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Construction of A Theoretical Framework for Performance Metrics for Road Safety

Raisidam Shivakumar[1], K. Ramu[2]

[1]*M. Tech Student, Transportation Engineering, A.M. REDDY MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY, Petlurivaripalem, Palnadu (Dt.) 522601, Andhra Pradesh.*

[2]*Assistant Professor, Civil Engineering, A.M. REDDY MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY, Petlurivaripalem, Palnadu (Dt.) 522601, Andhra Pradesh*

ABSTRACT

Public health, social, economic, and transportation issues are all greatly affected by road safety. A staggering 1.35 million individuals die and many more suffer injuries in vehicle accidents each year [2,3]. Modern road safety programs lack a comprehensive, coherent set of elements and policy tools that are supported by theoretically sound concepts. The objective of this thesis was to improve road safety measures by making them more pertinent, efficient, effective, and adaptive to changing circumstances and futures.

Road traffic accidents are a tragic human event that significantly harms people. Early deaths are a huge socioeconomic cost associated with them. Potential profits are lost as a result of injuries. The effects of an automobile accident can be severe, having an impact not only on the economy but also on people's health and well-being. As a result of road accidents, 3,000 individuals lose their right to life every day. Global humanitarian disaster that was caused by humans [3].

1.35 million people died in traffic accidents in 2018, according to the World Health Organization, which is comparable to all communicable disease mortality [2,3]. The most vulnerable group is the young, and it has been shown that deaths from traffic accidents are among the top three global causes of death for those between the ages of 5 and 44. If effective measures to minimise road fatalities and injuries are not taken, according to the WHO (2018), road traffic accidents will rank as the sixth leading cause of mortality worldwide by 2030, impacting an estimated 2.4 million families each year [3]. With 48% of the world's registered autos, low- and middle-income countries account for almost 90% of road fatalities [2]. Road traffic injuries are a major issue due to a huge growth in the quantity of automobiles and people using dangerous roads. Professionals and policymakers are interested in this topic because of the remarkable increase in mobility, morbidity, disability, and socioeconomic effects from accidents during the past ten years.

The quantity of traffic on the roadways has been growing recently, which has raised the likelihood of traffic accidents. Road traffic accidents are the fifth most major cause of mortality worldwide, according to evidence from both industrialised and developing nations, and they are on the rise. They are responsible for a sizable part of injuries, fatalities, and impairments among the population

As a result, the current effort will give organized information on the establishment of a theoretical framework for performance metrics for road safety. Indicators are instruments for tracking the progress of a certain phenomenon. They communicate scientific knowledge in a clear and pertinent way. Indicators may be used for a variety of purposes, including defining goals and priorities, recognizing trends, assessing the effectiveness of policy initiatives, and gauging relative performance. This makes it obvious how important indicators are for the field of road safety.

Keywords: Road accident, Road safety, Framework

I. INTRODUCTION

1.1 GENERAL

Almost all facets of economic, social, and cultural growth require transportation. Any nation, but particularly one that is expanding like India, needs the road transportation industry to grow. The Indian economy now heavily depends on the road transportation industry. The backbone of the Indian economy is road transportation. The internal road network, which includes of major district roads, village roads, national highways, and state highways, effectively transports people and products. When it comes to moving both people and goods, the country's surface transportation system heavily relies on the road. Around 60% of the goods and 80% of the passengers in India are transported by road. India is home to the third-largest road network in the world, with a total length of 6,215,797 kilometres [1]. The orderly flow of people and products on various types of highways is referred to as traffic management. As a result, traffic laws and their enforcement are essential worldwide and play a crucial role in traffic management.

1.2 A GLOBAL SCENARIO OF ROAD ACCIDENT FATALITY STATISTICS

It is a global phenomenon that people care about driving safely. Everyone should be informed of the rules of the road, whether they drive. The management of road safety has been a significant issue for policymakers. The years 2011 to 2020 have been dubbed the "Decade of Action for Road Safety" by the United Nations (UN). Also, they requested that the World Health Organization produce this study as a starting point for evaluating worldwide road safety at the beginning of the Decade and monitoring advancements throughout it. The overwhelming support of the member countries for the Decade of Action reveals a growing understanding that reducing traffic fatalities should be a top priority for global public health and development.

1.3 INTERNATIONAL COMPARISON OF TRAFFIC-RELATED FATALITIES

The worrisome rate of increase in traffic deaths has increased public awareness of road safety on a worldwide scale. In order to reduce traffic accidents, the focus is now on creating management strategies for road safety. To prevent traffic accidents, international organisations like the WHO and the UN have devised a variety of road safety policies. Figure 1.1 compares population, traffic accidents, and the number of registered cars among countries based on their economic development (Low, Middle, and High). 80% of traffic fatalities occur in middle-income countries, which include 76 percent of the global population but just 59 percent of registered cars.

2. ROAD ACCIDENT PROFILE IN INDIA & ACCIDENT PREDICTION MODELS

2.1 ACCIDENTS BY ROAD CATEGORY

In 2016, 34.5 percent of all fatalities and 29.6 percent of all traffic accidents occurred on the National Highway System. State highways were the scene of 25.3% of all accidents and 27.9% of all traffic fatalities during the same time period. In 2016, 37.6% of all fatalities and 45.1% of traffic accidents occurred on other roads. The number of accidents varies depending on the road system. Road accidents are multi-casual and frequently the result of several factors, including driver error, road conditions, and vehicle conditions. On motorway and state highways, speeding is a significant contributor to accidents, but reckless driving and poor road conditions are also major factors.

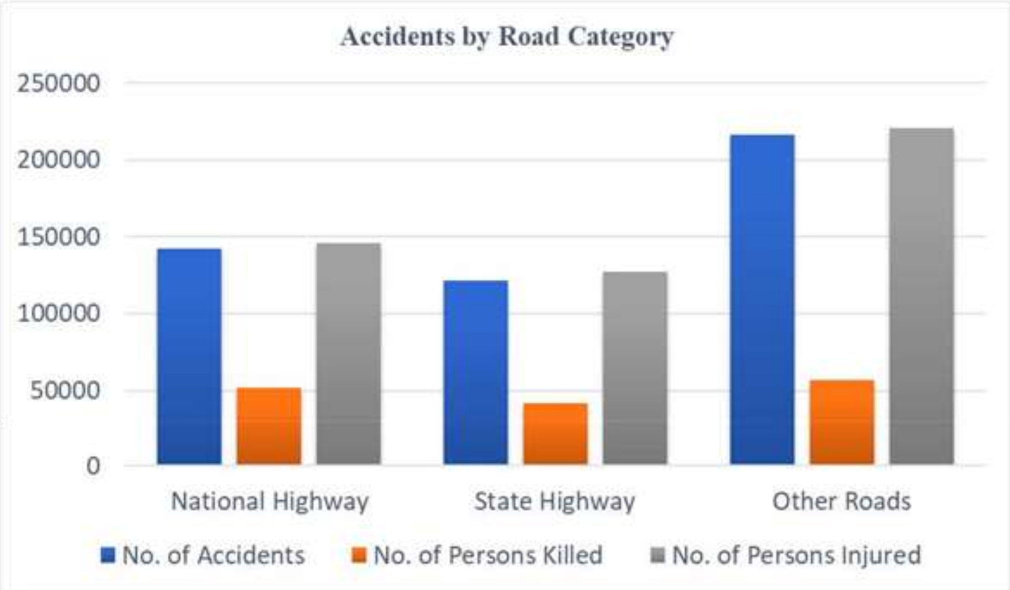

Figure 3.1: Accident sa by Road a Category in a India

(Source: Annual reports on road safety, Ministry of Road Transport & Highways, India)

2.2 Inter-State Comparison of road accidents in India

In terms of traffic accidents, Tamil Nadu, Madhya Pradesh, and Karnataka were the top three states in 2016. Madhya Pradesh comes in second with 11.2 percent of all accidents on the roads, while Karnataka is third with 14.9%. (10.1 percent). The top three states for fatalities are Uttar Pradesh, Tamil Nadu, and Maharashtra. Tamil Nadu was in second with 11.4 percent of fatalities, while Maharashtra ranked third with 12.8%. (10.1 percent). 7.9 percent The top three states in terms of casualties are Tamil Nadu, Madhya Pradesh, and Karnataka. Madhya Pradesh comes in second with 11.7% of all injuries, followed by Tamil Nadu with 16.6% of all injuries and Karnataka with 10.7%.

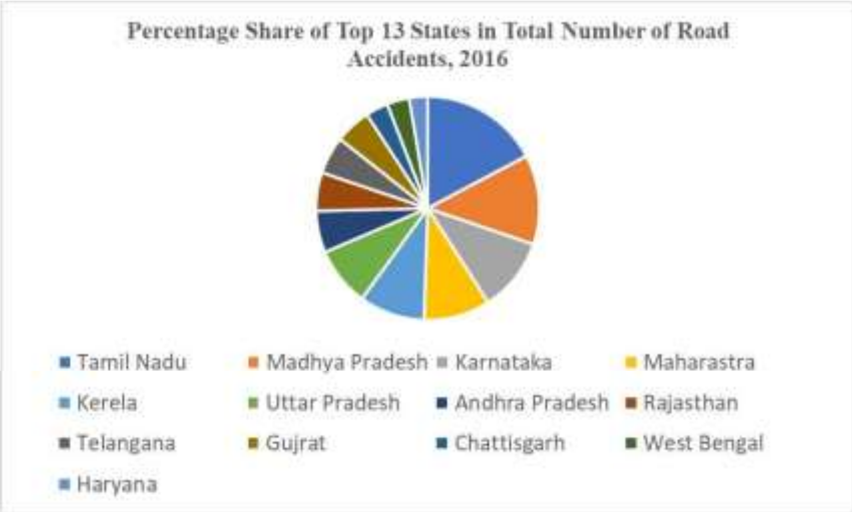

Figure 3.2: The a percentage a share of top a13 Indian States in "Total a no. of Road Accidents ina2016"

(Source: Annual reports on road safety, Ministry of Road Transport & Highways, India)

2.3 ACCIDENTS^ON^ROAD^JUNCTIONS

Since they are where traffic merges, road intersections are prone to accidents. Table 3.3 displays the number of collisions, fatalities, and injuries at traffic intersections. Table 3.3 displays the number of collisions that occur at a road intersection.

Table 3.3: $Total a number a of $ Road a Accidents, $ Number a of a persons a killed and injured a based a on Junction Type (2016)

(Source: Annual reports on road safety, Ministry of Road Transport & Highways, India)

	Accident s	Killed	Injured
$T-$Junction	63,243 (35.9)	19,884 (36.8)	59,923 (35.2)
$Y-$Junction	41,006 (23.3)	12,706 (23.5)	40,048 (23.5)
$Four $arm $Junction	42,829 (24.3)	12,342 (22.8)	40,704 (23.9)
Round about Junction	25,612 (14.6)	7,771 (14.4)	26,797 (15.7)
Rail Crossing	3,314 (1.9)	1,326 (2.5)	2,915 (1.7)

III. DEVELOPMENT OF ANAAPMAFOR THE STATE OF UTTAR PRADESH

A technique for tying together dependent and independent variables in order to predict the future is called model development. In this section, APMs for the state of Uttar Pradesh were created using STATISTICA software's linear regression technique. At that time, three different models were created, each of which contained all significant factors and their coefficients, to predict traffic accidents in the state. The models are Equation 3.8, Equation 3.9, and Equation 3.10. The equations are formed by multiplying significant variables by their coefficients. For instance, to calculate Equation 3.8, multiply the necessary variables (Tables 3.9, 3.10, and 3.11, column 1) by their corresponding coefficients (Tables 3.9, 3.10, and 3.11, column 2), then multiply the result by a constant value. All equations were produced using this method, and the results are displayed below:

APM-1,

$$A/R = 0.021*(E/P) + 0.018*(R/P) - 0.052*(L/R) - 0.729*(L/P) - 0.032*(R/L) + 4.131 \quad (3.8)$$

APM-2,

$$K/R = 0.031*(R/P) - 0.043*(L/R) - 2.105*(L/P) - 0.081*(R/L) + 7.101 \quad (3.9)$$

APM-3,

I/R= 0.013*(R/L) -0.223*(L/P) -0.014*(L/R) -0.007*(R/P) +1.877 (3.10)

Where, "A/R=Accidents/1000registered vehicles, K/R=Person Killed/1000registered vehicles, I/R=Injuries/1000registered vehicles, L/R=road length/1000motor vehicle, L/P=Road length/1000 population, E=number of employed people, R/P=registered vehicle/1000population,

R/L= registered vehicle/ Road Length, E/P=employed person/1000population".

Table 3.12: Model Summary

APM No.	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.957	0.939	0.917	0.0685
2	0.879	0.792	0.721	0.1079
3	0.928	0.859	0.783	0.1430

The model's performance is assessed using the coefficient of determination (R2). The accuracy of the model, or how well it will apply to the datasets, is referred to as this word. If the value is higher, the model is more accurate. It has a scale of 1 to -1. No relationship, no relationship at all, and a perfect negative relationship, which is represented by the number -1. All three models are very significant in defining the state's accidental condition as their significance values are less than 0.05.

The R2 rating for APM-1 is 0.939, or 93.9 percent. This suggests that the provided model correctly predicted 93.9 percent of the total number of accidents in Uttar Pradesh. According to Table 3.12, model one is the most accurate of the three models, followed by APM-3 and APM-2. After more significant factors were included, the modified R2 value indicates the lowest R2 that the model could attain.

The most populous and northernmost state of India, Uttar Pradesh, is where the current study is being conducted. In the previous 20 to 30 years, there has been a significant increase in the number of people killed or injured in auto accidents throughout the state. In order to address this problem, an effort has been made in the area of accident prediction. This level is essential because it requires us to take accidents into account while constructing smart roadways, smart cities, and urban planning. The study's purpose is to develop a statistical tool that can forecast accidents based on a variety of socioeconomic factors in the current environment. Three exact and reliable equations were developed by the study team to forecast traffic accidents in the state.

The first model, which estimates the overall number of accidents, is the most accurate of the three, according to the statistics. While this type of study has never been carried out in Uttar Pradesh before, the model's results may be used to enhance road safety throughout the planning phase. The study may also be carried out in a state with comparable socioeconomic and accident characteristics.

IV. CONCLUSION

1. In 2016, 34.5 percent of all fatalities and 29.6 percent of all traffic accidents occurred on national highways.
2. Throughout the same time period, state highways were the scene of 25.3% of all accidents and 27.9% of all traffic deaths.
3. In 2016, 37.6% of all fatalities and 45,1% of traffic accidents occurred on routes other than the main ones.
4. Thousands of people die in traffic accidents each year, making twowheelers the most exposed and unsafe road users in the nation. From 31.5 to 34.8 percent of two-wheeler riders were killed in collisions in 2015 and 2016, respectively.
5. According to a detailed analysis of the age distribution of road accident victims in 2016, the productive age group of 18 to 35 years accounted for 46.3 percent (69,851 people) of all fatalities from road accidents, while the 18-45 age group accounted for 68.6 percent (1,03,409 people).
6. In terms of the number of traffic accidents, the top three states in 2016 were Madhya Pradesh, Tamil Nadu, and Karnataka. Madhya Pradesh and Karnataka each account for 11.2 percent and 9.2 percent of all traffic accidents, respectively, with Tamil Nadu accounting for 14.9% of all incidents.
7. The top three states for fatalities are Maharashtra, Tamil Nadu, and Uttar Pradesh. Tamil Nadu comes in second with 12.8% of all fatalities, followed by Uttar Pradesh.
8. In terms of the number of injuries, Tamil Nadu, Madhya Pradesh, and Karnataka are the top three states. Madhya Pradesh and Karnataka each contribute for 11.7% and 16.6% of the total number of injuries, respectively. Tamil Nadu accounts for 16.6% of all injuries.
9. Three precise and trustworthy equations were created as part of the study to predict traffic accidents in the state. In Uttar Pradesh, population, registered automobiles, and road length are the three main contributors to accidents. The following are the equations

REFERENCES

1. List of countries by road network size - Wikipedia
2. World Health Organization and World Bank. (2004). World report on road traffic injury prevention. Geneva, World Health Organization, 2004.
3. Global status report on road safety 2018. Geneva: World Health Organization; 2018.
4. Planning Commission, Govt. of India, Report of the committee on Road safety and traffic management, The secretariat for the Committee on Infrastructure, February, 2007.
5. The Hindu, A Daily, New Delhi dated 22th April, 2014 (Supreme Court charts course forsafe roads - The Hindu)
6. World Health Organization. (2009). Global status report on road safety 2009. WHO, Geneva, Switzerland, 2009.
7. International Traffic Safety Data and Analysis Group (IRTAD) via the OECD statisticsportal, 2020
8. Accidental Deaths and Suicides in India, 2019 (ADSI_2019_FULL REPORT updated.pdf (ncrb.gov.in)
9. Ministry of Road Transport and Highways, Government of India (Road Accidents in India | Ministry of Road Transport & Highways, Government of India (morth.nic.in)
10. The World Bank data 2020(Population, total - India | Data (worldbank.org)
11. Al Haji, G. (2005). Towards a road safety development index. Linköpingsuniversitet. PhD
12. Litman, T. (2005). Well measured: Developing indicators for comprehensive and sustainable transport planning. Victoria, Victoria Transport Policy Institute
13. Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hoffman, A. and Giovannini, E. (2005b). Handbook on constructing composite indicators: Methodology and user guide. OECD
14. Shankar, V., Mannering, F. and Barfield, W.,1995. Effect of roadway geometrics and environmental factors on rural freeway accident frequencies. Accident Analysis & Prevention, vol 27, no. 3, pp. 371-389.
15. Brijs, et al. (2014). Evaluating the effectiveness of a post-license education program for young novice drivers in Belgium. Accident Analysis and Prevention. 66: 62-71.
16. Sutlovic, et. Al. (2014). The role of alcohols in road traffic accidents with fatal outcome: 10-year period in Croatia Split-Dalmatia country. Traffic Injury Prevention 15(3): 222227.
17. Sutlovic, et. Al. (2014b). Alcohol consumption, helmet use and head trauma in cycling collisions in Germany. Accident Analysis and Prevention, 65: 97-104.
18. Haikonen, H., &Summala, H. (2001, October). Deer-vehicle crashes - Extensive peak at 1 hour after sunset. American Journal of Preventive Medicine, 21(3), 209-213.
19. Verma, A.et.al (2011) Recommendations for driver licensing and traffic law enforcement in India aiming to improve road safety. Current Science.100(9): 1373-1385.
20. Linu, K. et. al. (2013). ROAD SAFETY AWARENESS INDEX & ROAD USER BEHAVIOR- A CASE STUDY AT KAZHAKKOOTTAM. International Journal Of Innovative Research In Science, Engineering And Technology, 2(1), 270-276.
21. Azmi, M., & Nadeem, M. (2020). Safety of Pedestrian under Mixed Traffic Condition – A Review Study. International Journal Of Innovative Research In Science, Engineering And Technology (IJIRSET), 9(7), 5442-5446.
22. Shewale, P. et. al. (2018). Rash Driving and Accidental Detection. International Journal For Scientific Research & Development, 5(11), 159-161.
23. K Saxena, A., & Bang, K. (2018). A Unique System to Prevent Rash Driving using Sensors of Smart Phones. International Journal For Scientific Research & Development, 6(9), 536-538.
24. Wallington,D.et al. (2014). Work-related road safety: Case study of British Telecommunications (BT). Transport Policy. 32:194-202.