

PRIORITIZATION OF ISSUES RELATED TO INDIAN ROAD ACCIDENTS USING MORTH AND NATRIP DATABASES

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ABSTRACT

According to World Health Organization 2015 report, India has one of the highest number (137, 572) of traffic accident fatalities when compared to other countries. There is a need to identify the accident characteristics and implement cost effective safety measures to reduce the fatalities. The objective of this study is to prioritize the issues related to Indian road accidents using MORTH and ADAC, NATRIP databases based on a triple-layer approach (i) “Society” related to infra-structure (ii) “Individual” related to drivers and (iii) “Vehicle” related to vehicle safety regulations. At first, macro analysis was performed on MORTH 2014 data and then followed by micro analysis was carried out with ADAC, NATRIP data (National Highway-08). In order to identify the characteristics for those NH-08 accidents, a data mining technique, Self-Organizing Maps (SOM) was applied. Macro-analysis results show that 45% of fatalities are related to society (infrastructure), 29% are related to individuals (driver) and 26% are related to vehicles (rules and regulations). Micro-accident analysis results indicate that more signal availability (30%) in urban areas compared to that in rural areas leads to less intersection accidents. Improper driving-manner (30%), improper lane-change (16%), failing to use restraint system (29%) are the important elements related to individual. Rear crashes (54%), angled/side crashes at junctions (14%), accidents caused by trucks (48%), and hitting stranded parked-vehicles (24%) are the influential factors related to vehicles. Five basic traffic injury patterns are revealed by SOM analysis within ADAC, NATRIP data and a few countermeasures were proposed for each group separately.

KEYWORDS: MORTH, NATRIP, Safety, Road Traffic Death

INTRODUCTION

According to World Health Organization (WHO) global status report (1) on road safety, India has one of the highest number (137, 572) of traffic accident fatalities when compared to other countries. Road traffic fatalities is a major problem for India. There is a need to prioritize and implement possible measures with respect to road design, vehicle safety and occupant protection. In-depth scientific data is needed to understand the accidents characteristics and injury mechanisms but there is not much of scientific data available so far to understand in detail patterns of road accidents. Many developed countries have already started collecting in depth scientific accident data to develop safety strategies intended to improve road infrastructure and vehicle safety. At present, India is collecting accident data from police investigations. This police data mainly were analysed by two Indian government organizations namely: a) National Crime

Record Bureau (NCRB), which publishes its annual report on Accidental Deaths and Suicides in India and b) Ministry of Road Transport and Highways (MORTH), Transport Research Wing, which publishes its annual report on Road Accidents in India (2). These reports provide basic understanding of Indian road accident characteristics such as road user type, gender, age, vehicle type etc. in all the states and major cities in India but they do not provide in-depth scientific data related to vehicle (seat belt usage, airbag deployment status, vehicle specifications) and occupant injury level (Abbreviated Injury Scale) and mechanisms. Many researchers analysed databases such as NCRB and MORTH etc. to understand the problems and contributing factors of road traffic fatalities (3). However, those analysis provide only the over-view of accident patterns but does not provide hints of possible solutions to prevent those road accidents. To address this problem, Indian government started a pilot project on National Highway-08 (between Gurgaon and Jaipur) with the help of Accident Data Analysis Centre (ADAC) facility of National Automotive Testing and R&D Infrastructure Project (NATRIP) to collect in depth crash information. It is a unique initiative by Indian government in the field of accident analysis scientific research. A few researchers (4) (5) have already performed studies on NH-08 to understand the road accident patterns (fatal) with respect to road user type, collision type, time and gender etc. A joint research work (6) was carried out by ADAC and IIT Delhi on NH-08 to understand the issues in road design, unsafe practices and also proposed a few suggestions to improve the road safety. However, detailed high-level statistical analysis is not carried out on accidents collected on NH-08 so far. So, it is necessary to correctly identify the issues and suggest relevant practical countermeasure to reduce those fatalities on NH-08. The objective of this study is to prioritize the issues related to Indian road accidents using MORTH and ADAC, NATRIP databases based on a triple-layer approach (i) “Society” related to infra-structure & emergency services (ii) “Individuals” related to drivers & rule violators and (iii) “Vehicle” related to vehicle safety rules and regulations, in order to effectively reduce the number fatalities on Indian roads incorporating the lessons of past actions and knowledge of the advanced motorized nations, e.g. Japan, USA, France, Germany etc. To identify and summarize safety issues related to road accidents in India, at first, a macro-accident analysis is performed on MORTH 2014 data and then followed by a micro-analysis on ADAC, NATRIP data (NH-08). In order to identify the issues in detail on NH-08, a data mining clustering technique, Self-Organizing Maps (SOM) (7) is applied to ADAC, NATRIP data. Based on it, a few safety related countermeasures are proposed. Many researchers have already applied clustering technique to understand accident characteristics in the past (8) (9) (10) (11). SOM helps to identify the different patterns on a 2d map based on accidents similarities. The objects which are similar or have same characteristics are grouped together and placed side by side. Basically, the whole set of SOM maps provides qualitative but not quantitative measurement. One can match or identify the features present in data by placing all the variables SOM maps side by side.

DATA & METHODS

To identify and summarize safety issues related to road accidents in India, at first, macro analysis is performed using MORTH 2014 data and then followed by micro analysis using ADAC, NATRIP data (NH-08). Key issues are identified on NH-08 using Self Organizing Maps (SOM) method to propose a few safety related countermeasures. Please note that a commercial software Viscovery was used to perform the SOM analysis. Macro-analysis is a statistical investigation to understand general characteristics of the accident causation using MORTH 2014 data. As per

MORTH 2014 report, 489,400 accidents were reported in which 493,474 persons were injured and 139,671 persons were killed. It also revealed that on an average of 56 accidents takes place and 16 lives are lost every hour in India. Micro-analysis is an individual crash injury investigation which helps to understand the influential factors to improve vehicle design, road infrastructure and traffic education system.

ADAC, NATRIP Data Collection Area

ADAC, NATRIP collected data on National Highway-08 for a stretch of 228 kilometer. NH-08 connects Gurgaon and Jaipur as shown in figure 1. It is collected, a total of 245 accident cases with 462 vehicle information, during period 2013 July to 2015 June. However, current analysis is restricted only to CY 2014-15 (210 cases, 407 vehicles). Due to the presence of many unknown variables, CY 2013 data is excluded. Total 18 important variables are selected and they are further divided into 69 variables (refer figure 8: results section) for better understanding of SOM analysis.

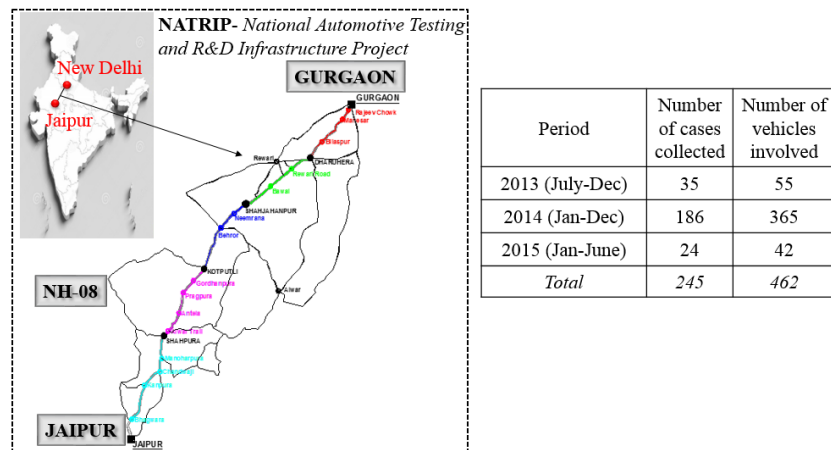


FIGURE 1 ADAC, NATRIP data collection area and number of data collected

RESULTS

The following section discuss results of the macro, micro and SOM analysis.

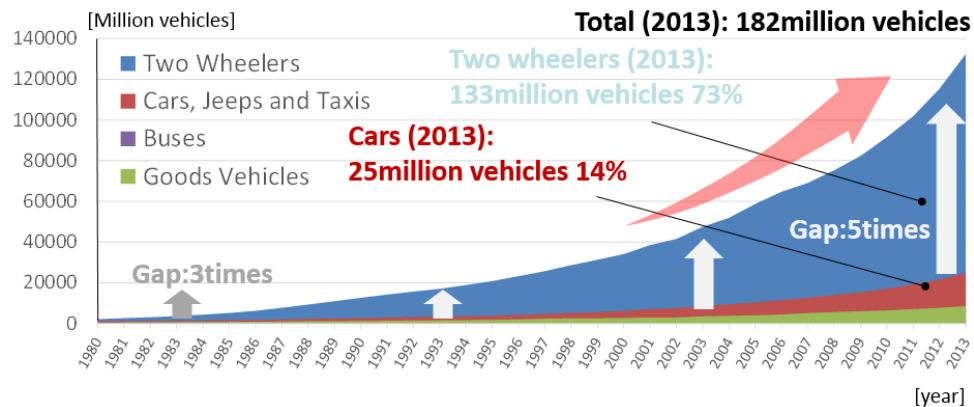


FIGURE 2 Number of registered motor vehicles in India

Figure 2 shows the number of registered motor vehicles in India (12). It shows the increasing trend of motor vehicle’s utilization every year. Two-wheelers have a largest share of registered motor vehicles. The gap between two-wheelers and cars has been increasing in the last 3 decades (3times to 5times).

Macro Analysis (MORTH Data Analysis)

Figure 3 shows the annual trend of accident, fatality and injured persons in India. The total number of accidents, fatalities, number of injured persons are gradually increasing but the number of fatalities per 10k registered vehicles are decreasing every year.

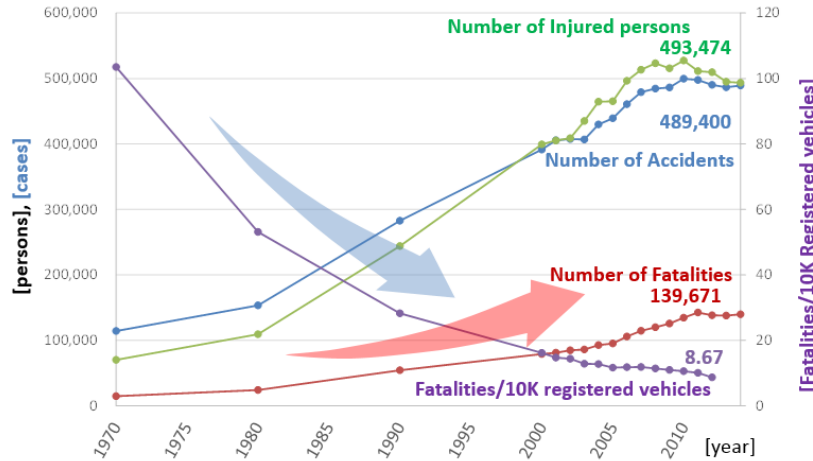


FIGURE 3 Annual trend of accident, fatality and injured persons in India

Figure 4 shows the fatal accident distribution across different states in India. Fatalities in rural area are larger than those of urban area. However, the trend is reversed in Uttar Pradesh and Madhya Pradesh. Further detailed accident analysis is needed to understand this phenomenon.

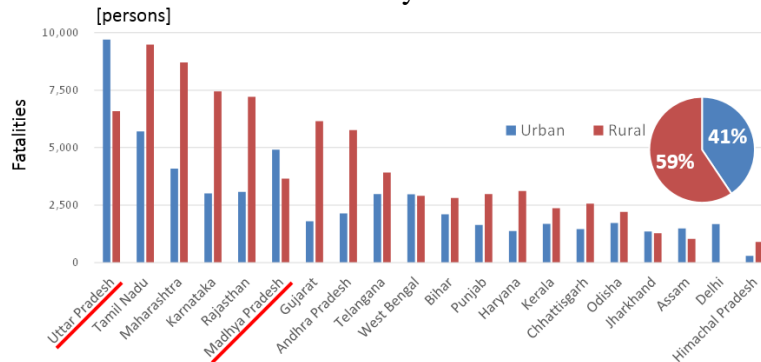


FIGURE 4 Fatal accident regions across different States (Top 20 states)

Figure 5 (a,b,c,d) shows the different characteristics of accidents w.r.t road user type, accident type, cause, driver’s fault and the following are the observations found from it: a) Two-wheeler mode (29%) of transport has most number of fatalities followed by cars, trucks, and buses b) head on collision (20%) causing the most number of fatalities c) own & other included all vehicles (2-4 wheelers) driver’s fault (74%) is main cause of fatal accident and d) over speeding (53%) is the dominating factor in driver’s fault.

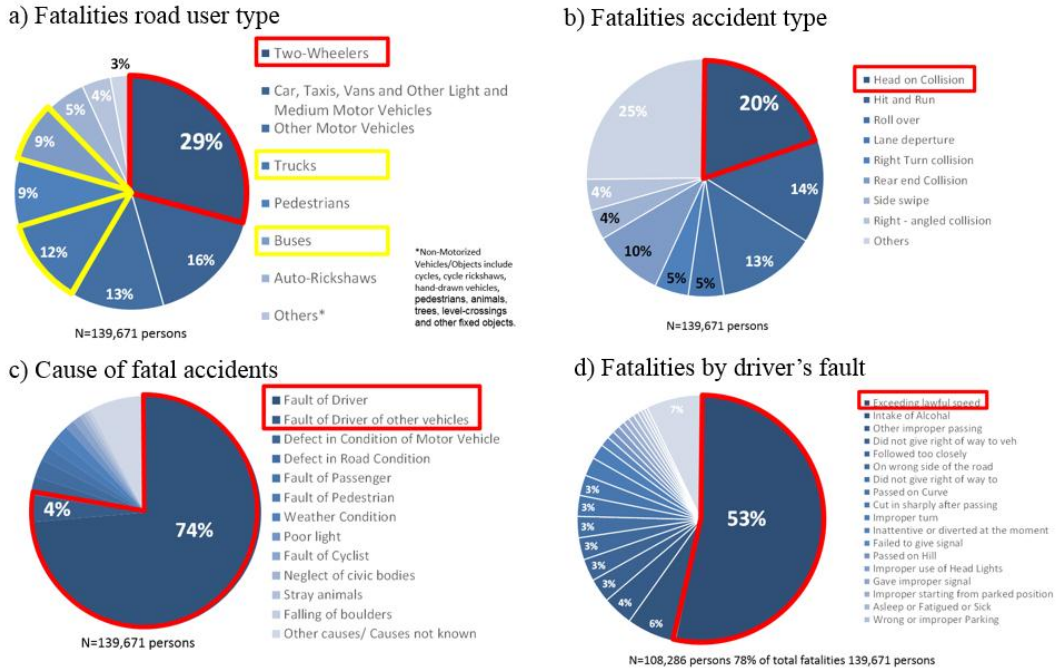


FIGURE 5 (a,b,c,d) Characteristic of accidents from MORTH report (2014)

Based on the understanding of macro analysis accident characteristics, the number of fatalities are grouped and prioritized with respect to society, individual and vehicle as shown in figure 6. Macro analysis results show that 45% of fatalities are related to society (infrastructure), 29% are related to individuals (driver) and 26% are related to vehicles (rules and regulations). Two main factors related to society are highway crashes (17% includes both national and state highway) and lack of proper medical emergency care (14%). Driver’s fault such as speeding (12%) and hit-and-run scenarios (11%) are the two main elements within the individuals. 2-wheelers (8%), head-on crashes (6%), heavy vehicles such as bus and truck (6%) and remaining others (11%) are the main components related to vehicles.

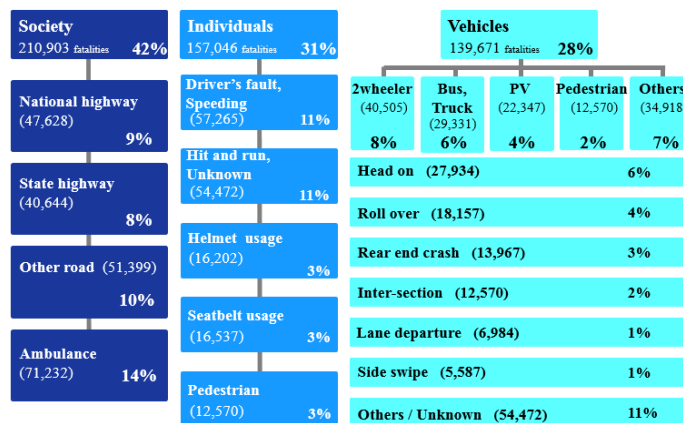


FIGURE 6 Prioritization of number of fatalities in each safety issue based on macro analysis

Micro Analysis (ADAC, NATRIP Data Analysis)

Since highway is the main contributing factor for fatalities as shown in figure 6 (society), the accidents happened on NH-08 are analyzed in detail to understand the safety issues on National highways. As mentioned in method section, the present analysis is restricted only to CY 2014-15 (210 case, 407 vehicle).

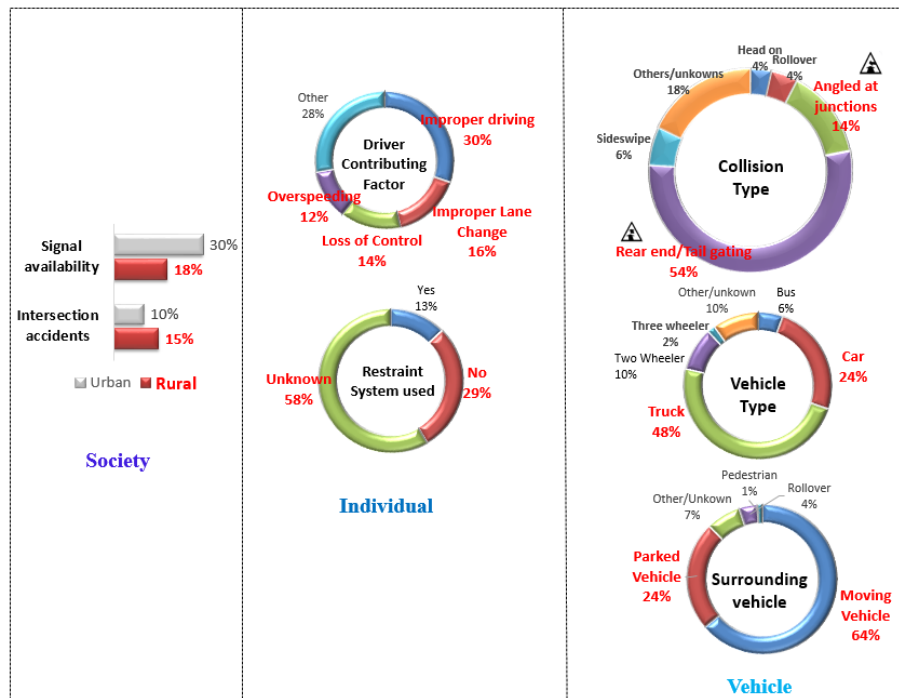


FIGURE 7 Prioritization of safety issues based on macro analysis

Out of 407 accident vehicles, 19% are fatal, 34% are serious, and 33% are minor accidents. Micro analysis (ADAC, NATRIP, NH-08) results show that more signal availability (30%) in urban areas compared to that in rural areas leads to less intersection accidents. Improper driving-manner (30%), improper lane-change (16%), failing to use restraint system (29%) are the important elements related to individual. Rear crashes (54%), angled/side crashes at junctions (14%), accidents caused by trucks (48%), and hitting stranded parked vehicles (24%) are the influential factors related to vehicles, as shown in figure 7.

SOM analysis

The selected data (407 vehicles and 69 variables) was clustered by SOM algorithm as shown in figure 8. 69 SOM maps are generated (1-map for 1-variable) and each dot point within it represents each one accident. Based on data availability of different variables, each dot point color highlighted in either red or blue. Blue represents data not available and red represents data available for that particle individual variable. After thoroughly studying all 69 individual SOM maps, five basic traffic injury patterns are observed within ADAC, NATRIP data and characteristics of each group are discussed separately. They are: 1) mode of impact: rear (54%), 2) unbelted-fatal accidents (19%), 3) intersection accidents (26%), 4) over-speeding (9%) and 5) alcohol accidents (2%).

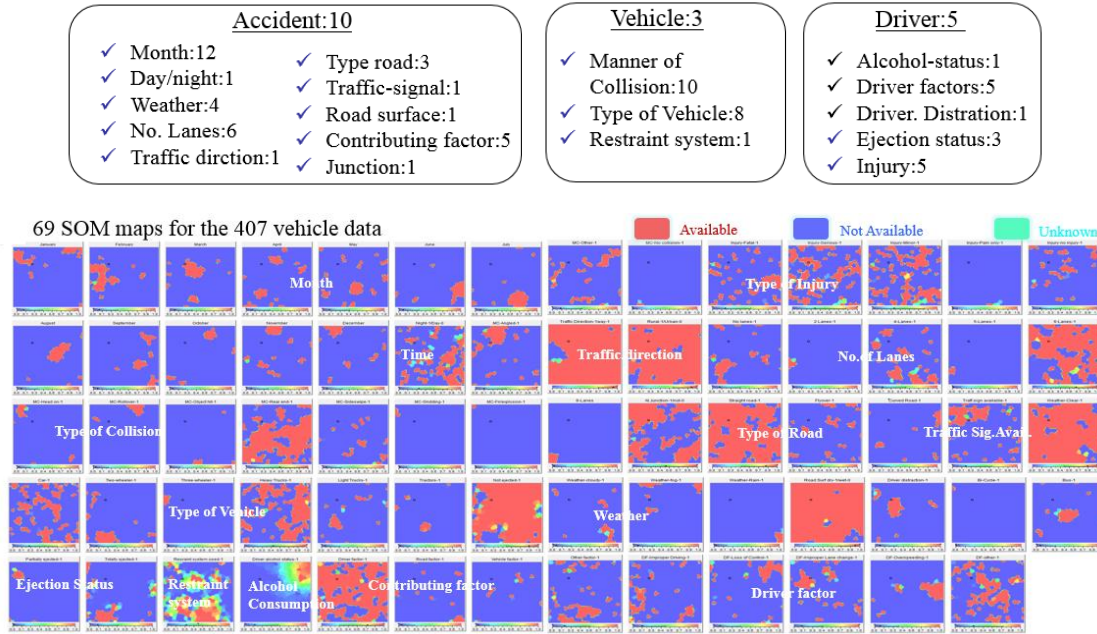


FIGURE 8 Visualization of data on SOM maps (69 maps: 1-map for 1-variable)

Feature 1: rear end collision

Figure 9 shows the breakup of rear end collisions (54%) and its related SOM component maps. Highlighted red dot points in rear end collision SOM map compared with other variable SOM maps. It is found that most of the rear end collisions are happening on straight roads (79%) and mainly because of heavy trucks (48%) & cars (20%).

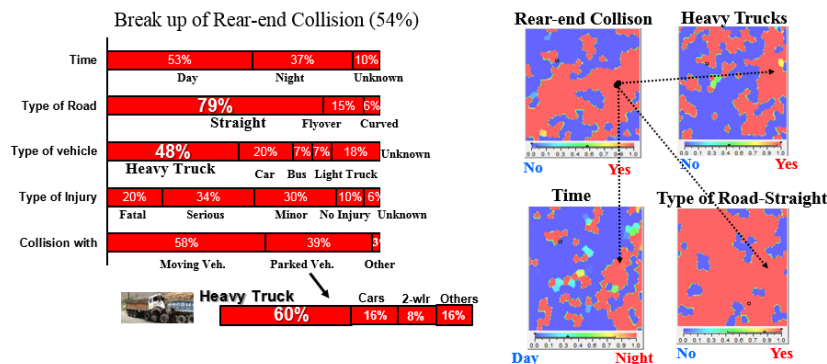


FIGURE 9 Breakup of rear end collisions and its related SOM component maps

Feature 2: unbelted-fatal accidents

Figure 10 shows the breakup of fatal accidents (19%) and its related SOM component maps. Highlighted red dot points in fatal injury SOM map compared with other variable SOM maps. For example, thick red portion in fatal injury map is highlighted and the same corresponding locations were searched in other SOM maps. It is found that most of the fatal injured drivers are not using restraint system especially in heavy trucks.

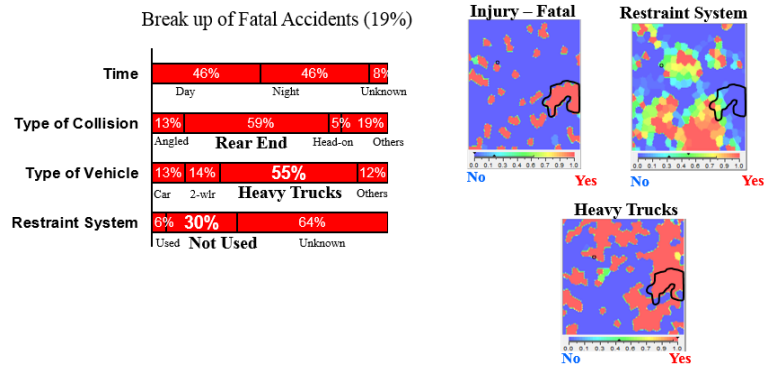


FIGURE 10 Breakup of fatal accidents and its related SOM component maps

Feature 3: accidents at junction

Figure 11 shows the breakup of accidents at Junction (26%) and its related SOM component maps. Highlighted red dot points in junction SOM map compared with other variable SOM maps. It is found that angled collision (32%) is the most frequent accident at junction and it is happening due to non-availability of signals at junctions.

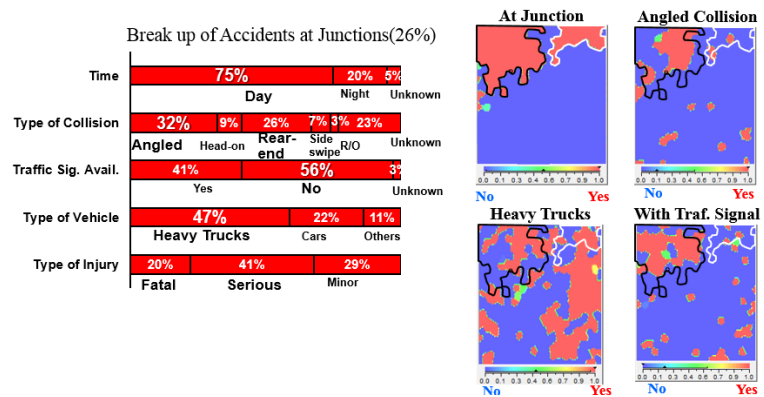


FIGURE 11 Breakup of accidents at junctions and its related SOM component maps

Feature 4: over speeding accidents

Figure 12 shows the breakup of Accidents due to over speeding (9%) and its related SOM component maps. Highlighted red dot points in over speeding SOM map is compared with other variable SOM maps. It is found that over speeding by truck drivers are causing fatal and serious injuries in rear-end crashes.

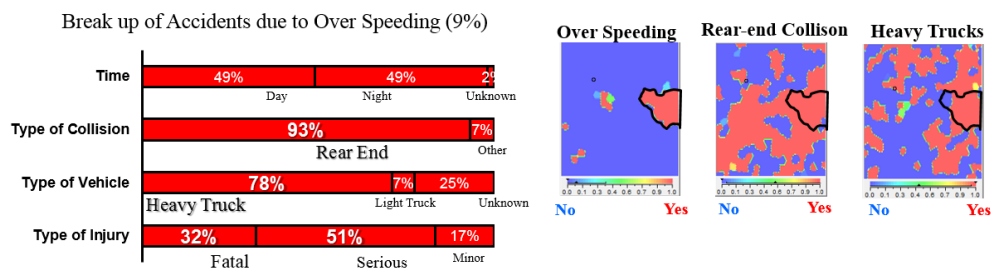


FIGURE 12 Breakup of over speeding accidents and its related SOM component maps

Feature 5: alcohol involved accidents

Figure 13 shows the breakup of accidents involving in alcohol consumption (2%) and its related SOM component maps. Highlighted red dot points in alcohol consumption SOM map is compared with other variable SOM maps. It is found that alcohol consumption cases are mostly related to heavy truck drivers (62.5%) and almost all drunk drivers are not using restraint system.

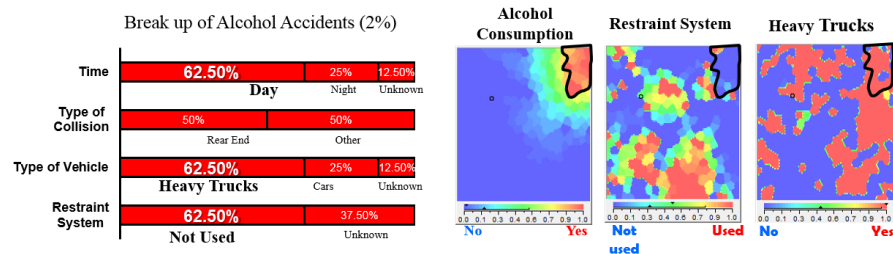


FIGURE 13 Breakup of alcohol involved accidents and its related SOM component maps

Based on the results obtained from SOM analysis, a few possible countermeasures are proposed and their regulatory activities are also mentioned in figure 14.

SOM Results	Countermeasures	Regulatory Movements
Rear End Collision	<ul style="list-style-type: none"> Enforcement of hazard lamp & traffic cones Mandating ABS Stricter enforcement of rear under guard protection 	<ul style="list-style-type: none"> Highway amenities management scheme. ABS mandate for relevant category of vehicles.
Unbelted-Fatal Accidents	<ul style="list-style-type: none"> Seat belt reminder (SBR) systems Strict enforcement of seat belt usage 	<ul style="list-style-type: none"> SBR going to be mandated for driver. Penalties for not using seat belt increased
Accidents at Junctions	<ul style="list-style-type: none"> Install traffic signals & impose severe penalty Improve infra-structure at roads 	<ul style="list-style-type: none"> Penalty for traffic violation increased (~10 times)
Over Speeding	<ul style="list-style-type: none"> Speed governors / speed alert system Over speeding check & penalties 	<ul style="list-style-type: none"> Speed governor mandated (heavy vehicles) Speed alert system planned by 2018. Electronic monitoring systems & huge penalties.
Alcohol Consumption	<ul style="list-style-type: none"> Frequent & stringent check by police Removing wine shops & their sign boards along highways 	<ul style="list-style-type: none"> Penalties for drink & drive increased. Court ordered to remove/relocate all wine shops & their sign boards along highways.

FIGURE 14 Summary of SOM analysis and proposed countermeasures

DISCUSSION

Since numbers of fatalities in India are increasing every year, there is a need to prioritize and implement possible measures with respect to road design, vehicle safety and occupant protection. Many developed countries have already designed and implemented safety related systems such as road design improvement, traffic management, use of intelligent transport systems, quick accident response and care, but immediate implementation of such systems may not be possible in India as they are costly and time involving processes. There is a need for active participation and involvement of more private and semi-government organizations to promote safety policy, especially from transport and health sectors. Many measures were already implemented in occupant protection technologies related to vehicles. However, keeping in mind that prevention is one of the best choices, faster implementation of some of the best practices of prevention of accidents adopted by advanced countries with good record of traffic injury and death reduction, can make the Indian transport system more safe and healthy in shorter span of time. Based on triple layer (a: vehicles with good structural integrity, fitted advanced safety equipment, b:

infrastructure with less chance of accidents, good quality of roads with signals and c: society with penalty and rewards in driver's license system, safety education manual, etc.) safety approach, accompanied by strict regulations and enforcement are the effective measures to reduce fatalities in India as shown in figure 15.

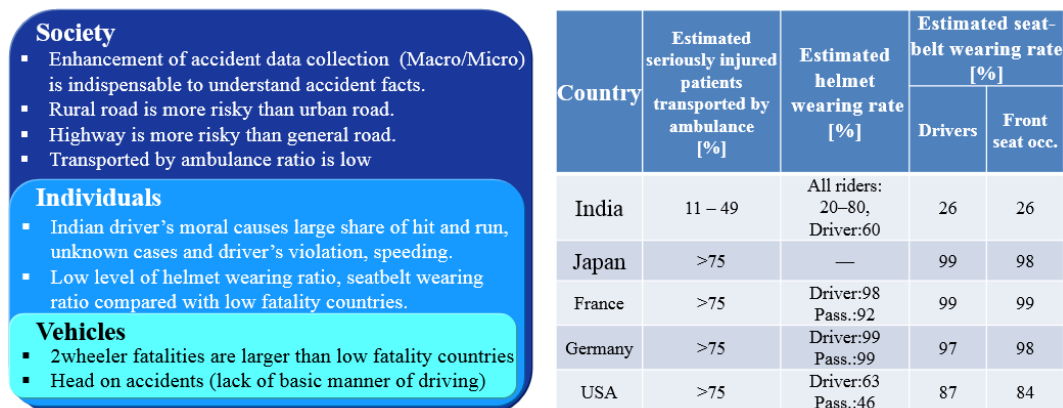


FIGURE 15 Traffic safety issues (India) prioritized based on triple-layered approach and comparison with low fatality countries (1)

Smeed's Law Analysis in Japan

Smeed's law analysis shows the fatality reduction trend in Japan (13) who is very successful in implementing proper traffic safety measures based on triple layer approach as shown in figure 16. The order of countermeasures is important, as the gradients of effectiveness (reduction of fatalities per 10k vehicles / automobile population rate) of "society" and "individuals" are much higher and then it should be focused on safety related issues related to "vehicle". It clearly shows the order; first it was society then the individual and finally the vehicle.

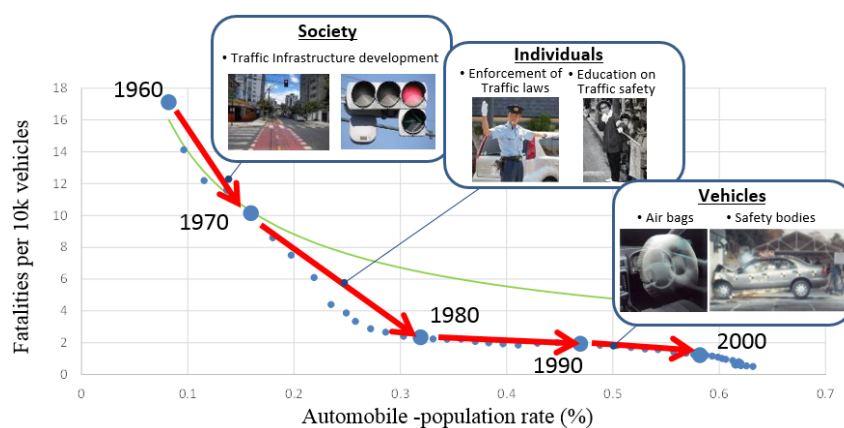


FIGURE 16 Fatality reduction in Japan (Triple Layer Approach)

CONCLUSION

This paper discussed the safety issues related to Indian road accidents using MORTH and ADAC, NARTIP databases based on a triple-layer approach. Combinations of balanced countermeasures related to individual road uses, society and vehicle will be the appropriate

actions to reduce fatalities effectively for India. Introduction of advanced vehicle technologies and proper evaluation procedure for safety performance are also useful. However, planning a seamless integration of short-term, mid-term and long-term strategies and striking a proper balance while implementing different levels of counter measures based on triple layered approach in real world are the key issues to maximize the efficacy of the future systems to be introduced on Indian roads.

LIMITATION

MORTH data has highest two-wheeler road type user percentage where as in ADAC, NATRIP, trucks and tractors have the highest percentage share among all road users, as shown in figure 17. Head on collision is the most frequent collision in MORTH data where as in ADAC, NATRIP, rear end collision is the most frequent collision type among all collision patterns, as shown in figure 18. Please note that ADAC, NATRIP data does not match with MORTH data because there is no sufficient number of data is available in ADAC, NATRIP data. So, one has to be careful while applying countermeasures obtained from ADAC, NATRIP data analysis to whole India.

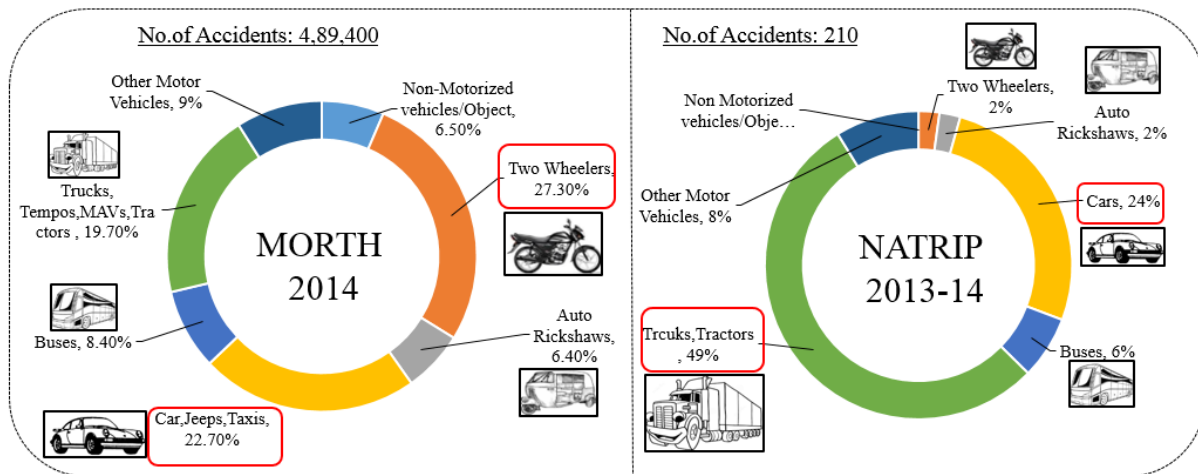


FIGURE 17 Comparison of MORTH and ADAC, NATRIP: Percentage share by type of motor vehicle

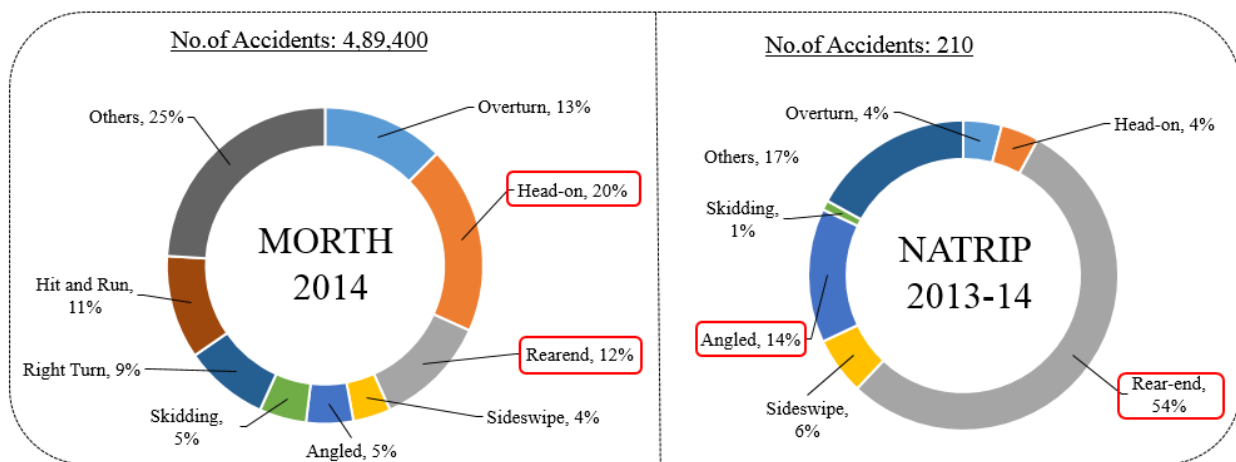


FIGURE 18 Comparison of MORTH and ADAC, NATRIP: Percentage share by collision type

DISCLAIMER

- (a) The data of ADAC, NATRIP used for this analysis, is only a set of some accidents on Gurgaon-Jaipur stretch of NH-08 where attempt was made to collect In-depth data out of all accidents happened in that stretch during that period.
- (b) This data does not represent the entire numbers of accidents for that period and does not represent any national or regional statistics.

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