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Evaluating the Effectiveness of Road Safety Interventions Using a Multi-Criteria Framework

Shashikant Kumar.[a], Nabal Kumar [b]

[a]: Department of Civil Engineering, K.K University Nalanda, Bihar 803115
[b]: Department of Civil Engineering, K.K University Nalanda, Bihar 803115
*Corresponding author *shashidesires80@gmail.com*

ABSTRACT :

At the national, state, and metro city levels, this article examines the data on traffic accidents in India. Road accident deaths and injuries in India are influenced by factors such as age, gender, month, and time, according to the analysis. In the 30–59 age bracket, men have a higher risk of mortality and injury. The number of road accidents increases during inclement weather and rush hour. There is a significant disparity in the fatality risk between state and municipal traffic accident situations. There is a higher-than-average risk of death in 16 out of 35 states and union territories of India. Although the overall number of traffic incidents in India is somewhat lower in urban areas, the death rate is greater in more than half of these cities compared to rural areas. China is one of many developed and developing nations where road safety is on the rise, while the situation in India is deteriorating. If India does not step up its efforts and become inventive, the number of people killed in road accidents would exceed 250,000 by 2025. There has to be swift action since the number of road fatalities and injuries is on the rise.

Keywords*:* Road safety, accidents rate, fatality risk, India.

Introduction :

The rising number of vehicle accidents in India that cause serious injuries or death is a growing concern for the country's public health. There are 2650 people killed and 11000 injured in car accidents per week. In 2023, 167423 public lost their lives and 56789 were injured in road accidents in India. India has overtaken China as the world top in road fatalities, with about 140,000 lives lost. With more than 53 casualties and 15 fatalities each hour, India is the only country in the world where this happens. A lot of developed and expanding countries, like China, are doing better than India, which is facing a fall. From 2013 to 2027, the number of fatalities caused by road traffic accidents in India is projected to double, if the present trends persist. There will likely be more than 250,000 road traffic deaths in India by 2025 unless more is done and new ideas are implemented.

At the national, state, and metro city levels, this research examines the incidence of road traffic accidents in India. The main goal is to find problems with road safety and then find solutions to those problems. The data used in this analysis mostly comes from a report on suicides and accidental fatalities in India that was put together by the National Crime Records Bureau from 1970 to 2023. This document was retrieved from the New Delhi-based Ministry of Home Affairs of the Government of India.

According to the data, India's population has increased by 1.4% in the last decade, while the number of fatalities caused by road accidents has increased by 5% every year. From 7.9 to 11.2 per 100,000 populations, the number of individuals killed in car accidents has grown since 2003. Death rates in India are rapidly rising and are four times higher than in industrialised countries like Sweden and the UK. Age, gender, month, and time are the primary determinants of traffic accident fatalities and injuries. The most susceptible demographic is economically active adults (those between the ages of 30 and 59). It was shown that in 2023, men were responsible for 85.2% of deaths and 82.1% of injuries.

May and June, along with December and January, are months when traffic accidents tend to spike, suggesting that severe weather plays a role in this. The nine o'clock hour is associated with an increase in accidents compared to other periods of the day. Additionally, the study breaks out the many factors that contribute to traffic accidents. While many things might go wrong on the road, in 2013 driver error accounted for 88% of all accidents.
Death rates in the Indian states of Andhra Pradesh (16.9%), Tamil Nadu (22.8%), and Haryana (17.2%) were each 50% more than the national average in 2023. Cities in India with populations of one million or more are considered metropolitan hubs, and car accidents there are rare. Conversely, the mortality rate differs between cities, ranging from 3.0 per 100,000 in Jaipur to 25.5 per 100,000 in Kolkata. Sixteen of the twenty-one metro regions had death rates that rose faster than the national average between 2003 and 2023. In Ahmedabad, the chance of death increased the most, going from 0.6 to 4.2. These cities were assessed in the following sequence.
The enquiry is divided into six stages. Section 2 delves into the present status of the road accident issue on a nationwide scale. Here we take a look at what goes into traffic accidents and how they cause injuries and deaths. Section 3 addresses concerns over road accidents in the US and its territories.

Section 4 addresses issues related to traffic accidents in metropolitan areas. In Section 5, we talk about the ways to get beyond these obstacles. Final portion includes study conclusions.

2. National-level analysis of road accident scenarios :

2.1. Road-related fatalities and injuries in India

India has observed a consistent increase in the number of people killed in accidents in recent years. The number of fatalities caused by automobile accidents increased from 14,500 in 1970 to 137,400 in 2013. There was an increase of 53,000 deaths and 87,000 injuries between 2003 and 2013. (Table 1). There was a 5% yearly rise in deaths and a 1.4% yearly growth in the country's population from 2003 to 2013. India has a worse mortality rate than wealthy countries even with less motorization (Table 2). India has a mortality rate that is almost double that of Germany and Japan, not to mention the UK and Sweden. The number of lives lost per 10,000 vehicles in road accidents is still very high when compared to affluent countries, despite a decline from 87.5 in 1970 to 8.6 in 2013. A lot of wealthy countries have death rates below one per 10,000 automobiles, as seen in Table 1.

Table 1. Compare of International Fatality Rates with India fatality rates.

Country Name	Vehicle ownership rate (number of automobiles per 1,000 people)	Mortality rate (number of deaths per 10,000 cars)	Mortality risk (number of deaths per 100,000 people)
India	137	8.8	11.5
Germany	697	0.77	4.6
Japan	671	0.65	4.3
New Zealand	783	0.97	7.2
Sweden	699	0.60	3.1
United Kingdom (U K)	659	0.61	2.9
United States of America (USA)	876	1.29	10.8

Age- and sex-wise distribution of road accidental deaths and injuries

the age distribution of those who have passed away. As well as being the most productive age group in India, those between the ages of 30 and 44 are also the most likely to be killed in a car accident. The death rate among people in this age range is 35%, despite the fact that they only make up 20% of India's total population. Through the course of the most recent decade, Accidents that result in fatalities are more likely to occur among those aged 45 to 59. Even though they make up just 12% of the population, this group is responsible for 21% of all deaths. Engaged individuals between the ages of 30 and 59 make up the most vulnerable demographic in India. Even though they make up less than a third of the population, they are responsible for approximately half of the deaths that occur in road accidents. Because they are at the pinnacle of their careers, people in this age bracket may be more likely to drive. Both the 15–29 and 60+ age groups have mortality rates that are proportional to their respective populations.

The gender breakdown of fatalities and injuries that occurred on Indian roads from 2003 to 2023. Within the year 2023, men accounted for 85.2% of deaths and 81.1% of injuries, according to Statistics. The mortality rate for men increased by 64.6% in 2023, going from 71,128 in 2003 to 117,055. The overall mortality rate rose by 53.1% (from 13,302 in 2003 to 20,368 in 2023), with the exception of female fatalities, who had a far smaller rise. When compared to deaths, the pattern of injuries is different. There was a 21.8% increase in male injuries, going from 313,055 in 2003 to 381,228 in 2023. From 2003 to 2023, the number of female injuries increased by 26.9%, going from 69,843 to 88,654.

3. The distribution of traffic accidents on a monthly and temporal basis :

This is a monthly breakdown of the number of accidents that occur on Indian roads. Road accidents are more likely to occur between the months of May and June and December and January, however there is not much change from month to month. As was said before, severe weather may have an impact on road accidents. It is possible that the months of May and June, which are very hot in India, would see a rise in the number of traffic accidents. When temperatures are high, it may have an impact on both the emotional and physical health of drivers. The worst feelings that individuals have are brought out by hot heat, which makes them uncomfortable. This may result in fatigue, cognitive difficulties, and delayed reflexes, as stated by Bijleveld and Churchill (2009) according to their findings. This may be the reason why May has the highest number of traffic accidents throughout the summer. December and January had a higher number of traffic accidents, despite the fact that they were lower than May and June. Fog causes impaired vision in some regions of India, particularly in the northern part of the country, during the months of December and January. Drivers reduce their speed and keep a tighter distance while driving in fog. It is more likely that an accident will occur if one's eyesight is restricted (Bijleveld and Churchill, 2009).

As time passes, the distribution of road accidents in India is seen in Figure 1. The figure illustrates the significant variations in the number of accidents that occur throughout the course of the day. Accident rates are relatively low between midnight and early morning, but they rapidly increase from nine in the morning until nine in the evening. On the other hand, driving at night is not always more dangerous than driving during the day. Driving at night is

more dangerous than driving during the day because of the higher accident risk per vehicle-kilometer or passenger-kilometer. Because we do not have enough data, we are unable to compare the accident risk during the day and during the night.

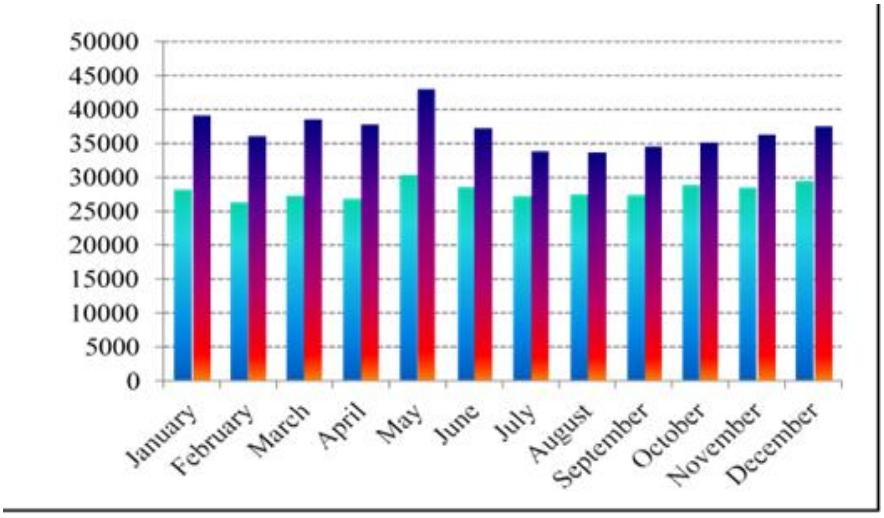

Figure 1. distribution of road accidents in India

4. Determinants of roadway accidents :

Figure 2 delineates the categorisation of the factors contributing to traffic accidents that transpired in India in 2023. The primary cause of most accidents is the driver. Seventy-eight percent of accidents, seventy-six percent of injuries, and seventy-three percent of deaths were attributable. Speeding accounted for 55.6% of all driving mistakes; this was the cause. Driver error accounted for 5.3% of accidents and 6.4% of fatalities due to the use of alcohol and drugs, respectively. 19.6% of all traffic incidents and 22.8% of all deaths were from cars that were overweight and overcrowded.

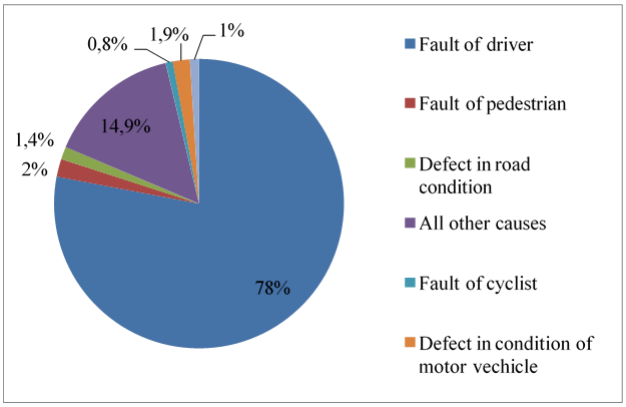

Figure 2. Resign of Road Accidents in 2023

Bicycle riders and pedestrians account for just 1.2% and 2.2% of all accidents, respectively. The condition of the road and automobiles contributes to fewer accidents compared to driver mistake.

Progressing forward

Road traffic accidents may be averted, since such situations are often predictable and several effective alternatives exist. An integrated approach that fosters cooperation across several sectors would be most successful in mitigating deaths and injuries. Advancements are being made as multispectral approach programmes reduce the incidence of deaths and injuries resulting from road accidents worldwide (Evans, 2003). Several factors, including as exposure, behavioural variables, the road environment, and vehicle characteristics, are identified as significant risk factors for road accidents by these methodologies.

Among road safety measures, risk-reduction tactics are the least used. Travelling for business, education, or leisure heightens the likelihood of encountering a traffic accident. Improving regional economies and establishing self-sufficient compact townships is essential to decrease short-distance travel inside metropolitan areas, hence reducing long-distance travel.

In India, the roadway accommodates a diverse array of vehicles, including hence complicating the avoidance of accidents. On the same road network, both motorised and non-motorized vehicles of diverse dimensions and velocities are permitted to operate freely. By categorising cars based on speed—

distinguishing between fast and slow autos, as well as heavy and light vehicles—and by enforcing speed restrictions on faster-moving vehicles, danger may be mitigated. The velocity of cars influences road accidents, injuries, and deaths. An average speed increase of one kilometre per hour correlates with a three percent rise in the probability of an injury-causing collision. An accident occurring at a velocity of 80 kilometres per hour has a death rate twenty times higher than one at a velocity of 32 kilometres per hour (Margie et al., 2004). At speeds of 30 kilometres per hour or less, pedestrians possess a 90% survival rate in vehicle accidents; conversely, this probability diminishes to below 50% at speeds of 45 kilometres per hour or above (Ashton and Mackay, 1983). Commercial vehicles, including trucks and buses, fitted with speed limiters are becoming prevalent in industrialised countries. Such gadgets are often disabled in India due to infrequent use. To expedite drivers, privately owned and run commercial bus and truck firms often use timetables. Private bus companies in India sometimes incentivise faster speeds by correlating driver remuneration with ticket sales and trip frequency. State governments, union territories, and municipalities in India has the authority to establish speed restrictions; however, these rules are seldom implemented. Speed restrictions on highways and streets in urban areas must be consistently enforced. Implementing speed restrictions on cars in mixed traffic would reduce injuries and fatalities among user.

Road users, including drivers, riders, and pedestrians, are the principal contributors to injuries and fatalities on the roadways. The probability of accidents and fatalities is influenced by several variables, including driver age, experience, substance usage, exhaustion, The substantial influx of new drivers in freshly motorised civilisations poses a considerable risk to road safety. The increase exacerbates the perilous scenario in India due to the scarcity of resources for driver training and testing.

The velocity of cars greatly impacts violent crashes and deaths on the road regulations all influence the speed decisions made by drivers. Many drivers are unaware that their speed-related decisions may elevate the risk of accidents, impacting both themselves and others. To reduce the incidence of accidents, drivers' perceptions of the risks connected with speeding must be modified.

The enforcement of traffic laws and associated penalties significantly influences the behaviour of road users. The insufficient enforcement of legislation designed to enhance road safety often undermines their effectiveness. The efficacy of law is very improbable without enforcement, education, and public awareness activities. Cultural norms about road safety may be advanced by education, publicity, and information, alongside legislation and law enforcement. determined that education, information, and publicity alone often fail to significantly reduce the incidence of unexpected deaths and injuries. Consequently, the government must devise a comprehensive policy to prevent traffic-related injuries. This method employs legislation, law enforcement, educational programmes, information distribution, and publicity campaigns to modify road user behaviour to reduce deaths and injuries on the roads.
Road accidents are mostly attributable to human error. road safety efforts seek to "rectify" driving conduct. The education and implementation of road safety measures, including seat belt use, helmet application, abstaining from driving under the influence of alcohol, and adherence to traffic laws, are essential for diminishing the incidence of road accidents. Although human mistake is inevitable, it must be acknowledged. To enhance accident outcomes, prioritising the development of safer automobiles and road infrastructure is essential. When vehicles and highways are engineered to operate in conjunction, it is feasible to maintain collision forces within the thresholds of human tolerance. When designing roadways, it is crucial to minimise the exposure of walkers, cyclists, motorcyclists, and users of informal public transit to high-speed vehicles (Singh, 2009). Consequently, the configuration of highways must be inviting to motorists.

5. Final Calculation :

Statistics indicate that the incidence of fatalities and injuries in road accidents in India fluctuates based on age, gender, month, and time. Individuals within the economically active age group are the most susceptible. Males have a higher incidence of accidents and deaths compared to females. Severe weather conditions significantly increase the probability of traffic accidents, as seen by the association between the months of May and June and December and January. Accidents peak between 9 AM and 9 PM, whereas they are few and variable from midnight to early morning. Seventy-eight percent of accidents, seventy-six percent of injuries, and seventy-three percent of deaths were attributable. The study examined the issue of traffic accidents in several cities and areas of India. In 2023, the mortality rates in Tamil Nadu (22.8), Haryana (17.2), and Andhra Pradesh (16.9) exceeded the national average of 11.2 percent by fifty percent. Motor vehicle accidents are quite infrequent in India's urban centres. Jaipur has 25.5 fatalities per 100,000 individuals, but Kolkata records just 3.0 deaths per 100,000 people.
The increasing number of fatalities and injuries from traffic accidents indicates that national, state, and municipal governments have not prioritised road safety. The principal reason is that vehicular mishaps on the road affect all tiers of government. The assessment of vehicle roadworthiness, the development of road networks and infrastructure, urban planning, the enforcement of road safety regulations, and post-accident medical care are managed by various agencies, sectors, and organisations. A leader's frequent absence complicates the coordination of activities and the management of the situation. Adjustments must be made to this scenario to accurately delineate responsibility, allocate duties to agencies, and reduce duplication.
In recent decades, the incidence of deaths and accidents on roads has decreased in numerous countries, particularly affluent ones. This was achieved via the execution of a comprehensive road safety strategy that prioritises environmental, vehicle, and road user interventions above direct alterations to user behaviour. The road safety procedures in India may vary from those in nations with far greater motorization rates; nonetheless, many core principles will remain consistent. In this sense, "effective road design and traffic management" There is an insufficiency of adequate road safety strategies now implemented. Various programmes has the capacity to save lives; nevertheless, cooperation across federal, state, and local governments is essential for efficacy. Individuals that use Indian highways need enhanced safety measures for travel.

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