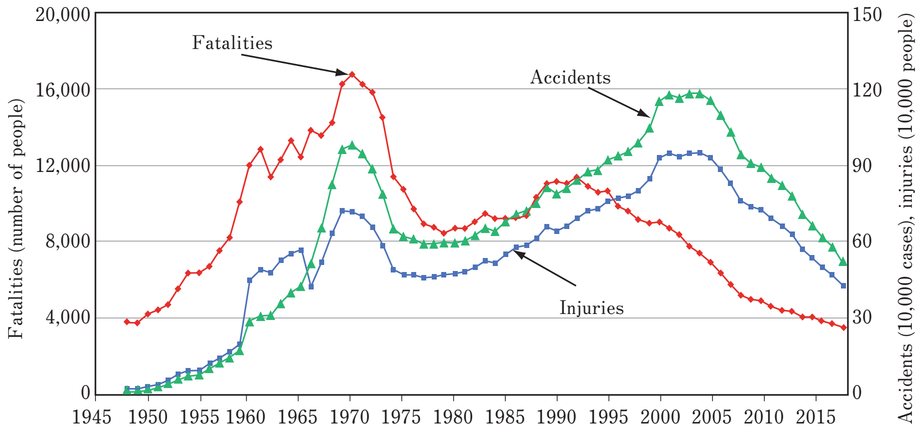
The total number of traffic accident fatalities in 2018 was 3,532. Of these, 1,258 were pedestrians, which was 90 people less than in the previous year, continuing the downward trend observed since 2016. The number of cyclist fatalities was 453 (down 5.4% from 2017). Fatalities of pedestrians and cyclists, who are vulnerable road users, both decreased compared to the previous year. This is attributed to the effects of integrated three-part safety measures such as initiatives intended to ensure pedestrians and cyclists follow traffic rules, the spread of the adoption of pedestrian-aware collision mitigation braking systems, and the improvement of the road infrastructure (Fig. 2)[2].

2. 1. 2. Number of Fatalities per Age Range

Breaking down traffic accident fatalities by age shows that in 2018, there were 1,966 fatalities of people aged 65 or older, which accounted for 55.7% of the total. This was higher than the number in 2016 (54.8%), and represents an all-time high. Pedestrians accounted for 45.7% of these elderly fatalities, far exceeding the overall proportion for all age ranges (35.6%). In addition, elderly people accounted for 60.7% of pedestrian and cyclist fatalities. This reflects the fact that elderly vulnerable road users account for a high percentage of the total number of victims (Fig. 3)[2].

2. 2. Traffic Accident Measures

In March 2016, the Japanese government introduced



Note 1: The population data used for the calculation of these statistics are from the previous year's statistical data for population estimates compiled by the Ministry of Internal Affairs and Communications (recalculated population as of October 1st for 1948 and 1949, and the population before recalculation as of October 1st for years other than 1948 and 1949), or from the Population Census.
Note 2: Until 1971, these statistics did not include Okinawa Prefecture.
Note 3: Until 1965, these statistics also included accidents involving property damage.
Note 4: Until 1959, these statistics did not include minor accidents (injuries lasting less than eight days, material loss of 20,000 yen or less).

Fig. 1 Traffic Accident Trends (1948 to 2018)

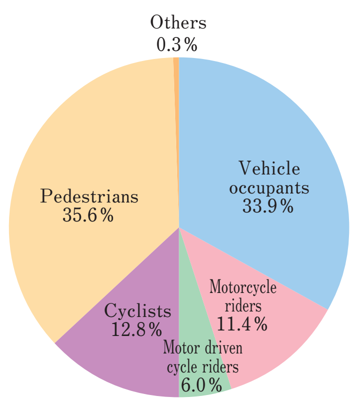


Fig. 2 Fatalities per Road User Status (2017)

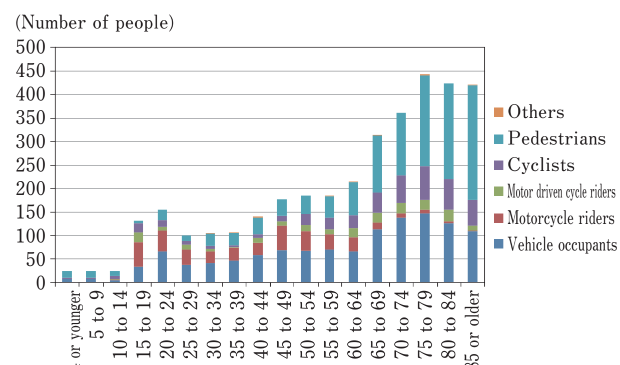


Fig. 3 Fatalities per Road User Status and Age Range (2017)

the Tenth Fundamental Traffic Safety Program[3], which included targets to reduce the number of traffic accident fatalities within 24 hours of the accident to 2,500 by 2020, reduce the number of traffic accident fatalities and injuries to 500,000, and achieve the world's safest road traffic environment. The traffic safety initiatives to achieve these targets are based on the following eight perspectives: (a) improving the road traffic environment, (b) ensuring thorough awareness of road safety, (c) ensuring safe driving, (d) enhancing vehicle safety, (e) maintaining an orderly traffic situation, (f) enhancing rescue and emergency services, (j) improving and promoting victim support, and (h) improving research and development as well as investigative research.

The Ministry of Land, Infrastructure Transport and Tourism (MLIT) traffic measures are based on a report drawn up in June 2016 called Vehicle Safety Measures for Building a Society Free from Road Traffic Accidents[4]. This report describes the basic concepts that will form the four pillars of future traffic safety, including (a) addressing accidents involving children or the elderly, (b) measures for the safety of pedestrians and automobile occupants, (c) measures to address grievous accidents involving heavy-duty vehicles, and (d) addressing new technologies such as automated driving. An overview of the present initiatives related those the four pillars is presented below.

2. 2. 1. Safety Measures for Children and Elderly People

Measures based on the age range (infants, elementary school students, junior high and high school students) are viewed as critical to address accidents involving children. Specific efforts include popularizing safe and user-friendly child seats and junior seats compliant with ISOFIX

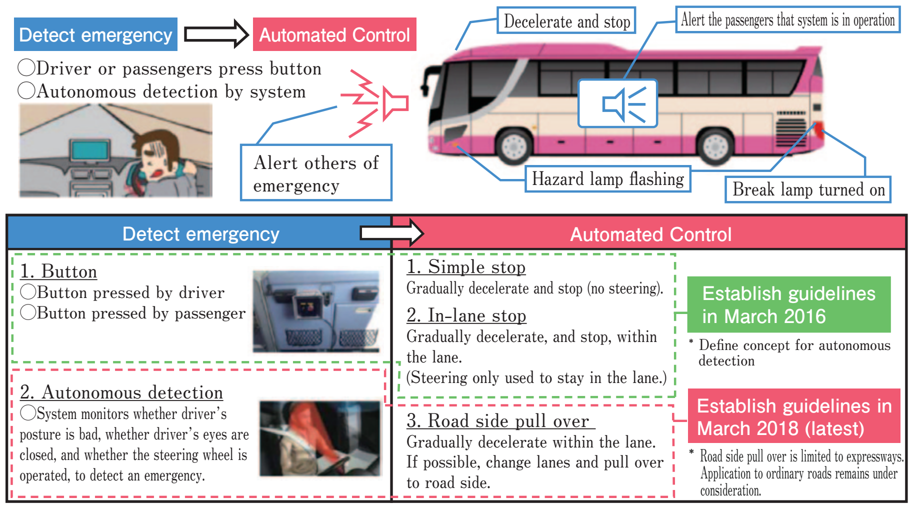


Fig. 4 Overview of Driver Emergency Autonomous Detection System

and i-Size (UN R129), and promoting their proper use by calling on car dealerships to provide guidance and advice on the proper way to use child and junior seats to users. Car accidents involving elderly drivers are increasing every year and developing countermeasures is now an urgent task. One measure enacted in 2017 by the Japanese government to prevent traffic accidents involving elderly drivers defines vehicles equipped with collision mitigation braking systems, devices that suppress acceleration when the accelerator is depressed by mistake, and advanced lighting as safe driving support vehicles, nicknamed Safety Support Car S, and takes step to raise awareness and encourage the spread of these vehicles[5]. Such efforts are made to spread active safety technologies that compensate for the deterioration of recognition, decision, and operational skills.

2. 2. 2. Safety Measures for Pedestrians and Vehicle Passengers

The basic concept of safety measures for pedestrians and vehicle occupants is defined by the importance of incorporating technology that improves recognition of drivers, pedestrians, and cyclists, and capitalizing on active safety technology to prevent collision. Specific efforts from automakers and automotive parts manufacturers include the development headlamps with advanced functionality and increased adoption of automatic lighting systems, which quickly make drivers of pedestrians or cyclists during twilight or at night, and the expansion of the range of detected objects and scenarios for collision mitigation braking systems.

2. 2. 3. Measures against Serious Accidents Involving Heavy-Duty Vehicles

Accidents involving heavy-duty vehicles such as buses and trucks tend to cause serious damage and must be actively prevented. In 2014, the Japanese government made the installation of collision mitigation braking systems mandatory for new models of buses and trucks. In addition, the government has made the installation of drive recorders and saving the data mandatory for new models starting in 2017 (2019 for registered chartered buses). Such efforts are made to spread technology that contribute to safe driving.

2. 2. 4. Adaptation to New Technologies such as Automated Driving

Phase 6 of the Advanced Safety Vehicle (ASV) Promotion Project (2016 to 2020)[6] to promote the development of ASVs, involves examining advanced technologies focused on autonomous driving and studying specific technologies. Guidelines for a driver emergency response system that utilizes autonomous driving technology that makes a vehicle pull over on a road side in case of a sudden condition change of the driver, as well as for a driver emergency autonomous detection system that utilizes cameras and sensors inside the vehicle to autonomously detect driver emergencies, were established (Fig.4). The spread of such systems is expected to help decrease accidents resulting from a driver emergency, which occur 200 to 300 times a year[7].

2. 3. Vehicle Safety Assessment Trends

Vehicle safety assessments are seen as a means of accelerating the development and spread of safety technology. Vehicle safety assessments are not only carried out in Japan, the U.S., and Europe, but also in China, the ASEAN nations, and Latin America. Test items are revised and evaluations are expanded on a regular basis. Recent trends include the introduction of active safety performance evaluations in addition to passive safety performance evaluations. Trends in Japan and around the world are presented below.

2. 3. 1. Trends in Japan

The Japan New Car Assessment Program (J-NCAP) evaluates passive and active safety performance. Recent expansions to active safety performance evaluations include broadening the scope of objects detected in collision mitigation braking system evaluations and adding the evaluation of devices that suppress acceleration when the accelerator is depressed by mistake. For 2020, there are plans to change the system from separate evaluations of passive and active safety performance to a single overall evaluation, and to add the evaluation of automatic accident notification systems[8].

2. 3. 2. Global Trends

As of December 2018, vehicles are assessed and updated every year by government organizations and insurance institutes in Europe, the U.S., China, Australia, the ASEAN nations, and South Korea. The majority of systems now make one overall evaluation of passive and active safety performance.

In Europe, the U.S., and other developed countries, there are plans to add collision evaluation methods corresponding to actual accidents and damage conditions (oblique impact test that simulates oblique frontal impact, far side lateral impact test) and add to active safety performance evaluations that account for autonomous driving (driver monitoring evaluation, damage mitigation braking system evaluation that simulates an intersection accident scenario).

Emerging countries such as the ASEAN nations and Latin American countries, are planning to introduce active safety performance evaluations adapted to their own markets in addition to passive safety performance evaluations. These active safety performance evaluations are based on the requirements in the assessments used in Europe or other developed countries.

3 Research and Technology Related to Active Safety and Autonomous Driving

The section on Enhancing Vehicle Safety in the Tenth Fundamental Traffic Safety Program[3], which stipulates broad measures regarding traffic safety in Japan, states that "in addition to implementing collision mitigation measures, every effort will be made to prevent traffic accidents, including accidents mainly caused by operation errors or other human factors, through measures based on vehicle structure". The evolution of active safety technologies and of the autonomous driving technologies they lead to is crucial to improving vehicle safety. Throughout 2018, many trends were observed in research and technology conducted in these fields.

3. 1. Active Safety Technology Trends

Automakers have been introducing collision mitigation braking systems and new technologies, as well as reducing their cost, to further popularize active safety technology. To provide further impetus to this trend, the Japanese government established the Advanced Emergency Braking System Performance Evaluation System in 2018 to certify that advanced emergency braking systems have a certain level of performance, in complement to the initiatives to promote greater implementation of the safe driving support vehicles described earlier. Information of the certified vehicles are announced on the MLIT website and are expected to serve as a means to effectively convey to users that the vehicles are certified to be safe by the Japanese government. For example, information on the certified vehicles are used in automaker propagation activities.

3. 2. Autonomous Driving Technology Trends

The Japanese government established the Public-Private ITS Initiatives & Roadmap in 2014 as a strategy for the entire government regarding ITS and autonomous driving. The roadmap promotes the objective of building and maintaining a society with the world's safest and smoothest traffic by 2030, and is revised every year. The 2018 revision lists the realization of level 3 autonomous driving technology around 2020, and of fully autonomous driving technology on expressways by 2025, in the targets for introducing private cars into the market. Discussions are taking place from the two standpoints of technological development and legal reform to realize the targets through public-private sector cooperation[9].

In terms of technological development, autonomous driving systems are being developed through government-industry-academia collaboration as part of the themes of the Strategic Innovation Promotion Program (SIP) promoted by the Cabinet Office. Since 2017, technologies in areas requiring cooperation have been assessed through means such as large-scale field tests on public roads for human machine interfaces (HMI), dynamic maps (high-accuracy three-dimensional digital maps), and pedestrian device systems to reduce pedestrian accidents.

In terms of legal systems, the MLIT established safety technology guidelines that set the operational design domain (ODD) for autonomous vehicles and defined requirements such as the need to install data recording devices[10]. The National Police Agency prepared an amended draft of the Road Traffic Act that enables level 3 autonomous driving, and aims to have it come into effect in 2020 following the 2019 ordinary Diet session.

The Japan Automobile Manufacturer Association (JAMA) is planning to seize the opportunity presented by the 2020 Tokyo Olympic and Paralympic Games to demonstrate autonomous driving technology equivalent to levels 2 to 4 autonomous driving in the regions of the Haneda airport and Tokyo Waterfront City, in coordination with the SIP demonstration project[11].

4 Research and Technology Related to Post-Accident Safety

The types of accidents that can be avoided with the advancement of active safety technology are rapidly expanding. However, real world accidents are varied and active safety technology cannot respond to all cases. Consequently, passive safety performance remains important. Authorities, research institutions, and automakers in various countries are analyzing accidents in detail to minimize damage in the event of an accident, assessing more effective technological countermeasures, and continuously studying test methods and measurement methods.

4. 1. New Test Methods and Measurement Devices

New test methods and measurement devices are continuously being researched in various countries based on surveys of real world accidents to further decrease the number of fatalities and injuries. There are movements to adopt these test methods and measurement devices for the assessment evaluations described above.

The U.S. is evaluating the introduction of an oblique test that simulates oblique frontal impact and is stricter than conventional offset impact tests. In Europe, the evaluation of compatibility rather than just vehicle protection performance will start in 2020 with the moving progressive deformable barrier (MPDB) test, which has a higher accident reproduction level for bidirectional travel. For lateral impact, there are plans to introduce a far side lateral impact test to evaluate the safety of the occupant in the seat on the side opposite the impact.

In terms of measurement devices, a next generation dummy is being developed and adopted. Since the dummy has higher biofidelity and an optical sensor is used, occupant injury in the event of a collision can be measured more accurately. For frontal impact, THOR dummies were adopted for oblique tests in the U.S. and MPDB tests in Europe. For lateral impact, WorldSIDs were adopted for conventional tests and the far side lateral impact test. Fifth-percentile female dummies that simulates the characteristics of a small female physique is also being developed for both the THOR and WorldSID models, and will eventually replace the Hybrid-III and SID-IIs female dummies presently in use. In terms of pedestrian protection performance tests, an advanced legform impactor (aPLI) with improved reproducibility of lower body behavior, is being developed to solve the issue (reproducibility of the effects of the upper body of the pedestrian) presented by the FLEX-PLI leg portion impactors presently in use. This development is carried out under the leadership of the JAMA and JARI with the goal of making it an International Organization of Standardization (ISO) international standard (IS).

4. 2. Protection Systems

Regarding protection systems, research and development are carried out to improve protection performance and to expand the protected area to cover various accident conditions, boarding positions, and physiques found in the real world.

Research on air bags is focusing on front air bags with an improved shape and larger size to improve restraint performance in the event of an oblique impact, on side air bags adapted to far side impact to prevent a collision with the occupant in the seat on the other side in the event of a collision, and on front air bags for rear seats that protect rear seat occupants. A pedestrian protection air bag which covers rigid parts of the vehicle such as the lower part of the windshield and the pillar to mitigate impact to the head and reduce damage in the event of a pedestrian accident has been commercialized.

Technology that uses active safety technology sensors to wind the seat belt and correct the seat position before a collision, optimize the occupant's posture, and optimize the timing of air bag and pretensioner triggering to improve occupant protection has been made available. In the future, coordination between protection systems and advanced technologies such as active safety technology and connected car technology is likely to further accelerate.

4. 3. Automatic Accident Notification Systems

The survival rate of a person seriously injured in an accident is greatly affected by how long it takes for that person to receive emergency medical care. Automatic accident notification systems (automatic collision notification (ACN)) that communicate the location of an accident and other information in the event of a collision are gradually coming into operation to shorten that delay. The installation of automatic accident notification systems is already mandatory in Europe and there are efforts to do the same in Malaysia and the UAE. Since the international standard related to ACN was established by the United Nations Economic Commission for Europe World Forum for Harmonization of Vehicle Regulations (WP.29), new models installed with ACN in Japan after 2020 will be required to meet the standard[12].

The U.S. has launched an advanced automatic collision notification (AACN) with more advanced functionality. The AACN determines the degree of injury based on the vehicle information transmitted at the time of the accident (e.g., collision direction, deceleration, seat belt use by occupants, and whether there are multiple impacts). In November 2015, Japan started a trial operation with the cooperation of some base hospitals with a medical helicopter service and in 2018, a framework involving 42 cooperating hospitals in 32 prefectures and all 730 fire department headquarters in Japan was established, turning the trial operation into a full-fledged one.

The above indicate how initiatives to spread ACN and AACN are becoming increasingly proactive around the world.

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