

DEVELOPMENT PLAN FOR ASSESSMENT TECHNOLOGY OF ADVANCED SAFETY VEHICLE

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ABSTRACT

Although an automobile is a necessity and a convenience in the modern era, traffic accidents take a great toll on the society, both economically and socially. Korea has the unenviable record being one of the highest traffic accidents and fatality rates. In 2009, there were 5,838 fatalities on the roads. A new and systematic approach to safety policy development is necessary to reduce traffic casualties.

The goal of this research is the development of advanced safety vehicles and relevant assessment technologies. The results will make a contribution to Korea's national goal of "Reducing Traffic Casualties by Half." There are four objectives in this research; the first objective is to develop technology that can reduce casualties in vehicle accidents, the second one is to establish advanced safety standards, the third one is to develop assessment technology for safety features integrated with information technology and the last one is to support the establishment of policies that can stimulate the commercialization and market penetration of these vehicles. The development plan was established with following criteria, such as the economic feasibility, safety enhancement, timeliness and redundancy under the above goal.

The research priorities were set after many elements were taken into consideration, such as target population to be protected, fatality reduction effects, technical feasibility and prospects. The planned timeline spans 7 years and 9 months, from December 2009 through September 2017 [1]. The research is divided into three stages; to reflect market variations and other development that cannot be foreseen at this moment the latter two stages will be finalized in the final year of the 1st stage which will end in 2012. The research subjects in the Stage 1 are as follow; vehicle compatibility, speed-sensitive active head restraint, commercial vehicle automatic emergency brake

system, lane departure warning system, blind spot warning system, adaptive front light system and emergency rescue system.

The results of this research will eventually lead to the standardization, establishment of laws/regulations, safety criteria and vehicle safety ratings. This research could be used as resources the development of global technical regulations in UN/ECE/WP.29. It is hoped that this project will stimulate the growth of advanced safety vehicle market and have a synergy effect with the integration of the latest information technology. This project was supported by the Ministry of Land, Transport and Maritime Affairs of the Republic of Korea. Eleven research institutes, including the Korea Automobile Testing and Research Institute, Hyundai Motor Company and Seoul National University take part in this project.

BACKGROUND

The damages caused by car accidents, not only injure people and their finances, but are also very detrimental to society at large; in order for a country to join the ranks of the most industrialized nations, car accidents should be dealt with as an issue at the social level. The "Accident Free Driving" vision has been established in all the leading industrialized countries and various policies and cutting edge auto technology have been put in place over the past 10 years to reduce the number of casualties. For example, in the past 10 years, the U.S. has set a reduction of 30% in casualties as their stated goal, as have the EU with a 50% reduction target and Japan, also slated for 50%.

While the necessity to create vehicles with advanced safety features to reduce the number of casualties through the convergence of intelligent technologies is currently being proposed, a new assessment method for advanced safety devices for automobiles should be developed to test the latest

technology, thereby reducing the negative effects to boost Korea's entry into the high-tech safety market.

Although improvements in auto safety, road infrastructure and driver education are needed in order to successfully reduce accidents, the development of assessment technology for advanced safety vehicles is necessary for better auto safety standards. Thus, the characteristics of accidents both in Korea and overseas need to be examined first. Then, it is necessary to discover the technology that can drastically reduce accidents based on this examination, allowing us to come up with detailed measures to commercialize the new technology.

By integrating safety with IT, a field Korea excels in, and an advanced safety vehicle that can greatly contribute to the government's aspiration to "Reduce Traffic Casualties by Half" should be developed. Accordingly, an assessment method for testing vehicles with advanced safety features should be organized and developed. The two developments could synergistically create new jobs and accelerate entry into the market for this new technology. The movement to establish an international set of standards for automobiles has been moving forward lately. Moreover, as one of the leading car manufacturing countries, Korea should conduct basic research to have an active voice in UN/ECE/WP.29 ECE Regulations and Global Technical Regulation (GTR).

ANALYSIS OF VEHICLE ACCIDENTS

Vehicle Accidents Data

According to 2007 figures, the number of traffic accidents per 100,000 people in major Organization for Economic Co-operation and Development (OECD) countries are 651.5 for Japan, 580.5 for the U.S., 436.8 for Korea, 407.6 for Germany, 308.5 for the UK and 132.1 for France (Figure 1). The trend between 1990 and 2006 for the same figure has been drifting downward on an overall basis, but the rate of traffic accidents for the U.S. has had the biggest reduction. This is a surprising finding, since the U.S. has the lowest dependence on public transportation and thus has a concomitant high car accident rate. Japan's figure was on the rise until 2000, but it has recently been decreasing mainly due to the increased ratio of elderly people.

The number of deaths from car accidents per 100,000 people is: 13.7 for the U.S., 12.7 for Korea, 7.5 for France, 6.0 for Germany, 5.2 for Japan, 5.0 for the UK and 5.1 for Switzerland. The OECD average is 9.1 deaths. Although the number of auto accidents per

100,000 in Korea is lower than in Japan or the U.S., the number of deaths from these accidents in Korea is double the Japanese figure and slightly lower than those for Americans. While the UK has a similar population density with Korea, the figures for fatal car accidents are far lower, which is an indication of advanced accident prevention measures; the low figures for France and Germany, where high-speed driving is common, are noteworthy (Figure 2) [2],[3].

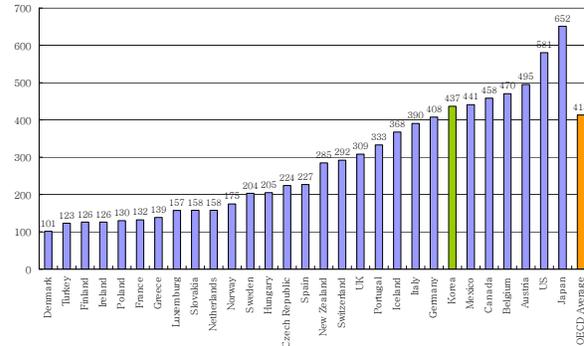


Figure 1. Number of Traffic Accidents per 100,000 People (OECD) [2],[3].

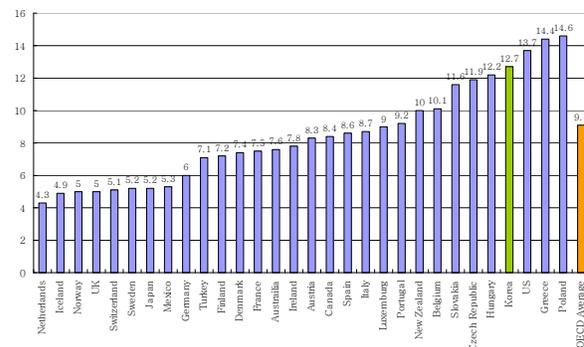


Figure 2. Number of Death from Car Accidents per 100,000 People (OECD) [2],[3].

Vehicle Accidents in EU 15

Road fatalities per 1 billion vehicle-km for Korea are about double the OECD average; compared to the UK, which has the lowest such figure, Korea has 3 times the number of fatalities. Road fatalities are too high relative to the number of accidents and hint at the gravity of the levels of fatal accidents on the road. Road fatalities of children under 14 per 100,000 people are 2.3 for Korea, 2.8 for the U.S., 0.9 for the UK, 1.0 for Germany, 0.8 for Japan. The OECD average is 2.1 children and Korea's figure is nearly 2

times as high compared to the others. The Korea's pedestrian death rate is much higher than any industrialized nation at 37.4%. Poland follows with a 34.9% rate. This is because the number of vehicle-to-people accidents is relatively higher.

Single vehicle accidents cause the highest death toll in absolute numbers and are accountable for more than one third of all fatalities. About 5% of all single vehicle accidents result in the death of an occupant, significantly more than the 3.4% average for all collision types. Pedestrians are also at a higher risk during a crash. Crashes at crossings or during turning bear a relatively low risk and result in a death in less than 2% of all collisions of this type. Similarly, rear-end collisions rarely cause fatalities and only account for 6% of all deaths, significantly less than their 15% share in the total accident number (Figure 3).

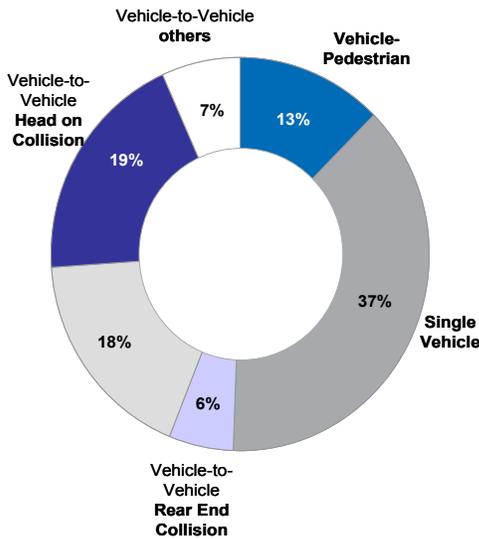


Figure 3. Number of Fatalities by Collision Type in EU15 [1].

Vehicle Accidents in Korea

Fatal crashes have been reducing over the past few years, but the rate of reduction itself has been at a relative standstill lately. In addition, the number of people injured from crashes has been increasing in investigations conducted by insurance companies, but the same figure has stayed the same according to police records. In 2007, there were 6,166 fatalities on the road; but the government reports 340,000 injured people, while insurance company reports 1.2 million injured (Figure 4).

Pedestrian accidents cause the highest death toll in absolute numbers and are accountable for 36.2% of all

fatalities. Crashes at crossings or during turning bear a relatively high risk. Single vehicle accidents are also at a higher risk during a crash. Rear-end collisions are account for 11.8% of all deaths. Head-on collisions are comparatively rare and account for 8.7% of all deaths (Figure 5).

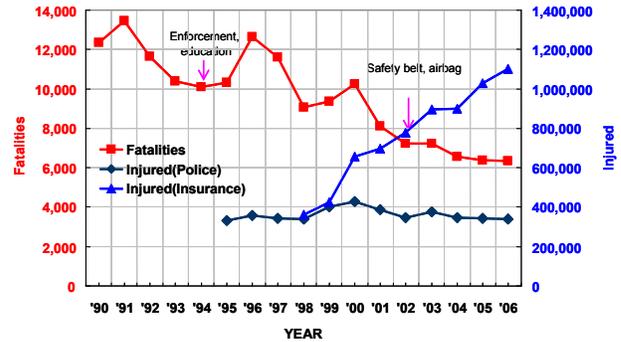


Figure 4. Trend of Accident Casualties in Korea [2].

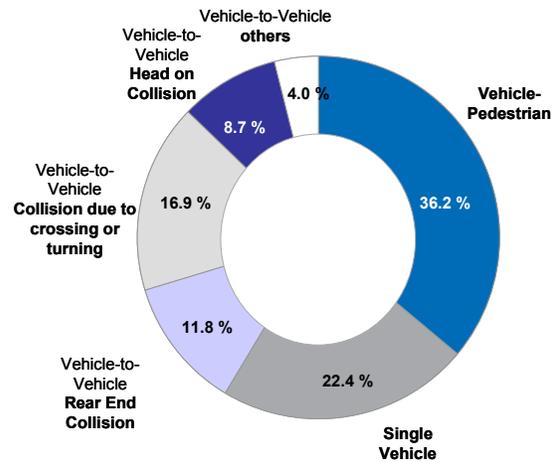


Figure 5. Number of Fatalities by Collision Type in Korea [1],[2].

With the increase in the number of Sport Utility Vehicles and Recreational Vehicles, the ratio of compact cars per SUV+RV has been increasing as well: from 0.08 in the late 1990s to 0.68 in mid-2000's. This also suggests the need to secure vehicle-to-vehicle safety measures as well. The highest number of deaths occurs for side impact, rear-ending and head-on collisions respectively, while the number of pedestrian deaths still make up a high percentage at 40. Also, as night activities are on the rise, the number of nighttime fatal crashes is also increasing. Although intersections take up only a small percentage of the

entire road, accidents occur most frequently at intersections (44%) due to the concentration of traffic in urban centers. There are fewer fatalities at the site of the accident (1,488 people) compared to deaths while in treatment (2,443 people), which demonstrates the need for prompt after-care. As for injuries from crashes, cervical (46%) and lumbar (29%) spine injuries from vehicle-to-vehicle rear-end collisions are occurring at an alarming rate. This calls to attention the importance of reducing neck injuries from rear impacts.

TECHNOLOGICAL ADVANCES

So far, advances in collision safety devices, such as seatbelts, airbags, improvements in the frame and ABS (Anti-lock Braking System) have greatly helped to reduce the number of casualties in traffic accidents. The focus of new research is on preventative safety devices like driver assistant functions and on reducing or avoiding the collision in case of an accident. At present, safety integrated with IT is advancing at an exponential rate and developed countries are on the verge of commercializing the new technology based on rather extensive research.

Many countries are coming up with policies and other ways to increase their overall safety levels, such as putting together databases on accidents and injuries, to help determine the cause and device response measures to reduce casualties in traffic crashes. By applying advanced safety technology in the development process, cars are now lighter and could alleviate traffic congestion, even potentially reducing exhaust and greenhouse gases (CO₂).

The adaptive front lamp system, Adaptive Cruise Control (ACC), blind spot detection systems and other functions can help the driver in normal driving conditions. The ACC uses a laser mounted on the radiator grill that can detect the distance from the car ahead, so that a safe buffer distance can be maintained. In case of a problem while driving, the ABS and the ESC can keep the vehicle stable. The ESC reduces or controls the momentum of the vehicle if the wheels lose bearing power or the chassis is unstable.

Functions to alarm the driver include the Tire-Pressure Monitoring System (TPMS), Lane Departure Warning System (LDWS) and the Lane Keeping System (LKS). Functions that can avoid collision or reduce the impact, as well as the Automatic Emergency Braking System (AEBS) have increased driver safety by enhancing safety and convenience. Research on the Human Machine Interface (HMI), which can equip the driver with information for

convenience and safety, is being actively carried out in leading industrialized countries.

Recently, the power of IT has been added to all this and cars can now play the role of moving offices. The biggest characteristic of an advanced safety vehicle technology is that it prevents accidents or reduces injuries by reducing the collision speed. The effects of advanced safety features are also great, as an 18% reduction in accidents was reported for AEBS and 12% for LDWS [5]. To meet consumers' expectations who seek proactive safety and convenience, vehicles with electronic and IT integrated safety features are rapidly being developed. Vehicle-to-vehicle information exchange (infrastructure needed) systems are currently being developed so that data could be exchanged via satellite or a nearby network to prevent accidents.

As such, vehicles have advanced to the point that they can detect dangers on the road and are becoming intelligent enough to control themselves. However, this is only possible as long as the sensors and various high-tech devices on the vehicle are properly functioning. If they were to malfunction, smart vehicles could be at even greater risks on the road than conventional ones. Safety standards for AEBS and LDWS are currently being drafted in the U.S., Europe and UN/ECE/WP.29 and discussions on diverse safety features will gain momentum in the future.

RESEARCH OBJECTIVES AND TOPICS

Research Objectives

The vision of this research is to make a contribution to Korea's national goal of "Reducing Traffic Casualties by Half" through the development of advanced safety vehicles and relevant assessment technologies. The objective of the research is to develop technology that can reduce casualties in car accidents, to establish advanced safety standards, to develop assessment technology for safety features integrated with IT and prepare policies that can stimulate market penetration and practical uses for these vehicles. The development plan proposed here is based on the above vision and on such objective criteria as the economy, safety, timeliness and redundancy.

Research Topics

Mitigation of Casualties

- Vehicle compatibility

- Speed-sensitive active head restraint to protect neck injuries in rear-end collisions
- Protecting passengers in rollover accidents
- Injury criteria database
- Protecting pedestrians and bicycle riders through active hood and bumper technology

Improved Active Safety Technology

- Passenger vehicle ACC
- Commercial vehicle AEBS
- Lane Departure Warning System
- Blind Spot Warning System
- Adaptive Front Lamp System
- Passenger vehicle AEBS
- Commercial vehicle ACC
- Lane Keeping System
- Detecting pedestrians at nighttime
- Human factor for active safety

Safety Integrated with IT

- Emergency rescue
- V2X Infrastructure communication
- Intersection based on V2I communication
- Stability of integrated electromagnetic compatibility
- V2X control system

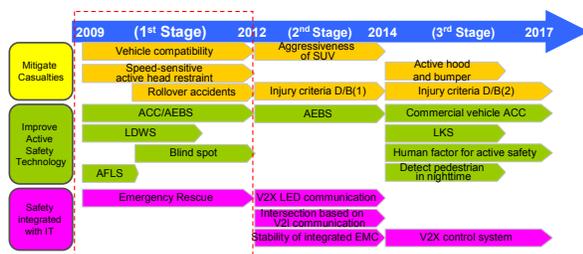


Figure 6. Development Plan for Assessment Technologies of Advanced Safety Vehicle.

The selected research priority took many elements into account, factoring in target population, reduction effects for number of fatalities, potential, concreteness and prospects. About 11 research institutes will

participate, including the Korea Automobile Testing and Research Institute, Hyundai Motor Company and Seoul National University. The planned timeline spans 7 years and 9 months, from December 2009 through September 2017. The estimated budget is at 20.6 billion KRW (18 million US\$). The research will be divided into stages 1, 2 and 3; the latter two stages will be planned in the future, after 3 years into stage 1, to reflect market variations and other situations that cannot be foreseen at the moment (Figure 6).

Research Stage 1

The details of Stage 1 of the research, which runs from December 2009 to September 2012, are as follow.

Mitigation of Casualties

- Vehicle compatibility: compatibility enhancement measures for frontal/side collisions between a passenger vehicle and an SUV/RV
- Speed-sensitive active head restraint: preventative measure for neck injuries in rear-end collisions
- Protecting passengers in rollover accidents: minimize injuries to passengers due to roof crush in rollover accidents by finding design constraints of roof

Improved Active Safety Technology

- Passenger vehicle ACC: support the driver to take on some of the driver's responsibility
- Commercial vehicle AEBS: enhance driving safety of commercial vehicles
- Lane departure warning system: prevent accidents by alarming the driver when the vehicle moves out of the lane due to drowsiness or inattentiveness
- Blind Spot Warning System: detect obstructions in blind spots and notifies the driver to prevent accidents
- Adaptive Front Lamp System: control the lower beam depending on speed and adapt to highway driving

Safety Integrated with IT

- Emergency rescue: in case of an accident, automatically sends information on location and time of accident, vehicle data, and passenger's vital signs to allow for rapid emergency rescue response

CONCLUSIONS

Developing assessment technology for advanced safety vehicles that can contribute to the agenda of Korean government to "Reduce Traffic Casualties by Half" will not only reduce accidents in Korea but also enhance automobile technology in the future. Furthermore, lower numbers for traffic crash casualties can be expected with AEBS (18%) and LDWS (12%) technologies. This research could be used as basic material for the enactment of WP.29 global technical regulations stimulate the growth of advanced safety vehicle markets and have a synergistic effect with the integration of the latest IT technology.

The results of this research could also contribute to the founding of a new traffic environment with the expertise that affect real life, with standardization, enactment/amendment of laws/regulations, safety criteria and car safety ratings. By putting together a comprehensive body injury database, the results of the accident analysis could be used as basic material for the development of advanced safety vehicles and assessment technologies. Finally, an enhanced national image from the drastic reduction of auto accidents and road fatalities can also be expected.

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