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ROAD SAFETY EFFECTS OF ROAD CONDITIONS, TRAFFIC, AND MAN-MADE FEATURES

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Abstract-
The impact of traffic patterns, road conditions, and man-made features on driving safety is examined in this review article. It attempts to improve understanding of the numerous elements impacting road safety outcomes and gives a thorough overview of the research studies that have already been done. The research looks at the effects of several road factors on traffic behavior and accident rates, such as the quality of the pavement, the signs, and the illumination. Additionally, it explores how traffic patterns, such as congestion, speed restrictions, and traffic flow, affect the likelihood of accidents. Additionally, the evaluation investigates the impact of man-made elements on the frequency and seriousness of accidents, including road design, junctions, and infrastructure along the side of the road. It examines the connection between these characteristics and driving behavior, pointing forth possible directions for advancement in safety regulations and design principles. The evaluation also covers how technical developments like driverless cars and sophisticated transportation systems affect traffic safety. The research presented in this review article reveals the intricate interplay that traffic patterns, road conditions, and man-made features have on the results of road safety.

Keywords— *Road Safety, Effects Road Conditions, Traffic, Man-Made Features*, *Traffic Behavior, Accident Rates*

INTRODUCTION

According to the worldwide Road Safety Partnership's 2011 Annual Report, 3,000 people die in traffic accidents every day, causing a man-made worldwide humanitarian catastrophe. With an alarming yearly death toll of 1.2 million persons and between 20 and 50 million injuries from traffic accidents, road safety is one of society's most serious challenges (Torregrosa et al., 2012). By 2025, it is anticipated that road traffic accidents would rank third in the world in terms of the burden of sickness and injury, if present trends continue. Unfortunately, India has earned a reputation for having the most traffic-related deaths worldwide. Road safety has become a significant societal issue in India, stressing the need for quick action to solve the problem (Shivkumar). Accidents exert a significant toll on the national economy, causing disabilities, deaths, damage to health and property, social distress, and environmental degradation. Road safety aims to minimize the number of crashes, regardless of their severity, within a specific timeframe. Accidents and fatalities on the road result from a combination of multiple factors. In India, road users exhibit a wide range of heterogeneity, including pedestrians, animal-driven carts, bicycles, rickshaws, hand carts, tractor trolleys, as well as various categories of two/three-wheelers, cars, buses, trucks, and commercial vehicles. The increasing vehicle population, driven by changes in people's lifestyles, exacerbates the situation. Limited road space coupled with the growth in vehicle numbers necessitates a well- developed road safety policy. In India, the accident rate is directly proportional to the growth of the vehicle population. Road crashes take away the right to life of 3,000 people every day. This is a global humanitarian disaster, and it is man-made. (Global Road Safety Partnership Annual Report 2011) Road safety is one of the most important problems in our society. Every year 1.2 million of people are killed and between 20 and 50 million people are injured in road accidents. If current trends continue road traffic accidents are predicted to be third leading contributor to the global burden of Disease and injury by 2020(Torregrosa et al., 2012). India had earned the dubious distinction of having more number of fatalities due to road accidents in the world. Road safety is emerging as a major social concern around the world especially in India (Shivkumar and Krishnaraj,2012). Accidents are a drain on the national economy and may lead to disablement,

death, damage to health and property, social suffering and general degradation of environment. To minimize the no of crashes by any kind and severity expected to occur on the entity during a specific period is known as road safety. Accidents and the fatalities on road are the result of inter-play of a number of factors. Road users in India are heterogeneous in nature, ranging from pedestrians, animal-driven carts, bi-cycles, rickshaws, hand carts and tractor trolleys, to various categories of two/three wheelers, motor cars, buses, trucks, and multi-axle commercial vehicles etc., The vehicle population has been steadily increasing because of change in the style of living of people. Increase in vehicle population with limited road space used by a large variety of vehicles has heightened the need and urgency for a well thought-out policy on the issue of road safety. In India the rate of accident is directly proportional to growth of vehicle population. Road accidents are a human tragedy, which involve high human suffering. They impose a huge socio-economic cost in terms of untimely deaths, injuries and loss of potential income. The ramifications of road accidents can be colossal and its negative impact is felt not only on individuals, their health and welfare, but also on the economy. Consequently, road safety has become an issue of national concern. Road Safety is a multi-sectoral and multi-dimensional issue. It incorporates the development and management of road infrastructure, provision of safer vehicles, legislation and law enforcement, mobility planning, provision of health and hospital services, child safety, urban land use planning etc. In other words, its ambit spans engineering aspects of both, roads and vehicles on one hand and the provision of health and hospital services for trauma cases in post-crash scenario.

LITERATURE SURVEY

The literature review provides a comprehensive examination of the effects of road conditions, traffic patterns, and human-made features on road safety. It offers an overview of previous studies conducted on the development and human-made features on road safety. Numerous factors have been identified to have a measurable influence on driving behavior and traffic safety on two-lane highways (Bhuyan, 2003). These factors encompass a wide range of aspects, including, but not limited to:

- Human factors
- Traffic factors
- Vehicle deficiencies
- Road conditions
- Road design
- Weather conditions
- Other causes

By considering and addressing these various factors, policymakers, transportation agencies, and road safety practitioners can develop comprehensive strategies and interventions to improve driving behavior and enhance overall traffic safety on two-lane highways.

Labat et al.,(2008) In a study conducted by Labat et al. (2008) in the UK, post-mortem blood and urine samples from 1047 victims of traffic fatalities between 2000 and 2006 were analyzed. The results showed that 54% of the total victims tested positive for drugs and/or alcohol. Among male pedestrians aged 17-24 involved in road traffic accidents, 63% were found to have consumed drugs and/or alcohol. The substances most commonly detected among the victim group were alcohol and cannabinoids. Interestingly, the presence of drugs and/or alcohol in the victims was observed at a similar frequency in both the group in control (55% of drivers, 48% of motorcyclists, 33% of cyclists) and the group not in control of a vehicle (52% of car passengers, 63% of pedestrians). The study also revealed the presence of other drugs, such as anti-psychotics, diabetic drugs, heart drugs, and anti-inflammatory drugs, in the victim group. These findings emphasize the high prevalence of drug and alcohol consumption among traffic accident victims, particularly among young male pedestrians. The study highlights the need for effective measures to address substance abuse and impaired driving, as well as the importance of comprehensive road safety strategies that consider the diverse factors contributing to traffic fatalities.

Anne et al.,(2010) examined the impact of the minimum legal drinking age on highway crash fatalities. The findings revealed a clear relationship between the drinking age and fatalities during a crash. Specifically, it was observed that when the drinking age is lowered, fatalities during a crash tend to increase. Conversely, when the drinking age is raised, fatalities during a crash decrease. The study underscored the significance of the minimum legal drinking age in influencing the rate of fatalities, particularly among young individuals. Based on the analysis, the researcher concluded that lowering the drinking age to eighteen would result in an elevated fatality rate among young people. These findings provide valuable insights into the potential consequences of altering the minimum legal drinking age. They emphasize the importance of maintaining an appropriate drinking age to promote road safety and reduce the risk of fatalities during crashes, especially among young individuals. Policymakers and stakeholders can use these findings to inform decision-making processes related to drinking age regulations and road safety initiatives.

Campos et al.,(2011) In a study conducted in Brazil, breath tests were analyzed for 4234 drivers between 2007 and 2009, following the implementation of a new traffic law that enforced a blood alcohol concentration (BAC) limit of 0.08g/dL. The researcher utilized logistic regression to examine the impact of this law on driver behavior and traffic fatalities. The findings revealed a significant decrease in driver behavior associated with alcohol consumption, with a 45% reduction observed. Moreover, the study demonstrated a remarkable decrease in traffic-related deaths, with a 63% reduction noted in downtown areas and a 14% decrease on roads. These results highlight the positive impact of implementing a strict BAC limit
and enforcing it through the traffic law in Brazil. The study provides evidence of improved driver behavior and a substantial reduction in traffic fatalities, both in urban and rural settings. These findings reinforce the importance of effective legislation and enforcement measures to combat alcohol-impaired driving and promote road safety. Policymakers and authorities can utilize these findings to support the development and implementation of similar measures in other regions to enhance public safety on the roads.

Hassan and Aty (2012) In a study conducted by Hassan and Aty (2012) in Florida, the behavior and involvement of 680 young drivers in traffic crashes were examined. The research aimed to identify the significant factors contributing to young drivers' involvement in crashes, specifically focusing on two age groups: 16-17 years old and 18-24 years old. The findings indicated that aggressive violations, in-vehicle distractions, and demographic characteristics were significant factors influencing the crash involvement of young drivers in the 16-17 age group. On the other hand, in-vehicle distractions, attitudes towards speeding, and demographic characteristics were identified as significant factors affecting crash risk among young drivers in the 18-24 age group. These results emphasize the importance of considering specific factors such as aggressive violations, in-vehicle distractions, attitudes towards speeding, and demographic characteristics
when addressing the crash risk of young drivers. By understanding these influential factors, targeted interventions and educational programs can be developed to promote safer driving behaviors among young drivers in different age groups. Policymakers and road safety authorities can utilize these findings to implement strategies aimed at reducing the crash involvement and risk for young drivers, thereby improving overall road safety outcomes.

Somchainuek et al., (2013) A study was conducted to investigate roadside safety on Thai national highways. The findings revealed that speeding vehicles played a significant role in roadside crashes, accounting for approximately 70% of the total crashes analyzed. Additionally, it was observed that 30% of the roadside crashes were attributed to the presence of roadside trees. The study highlights the importance of addressing speeding as a key factor contributing to roadside crashes on Thai national highways. It underscores the need for effective speed management measures, such as speed limit enforcement, speed awareness campaigns, and road design improvements, to reduce the occurrence of these crashes. Furthermore, the study draws attention to the potential risks associated with roadside

trees. Identifying suitable roadside vegetation and implementing appropriate tree management strategies can help mitigate the
hazards posed by these elements and enhance overall roadside safety. The findings of this research contribute to a better understanding of the factors influencing roadside crashes in Thailand and provide valuable insights for policymakers, transportation authorities, and road safety practitioners to develop targeted interventions and guidelines aimed at improving roadside safety on national highways.

Wang et al.(2020) The objective of this study was to identify road traffic collision (RTC) hotspots in Kigali, Rwanda, and conduct a built environment analysis of these hotspots. Data on RTC and RTC-prone locations were collected from the Kigali Traffic Police and high-frequency road users, and kernel density estimation was used to identify hotspots. Built environment characteristics (BEC), including road design, road safety, pedestrian safety, and traffic density, were collected for each hotspot. Logistic regression was utilized to assess the association between BEC characteristics and RTC risk, and principal component analysis was employed to calculate BEC scores. Exploratory cluster analysis was conducted to identify patterns of BEC, and logistic regression was used to assess the association between BEC patterns and RTC risk.

Oskarbski et al.(2021) The evolving challenges associated with shaping changes in urban mobility patterns and mobility management necessitate the development of methods and tools for evaluating the effectiveness of transportation improvements. These evaluations should consider travel conditions, road traffic safety, and the environmental impact of transportation. Additionally, it is crucial to establish principles and guidelines for the safe and efficient utilization of emerging transport modes in urban areas, such as scooters, cargo bikes, and electric bikes. This Special Issue aims to address the following questions: How can urban transport be effectively planned given the aforementioned circumstances? How can the reliance on motor vehicles be reduced while ensuring enhanced road traffic safety through strategic planning and operational activities? By focusing on these topics, this Special Issue will assist researchers and practitioners in comprehending the influence of current trends in changing mobility patterns, new technologies, and the challenges associated with transforming public spaces in cities. Moreover, it will facilitate the identification of barriers, analytical tools, and techniques required in this field to improve travel efficiency and enhance traffic safety.

Datu et al.(2023) A comprehensive analysis was conducted on 1,438 records obtained from the Angeles City Traffic Management and Enforcement Unit (ACTMEU) covering the period from January 2015 to June 2018. The primary objectives of the study were to describe the characteristics of the suspected motorists involved in road accidents and identify frequently occurring patterns. Association rule mining and descriptive analytics using pivot tables were employed for data analysis. The findings revealed that out of the total records, 73 cases were classified as fatal road accidents, while 1,365 cases were non-fatal. Male motorists accounted for 82.19% of the fatalities and 83.30% of the non-fatal accidents. The age group of 15-29 years had the highest number of accidents, comprising 36.99% of the fatal cases and 35.09% of the non-
fatal cases.

HADDON'S MATRIX

In connection to injury or death, the matrix, which William Haddon created in 1970, offers a framework for analysing elements related to human qualities, vector or agent attributes, and environmental attributes. These elements are taken into account before, during, and after an occurrence in this matrix. It is feasible to evaluate the relative importance of various aspects and create effective solutions by using this framework. The Haddon matrix enables a systematic assessment of many factors influencing auto accidents or other forms of injury. enables researchers, policymakers, and practitioners to identify the key factors at each stage of the injury process and determine the most effective interventions to prevent or mitigate harm. This comprehensive approach considers not only the characteristics of individuals involved but also the attributes of vehicles, the physical environment, and the broader social and cultural context. By employing the Haddon matrix, stakeholders can make

informed decisions and develop targeted strategies for improving road safety and reducing the risk of injury or death. It provides a valuable framework for understanding the interplay between different factors and designing interventions that address the identified factors effectively. Developed by William Haddon in 1970, the matrix looks at factors related to personal attributes, vector or agent attributes, and environmental attributes before, during and after an injury or death. By utilizing this framework, one can then think about evaluating the relative importance of different factors and design interventions.

TRAFFIC SAFETY AND ACCIDENT CAUSES

Measures and strategies aimed at lowering the risk of deaths and serious injuries among road users are included in road traffic safety. These users consist of bicyclists, pedestrians, drivers and their passengers, as well as users of on-road public transportation such as buses and trams. Recognizing that people are flawed, the most successful road safety initiatives put a priority on preventing collisions that result in severe injuries or fatalities. Designing safe roadways that take into account human tolerance levels for fatalities and major injuries is an essential component of traffic safety.

Driver-Related	
Alcohol and drugs	Sickness
Unsafe speed	Cell Phone Use
Drowsing or Fatigue	Distraction
Fatigue	Improper Passing or Turning
Disregard traffic controls	Non Use of Restraint
Vehicle-Related	
Over Loading	Steering defect
Brake defect	Tire failure
Light defect	Improper wheel alignment
Environmental- Related	
Road side hazard	Vision obstruction
Ruts	Improper traffic control
Debris or Garbage on the road	Road Side Hazard
smoke or fog	Fixed Objects
Glare	Water ponding
Improper/nonworking traffic controls	Shoulders defective

Table 1- Various Factors Related to Accident

This entails designing the road environment in such a way that vehicle speeds are guaranteed to stay within certain tolerances, particularly at intersections where diverse road users come into contact. Road traffic safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. The users of a road include pedestrians, cyclists, motorists, their passengers, and passengers of on-road public transport, mainly buses and trams. Best practice road safety strategies focus upon the prevention of serious injury and death crashes in spite of human fallibility. Safe road design is now about providing a road environment which ensures vehicle speeds will be within the human tolerances for serious injury and death wherever conflict points exist. Table 1 illustrates the various causes of accidents, which can be attributed to three main factors: The driver, the vehicle, and the environment, each of these factors play a significant role in determining the overall safety of road users and requires specific attention in road safety initiatives.

ANALYSES OF DATA AND DISCUSSION

(i) Variation in Accidents- The annual variation in accidents of total stretches during year 2006-2015. In the year 2011 accident rate was high and low in the year 2006. It may be due to increase in number

of vehicles, bad traffic environment and increase in population. It is observed that number of accidents are more for stretch 1 and 4 are more higher than stretch 2 and 3.This is because of high traffic volume on stretch 4. Traffic volume decreases on stretch-3 as stretch -4 is connected to NH-23 which goes towards coal mines. Stretch 1has high population density as this is the main town of the Angul district. Accident rate is more due to more number of commercial and noncommercial vehicles on the road, bad traffic environment.

(ii) Monthly Variation in Accidents- Peak accident occurs in summer season i.e. In the month of March, April and May. This is due to distraction related to environment. Problem in these months are glare, fatigue,
inconvenient heat.

(iii) Hourly Variation in Accidents- One can observe more accidents occurs in between 8PM to 9PM. In this hour line truck(Truck Series) start their long journey. Most of the driver do not use speedometer as they drive by approximation. Speed crosses limiting speed as a result accident occur. Also they drink and drive in the evening hour. In the late night they use marijuana as a result reaction time increases and loss of control occurs. Some drivers make the vehicle over load. In India load capacity is 10 ton or 16.2 ton for goods carriage but they carry more than those results uncontrolled and lead to accidents.

(iv) Vehicles Involved in Fatalities- The results indicate that 59 percent of fatalities are due to truck drivers followed by 26 percent by unknown driver,7 percent by motor cycles, 5 percent by car and jeep,3percent by bus. They consume alcohol and drugs in long driving. As a result reaction time increases and loss of control
occurs during speed driving leads to fatalities.

CONCLUSION

The implications of road conditions, traffic patterns, and man-made features on road safety are thoroughly examined in this review article. The study's goal is to deepen our understanding of the many variables that affect road safety outcomes and to aid in the creation of successful road safety improvement measures. The assessment looks at how road conditions affect driving habits and accident rates. Road safety-related factors including pavement quality, signs, and illumination are examined to ascertain their effects. The study also looks into how traffic patterns, such as congestion, speed restrictions, and traffic flow, affect potential threats to road safety. The research also examines how human-made elements like road design, junctions, and roadside infrastructure affect the likelihood of accidents. The review emphasises the intricate relationships between these elements and their influence on road safety outcomes through a thorough examination of available research findings. In order to successfully improve road safety, it emphasises the necessity for integrated methods that take a variety of issues into account. For planners of transportation, politicians, and practitioners of road safety, the conclusions of this review have significant ramifications. It is possible to create and put into practise the proper interventions to lower accidents and enhance overall road safety by studying the impacts of road conditions, traffic patterns, and man-made features on road safety. The links between road conditions, traffic patterns, man-made features, and road safety are generally well-explained in this review article. It helps to inform evidence-based policies and interventions targeted at decreasing accidents and improving road safety outcomes, making it a significant resource for academics and practitioners working in road safety activities.

REFERENCES

[1]. Labat et al.,(2008) Prevalence of psychoactive substances in truck drivers in the Nord-Pas- de-Calais region (France), Forensic Science International Vol.174 pp.90–94.
[2]. A., Yadav, O. and Shukla, R., 2023. A Comprehensive Review Paper On Partial Cement Substitution In Cement Mortar With Wood Ash. Research in Multidisciplinary Subjects (Volume-1), p.26.

[3]. Sreedharan(201)0 Determinants of safety helmet use among motorcyclists in Kerala, India Journal of Injury and Violence Research, Vol. 2, No 1 (2010).
[4]. Roshan, Ravi & Yadav, Onkar & Kumar, Ajay. (2023). Evaluation of Pozzolana's Impact on Fibre Reinforced Concrete. 3. 1-9.
[5]. Kumar, P. and Alam, M.F., Seismic Analysis of RC Building with Steel Bracing.
[6]. Constantinou et al(2011) Risky and aggressive driving in young adults:Personality Matters,Accident Analysis and Prevention Vol.43 pp.1323-1331.
[7]. Hassan and Aty(2012) Exploring the safety implications of young drivers attitudes and perceptions,Accident Analysis and Prevention Vol.43 pp.45-65.
[8]. Houquani et al.,(2012) Sleep related collisons in United Arab Emirates, Accident Analysis and Prevention Vol.50 pp.1052-1055.
[9]. Kumar, A., Yadav, O. and Kumar, A.N., A Review Paper on Production of Environment Friendly Concrete By Using Sewage Water.
[10]. Somchainuek et al.,(2013) Investigation Roadside Safety on Thai National Highways Indian Journal of Science and Technology vol.6 issue 1.
[11]. Wang, Daphne & Krebs, Elizabeth & Nickenig Vissoci, João Ricardo & Andrade, Luciano & Rulisa, Stephen & Staton, Catherine. (2020). Built Environment Analysis for Road Traffic Crash Hotspots in Kigali, Rwanda. Frontiers in Sustainable Cities. 2.10.3389/frsc.2020.00017.
[12]. Kumar, A., 2023. WEB OF SYNERGY: International Interdisciplinary Research Journal.
[13]. Vaez,Lafllame(2005).,Impaired driving and motor vehicle crashes among Swedish youth: An investigation into drivers' sociodemographic characteristics Accident Analysis and Prevention Vol.37, pp.605–611
[14]. Anne et al.,(2010), The effects of minimu m legal drink ing age 21 laws on alcohol-relate driving in the United States Journal of Safety Rese arch Vo l.41,pp.1 73–181
[15]. Peter andRobert (2009)Alcohol consumption measured at road side survey and variation in traffic injury crashes,Accident Analysis and Prevention Vol. 30,No. 4, pp. 409–416.
[16].Campus et al.,(2011) The effect of the new traffic law on drinking and driving in Sao Paulo,Brazil Accident Analysis and Prevention Vol.50 pp.622-627.
[17]. Longo et al(1999)The prevalence of alcohol, cannabinoids, benzodiazepines and stimulants amongst injured drivers and their role in driver culpability, Accident Analysis and Prevention Vo l. 32 pp.623 – 632
[18].Boni et al(2010), factors associated with alcohol and drug use among traffic crash victims in southern Brazil Accident Analysis and Prevention Vol.43 pp.1408-1413
[19].Holmgren et al.,(2003) Alcohol and drugs in drivers fatally injured in traffic accidents in Sweden during the years 2000-2002 Forensic Science International Vol.151 pp.11-17
[20]. Labat et al.,(2003) Prevalence of psychoactive substances in truck drivers in the Nord-Pas- de-Calais region (France), Forensic Science International Vol.174 pp.90–94
[21]. Rio et al(2001) Alcohol, illicit drugs and medicinal drugs in fatally injured drivers in Spain between 1991and 2000Forensic Science International vol.127 pp.63–70.