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Research Article

A Study on Application of Advanced Automobile Safety Features and their Implication on Road Traffic Accidents and Road Fatalities

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Abstract

Improving vehicle safety is a key strategy used in addressing international and national road casualty reduction targets and in achieving a safer road traffic system. Vehicle safety addresses the safety of all road users and currently comprises measures to help avoid a crash (crash avoidance) or reduce injury in the event of a crash (crash protection).Road traffic injuries are a major but neglected global public health problem, requiring concerted efforts for effective and sustainable prevention. Of all the systems that people have to deal with on a daily basis, road transport is the most complex and the most dangerous. Worldwide, the number of people killed in road traffic crashes each year is estimated at almost 1.2 million, while the number injured could be as high as 50 million – the combined population of five of the world's large cities. What is worse, without increased efforts and new initiatives, the total number of road traffic deaths worldwide and injuries is forecast to rise by some 65% between 2000 and 2020 , and in low-income and middle-income countries deaths are expected to increase by as much as 80%. Improving vehicle safety is a key strategy used in addressing international and national road casualty reduction targets and in achieving a safer road traffic system. In the computer era the technology had grown leaps and bounds in almost all the fields. So many advanced vehicular safety equipment are available in the market to select from. This paper analyse about some of the advanced vehicular s afety features, its implications and importance of having them in the vehicles and the need of making some mandatory.

Key words: *Road Traffic Accidents, Accident prevention, Ignition Interlocks, Drunken Driving, Active and Passive Safety Features*

1. Introduction

With the advent of New Technology and increasing vehicular population, occurrence of Accidents have become almost inevitable and the number of accidents are increasing day by day, taking toll of more human lives equally or at times more than any natural catastrophe. The increasing rate of accidents is a real problem, that has to be tackled in real-time, by drawing up of a comprehensive action plan, involving various components of Traffic Engineering Measures, Enforcement Action plans, Educational tools/techniques, which needs co-ordination of more than one agencies/techniques/concepts.

Vehicle design is fundamental to a safe traffic system which requires safe interaction between users, vehicles and the road environment. Vehicle design, which takes account of the behavioural and physical limitations of road users, can address a range of risk factors and help to reduce exposure to risk, crash involvement and crash injury severity. To date, vehicle engineering for improved safety has usually been directed towards modifying a vehicle to help the driver avoid a crash, or to protect those inside in the event of a crash.

Advance technology had often been advocated as a means of significantly reducing the incidence and severity of road crashes. For example, a radar alerting breaking system will prevent or moderate, one of our most destructive and daily occurrences, the rear – end collision. In recent years there has been a resurgence of interest in the development of high technology crash countermeasures; possibly as a result of significant advances in miniaturisation of electronic equipment and the use of micro-electronics in vehicle ignition, braking and performance monitoring.

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2. Causes of road accidents

The causes of road accidents are classified as Human Related, Vehicle Related, Road Related and Environment related factors. Of which most of the studies reveals that about 90% of the road accidents are Human Related.

A 1985 report based on British and American crash data, found that driver error, intoxication and other human factors contribute wholly or partly to about 93% of crashes. (Harry & Reagan, 1995).As shown in Figure 1,it is found that 57% of crashes were solely due to driver factors, 27% to combined roadway and driver factors, 6% to combined vehicle and driver factors, 3% to combined roadway, driver, and vehicle factors, 2% solely to vehicle factors and 1% to combined roadway and vehicle factors.

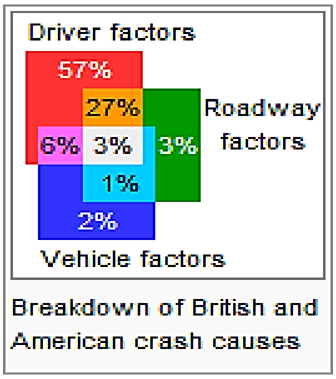
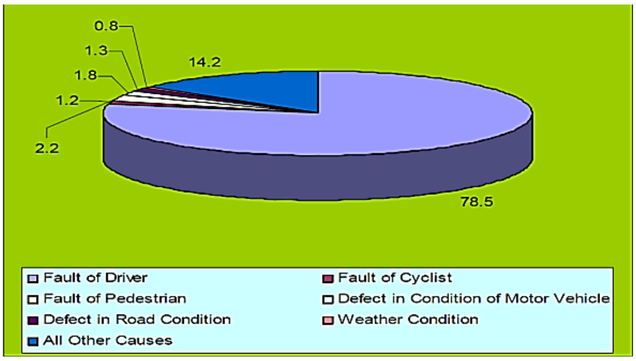
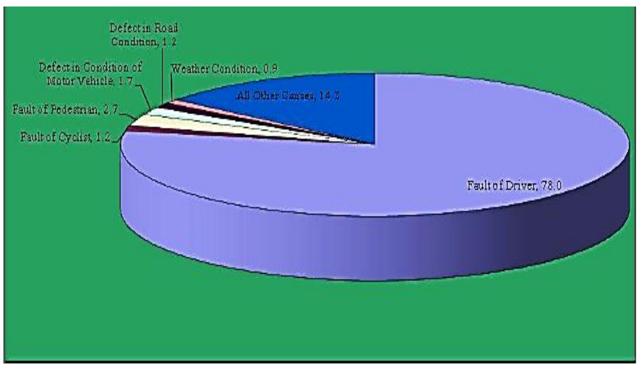


Figure 1

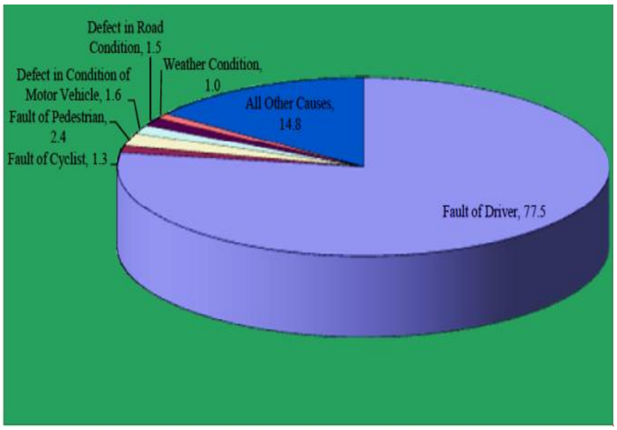
The total number of Road Accidents in India where there are more number of road fatalities is 146361, of which 102620 were due to Human Errors during 2011.The details of Road accidents according to their causes in India in which about 78% are due to human faults over the past three years is shown in Figure 2.



2009



2010



2011

Figure 2 Road traffic accidents in india according to causes

Total number of accidents and fatalities and the accidents and fatalities due to Human Errors over the past three years is given in Table 1, Figure 3 and 4.This will clearly indicate that about 78% of the accidents occur due to Drivers' errors and hence it will be very much necessary to find out the controlling measures for the human factors which is the cause of road accidents.

Table 1Total number of accidents and fatalities

Year	**Total No. of RTAs**	**Total Fatalities**	**RTAs due to Drivers' Error**	**Fatalities due to Drivers' Error**
2009	486384	125660	381648	90053
2010	499628	134513	389885	100319
2011	498471	146361	385806	102620

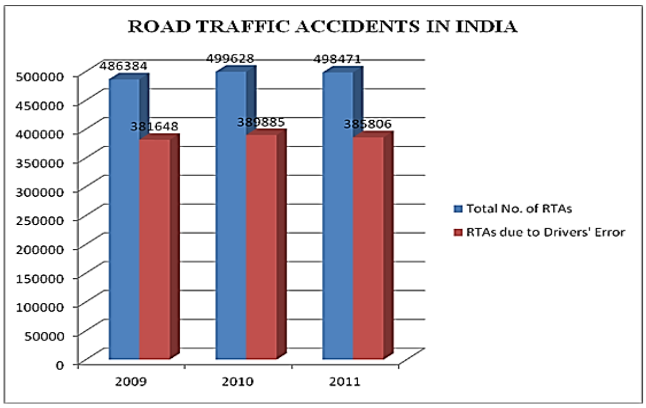


Figure 3

An analysis of mishap-related statistics in six years from 2006 by the Maharashtra State Road Development Corporation, India (MSRDC), indicates that eighty-four per cent of accidents on the Pune-Mumbai expressway are human error driven. Such being the scenario a system which permits human errors should be designed, i.e., the road geometry should permit human errors and in the same way the vehicle should be designed to permit human errors and assist to prevent the same.

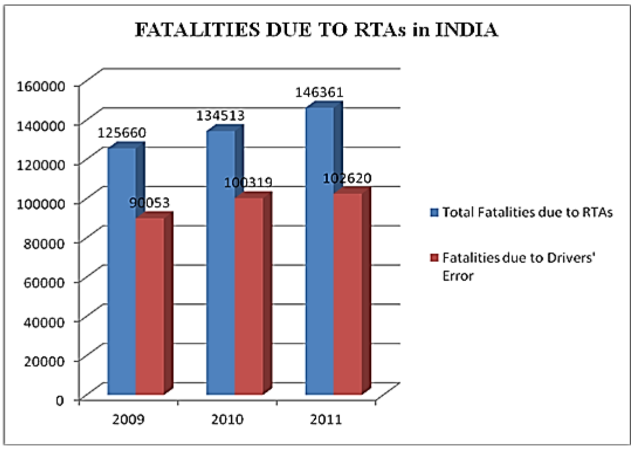


Figure 4

Comparison between total road accidents, fatalities and RTAS , fatalities due to drivers' error in India

3. New technologies and advanced safety features

Society thinks this Road Accident is a behavioural problem, rather than a problem that requires both changes to behaviour and technology. But by applying the latest technologies we can save many persons from fatalities and major injuries. This doesn't mean that let people drive irresponsibly or as they wish but to save lives from some unintentional errors by providing latest innovative technologies.

In recent years, there has been rapid and significant development of road transport technologies. At one extreme, the technology is now available for vehicles to drive safely in traffic independent of human input (though deployment is still some way off). At the other extreme, some quite simple technologies (such as seatbelt wearing detection) could dramatically reduce fatalities if compulsory in vehicles for all seats. Even in countries that have achieved very high rates of seatbelt wearing (95% or higher) through publicity and enforcement campaigns, unbelted drivers are considerably over-represented in fatality statistics. Technology is likely to be the most cost-effective way to target the remainder of unbelted drivers whose lives could be saved.

Vehicle safety technologies primarily include on-board sensors that collect data and on-board units (OBUs) that issue warnings or take partial control of the vehicle. The advantage of these systems is that they can warn the driver of potential dangers or override to some degree the driver's control of the vehicle in attempt to avoid collisions. These benefits are only available to vehicles equipped with such on-board equipment. Some unresolved issues concerning these systems include the need to ensure reliability and establish system standards to avoid driver confusion and potential dangers due to variations in commercially available OBUs. Moreover, it is important to make drivers aware of the extent to which the system is able to reduce danger, in order to avoid excessive reliance on OBUs.

Safe use of in-vehicle technologies can be ensured by:

- User-friendly design, taking into account human limitations (distractibility, limited memory, field of view, attention, etc).
- Integrated solutions (*e.g*. automatically turning down the radio when a phone call comes in or turning off the computer when the vehicle is moving).
- Adaptive solutions (*e.g*. adapted to driving conditions).
- Standardised testing procedures of the total task load (visual, cognitive manual).

3.1. Active and passive safety features

The terms "active" and "passive" are simple but important terms in the world of automotive safety."Active safety" is used to refer to technology assisting in the prevention of a crash and "passive safety" to components of the vehicle (primarily airbags, seatbelts and the physical structure of the vehicle) that help to protect occupants during a crash. Active safety features, like anti-lock braking systems, traction control and electronic brake distribution, are meant to avoid an accident. Passive safety features, like in-built crumble zones in the monologue body shell which deform in a head-on collision to absorb the energy of the oncoming vehicle, are being to protect the driver and passengers inside the vehicle when an accident occurs despite the functioning of the various active safety systems. Airbags, side impact beams in the doors and collapsible steering columns are other examples of passive safety systems.

During the past decade car safety technology has changed in emphasis, according to Russ Rader of the Insurance Institute for Highway Safety, or IIHS. That change has been from "passive" safety technology to "active" technology. In the past, safety features have been about protecting people in crashes. Now it's about preventing crashes.

Six active safety technologies that are either proven or do hold promise:

Electronic stability control or ESC: the biggest game changer in auto safety in years. ESC is built on ABS. Sensors determine when the vehicle isn't going where its pointed, and uses the ABS to brake the appropriate wheels to get it back on course.

Lane departure warning: Recognizing when the vehicle is unintentionally drifting out of its lane, it alerts the driver. Sophisticated systems, like that on the 2011 Infiniti M, will even nudge the vehicle back on course. This system will have a similar impact on accident reduction as roads with warning rumble strips dividing their lanes. On such roads, there has been a 25 (percent) to 30 percent decrease in head-on, sideswipe and run-off-the-road accidents.

Collision warning with automatic braking: Using radar similar to that for adaptive cruise control, this system senses when the traffic ahead is slowing or stopped. It alerts the driver with an audible warning and will bring the car to a stop if he fails to react.

Blind-zone warning: Sensing when another vehicle is approaching your vehicle's flanks, this system alerts you with a warning light and/or audible alarm. One factor that might reduce its effectiveness is that when the warning light is on the outboard mirror, some drivers simply don't use.

Emergency brake assist: This system determines when the driver is applying the brakes in a panic situation and applies more brake quicker. Not only might it prevent some crashes but it may reduce the severity of a crash.

Adaptive headlights: These headlamps pivot in response to where the front wheels are pointed, helping illuminate around curves on dark roads.

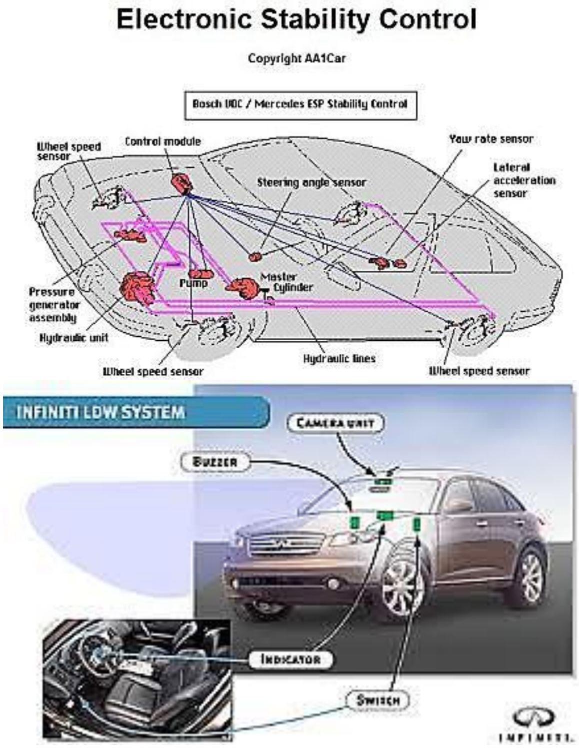


Figure 5 Electronic stability control and lane departure warning system

3.2. Must have safety features

At present India's congested roads are the deadliest in the world. The automobile tragedy is one of the most serious of these manmade assaults on the human body. Most of the following safety features are mandatory for the vehicles in American and Europe which is not so in India. Making these as mandatory will certainly will have good impact and save so many lives.

- Anti-lock braking systems (ABS)
- Electronic Brake force distribution systems
- Automatic Braking system to prevent or reduce the severity of collision
- Seat belts limit the forward motion of an occupant, stretch to slow down the occupant's deceleration in a crash, and prevent occupants being ejected from the vehicle.
- Airbags inflate to cushion the impact of a vehicle occupant with various parts of the vehicle's interior.
- Laminated windshields remain in one piece when impacted, preventing penetration of unbelted occupants' heads and maintaining a minimal but adequate transparency for control of the car immediately following a collision. Tempered glass side and rear windows break into granules with minimally sharp edges, rather than splintering into jagged fragments as ordinary glass does.
- Crumble zones absorb and dissipate the force of a collision, displacing and diverting it away from the passenger compartment and reducing the impact force on the vehicle occupants. Vehicles will include a front, rear and maybe side crumple zones (like Volvo SIPS) too.
- Side impact protection beams.
- Collapsible universally jointed steering columns, (with the steering system mounted behind the front axle - not in the front crumple zone), reduce the risk and severity of driver impalement on the column in a frontal crash.

3.3. Advance safety features

There are also some more sophisticated advanced safety features available in markets which are normally fixed in costlier cars like:

- Infrared night vision systems to increase seeing distance beyond head lamp range.
- Adaptive high beam which automatically and continuously adapts the headlamp range to the distance of vehicles ahead or which are oncoming
- Adaptive head lamps swivels headlamps around corners
- Reverse back up sensors ,which alert drivers to difficult-to-see objects in their path when reversing
- Back up camera
- Adaptive cruise control which maintains a safe distance from the vehicle in front
- Lane departure warning systems to alert the driver of an unintended departure from the intended lane of travel
- Tire pressure monitoring systems or Deflation Detection Systems
- Traction Control Systems which restore traction if driven wheels begin to spin
- Electronic Stability Control, which intervenes to avert an impending loss of control
- Emergency brake assist systems
- Cornering Brake Control systems

- Automated parking system Pedestrian protection systems.

3.4. Safety for two wheelers

In India, most vulnerable road users are pedestrians and Two wheeler riders. Such being the case advance safety technologies need to be implemented for Two Wheelers also which will help in reducing road fatalities. Some of the following safety features may be adopted in Two wheelers are

- Speed Control devices, the maximum speed should be restricted to 50KmpH in city limits where the density of traffic is very high.
- Air bags may be introduced in Two Wheelers also.
- Vehicles shall be tracked using GPS Technology.
- Auto Geared shall be made mandatory.
- Tubeless tyres may be used in all Two wheelers.
- Anti-skid braking systems may be installed.

4. Drunken drivers - devils on roads

Accidents due to drunken driving are a major problem in India. The problem is unrecognized and hidden due to lack of good quality research data. A study conducted by Alcohol & drug Information Centre (AIDC), India revealed that around 40% of the road accidents have occurred under the influence of alcohol. Young male drivers are at a high risk of such accidents. Though some efforts are being taken to reduce the Road Accidents due to drunken driving, considering the gravity of the situation it is important to change strategies and mechanisms with foresight and effective implementation.

Alcohol causes deterioration of driving skills even at low levels and the probability of accidents increases with rising blood alcohol levels. Alcohol needs no digestion and is absorbed rapidly into the blood stream; about 10% to 15% of alcohol users develop alcohol dependence and become alcoholics. After drinking, the judgment power of the driver gets impaired which is a threat to road safety. Due to its effects, driver tends to take more risks, becomes more aggressive and takes a longer reaction time. It has been well established that the relative probability of causing accidents increases with the rising blood alcohol levels keeping road safety at stake.

Advanced device like Alcohol Ignition Interlocks can be fitted in the vehicles to control drunken driving. Alcohol ignition interlocks are automatic control systems that are designed to prevent drivers who are persistently over the legal alcohol limit from starting their cars if their Blood Alcohol Concentrations Levels (BAC) levels are over the legal driving limit. These devices can be fitted in any vehicle.

An ignition interlock device or breath alcohol ignition interlock device (IID and BAIID) is a mechanism, like a breathalyzer, installed on a motor vehicle's dashboard. Before the vehicle's motor can be started, the driver first must exhale into the device; if the resultant breath-alcohol concentration analyzed result is greater than the programmed Blood Alcohol Concentration usually 0.02% or 0.04%, the device prevents the engine from being started.

At random times after the engine has been started, the IID will require another breath sample. The purpose of this is to prevent a driver from taking an alcohol bottle inside the car and drinking while driving, after the breath sample is provided. If the breath sample isn't provided, or the sample exceeds the ignition interlock's preset blood alcohol level, the device will log the event, warn the driver and then start up an alarm (e.g., lights flashing, horn honking) until the ignition is turned off, or a clean breath sample has been provided.

Such devices, when introduced in vehicles as part of a comprehensive monitoring programme, led to reductions of between 40% and 95% in the rate of repeated offending. Around half of Canada's provinces and territories have embarked on alcohol interlock programmes and in the United States, most states have passed enabling legislation for such devices. Some states in Australia have small experimental programmes in progress, involving public transport and commercial road transport, and the European Union is conducting a feasibility study. In Sweden, alcohol interlocks are now installed in over 1500 vehicles and, since 2002, two major truck suppliers have been offering interlocks as standard equipment on the Swedish market. Preliminary data from the Quebec interlock programme provide encouraging evidence to suggest that the crash rates of interlock participants are actually lower during the interlock period than before: 60% reduction in the rate of casualty crashes (Dussault and Gendreau, 2000).

If limited to use in dealing with drivers who are persistently over the legal alcohol limit, alcohol interlock devices might have only a numerically small impact. However, their wider use in public and commercial transport in the future could extend the potential impact of this tool in dealing with the problem of drink-driving.

Figure 6 Alcohol ignition interlocks

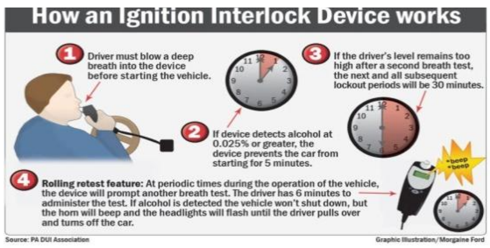


Figure 7

5. Vehicle tracking systems

A vehicle tracking system combines the installation of an electronic device in a vehicle, or fleet of vehicles, with purpose-designed computer software at least at one operational base to enable the owner or a third party to track the vehicle's location, collecting data in the process from the field and deliver it to the base of operation. Modern vehicle tracking systems commonly use GPS or GLONASS technology for locating the vehicle, but other types of automatic vehicle location technology can also be used. Vehicle information can be viewed on electronic maps via the Internet or specialized software. Urban public transit authorities are an increasingly common user of vehicle tracking systems, particularly in large cities. Several types of vehicle tracking devices exist. Typically they are classified as "passive" and "active". "Passive" devices store GPS location, speed, heading and sometimes a trigger event such as key on/off, door open/closed. Once the vehicle returns to a predetermined point, the device is removed and the data downloaded to a computer for evaluation. Passive systems include auto download type that transfer data via wireless download. "Active" devices also collect the same information but usually transmit the data in real-time via cellular or satellite networks to a computer or data center for evaluation.

Many modern vehicle tracking devices combine both active and passive tracking abilities: when a cellular network is available and a tracking device is connected it transmits data to a server; when a network is not available the device stores data in internal memory and will transmit stored data to the server later when the network becomes available again.

Historically, vehicle tracking has been accomplished by installing a box into the vehicle, either self-powered with a battery or wired into the vehicle's power system. For detailed vehicle locating and tracking this is still the predominant method; however, many companies are increasingly interested in the emerging cell phone technologies that provide tracking of multiple entities, such as both a salesperson and their vehicle. These systems also offer tracking of calls, texts, Web use and generally provide a wider range of options.

GPS based tracking systems

The GPS based will be helpful in Developing Automatic Vehicle Location system using GPS for positioning information and GSM/GPRS or information transmission with following features:

- Acquisition of vehicle’s location information (latitude longitude) after specified time interval.
- This will be helpful to trace the vehicle in case of accidents and rush the injured to the nearest trauma care centre with in the Golden Hour which can save many lives.
- Transmission of vehicle’s location and other information (including ignition status, door open/close status) to the monitoring station/Tracking server after specified interval of time.
- Developing a web based software to display all transmitted information to end user along with displaying location of vehicle on a map.
- The objective of the project is to build an additional feature to the present security system that will warn the owner of the vehicle by sending SMS when there has been an intrusion into the vehicle.

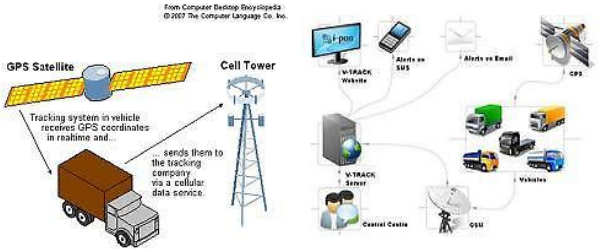


Figure 8Automatic vehicle tracking system

Though vehicle tracking system may not directly have any impact or involvement in preventing road accidents, it will be of immense help in preventing road fatalities by getting the exact locations of accident occurrence and thus rushing the victims to trauma care centres and providing necessary assistance.

6. Principles for assessing advance technology

There should be some principle in assessing the advanced technology like:

- Evidence of a potential to reduce the incidence and severity of road crashes. This requires an understanding of the target class of crashes such as proportion of the total crash problem, casual factors and distribution amongst the road user population;
- High likelihood of community acceptance and support for widespread use the equipment;
- Evidence of technological feasibility and successful and successful testing of prototypes of the equipment involved;
- The equipment involved can be applied to existing vehicles.
- The cost of the equipments shall be nominal and easily acceptable by normal users.
- The equipments produced from the technology shall not be complicated and service shall be easily available. This only will lead to the success of the technology and equipment.

7. Benefits of advanced safety features, vehicle monitoring system

Benefits of Advanced Safety Features and Vehicle Monitoring Systems had been studied at various countries ,according to Elvik *et al.* (1997), it is estimated that feedback on speed using VMS and other measures can reduce 65% of pedestrian crashes, 41% of injuries, and 16% of rear-end crashes. Project level studies include

ATEC/ITS-France (2002), which surveyed various study results in Europe. In the United Kingdom, 28% of the injuries were reduced, 10-30% in Germany and 35% of all crashes in Switzerland. Similarly, PIARC (2000) surveyed the accident reduction by weather information systems in various countries, and reported an average crash reduction of 30-40%.

Estimated safety benefits from OECD countries for speed control technologies

	Technology	Country	Project-level crash reductions	System-level crash reductions	Reference
Speed control	Intelligent speed adaptation	United Kingdom (by simulation)	N/A	Advisory system: 18-24% of fatal crashes	Carsten *et al.* (2001)
				Driver select: 19-32% of fatal crashes	
				Mandatory: 37-59% of fatal crashes	
		Netherlands	N/A	15% of injuries and 21% of fatalities	Besseling and van Boxtel (2001)
	Intelligent cruise control	Various	N/A	5.9% all crashes	Elvik *et al.* (1997)
	Speed governors on heavy goods vehicles	Sweden	N/A	2% of all injury crashes	Elvik *et al.* (1997)

Estimated safety benefits for driver status

	Technology	Country	Project level crash reductions	System level crash reductions	Reference
Other technologies	Variable message signs (for speed regulation and other targets)	Various	N/A	65% pedestrian crashes	Elvik *et al.* (1997)
				41% of all injury crashes	
				16% of rear-end injury crashes	
		United Kingdom (M25)	28% of injury crashes	N/A	ATEC/ITS-France (2002)
		Germany (A8) unusual (foggy) conditions	10-30% property damage only and injury crashes		
		Switzerland (A1)	35% reduction of all crashes		
	Weather monitoring with VMS	Various (Europe)	N/A	30-40%	PIARC (2000)
	Emergency response	Various (Europe)	N/A	7-12% of all crashes	PIARC (2000)
	Seatbelt reminders	United States	N/A	1.7% of all fatalities	IIHS (2002)

The Benefit/cost ratios for selected technologies had been studied by PIARC had been tabulated below , which clearly indicates that in almost all the cases the B/C ratio is very good, certainly more than 1 and the value of human life which can be saved is invaluable.

Technology	Benefit/cost ratio
Incident detection	1.7 – 3.8
Speed control	2.9
Lane control	2.7
Ramp control	3.6
Intersection control	34.0
Emergency vehicle priority	4.8
Speed enforcement	4.1

Source: PIARC, 2000.

8. New challenges

There are several claims and concerns resulting from the arrival of the new technology.

It is feared that drivers may lose skills they previously had. This is only a danger if those skills are still required (*e.g.* the use of the hand crank to start an engine is an obsolete skill). Drivers who have only driven vehicles equipped with ABS may not be aware of the technique of modulating brake pedal force to maintain control on slippery roads. Old skills that may still be useful on occasion may no longer be taught. Certain drivers cannot operate manual transmissions. Most of the danger in loss of skill is during transition from one technology to another.

It is feared that drivers may come to overly depend on a new technology. Drivers may expect the new technology to do more than it is designed to do. They may not be alert to the situations that are outside the performance envelope of the technology and so may not be ready to take manual control in these circumstances.

- Drivers may not take full advantage of the new technology. This phenomenon is evident with other technologies (*e.g.* video recorders, computers, washing machines) that offer facilities which are rarely used or too complicated to remember. However, in vehicles, these facilities could enhance safety, and failure to take advantage of them will reduce the safety potential and could, in certain circumstances, increase the road death and injury toll.
- Drivers may misuse or abuse the new technology. The technology could be designed for one purpose but used for another that may result in danger.
- Drivers may be confused or distracted by the new technology. The attention allocated to the new technology may leave insufficient mental capacity for essential safety and observational tasks. Recent research on cell phone use by drivers has highlighted this problem.
- Drivers' past experiences may result in incorrect understanding of the new technology.
- Drivers may consider the imposition of some systems as an infringement of their liberty such as was initially felt with the introduction of compulsory motorcycle helmet wearing, seatbelt wearing, and alcohol breath testing.

9. Research and development

A critical aspect of successful deployment is a commitment to carry out targeted research and development. This includes developing outreach programmes to communicate information on technologies, their benefits and drawbacks, and better understand how to make systems simple and understandable. Other areas for research and development include human factors, various individual technologies, legal issues and ongoing technology evaluations. Another critical issue for research and development is related to data. Specifically, better knowledge and understanding about safety data and evaluation would be desirable because this could lead to the development of technologies that better target specific crash causes. Also, a focus on better storage and use of archival data generated by ITS technologies could lead to overall better safety systems and countermeasures.

Knowledge gaps

Effective vehicle safety design result relies upon continuing research and development, understanding of the source and mechanism of injury' protection in a range of crash conditions, regular monitoring of performance in real world conditions, and confirmation that new technologies are used and accepted.

What role does research play?

Effective vehicle safety design result relies upon continuing research and development, understanding of the source and mechanism of injury protection in a range of crash conditions, regular monitoring of performance in real world conditions, and confirmation that new technologies are used and accepted. It is the result of complex multi-disciplinary scientific research and development which can take up to ten to fifteen years from definition of concept to practical realisation.

Conclusion

Vehicle design is fundamental to a safe traffic system which requires safe interaction between users, vehicles and the road environment. Vehicle design, which takes account of the behavioural and physical limitations of road users, can address a range of risk factors and help to reduce exposure to risk, crash involvement and crash injury severity.

If a revolution, through legislation, took place with a focus on automobile safety then sure the accident rate would drop drastically resulting in fewer injuries, maims and deaths on the roads. Indian consumers are not paying special attention towards safety. This is because of the negligence and different kind of mentality when compared with Europe or America which has to change.

The Government should insist insurance companies to give considerable discounts in premium for the vehicles fixed with advance safety features. According to the Insurance Institute for Highway Safety, Electronic stability control (ESC) could prevent nearly one-third of all fatal crashes. Though many insurers do grant lower premiums for safer cars and discounts for safety equipment, however it is plausible that the current level of discounts offered today by insurers is lower than is socially optimal. Granting lower premiums and discounts for safer cars and safety devices would probably increase consumer demand to these products, and thus the level of research and development of new safety products would rise and accident fatalities will reduce. Though new technologies may compensate for driver errors, it is important that drivers be aware of the capabilities and limitations of systems. To fully realize the benefits of new technologies, drivers need to learn to use them and gain experience. Proper design is important to ensure that drivers are not overwhelmed.

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