ANALYSIS OF THE EFFECT OF REDUCING ACCIDENTS INVOLVING PEDESTRIANS THROUGH THE COORDINATION OF ACTIVE SAFETY AND PASSIVE SAFETY

Yuichi Omoda
Yuji Arai
Kazunori Kikuchi
Ryohei Homma
Hisashi Imanaga
Japan Automobile Research Institute
Japan

Nobuhiko Takahashi
Japan Automobile Manufacturers Association
Japan

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ABSTRACT

In order to efficiently reduce traffic fatal accidents, it is important that all parties involved in traffic safety (traffic participants, road infrastructure, and vehicles) work in unison to implement countermeasures. For this purpose, it is necessary to analyze the reduction effects of vehicle safety measures, the limitations of vehicle safety measures, and the accident patterns that remain after the vehicle safety measures are taken. In this study, the fatal accident reduction effect of vehicle safety measures combined with active and passive safety technologies was estimated for the accidents involving pedestrians, which are the most common type of fatal traffic accidents in Japan. In addition, the characteristics of fatal accidents in which vehicle safety measures are not currently addressed are summarized.

First, we estimated the extent to which pedestrian fatalities can be reduced through the AEB for pedestrians and improvement of pedestrian head protection performance. For the remaining fatal accidents, we estimated the number of fatal accidents that could be reduced by expanding AEB functions (additional fatal accident reduction effects are expected by increasing AEB corresponding scenarios) and by other vehicle safety measures (advanced emergency steering systems, etc.). This clarifies the extent of fatal accidents that have not yet been addressed by vehicle safety measures. This study used accident data collected by the Japan Institute for Traffic Accident Research and Data Analysis (ITARDA) from year 2015 to 2017. The analysis assumed a vehicle safety measure penetration rate of 100%.

It was found that the number of fatal accidents could be reduced by 20% and 29% by the AEB for pedestrians and improving the performance of pedestrian head protection in the daytime and nighttime, respectively. It could also be observed that AEB function expansion and devices other than AEB covered approximately 38% and 23% in the daytime and nighttime, respectively. The results suggest that the accident reduction effect of AEB for pedestrians is significant, but that 42% and 48% of accidents are left behind even when the functional enhancements of AEB and other vehicle safety measures are added up in the daytime and nighttime, respectively. In order to further reduce the number of accidents left behind, it is efficient to to promote not only vehicle safety measures but also measures for the society as a whole.

PURPOSE

The number of traffic accident fatalities in Japan was 2,636 in 2021 [1], and although it is steadily declining, the downward trend has slowed. In particular, the proportion of pedestrians in the number of traffic accident fatalities is increasing, and under the safety concept of putting people first, the safety of pedestrians must be ensured. To achieve a society without traffic accidents, more effective and efficient traffic safety measures must be strongly promoted throughout all parties involved in traffic safety (traffic participants, road infrastructure, and vehicles).

To that end, we first need to estimate the effect of currently anticipated measures (i.e., the number of traffic accident fatalities reduction effect), then, organize the issues for reducing the number of accidents further after the implementation of such measures, and propose new measures with a view towards cooperation that is based not only on vehicles but on people and the road as well. In terms of vehicle safety measures, there are active safety technologies and passive safety technologies, and when estimating the effects of such measures, the combination of both technologies are assumed to produce continuous effects in light of the chronological flow of accidents (Figure 1). Therefore, it is ideal to estimate accident reduction effects by combining the two technologies.

However, there are only a few cases in which the effects of combining the two technologies were estimated.

The purpose of this study is to promote initiatives aimed at eliminating traffic accident fatalities. To that end, we attempted an analysis to derive the traffic accident fatality reduction effect by combining active safety technologies and passive safety technologies, with a focus on fatal accidents involving pedestrians. Furthermore, we analyzed the characteristics of fatal accidents that are currently not addressed in vehicle safety, and organized the perspectives for future safety measures.

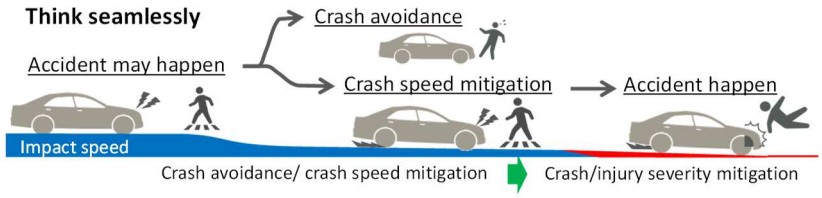


Figure 1. Concept of vehicle safety measures by combining active safety and passive safety with pedestrian accidents

ANALYSIS METHOD

Overall policy

Figure 2 shows the basic concept of the analysis. In this study, we aimed to classify the areas that can be addressed by vehicle safety measures and those that are difficult to address with vehicle safety measures, and accidents corresponding to each area were aggregated using national traffic accident statistical data (macro accident data). The areas that can be addressed by vehicle safety measures were further subdivided into three areas: active safety measures (Advanced Emergency Brakes (AEB)), passive safety measures, and other vehicle safety measures. For the reduction effects of active and passive safety measures, we targeted the typical equipment in the pedestrian accident, and when estimating the reduction effect of passive safety measures, we aimed to avoid overlap with the reduction effect of active safety measures. This method is described in detail in two next Section. As for other vehicle measures, equipment that is not yet widespread but whose dissemination is expected in the future was selected, and the areas of the target accidents were indicated.

Figure 3 shows the analysis flow for pedestrian accidents. First, we focused on AEB for pedestrian (henceforth, "AEB"), a typical item of active safety measures for reductions that can be expected in vehicle safety measures against pedestrian accidents. The accidents within the scope of AEB operation were classified into those for which reductions can be expected and those for reductions would be difficult (fatal accidents that would be targeted by AEB but for which reductions could not be achieved owing to the decreased performance of the AEB = reduction difficulty). Next, we estimated the extent to which fatal accidents involving pedestrians among accidents for which AEB reduction is difficult and accidents that are not targeted by the AEB could be reduced by designing vehicles with improved pedestrian head protection performance. We also estimated the area of other vehicle safety measures. Specifically, we estimated the number of fatal accidents that could be reduced by enhancing the AEB functions (i.e., additional fatal accident reduction effects can be expected by widening the sensing range and thereby diversifying the AEB response scenarios) or other vehicle safety measures (e.g., device for pedal misapplication prevention, automatic high beam, Advanced emergency steering system). The remaining accidents are currently unaddressed fatal accidents that cannot be addressed through vehicle safety measures.

In this estimation, we targeted accidents from 2015 to 2017, when the AEB had just begun to spread, and assumed that the AEB dissemination rate was 0%. We estimated the number of fatal accidents that would be reduced if the AEB were 100% disseminated.

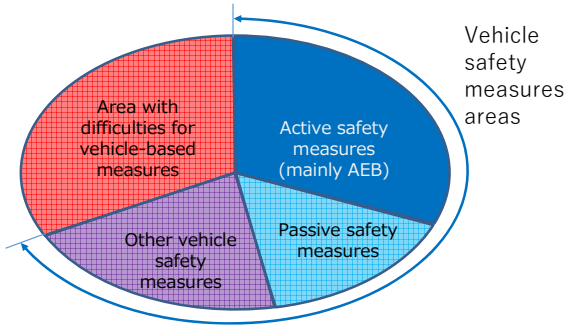


Figure 2. Accident classification method

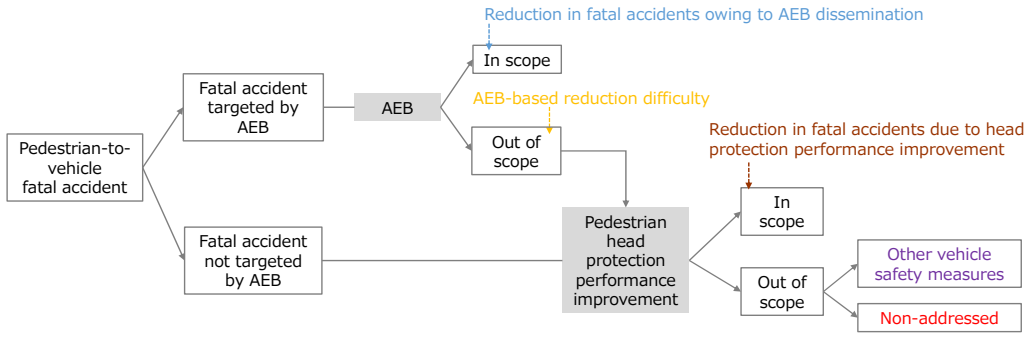


Figure 3. Pedestrian accident analysis flowchart

Estimation of fatal accident reduction effect of AEB

We used the macro accident data to estimate the effect of the AEB on fatal accident reduction. The basic idea of estimating the accident reduction effect was to calculate the number of accidents that can be prevented by equipping the vehicle with an AEB. The target AEB-installed vehicles were four-wheeled vehicles (ordinary passenger + light(Kei) passenger + regular cargo + light(Kei) cargo) for which the Japan New Car Assessment Program (JNCAP) started evaluation tests from FY2016 and future installation was expected. Figure 4 shows the procedure for effect estimation. First, we extracted the accident scenes where accident reduction could be expected by the AEB according to its function (i.e., accidents targeted by AEB). The commercially available AEB applies brake control when the system determines that a collision is unavoidable based on the distance and speed of a pedestrian crossing the road as the vehicle is traveling straight ahead, and the conditions for extracting a specific accident were set as listed subsequently. Additionally, it is difficult to address scenes in which a pedestrian suddenly rushes out of a blind spot. Therefore, in addition to the extraction conditions, accidents involving a pedestrian “rushing out” in violation of the law were excluded as being out of the scope of support. Accidents within the extraction conditions were aggregated, regardless of whether four-wheeled vehicles driver's fault or not.

- Accident type: pedestrian-to-vehicle accident(as pedestrian crosses road)
- Action type: driving straight ahead
- AEB Operating speed range: driving speed (hazard recognition speed for four-wheeled vehicles) not exceeding 60 km/h
- Pedestrian law violations: other than rushing out

The 2021 JNCAP AEB for pedestrian test results indicate that most of the vehicle models tested earned perfect scores. Therefore, it is assumed that AEB could prevent fatalities in all extracted accidents. However, the JNCAP results were obtained under limited conditions, and in an actual traffic environment, the AEB may not operate normally even within the above extraction conditions (i.e., conditions in which it functions) owing to the weather or the state of the detection target (i.e., when the contour of the entire pedestrian's body is vague, such as when the pedestrian is slouching or wearing a raincoat) [2]. Excluding such conditions from the aggregate conditions of the macro accident data, although desirable for more precise prediction of effects, is difficult. Therefore, in this study, we estimated the extent to which the number of accidents were reduced after the introduction of AEB by applying a coefficient for converting the JNCAP evaluation results under limited conditions into performance under the actual environment (i.e., traffic environment application coefficient).

The Ministry of Land, Infrastructure, Transport and Tourism [3] evaluated the degree to which accidents were reduced by an AEB with average performance. In the study, macro accident data (2016) were used to estimate the accident rate of vehicles with and without an AEB (number of accidents per 1,000 vehicles per year), as shown in Table 1. The daytime accident reduction rate (which expresses the number of accidents that can be avoided by equipping a vehicle with pedestrian AEB) were 35.7%. However, this value was attributed to not only the AEB performance but traffic environment factors as well. Therefore, we investigated the JNCAP results, which indicated the AEB performance, to extract traffic environment factors. The JNCAP performance evaluation results of AEB in the same period as the evaluation' period are summarized in Table 2. For example, at a test speed of 30 km/h, 95.8% of the vehicles successfully stop in front of the pedestrian target (=accident reduction rate); however, at 60 km/h, the accidence reduction rate, at 33.3%, was different as a result of speed, and the range was 33.3–95.8%. The accident avoidance rate of the AEB was applied to the accident data from 2015–2017 and it was found that the AEB reduced the accident rate by 76.4% (=10687.39/13980) on the average. Therefore, the traffic environment application coefficient was calculated as 0.467 (=0.357/0.764). Strictly speaking, it is possible that the traffic environment application coefficients during the day are different from those at nighttime. However, in this study, we assumed that they were the same.

Table 3 shows the final reduction effect of the AEB. In 2015–2017, there were a total of 3,441 accidents involving pedestrian fatalities, 1,855 of which were within the scope of AEB operation. Of this number, a total of 866.29 cases (=1855×0.467) were found to be reduction cases.

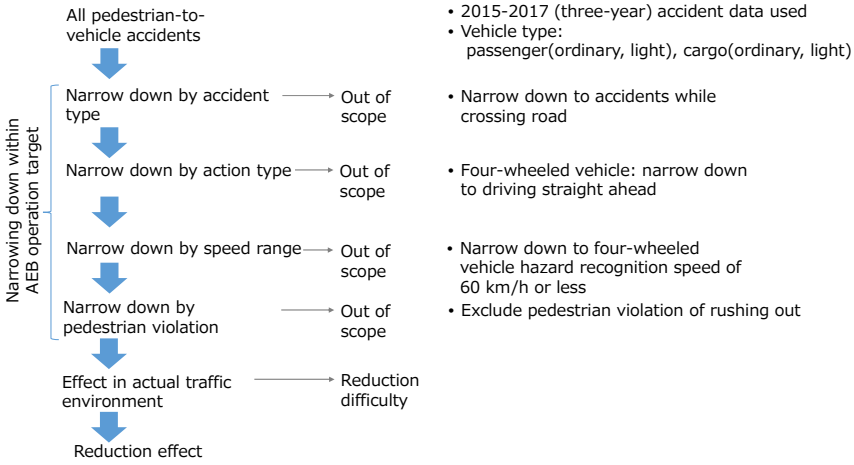


Figure 4. Reduction effect estimation flowchart for AEB for pedestrian

Table 1. Average AEB for pedestrian accident reduction rate (daytime)[3]

Accident rate (number of accidents per 1,000 vehicles per year)	Equipped	0.09
	Unequipped	0.14
Accident reduction rate		35.7%

（Accident reduction rate）＝1 - (Accident rate of equipped vehicle) / (Accident rate of unequipped vehicle)

Table 2. Test results of AEB for pedestrian in JNCAP (daytime) and estimated number of accident reductions

		Collision speed (km/h)						
		Collision Avoidance	≤10	≤20	≤30	≤40	≤50	≤60
Initial speed (≒Hazard recognition speed) (km/h)	≤10	44.4%	55.6%	-	-	-	-	-
	≤20	81.9%	0.0%	18.1%	-	-	-	-
	≤30	95.8%	1.4%	0.0%	2.8%	-	-	-
	≤40	76.4%	1.4%	11.1%	6.9%	4.2%	-	-
	≤50	61.1%	0.0%	2.8%	8.3%	15.3%	12.5%	-
	≤60	33.3%	0.0%	19.4%	6.9%	4.2%	4.2%	31.9%

Hazard recognition speed (km/h)	Number of accidents	Accident reduction
≤10	2097	931.07
≤20	3761	3080.26
≤30	3741	3583.88
≤40	3142	2400.49
≤50	1004	613.44
≤60	235	78.26
Total	13980	10687.39

Table 3. Fatal accident reduction effect of AEB for pedestrian

Hazard recognition speed [km/h]	≤10	≤20	≤30	≤40	≤50	≤60	≤70	≤80	≤90	≤100	＞100	Others	Total
Total number of pedestrian to vehicle fatal accidents	248	327	276	720	921	648	195	66	15	10	8	7	3441
AEB targeting fatal accidents	4	24	120	515	693	499	–	–	–	–	–	–	1855
Fatal accidents reduction by AEB	1.87	11.21	56.04	240.51	323.63	233.03	–	–	–	–	–	–	866.29

Estimation of fatal accident reduction effect by pedestrian head protection performance improvement

A majority of injuries to pedestrians in fatal accidents are head injuries. Therefore, a shock-absorbing structure for the front part of the vehicle, such as a bonnet hood, has been adopted as a technology for pedestrians as a passive safety measure. In this study the reduction effect of this measure were analyzed.

Figure 5 shows the relationship between all pedestrian accidents and accidents where fatalities could be avoided by improved pedestrian head protection performance. The reduction effect (s) was obtained by multiplying the pedestrian head protection target accident (S) with the effect (E) arising from the improved pedestrian head protection. Pedestrian head protection performance is considered effective in accidents where fatalities cannot be prevented by the AEB. Therefore, it is crucial to prevent overlapping effects with AEB when estimating the effect of improved pedestrian head protection on fatal accident reduction. We estimated the effect through the following procedure.

1) Estimate the number of fatal accidents that could be prevented by improving head protection performance ($s_{\alpha+\beta+\gamma}$)

2) Estimate the number of fatal accidents that were avoided with AEB that could be avoided by improving head protection performance (s_β)
3) Estimate the number of fatal accidents that could be avoided by improving head protection performance, excluding the overlapping effect with AEB ($s_{\alpha+\beta+\gamma}$ - s_β)

Of all pedestrian accidents, those that are targeted by head protection $S_{\alpha+\beta+\gamma}$ were extracted by applying the following restrictions.

- collision site where a pedestrian collide : “front of four-wheeled vehicle”
- body part of a pedestrian mainly injured: “head”

Accidents where fatalities were prevented by the AEB and were subject to head protection (S_β) were obtained by limiting the AEB accident reduction effects in the previous section to those subject to head protection.

For improvement of the pedestrian head protection performance, we estimated the degree to which fatal accidents could be reduced if vehicles with performance equivalent to JNCAP Level 5 became widespread. The effect is assumed to the difference in the fatality rate between the average performance of vehicles from 2010 to 2017 and the performance of vehicles that acquired JNCAP Level 5 during the same period. Figure 6 shows the the results of fatality rates by speed (number of fatal accidents / (number of fatalities + serious injuries + minor injuries)), and Figure 6(b) shows the fatality rate by speed, as estimated by logistic regression, based on Figure 6(a). It can be confirmed that JNCAP Level 5 had a lower fatality rate over a wide speed range.

Table 4 shows the number of fatal accidents that were reduced by improving the pedestrian head protection performance. The estimated result after excluding the overlap with the final AEB was 41.50 cases.

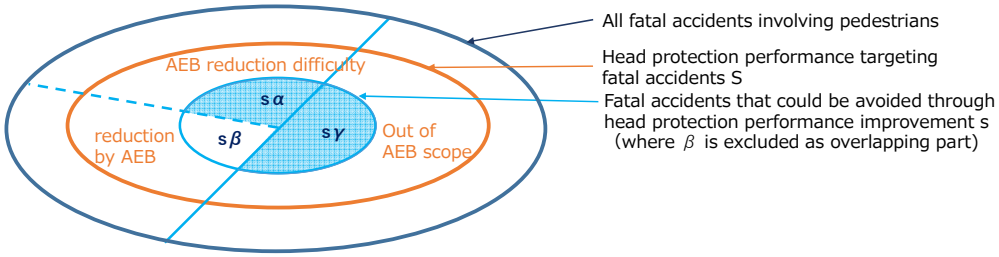
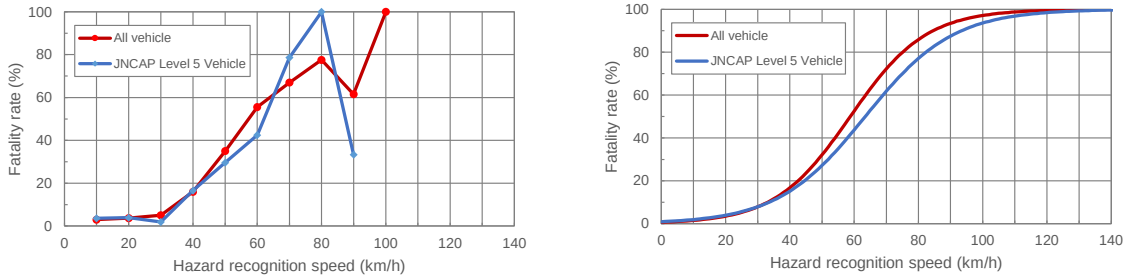


Figure 5. Relationship between AEB for pedestrian and number of fatal accidents that could be reduced by pedestrian head protection performance



(a) Actual data *(b) Logistic regression curve*

Figure 6. Fatality rate by hazard recognition speed

Table 4. Reduction effect of improved head protection performance

Hazard recognition speed [km/h]		≤10	≤20	≤30	≤40	≤50	≤60	≤70	≤80	≤90	≤100	Total
Number of fatal accidents	$S_{\alpha+\beta+\gamma}$	38	81	75	280	357	254	89	34	8	4	1220
	S_β	1.40	1.40	15.41	88.26	125.16	88.26	–	–	–	–	319.90
Fatality rate reduction %	E	-0.41	-0.43	-0.01	1.58	4.92	8.85	10.43	8.81	5.96	3.52	–
Fatal accident reduction	$s_{\alpha+\beta+\gamma}(=S_{\alpha+\beta+\gamma}\times E)$	-0.16	-0.35	-0.01	4.42	17.56	22.48	9.28	3.00	0.48	0.14	56.85
	$s_\beta(=S_\beta\times E)$	-0.01	-0.01	0.00	1.39	6.16	7.81	–	–	–	–	15.35
	$s_{\alpha+\gamma}(=s_{\alpha+\beta+\gamma}-s_\beta)$	-0.15	-0.34	-0.01	3.03	11.41	14.67	9.28	3.00	0.48	0.14	41.50

Survey of other vehicle safety measures

In this section, we summarize the initiatives for vehicle safety measures other than AEB and pedestrian head protection performance improvement. We made selections based on technologies that target pedestrian accidents among the technologies summarized in the ASV (Advanced Safety Vehicle) Technologies Overview [4] as initiatives of other vehicle safety measures. The selections were divided into two categories: enhancements of

AEB function and devices other than AEB. Devices that are mainly intended to reduce driving-related burdens (i.e., devices classified as driving load reduction control) were excluded from this study.

Enhancements of AEB function

In the ASV Technologies Overview, driving assistance technologies for passenger cars, which are positioned as an accident avoidance support control function with a function for controlling braking devices include low-speed vehicle peripheral collision mitigation braking devices (Peripheral sonar with brake) and rear obstacle collision mitigation braking devices(Rear cross traffic advanced emergency brake). It was not clearly specified that the target accident is a pedestrian-vehicle accident for any of the devices. However, it is expected that the devices will be expanded in the future.

Current AEB were designed mainly to respond to events in which a vehicle equipped with this function traveling "straight ahead" collides with a "pedestrian crossing the road" . However, improvements in pedestrian detection performance can expand the events that can be handled. Meanwhile, the NCAP in each country has started to evaluate AEB performance for bicycle accidents and intersection accidents [5], [6]. For example, if the device can respond to rear-end collisions with bicycles, then it can be expected to reduce the number of collisions with pedestrians facing or backing to a vehicle, and collisions when vehicle are overtaking or passing a pedestrian. Additionally, the ability to respond to accidents at intersections is expected to detect pedestrians when the vehicle is turning left or right at intersections. Table 5 shows the expected accident reduction areas by the AEB function expansion.

Table 5. Areas expected to benefit from AEB function expansion

Device name	Accident type	Vehicle behavior type	Vehicle speed range
Low-speed vehicle peripheral collision mitigation braking device	・While working on road, ・While playing on road	・Other than backing up	・Low-speed range
Rear obstacle collision mitigation braking device	・Other than while lying on road	・Backing up	・Low-speed range
Expanded AEB pedestrian detection range (rear-end collision)*	・While crossing road, ・Facing to vehicle / back to vehicle, ・While standing on road	・Straight ahead, ・Overtaking / passing, ・Changing course,	・Low- / medium-speed range
Expanded AEB pedestrian detection range (intersection)*	・While crossing road ・Facing to vehicle / back to vehicle ・While stationary on road	・Left / right turn, ・While turning	・Low-speed range

Low-speed range: 30 km/h or less; medium-speed range: 30 km/h –60 km/h; high-speed range: >60 km/h
*Not name of device

Devices other than AEB

Accident types that are difficult to address using AEB include "accidents in which the brake pedal is mistaken for the accelerator" and "accidents when the speed range is high". In both cases, there may be interference between the AEB brake control and the driver's operation, such that the device may be unable to actively intervene in braking. To avoid interference with the driver's operation, driving support system generally prioritize the intention of the driver [7], and in the event of an accident in which the driver accidentally steps on the accelerator instead of the brake, the device may prioritize the driver's accelerator position. Therefore, it is difficult for the system to intervene in braking even if the driver operates the accelerator pedal by mistake. Pedal misapplication prevention device compatible with pedestrians detection is expected to spread in the future [8].

On high speed, avoidance by steering is more effective than avoidance by braking [9]; therefore, braking interventions by the device are delayed to avoid interference with the driver's steering avoidance operation. An advanced emergency steering system, which was commercialized in 2017 [10], may be able to respond to accidents in the high-speed range. The device enables pedestrian accident avoidance by intervening in steering when pedestrians are in front of the vehicle and it is impossible to avoid an accident using AEB alone.

Another type of accident that is difficult for AEB to address is "the accidents when pedestrian lies on the road (road-lying accidents)". In road-lying accidents, the pedestrian who is lying on the road can have a variety of postures, and it is currently considered technically difficult to respond to such pedestrians using AEB [11]. Advanced lights may enable drivers to better detect pedestrians, thus avoiding road-lying accidents. Advanced lights include four devices related to headlights, high-intensity headlights, variable orientation headlights, automatic switching headlights, and automatic anti-glare headlights. Among these devices, automatic anti-glare headlights will reduce accidents, considering that the "majority of nighttime pedestrian accidents occurred while driving with low beams, and that it has been indicated that in many cases, such accidents may possibly have been avoided if driving with high beams" [12]. It is difficult to obtain the effects of high beams at low-speed ranges. Therefore, there are many vehicle models in which the device operates at medium-speed ranges (over 30 km/h)

and higher.

From the above results, the pedal misapplication prevention device, advanced emergency steering system, and automatic anti-glare headlights are considered specifically effective for accident types that are difficult to address using AEB. Table 6 shows the accident areas in which devices other than AEB are expected to have an effect. The area where the effects of these devices are expected may overlap with the area of AEB function expansion. However, in the case of overlap, we decided to prioritize the AEB function expansion.

Table 6. Areas where vehicle safety measures other than AEB are expected to be effective

Device name	Accident type	Vehicle behavior pattern	Speed range etc.
Pedal misapplication prevention device	Unlimited	Unlimited	・Low-speed range ・Operational error
Advanced emergency steering system	・Other than during crossing	・Straight ahead	・Medium-/high-speed range
Automatic anti-glare headlights	・Lying on road	・Straight ahead	・Medium-/high-speed range ・Night

Low-speed range: 30 km/h or less, medium-speed range: between 30 km/h and 60 km/h, high-speed range: over 60 km/h

RESULTS AND DISCUSSION OF THE STATUS OF INITIATIVES TO REDUCE FATAL ACCIDENTS INVOLVING PEDESTRIANS THROUGH VEHICLE SAFETY MEASURES

Results

Figure 7 shows the results of categorizing fatal accidents involving pedestrians according to daytime and nighttime. These data were the total number of fatalities from 2015 to 2017. The accident reduction estimation were carried out in case that the dissemination of AEB and improvement of pedestrian head protection performance is 100%. Meanwhile, the areas of other vehicle safety measures are areas where not all accidents can be reduced by the other vehicle safety.

Figure 7 shows that, the rate of fatal accidents can be reduced by approximately 20% and 29%, respectively, by dissemination of AEB and improvement of pedestrian head protection performance in the daytime and nighttime. It could also be observed that AEB function expansion and devices other than AEB covered approximately 38% and 23% during the daytime and nighttime, respectively. Meanwhile, when combining the areas where accident reduction with AEB is difficult and those that are not addressed (by current vehicle safety measures), the areas that it is difficult for the vehicle safety measure to prevent fatal pedestrian accident are left approximately 42% and 48% of fatal accidents in the daytime and nighttime, respectively.

Characteristics of non-addressed areas

Figure 8 shows the categorization of fatal accidents involving pedestrians by hazard recognition speed and by day/night. Three areas with many accidents can be observed as characteristics of the “non-addressed” areas: (1) low-speed range (30 km/h or less) in daytime; (2) high-speed range (over 60 km/h) at night; and (3) low-speed range (30 km/h or less) at night. Therefore, we further analyzed the characteristics of accidents in each area according to the accident location.

(1) Low-speed range in daytime

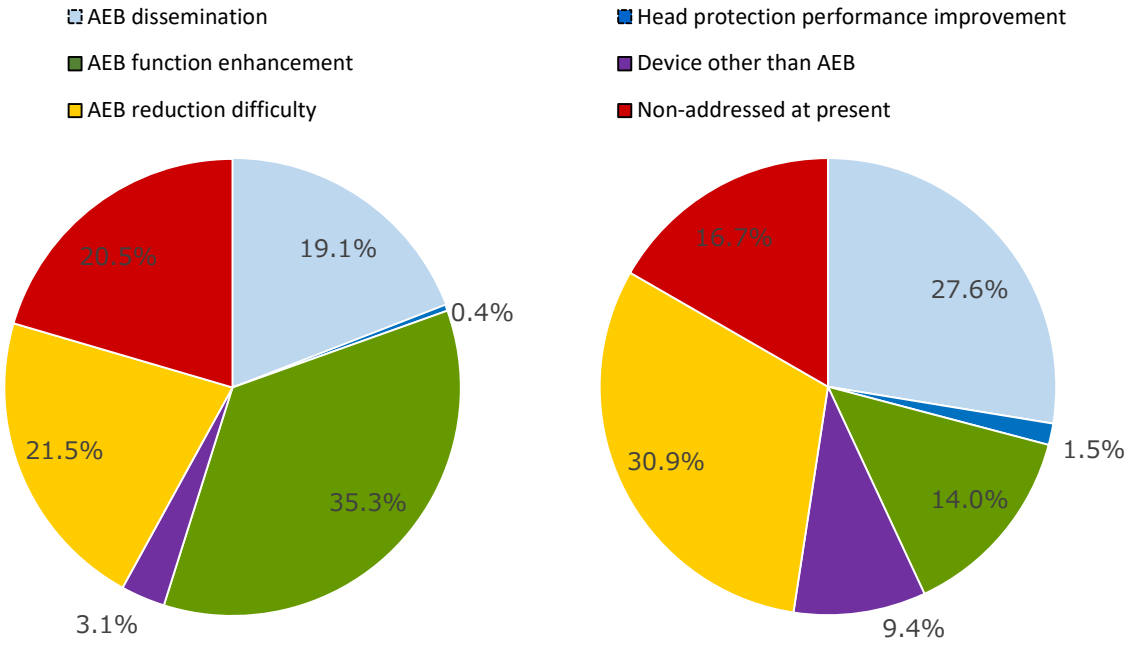
Figure 9 shows the number of fatal accidents in non-addressed areas according to accident location and speed range. Figure 9(a) shows that there were 153 cases at the low-speed ranges of 30 km/h or less during the day, which accounted for approximately 77% of the total. Of these, approximately 45% (=69/153) occurred in other locations used for public traffic, which include parking lots of stores, as well as squares, vacant lots. In the future, it is important to take measures against accidents that occur in such locations. However, in the macro accident data classification, the types of accidents that occur in other locations used for public traffic are often classified as “other”, which makes it difficult to glean details from such data.

(2) High-speed range at night

Figure 9(b) shows that there were 215 cases at high-speed ranges exceeding 60 km/h during the night, which accounted for approximately 53% (=215/406) of the total. Of these, 205 occurred in areas equivalent to arterial roads with a road width of 5.5 m or more (henceforth, referred to as “arterial road”). Furthermore, of the 205 cases, 67% (=138/205) occurred within the speed range of 60 km/h– 70 km/h; fatalities can be avoided by increasing the operating speed range of the current AEB or by individual and technical approaches to make drivers keep speed limit.

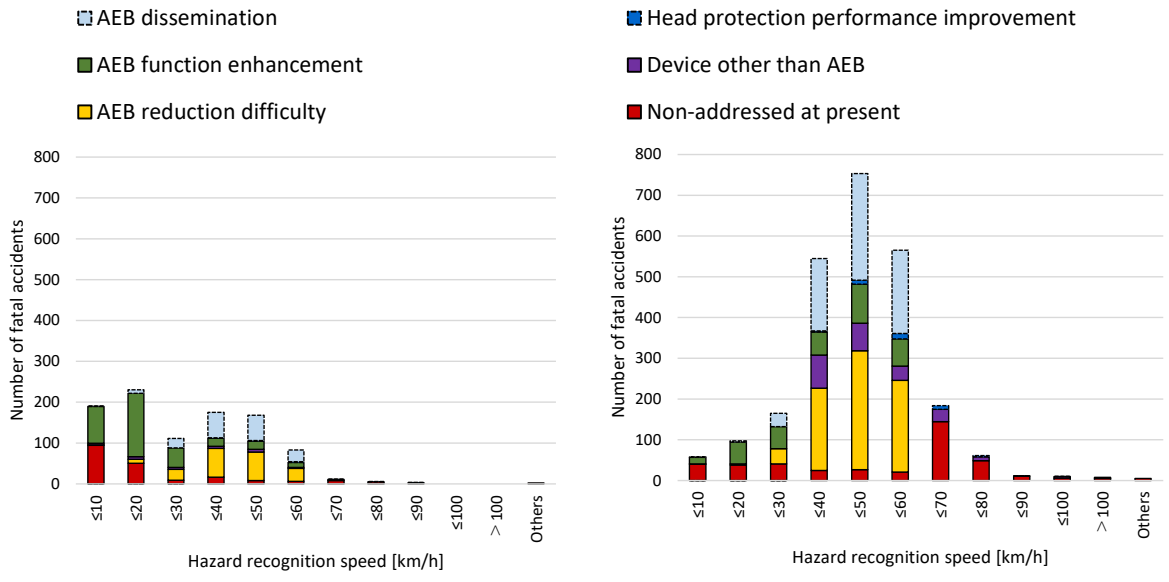
(3) Low-speed range at night

During the nighttime, 119 cases within the low-speed ranges, accounting for approximately 31% (=119/385) of the non-addressed areas at night. Furthermore, of the 119 cases, 73 were road-lying accidents, which are difficult to address using the current AEB [11]. Fatal accidents can be further reduced by considering safety measures that are not dependent on the vehicle only.



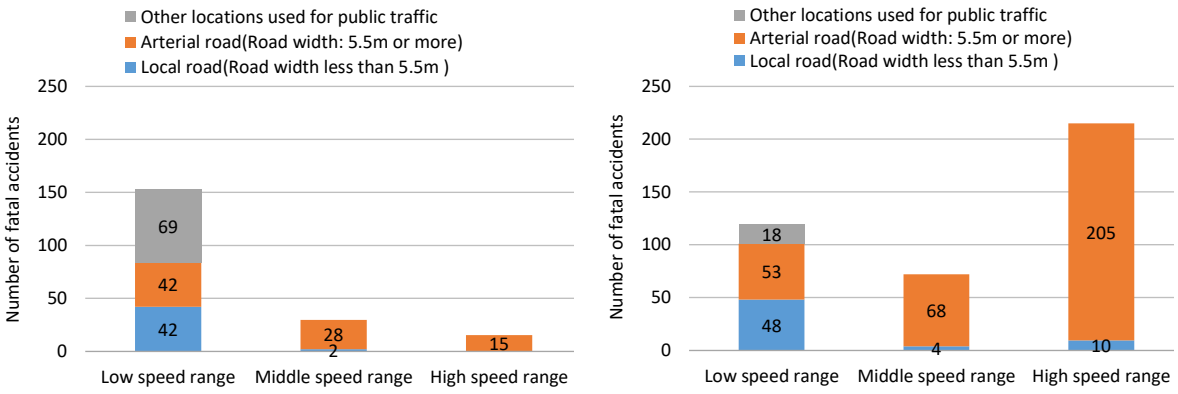
(a) Daytime (978) *(b) Nighttime (2463)*

Figure 7. Ratio of vehicle safety measures against pedestrian accidents (at 100% dissemination)



(a) Daytime (978) *(b) Nighttime (2463)*

Figure 8. Ratio of vehicle safety measures against pedestrian accidents by speed (at 100% dissemination)



(a) Daytime (198) **(b) Nighttime (406)**

Figure 9. Non-addressed areas by accident occurrence location and speed range (speed range = other excluded)
Low-speed range: 30 km/h or less; medium-speed range: 30 km/h– 60 km/h; high-speed range: > 60 km/h

Analysis issues

In this study, we expressed situations where the AEB could not operate normally owing to the weather or the state of the detection target, even if the conditions are favorable, using the traffic environment application coefficient that was calculated from the evaluation results of AEB. The results showed that there were many areas (AEB reduction difficulty) where pedestrian accident reduction with AEB was difficult within the speed range of 30 km/h– 60 km/h. To investigate the safety measures in this area, it is important to investigate the actual conditions under which these accidents occurred. It is necessary to collect data that enables the analysis of situations where AEB does not function.

CONCLUSION

In this study, we organized the status of initiatives for vehicle safety measures for pedestrian traffic accidents to promote not only vehicle safety measures but also measures for the society as a whole to achieve zero traffic accident fatalities. The status of initiatives refers to such as AEB and pedestrian head protection performance, as well as other vehicle safety measures whose effects are unknown but which are taken to reduce fatal accidents. These were then organized by day/night and speed. These analyses showed that areas in which vehicle safety measures are currently not implemented account for approximately 42% and 48% of fatal accidents in the daytime and nighttime, respectively.

In the future, it is expected that such quantitative results serve as a basis for not only considering additional vehicle safety measures but also for collaborations with such as road and traffic administrators, to efficiently achieve goals toward zero fatalities. In particular, there are increasing expectations for safety measures that utilize communication technology (vehicle to everything: V2X), and it is necessary to specifically investigate the direction of measures that utilize V2X. Furthermore, although this study was the analysis of pedestrian accidents, similar studies are necessary for bicycle accidents, which are also related to vulnerable road users.

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