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Development of Road Traffic Accident Prediction Model By Using Artificial Neural Network

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ABSTRACT: In rapidly developing metropolitan agglomerations, road traffic accidents are a big concern. There is a substantial body of research literature that sheds light on the scope of the problem and the remedies that are required. Road traffic accidents are the third leading cause of unnatural death among all deaths. Transportation engineers and academics have attempted to construct safe roads that adhere to suitable design standards, yet traffic accidents are inescapable. If an accident occurs, the reasons that caused it must be identified, and suitable corrective measures must be established and implemented as soon as possible. The goal of this study is to gain a better knowledge of the problem of road traffic accidents on the Mumbai Pune Expressway (MPEW) and the factors that may contribute to the high accident rates. Using Artificial Neural Networks, this research will construct an accident prediction model to anticipate the amount of accidents along the MPEW (ANN)

KEYWORDS: Artificial Neural Network, Road traffic Accidents, Planning, Management, Prediction, Deep learning Algorithm, Highway, Expressway, MPEW

I.INTRODUCTION

Significant effort and money have been expended in recent years to improve road and highway safety. A continuing problem for transportation engineers is to build and operate the transportation system in such a way that it serves a variety of social goals such as shortening travel time and increasing safety. There has been an increase in due to an exceptional surge in road transportation and automotive traffic in India as a result of and the economy's and consumers' consumption habits have grown at an exponential rate, resulting in dangerous conditions.

Road safety is both a health and a safety concern and development issue of significance given its magnitude and gravity, as well as the as a result, negative effects on the economy, public health, and general well-being individuals, particularly those with modest means

Road Accident Trend in India

There have been numerous types of vehicles on the road in India due to the development of road networks, such as cars, buses, motorcycles, trucks, vans, and others that have been used as a base to move from one place to another. According to the statistics from the Road Transportation Department website in 2019, as shown in Figure, the registered public vehicles in India are increasing every year, indicating that road safety is an important aspect because it involves the majority of the people in this country who are primarily transported by road

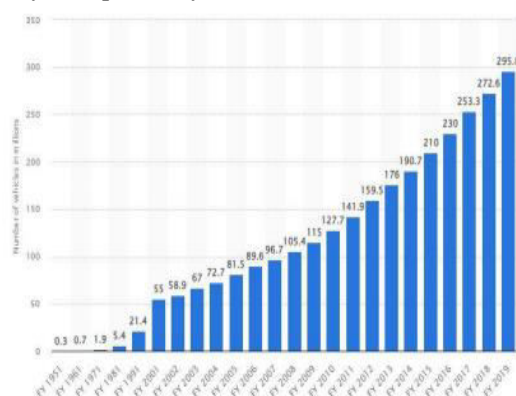
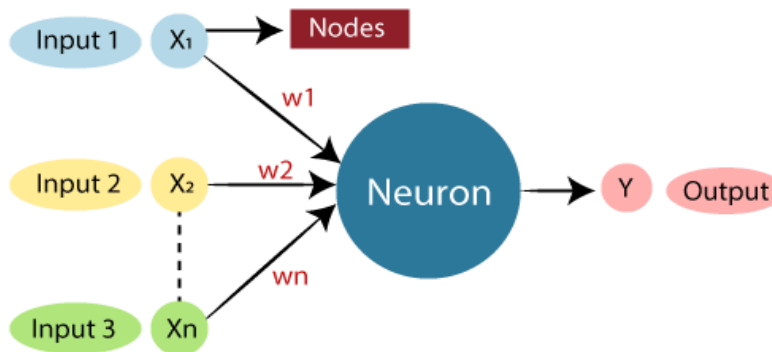


Fig1.1: Total cumulative of registered public vehicles in India upto year 2019 (MoRTH website)

II. ANN ALGORITHM

The term "Artificial Neural Network" is derived from Biological neural networks that develop the structure of a human brain. Similar to the human brain that has neurons interconnected to one another, artificial neural networks also have neurons that are interconnected to one another in various layers of the networks.

To understand the concept of the architecture of an artificial neural network, we have to understand what a neural network consists of. In order to define a neural network that consists of a large number of artificial neurons, which are termed units arranged in a sequence of layers. Lets us look at various types of layers available in an artificial neural network.



Artificial Neural Network primarily consists of three layers:

Input Layer: As the name suggests, it accepts inputs in several different formats provided by the programmer.

Hidden Layer: The hidden layer presents in-between input and output layers. It performs all the calculations to find hidden features and patterns.

Output Layer :The input goes through a series of transformations using the hidden layer, which finally results in output that is conveyed using this layer.

The artificial neural network takes input and computes the weighted sum of the inputs and includes a bias. This computation is represented in the form of a transfer function.

$$\sum_{i=1}^n W_i * X_i + b$$

It determines weighted total is passed as an input to an activation function to produce the output. Activation functions choose whether a node should fire or not. Only those who are fired make it to the output layer. There are distinctive activation functions available that can be applied upon the sort of task we are performing.

III. LITERATURE SURVEY

- [1] **Rana Maya, Bassam Hassan, Ammar Hassan, et.al** Purpose of this paper is to enable members of the construction project team to understand the factors, which they must closely monitor to complete the project with the required performance. Therefore, the research aimed to develop an artificial neural network (ANN) model to predict construction project performance based on the above factors.
- [2] **Xu Yang a, Jinchao Guan a, et.al** Study the ANN architectures used in these studies mainly included multi-layer perceptron neural network (MLPNN), convolutional neural network (CNN) and recurrent neural network (RNN) for processing one-dimensional data, two-dimensional data and time-series data. CNN-based pavement health inspection and monitoring attracted the largest research interest due to its potential to replace human labor. While ANN has been proved to be an effective tool for pavement material design, cost analysis, defect detection and maintenance planning, it is facing huge challenges in terms of data collection, parameter optimization, model transferability and low -cost data annotation.
- [3] **Menno Yap a, Oded Cats, et.al** We propose a modelling framework to quantify disruption impact propagation from the train network to the urban tram or bus network. This framework combines an optimization-based train rescheduling model and a simulation-based dynamic public transport assignment model in an iterative procedure. The iterative process allows devising train schedules that take into account their impact on passenger flow re-distribution and related delays more complete quantification of disruption costs, including their spilled-over impacts, retrospectively.



- [4] **Yanfeng Jia , Dayi Qu, Lewei Han, et.al** We analyze the evolution rule of the disturbance in the traffic flow in different states with the help of the time-space diagram, and compare the molecular model and the classical optimal velocity model. The results show that the molecular car-following model can better describe the car-following behavior from the micro level.
- [5] **Huaikun Xiang, Jiafeng Zhu, et.al** In this paper, we propose a new method for dangerous driving behavior prediction by using a hybrid model consisting of cloud model and Elman neural network (CM-ENN) based on vehicle motion state estimation and passenger’s subjective feeling scores, which is more intuitive in perceiving potential dangerous driving behaviors. To verify the effectiveness of the proposed method, we have developed a data acquisition system of driving motion states and apply it to real traffic scenarios in Shenzhen city of China. Experimental results demonstrate that the new method is more accurate and robust than classical methods based on common neural network.

IV. PROBLEM STATEMENT

“By studying different examinations like Highway survey and traffic analysis that the problem at city by pass Highway is due to insufficiency of Highway space for the vehicles to pass through the junction at different instants of time in a day which is effecting the free flow of traffic, and improper movement of traffic also results in occurrence of accident in different instants of time.”

As previously said, the number of incidents is increasing year after year and has become a major source of safety concern. As a result, doing this research is vital in order to grasp the scale of the problem, as well as to understand what causes accidents and injuries and what steps can be taken to prevent them. Furthermore, an effective solution for ensuring the safety of road users must be offered.

V. AIM OF PROJECT

This study focuses on accident investigations along the Mumbai-Pune Expressway, which runs through the Pune District. The goal of this study is to identify the primary elements that influence the occurrence of accidents and to construct an accident prediction model utilizing Artificial Neural Networks (ANN)

VI. OBJECTIVES

1. To collect road accident data on MPEW.
2. To analyze the accident trend and accident parameters on MPEW.
3. To determine the critical accident variables for accident prediction purposes.
4. To develop an Accident Prediction Model for MPEW by using Artificial Neural Network (ANN) applied software.

VII. RESEARCH METHODOLOGY



VII. DEVELOPMENT AND APPLICATION OF ANN MODEL

What is ANN?

Artificial neural networks (ANNs) have gained popularity in recent years due to their ability to solve a wide range of issues. ANNs have been used to detect road traffic accidents in the transportation sector (RTAs). This section introduces basic neural network concepts and discusses why neural networks are appropriate for traffic data prediction.

A biological neuron is to the brain what an artificial neuron is to an ANN. The basic building block of the ANN is an artificial neuron. A neural network is a set of algorithms that attempts to uncover underlying relationships in a set of data by simulating how the human brain functions.

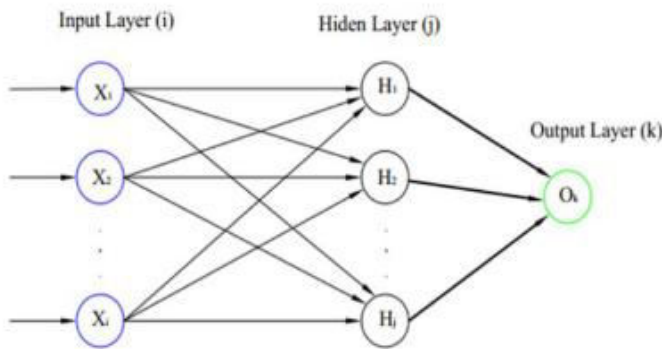


Figure 1.3: General neural network structure

The total of the numerous x_n inputs multiplied by their corresponding weights of the relation w_n is thus the beginning stage of an artificial neuron. After that, the $w_n \cdot x_n$ products are fed into the summing function, which is iterated to reduce error.

VIII. DATA COLLECTION & EXPERIMENTATION

The Mumbai–Pune Expressway (MPEW) (formally known as the Yashwantrao Chavan Expressway) is India's first 6-lane wide concrete toll road. It connects Mumbai, Maharashtra's capital, and Pune, the state's capital, across a distance of 94.5 kilometers. Pune, Maharashtra's cultural and educational hub, is India's financial capital. In the year 200, it was fully operationalized.

MPEW has witnessed a large number of road accidents, attributed to human errors and the large volume of traffic. In last three years 872 numbers of accidents have been recorded by Highway Police. Out of which 232 were recorded as fatal accidents and 268 users were killed, 392 were seriously injured and 67 suffered minor injuries.

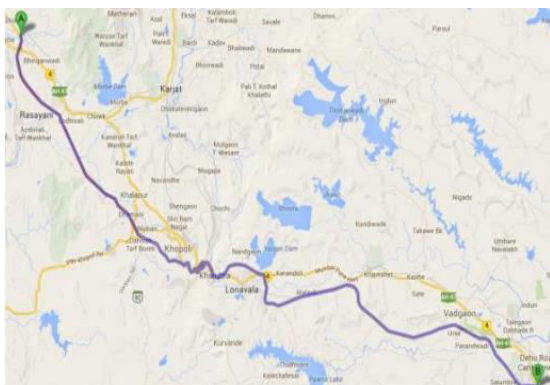


Figure 1.4: Map Showing Mumbai – Pune Expressway

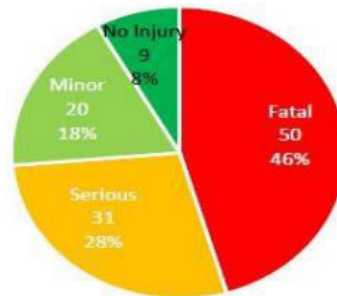


Fig 1.5: Distribution of accidents by highest

Distribution of accidents by Weather Conditions:

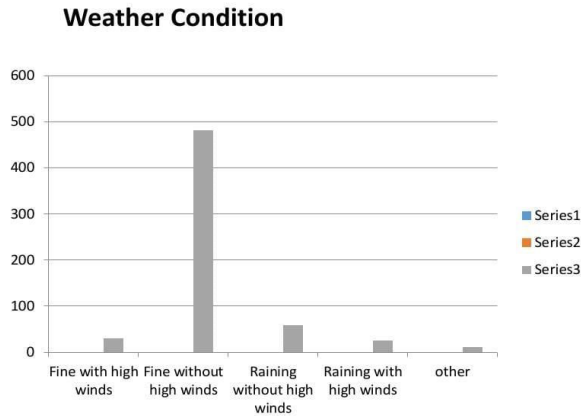


Fig. 1.6: Distribution of accidents by Weather Conditions

Distribution of accidents by lightning conditions:

Lighting_Conditions	No_of_accidents	percent
0 Darkness: no street lighting	58	1.864352
1 Darkness: street lighting unknown	21	0.675024
2 Darkness: street lights present and lit	696	22.372228
3 Darkness: street lights present but unlit	8	0.257152
4 Daylight: street lights present	2328	74.831244

Fig 1.7(a): Distribution of accidents by Lighting Condition

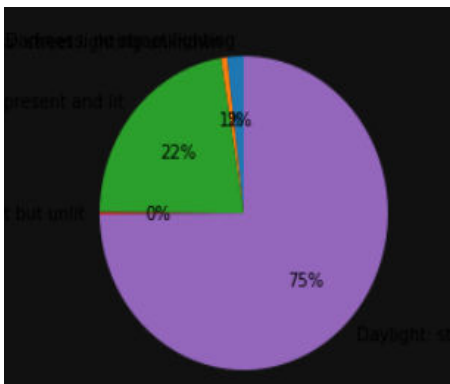


Fig 1.7 (b): Distribution of accidents by Lighting Condition

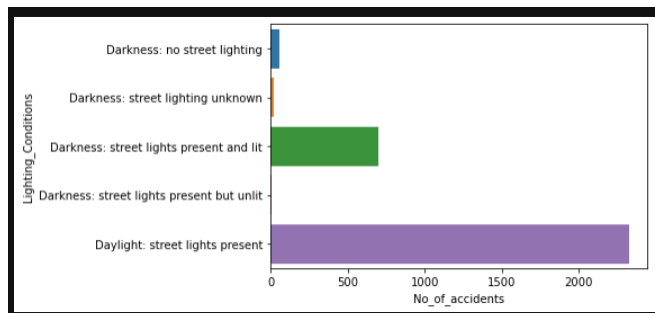


Fig 1.7(c): Distribution of accidents by Lighting Condition

Distribution of accidents by Road Surface: Distribution of accidents Speed:

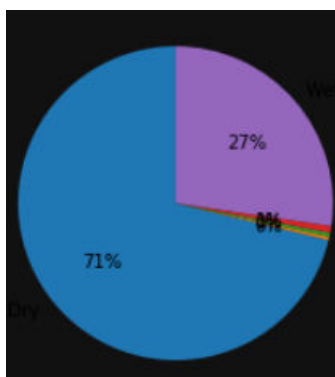


Fig 1.8: Distribution of accidents by Road Surface

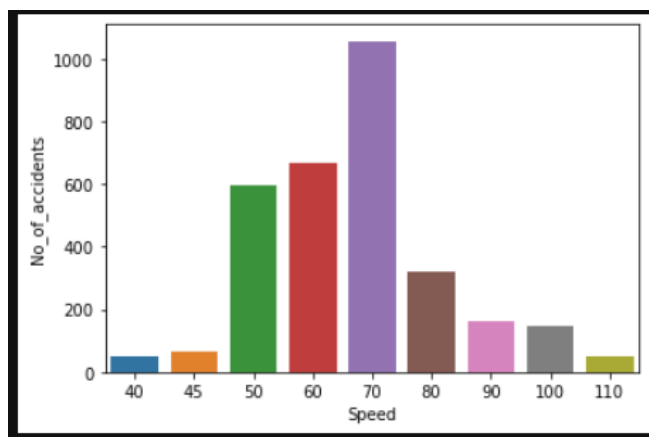


Fig 1.9: Distribution of accidents by Speed



Analysis of Contributing Factors:

Most road traffic accidents and fatalities are caused by a combination of circumstances.

The injuries that resulted were thoroughly investigated and are detailed. Accidents and injuries are influenced by a variety of factors. The properties of contributing components are used to create a distribution.

The Venn diagram depicts (Human/Vehicle/Infrastructure) for road traffic accidents. The combination of human and vehicle components (56%) resulted in this diagram.

The combination of all factors (24 percent) has the greatest impact on the occurrence of accidents and the resulting injury cause, followed by human factors (14 percent).

Contributing human influencing the accidents :

HUMAN FACTORS (Influencing accidents and injuries)	All accidents	Fatal accidents
Driver - Sleep/Fatigue/Drowsiness	35%	26%
Speeding - Exceeding speed limit	32%	38%
Overtaking on left side of vehicle	15%	24%
Improper lane change/lane usage	15%	12%
Parked - vehicle off the road	10%	10%
Driving too slow for conditions	10%	12%
Pedestrian – Dangerous behavior on roadway	10%	20%
Parked – Vehicle on road (Full or partial)	7%	12%
Driver Inattention	3%	4%
Pedestrian Inattention	4%	6%
Speeding - Excessive speed for conditions	4%	4%
Following too closely	3%	4%
Turning suddenly or without indication	3%	2%
Illegal road usage	2%	4%
Vehicle slowed down/ stopped suddenly.	2%	%
Driver – Alcohol	1%	2%
Seatbelt not used	66%	64%

Table 1.1'

Human error, vehicle characteristics, and infrastructure/ environmental factors are the three key contributing factors in traditional accident analysis. It should be noted that when investigating an accident, it is important to try to identify all possible contributing variables (human, vehicle, and infrastructure) that may have contributed to the accident's occurrence, as any of these aspects might have an independent or combined effect. Despite human flaws, this type of study provides a broader viewpoint and can aid in the identification of vehicle and infrastructure-related solutions.

Accidents and injuries are influenced by human factors.

For each contributing human component, Table 1.1 tabulates all accidents and fatal accidents. More than one component can influence the cause of an accident or injury; thus, the sum of percentage influences will not match the amount of human variables influencing crashes.

Accidents and Injuries Caused by Vehicle Factors

The following are the vehicle factors that have been determined to have influenced accidents and injuries. The percentage of accidents is shown in table 1.2 each factor has an impact.



List of contributing vehicle factor:

VEHICLE FACTORS (Influencing accidents and injuries)	All Accident	Fatal Accident
Absence of Reflectors	4%	8%
Defective - Brakes	1%	2%
Vehicle-other	1%	2%
Passenger Compartment Intrusion - Underride/Override & Other	67%	72%
Seatbelts not available/usable	24%	20%
Knock-down of Pedestrian	11%	22%
Runover of Pedestrian	2%	4%
Unsecured Cargo	1%	2%
Ejection	16%	26%

Table 1.2

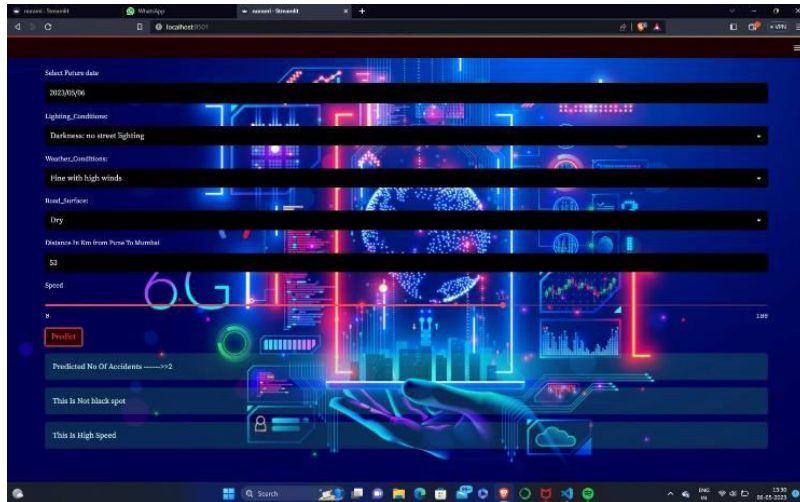
Infrastructure Factors influencing Accidents and Injuries:

Following are the contributing infrastructure factors determined to have influenced the accident. The table shows the percentage of crashes influenced by each factor

INFRASTRUCTURE FACTORS (Influencing Crashes and Injuries on the MPEW)	All accident	Fatal Accident
Inadequate warning about accident / parked vehicle	8%	12%
Shoulder – Narrow	3%	2%
Sharp Curvature	2%	2%
Gap-in-Median	2%	2%
Poor road marking/signage	1%	2%
Slippery road surface	1%	--
Animal/Object on roadway	1%	--
Poor object conspicuity	1%	--
Object impacts - roadside – manmade structures	12%	10%

Table 1.3

IX.RESULTS



X.CONCLUSION

The following are the important results based on the above discussions on road traffic accidents for the Mumbai-Pune Expressway:

Between the hours of 00:00 and 09:00, 56 percent of all accidents and 54 percent of fatal accidents occur.

Crashes with another vehicle going ahead, waiting, or stopped (rear-end collisions), leaving the carriageway to the left or right, and pedestrian accidents account for 90% of all accidents and 94% of fatalities.

Trucks, vehicles, and pedestrians account for 95% of all road users engaged in collisions and 98 percent of all road users with at least one fatality.

Car occupants were outside the vehicle in 4.58 percent of pedestrian accidents while the vehicle was parked, broken down, or being pushed to the side of the road.

Factors that cause accidents, together with their severity in percentages

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