AUTOMOBILES AND SAFETY

1 Introduction

In 2017, the number of traffic accident fatalities in Japan was 3,694 people, the lowest total since the National Police Agency started recording statistics in 1948. Nevertheless, tragic accidents involving children, frequent accidents due to mistakes by elderly drivers, and tragic accidents resulting from malicious or dangerous driving such as still far too common occurrences of drunk driving, among others, continue to present a bleak outlook on achieving the government target of reducing fatalities to 2,500 or less by 2020. Dealing with such accidents will require intensified cooperation between the public and private sectors and the adoption of concrete integrated three-part measures that incorporate pedestrians, drivers, and society.

2 Traffic Accident Trends and Measures

2. 1. Traffic Accident Trends

Annually, the number of traffic accident fatalities (within 24 hours of the accident) peaked at 16,765 in 1970, before falling to 8,466 in 1979 due to a range of measures to enhance safety. Traffic fatalities then began to trend back upward, peaking again at 11,452 in 1992. Since then, the number of fatalities has fallen each year, reaching 4,113 in 2014. In 2015, fatalities rose to 4,117, a first increase in 15 years. However, in 2016, that number decreased to 3,904, and in 2017, it decreased to 3,694, a 5.4% drop over the previous year, and the lowest total among the National Police Agency statistics maintained since 1948.

The number of traffic accidents and injuries (including fatalities) has fallen since reaching a peak in 2004. In 2017, the number of injuries was 584,541, 6.1% less than in the previous year, and the number of traffic accidents was 472,165, a 5.4% decrease compared to the previous year. These numbers are at the same level as those of the late 1950s (Figure 1)[1].

The following sections outline the salient characteristics of fatal accidents in 2017.

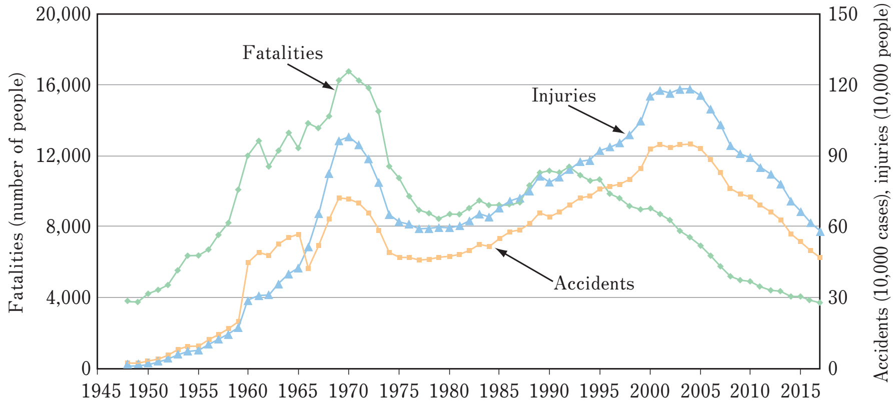
2. 1. 1. Number of Fatalities per Road User Status

The total number of traffic accident fatalities in 2017 was 3,694. Of these, 1,347 were pedestrians, which was 14 people less than in the previous year, continuing the downward trend. However, the proportion of pedestrian fatalities was 36.5%, exceeding the 33.1% proportion for vehicle occupants, a trend that has continued since 2008. The number of vehicle occupant fatalities was greatly reduced in 2017, dropping to 1,221, which was 177 fewer than in the previous year.

The number of cyclist fatalities was 480 (down 5.7% from 2016). 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 bicycle-related revisions to the Road Traffic Act, the improvement of road infrastructure, and the spread of the adoption of pedestrian-aware collision mitigation braking systems (Figure 2)[2].

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

Breaking down traffic accidents by age range shows that in 2017, there were 2,020 fatalities of people aged 65 or older, which accounted for 54.7% of the total. This number remains unacceptably high, following the number of previous year (54.8%) which was the highest ever. The number of pedestrian fatalities among all ages, including elderly people, is decreasing. However, the proportion of elderly people in the pedestrian category of fatalities was 72.2%, which is even higher than the proportion of fatalities of elderly people among the total number of traffic accident fatalities. Among the factors of fatal accidents by drivers aged 75 and over, inappropriate driving maneuvers were the most common human factor. The proportion of erroneous application of the brake or acceleration pedal by drivers aged 75 and over was 6.2%, which was especially high compared to the



Note 1) The population data used for the calculation of these statistics are from the population estimates (recalculated population as of October 1st for 1948 and 1949, and the population before recalculation as of October 1st for years other than 1948 and1949) or the population census that are from the statistical data of the previous year of the Ministry of Internal Affairs and Communications.
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 2017)

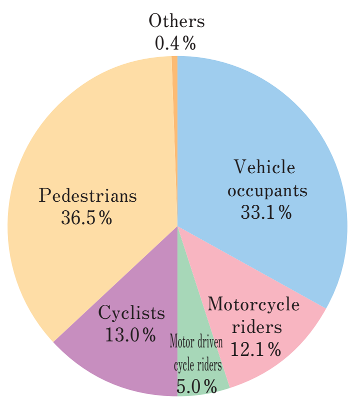


Fig. 2 Fatalities per road user status (2017)

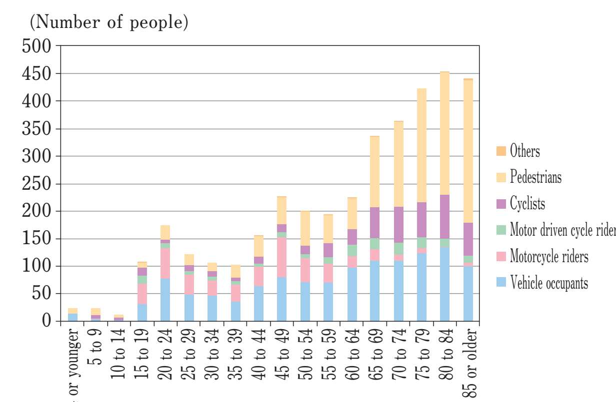


Fig. 3 Fatalities per road user status and age range (2017)

0.8% proportion for drivers under 75 (Figure 3)[2].

As Japan's society continues to age, these trends are likely to become even more significant. In addition to government-led measures to enhance traffic safety courses for elderly drivers and provide better support those who give up their license, initiatives that apply to vehicles are also becoming more and more important. These include active safety initiatives to compensate for the drop in cognitive, decision-making, and movement abilities that characterize elderly drivers, as well as passive safety initiatives adapted to the lower impact tolerance of elderly people if an accident does occur.

2. 2. Traffic Accident Measures

In March 2016, the Japanese government introduced the Tenth Fundamental Traffic Safety Program[3], which included targets to reduce the number of traffic accident fatalities and injuries to 2,500 and 500,000, respectively, by 2020. The eight measures to achieve these targets are: (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 MLIT traffic safety 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 measures. They are outlined below.

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

Measures envisioned to protect children riding in a vehicle include popularizing safe and user-friendly child seats compliant with ISOFIX and i-Size (UN R129), and promoting their proper use. Measures to protect children in the pedestrian and cyclist categories will be described in a later section.

Traffic accidents involving elderly people, as both victims and offenders, are increasing. Measures to prevent elderly people from becoming offenders include active safety technologies incorporated in the vehicle that can prevent accidents or mitigate the damage they cause, even when an elderly driver makes a mistake. Measures to prevent elderly people in the pedestrian category from becoming victims are especially important and will be described in the next section.

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

It is important to incorporate measures that apply active safety technology to prevent collisions between vehicles and pedestrians, or vehicles and bicycles, to reduce injuries to pedestrians and bicycle riders.

Auxiliary measures to improve the driver's awareness of the vehicle surroundings, such as headlamps with advanced functionality (e.g., ABD or AHB) and automatic lighting, are also perceived as effective means of improving the safety of pedestrians and cyclist at night.

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. Therefore, the installation of active safety technologies such as collision mitigation braking, electronic stability control, lane departure warning, or a camera monitoring system (CMS) provide effective countermeasures. In addition, it is also important to popularize technologies that provide safe driving assistance for drivers, such as drive recorders or systems that address abnormal driver states to ensure the safe operation of trucks or buses.

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

The theme of phase 6 of the ASV project (2016 to 2020)[5] is promoting ASVs to realize automated driving. It involves systematizing advanced safety technologies focused on automated driving and studying them more concretely with the intent of establishing guidelines for their development and commercialization, as well as working to popularize technologies, including those already completed for ASVs, for automated driving. Driver errors account for over 90% of traffic accident factors. Automated driving technology could drastically reduce accidents caused by such errors or traffic law violations such as failing to check for safety.

2. 3 Vehicle Safety Assessment Trends

2. 3. 1. Trends in Japan[6]

In 2017 the JNCAP Japanese a car assessment program started assessing lane keeping assistance systems (LKA, LDP) in active safety performance tests. The active safety assessment includes lane departure warning, lane-keeping assistance, rear view information, and collision mitigation brakes (vehicles, pedestrians). Among the eight models presented in the assessment results released in October for the JNCAP tests conducted in the first half of 2017, seven models achieved the highest rank of ASV++. With respect to the child seat assessment, vehicle models compliant with the new i-Size child seat have begun to be released.

The biggest change since the introduction of the new general assessment in 2009 will be implemented in 2018. For example, side collision testing methods for the passive safety performance assessment, the physique and injury criterion of crash test dummies for the frontal collision test, and crash test dummies for the side collision test will all change, and the size of collision simulation vehicles will increase. In the active safety performance test, assessments to tackle important issues concerning traffic accidents in Japan will be gradually implemented. Assessments are planned for collision mitigation brakes (pedestrian, nighttime), head lamps with advanced functionality, and devices that suppress sudden acceleration when the driver accidentally steps on the accelerator instead of the brake pedal.

2. 3. 2. Global Trends

In the U.S., the plan to make major changes to the US-NCAP may be altered.

In 2018, Euro NCAP is planning to expand the scope of both evaluation scenarios for collision mitigation brakes, such as scenarios including pedestrians at nighttime or cyclists, and of the assessments of lane-keeping assistance and other systems. September 2017 saw the release of Roadmap 2025, a new roadmap defining an assessment introduction plan for the period between 2020 and 2025 that proposes the new concept of the active safety field as primary safety, the passive safety field as secondary safety and other fields such as rescue after a collision as tertiary safety. Many new assessments will be introduced in all fields in and after 2020.

The trend toward broadening the scope of active safety performance assessments is spreading worldwide, and there are plans to introduce collision mitigation brakes (vehicles, pedestrians and more) in the CNCAP 2018 assessment. The introduction of collision mitigation brakes in the ASEAN NCAP and LATIN NCAP assessments in the future is under consideration. A unique initiative under consideration at ASEAN NCAP is the introduction of an assessment for blind spot detection devices for 4-wheeled vehicles.

3 Research and Technology Related to Active Safety and Automated Driving

The section on Measures for Vehicle Safety in the Tenth Fundamental Traffic Safety Program[3], states that "we will strive to prevent traffic accidents as much as possible, including accidents caused by human factors such as operation errors, through measures based on the vehicle structure". The evolution of active safety technologies and of the automated driving technologies they lead to is crucial for improving vehicle safety. Throughout 2017, research and technology in these fields continued to follow many trends.

3. 1 Active Safety Technology Trends

Automakers have been introducing collision mitigation braking systems and new active safety equipment, as well as reducing the costs of the technologies, to further popularize active safety equipment. To provide further impetus to this trend, one measure enacted by the Japanese government to prevent traffic accidents involving elderly drivers involves defining vehicles equipped with automatic braking systems, a mistaken acceleration suppression device, or both as safe driving support vehicles, nicknaming vehicles with both Safety Support Car S and vehicles with only automatic braking Safety Support Car, and establishing public-private partnerships to raise awareness and encourage the spread of these through public-private partnerships[7].

3. 2 Automated Driving Technology Trends

Among the many trends regarding automated driving technology observed in various countries in 2017, this section will focus on outlining those in Japan.

In May 2017, the Japanese government announced the Public-Private ITS Initiatives & Roadmap 2017 in coordination with the Automated Driving Systems Promotion Committee of the Strategic Innovation Promotion Program (SIP) promoted by the Cabinet Office[8]. The roadmap presents the objective of building and maintaining a society with the world's safest and smoothest traffic by 2030 through the development and popularization of automated driving systems and the establishment of data infrastructure. It addresses private cars, logistics services, and transport services separately. For private cars, technologies such as systems that address abnormal driver states, automatic accident notification systems, and pedestrian-vehicle communication technology for pedestrian collision mitigation are among the measures proposed to promote the popularization of driving safety support systems.

At the same time, large-scale demonstration tests on public roads for human machine interfaces (HMI) and dynamic maps (high-accuracy three-dimensional digital maps) were initiated by SIP in October 2017 for the purpose of validating automated driving technology. The Japan Automobile Manufacturers Association (JAMA) is planning to make use of the outcomes of the SIP tests and seize the opportunity presented by the 2020 Tokyo Olympic and Paralympic Games to carry out for demonstrations and test rides of level 2 to 4 automated vehicles in Haneda and Tokyo Waterfront City[9].

Similarly, the Japan Automobile Research Institute established a test center for automated driving (commonly known as "Jtown") in April 2017. It reproduces the conditions of actual roads and is expected to lead to advances in the development of automated driving technology. A preliminary test service in line with the Guidelines for Public Road Testing of Automated Driving Systems issued by the National Police Agency in May 2016 is available, making it possible to ascertain the capabilities of the system and driver. Expectations are being placed on the test center providing solutions to problems in areas of automated driving technology that require cooperation between industry, academia, and government, as well as establishing future evaluation methods[10].

After 2018, there are a number of plans to introduce vehicles which are installed with level 3 or higher automated driving technology into the market. Development efforts to realize more advanced automated driving are underway, but responsibility and preparing the legal framework are issues that must be promptly resolved. There is also the need to foster social receptivity of automated vehicles.

4 Research and Technology Related to Post-Accident Safety

Active safety technologies can drastically reduce the occurrence of traffic accidents. However, current active safety technologies cannot cope with all accidents, and it is difficult to completely eliminate all traffic accidents. Consequently, passive safety performance remains important. Authorities and research institutions in various countries are continuously analyzing accidents to ascertain their actual conditions, performing root cause analyses on injuries, studying technological countermeasures, and assessing new test methods or measurement devices.

4. 1. New Test Methods and Measurement Devices[11]

New test methods and measurement devices are continuously being researched and discussed based on actual accident conditions in various countries.

The U.S. is evaluating the introduction of a frontal oblique impact test that is more stringent than current offset tests and designed specifically to address oblique frontal collisions. In 2020, Europe will introduce an MPDB test that assesses compatibility with the other vehicle in a collision. Japan and China will adopt the AE-MDB barrier currently used in Europe in 2018. A far-side collision test specifically targeted at occupant protection in both near- and far-side collisions side will be introduced in Europe in 2020.

An advanced THOR dummy for frontal impact tests will be used as the measurement device in the oblique trolley and MPDB tests. An advanced WorldSID dummy for side impact tests will be used for the AE-MDB barrier and far-side tests. These dummies have higher biofidelity than conventional dummies and feature measurement devices capable of measuring the degree of injury in the event of a collision with more precision. For example, an optical sensor is used to measure the deformation of the chest and the abdomen. The Flex-PLI flexible pedestrian legform impactor, which provides an improved reproduction of the human leg, has been used in assessments of vehicle pedestrian protection performance in various countries since 2013. However, the Flex-PLI, does not account for the influence of the upper body of the pedestrian on the legform, and the inability to appropriately assess the risk of injury is an issue. An advanced legform impactor (aPLI) with improved reproducibility of human body behavior is currently being developed under the leadership of the JAMA and JARI.

4. 2. Protection Systems

Various automobile occupant protection system technologies are being refined, and new technologies are being developed. Examples include the development of center airbags that have improved passenger restraint performance in the event of an oblique frontal collision and of center airbags that restrain the passenger on the far side of collision to prevent contact with the vehicle structure pushed into the cabin as well as with the adjoining occupant. Seat belt reminders encourage passengers to wear their seat belts, and a system with an occupant detection function for all seats has been commercialized. The pedestrian protection airbag[12] which mitigates impact with rigid parts such as the pillar and the lower part of the windshield represents a technology implemented to protect pedestrian victims. With the recent popularization of active safety technology, the development of technologies that coordinate between active safety systems and occupant protection systems is likely to accelerate. Commercialized technologies that improve occupant safety include an active safety system to wind the seat belt and correct the seat position and adjust occupant posture before impact, as well as technology that optimizes the timing of seat belt pretensioner and airbag activation.

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. Emergency notification systems that communicate the location of an accident and other information automatically immediately after a collision (ACN, e-Call) are gradually coming into operation to shorten that delay. ACN and e-Call are already operating in parts of Japan, the U.S., and Europe, and efforts to regulate them and mandate their installation are moving forward. The UN WP.29 adopted standards for their inclusion in UN regulations in November 2017, and Malaysia is considering introducing e-Call starting in 2021.

In addition, parts of North America have started the operation of AACN, a system which 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, or whether there were multiple impacts). In 2015, Japan started the trial operation of an ACCN-based automatic emergency notification system

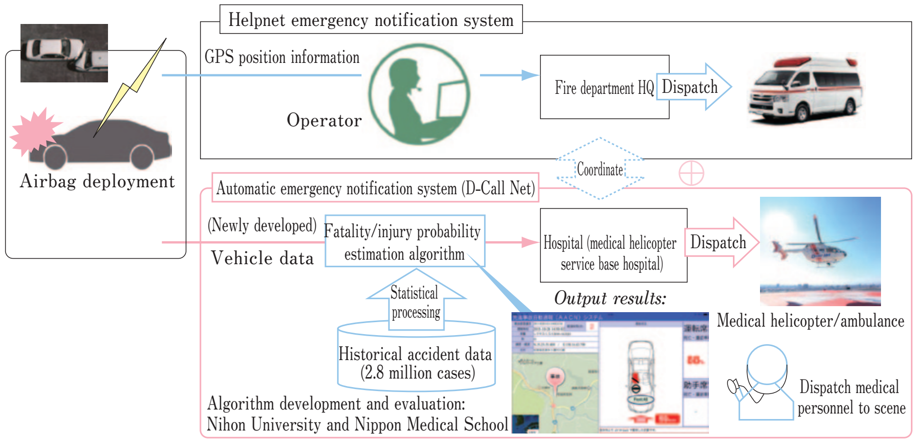


Fig. 4 Automatic emergency notification system (D-Call Net)

(D-Call Net) that determines whether to dispatch a medical helicopter at an early stage (Figure 4) [13]. The ACN T/F has been actively discussing means of spreading automatic emergency notification systems, and JNCAP released a list of models equipped with ACN/AACN in 2017. The performance assessment methods for ACN/AACN are under discussion and scheduled to be introduced to the JNCAP in 2018.

References

(1) Transportation Bureau, National Police Agency: 2017 Occurrence Situation of Traffic Accidents, https://www.npa.go.jp/news/release/2018/20180213001H29zennjiko.html (in Japanese)

(2) Transportation Bureau, National Police Agency: Characteristics of Fatal Traffic Accidents in 2017, https://www.npa.go.jp/publications/statistics/koutsuu/H29siboumatome.pdf (in Japanese)

(3) Cabinet, Office, Government of Japan: 10th Basic Plan of Traffic Safety, http://www8.cao.go.jp/koutu/kihon/keikaku10/index.html (in Japanese)

(4) Ministry of Land, Infrastructure, Transport and Tourism: Automobile Panel, Land Transportation Section Meeting, Traffic Policy Council: Future Safety Measures of Automobiles Aiming to Achieve Society without Traffic Accidents, http://www.mlit.go.jp/common/001137710.pdf (in Japanese)

(5) Ministry of Land, Infrastructure, Transport and Tourism: 6th Period Promotion Plan for Advanced Safety Vehicles (ASV), http://www.mlit.go.jp/jidosha/anzen/01asv/resourse/data/asv6pamphlet.pdf (in Japanese)

(6) Ministry of Land, Infrastructure, Transport and Tourism: Road Map of Automobile Assessment (2017), http://www.mlit.go.jp/jidosha/anzen/02assessment/data/h29_1_6.pdf (in Japanese)

(7) Ministry of Economy, Trade and Industry: Website of Support Car and Support Car S (Support car for Safe Driving), https://www.safety-support-car.go.jp/ (in Japanese)

(8) Prime Minister of Japan and His Cabinet: 2017 Road Map of ITS Framework by Government and Private Sector, http://www.kantei.go.jp/jp/singi/it2/kettei/pdf/20170530/roadmap.pdf (in Japanese)

(9) Japan Automobile Manufacturers Association, Inc.: Action towards 2020 Tokyo Olympic and Paralympic Games, http://www.jama.or.jp/tokyo2020/innovation/vision/ (in Japanese)

(10) Japan Automobile Research Institute: Evaluation Site for Self Driving (Jtown), http://www.jari.or.jp/tabid/142/Default.aspx (in Japanese)

(11) Humanetics Crash Test Dummies, http://www.humaneticsatd.com/crash-test-dummies

(12) SUBARU OFFICIAL WEBSITE, https://www.subaru.jp/impreza/impreza/safety/safety3.html (in Japanese)

(13) Toyota Motor Corporation: Toyota Global News Room, https://newsroom.toyota.co.jp/en/detail/10403699