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Modelling Road Accident using Poisson Regression Models

Dvij Chaudhari[1], Dr. Pinakin N. Patel[2], Dr. L. B. Zala[3], Dr. Amit A. Amin[4]
[1]*M.Tech, Student, Transportation Engineering, Civil Department, BVM Engineering College, Vallabh Vidyanagar, Gujarat*
[2, 4]*Assistant Professor, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar, Gujarat*
[3]*Professor and Head, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar, Gujarat*

Abstract: ***The objective of this research is to evaluate the safety of multi-lane urban roads in India. In this paper, a generalised linear modelling technique is applied for the analysis of the Indian Highway's road accident. The features of road, speed, and traffic data are analysed in Surat on four-lane urban roads. A novel approach to the model of accident prediction for an urban highway is being proposed to include daily average travel (ADT) and average spot speed (AS). The model was developed as a reliant variable and significant variables such as chain width, intersection no, ADT, AS, as separate variables for accidents per kilometre.. The results of the model provide a better assessment of accidents on a multilateral urban road. Because road accidents are different, statistical models do not adequately capture the characteristics of each section. As a result, the results of Poisson regression were the opposite of these variables. There was also no statistically significant type of traffic control. Significant statistically at level 0.05. Accident locations were assessed by correlating the severity of the accident with different attributes. This investigation will contribute to improving urban road safety.***
Keywords: Road accidents, Generalized linear model, Poisson regression, Accident-prone locations

I. INTRODUCTION

In India, road accidents are a major concern. There have been 4.67.044 road accidents in India in 2018, in which 1,51,417 people died, which means that every quarte minutes one death[1] has occurred. India is the second-largest country in the world in terms of road networks (5,897,671 km). This indicates that national roads are more susceptible to traffic accidents. Urban road deaths and injury rates are higher for a number of reasons, including lengthy emergency response time and distance from accident scenes, high vehicle speed and poor driving habits such as driving and drinking, as well as the use of seat belts. The country faces approximately one hundred billion rupees annually, in the event of fatalities, injuries and community problems resulting from road crashes. [2] Accidents cannot be prevented, but frequency and severity can be reduced by scientific research and efficient technological solutions. The analysis of road accidents therefore provides solutions for various causes that can lead to accidents. If appropriate engineering actions are to be taken to minimise road accidents, a road accident analysis is essential. It's a tough task to model road accidents. In many parts of the world, considerable research has been done to determine the safety of various road types. Multi-lane urban roads' safety performance is an area of research in India. There is enormous failure to investigate urban incidents in India. Consequently, multi-city evaluations of road safety are essential because it is more likely to result in accidents. Models of crash prediction are one of the main methods for assessing accident-risk relations between different carriers. [3] The aim of this investigation is to develop a model for accident prediction and a methodology to identify vulnerability areas on a multilateral urban road. The Poisson regression model was developed using an advanced method called Generalized Linear Models (GLM). A link function in GLM can be used to describe the dependent variable as a linear function of the independent variables. In recent years, generalised linear models used for continuous, discrete or dumb variables have been becoming more popular as useful methods to connect the frequency of accidents to the explanation of the variables.

II. OBJECTIVES

The objectives of this study are listed below:

A. The main objective is to investigate the causes of Road Accidents.
B. To study the various collapse characteristics in Surat that cause more accidents on the roads.
C. To analyze the causes of accidents and occurring on the roads and to find the accident-prone area.
D. To develop a road accident prediction model.
E. To suggest suitable remedial measures for overcoming the deficiencies that lead to accidents.

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III.STUDY CORRIDOR

Total there are six arterial corridors in Surat city.

A. Varachha- KamrejVarachha corridor
B. Olpad-Rander corridor
C. Hazira-Adajan corridor
D. Udhna –Sachin corridor
E. Sahara-Kadodara corridor
F. Dumas-Athwa corridor

Surat's main city These six corridors represent six arterials, including various residential, commercial, industrial and industrial activities. On these corridors / streets there is a mixture of traffic. For these reasons, the corridors for the study and the production of accident prediction models for the three corridors were chosen from the six corridors Varachah Kamrej, Sahara-Kadodara and Udhna-Sachin

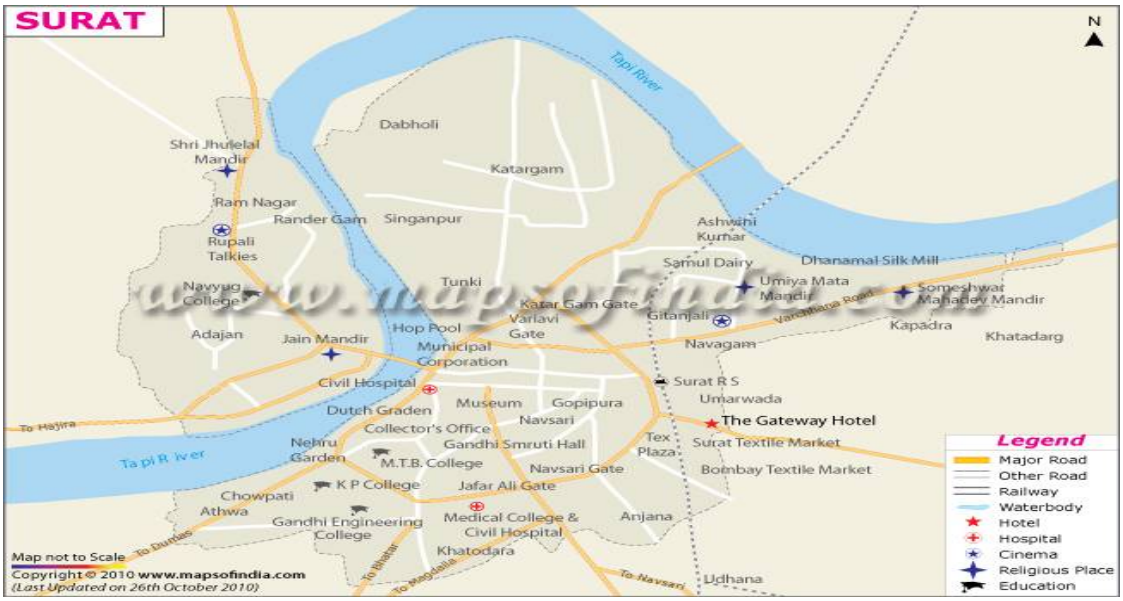

Fig. 1 Map of Surat city showing major arterial roads

IV.DATA COLLECTION

The data and methodology used in this document are described in this section. For the years 2016 to 2020, accident data were blown up by the Vairouse Police Station. The accident data contain information such as where the accident took place. The information also includes the type of accident (fatal, minor and serious injury), the number of people killed or injured, accident cars, the likely cause and jurisdiction of a police station.

TABLE I
Yearly Road Accident Distribution Udhan-Sachin Corridor

Year	Fatal	Serious	Minor	Total
2016	23	27	9	59
2017	26	30	13	69
2018	26	26	11	63
2019	30	29	8	67
2020	25	22	7	54
Total	130	134	48	312

The number of accidents in roads between 2016 and 2020 is shown in Table 1. 312 road accidents have been recorded between 2016-2020 and 130, 134 and 48 have occurred, with fatal, serious and minor accidents.

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TABLE II
Yearly Road Accident Distribution Sahara-Kadodara Corridor

Year	Fatal	Serious	Minor	Total
2016	41	21	9	71
2017	22	29	13	64
2018	15	19	8	42
2019	22	26	11	59
2020	20	18	9	47
Total	120	113	50	283

The number of accidents on the roads between 2016 and 2020 is shown in Table 2. There have been 283 road accidents in 2016-2020, with 120, 113 and 50 respectively fatal, serious, and minor crashes.

TABLE III
Yearly Road Accident Distribution Varachha-Kamrej Corridor

Year	Fatal	Serious	Minor	Total
2016	20	31	11	62
2017	19	29	17	65
2018	26	41	14	81
2019	27	31	21	79
2020	25	27	9	61
Total	117	159	72	348

The number of road accidents between 2016 and 2020 is shown in Table 3. 348 accidents were reported between 2016 and 2020, with 117, 159 and 72 accidents that resulted in fatal, serious and minor accidents.

TABLE IV
Junction Wise Distribution Of Road Accident Udhana-Sachin Corridor

Severity	Not at junction	T-junction	Y-junction	Bridge	U-turn	Total
Fatal	75	27	19	2	5	128
Serious	59	48	15	1	11	134
Minor	28	15	4	0	3	50
Total	162	90	38	3	19	312

Table IV shows that 59% of road accidents occurred on straight roads (Not at junction). In 21 and 15 percent of road crashes, T-junction and Y-junction occur respectively.

TABLE V
Junction Wise Distribution Of Road Accident Sahara-Kadodara Corridor

Severity	Not at junction	T-junction	Y-junction	Bridge	U-turn	Total
Fatal	61	33	9	1	9	113
Serious	55	42	15	0	11	123
Minor	17	16	1	0	13	47
Total	133	91	25	1	33	283

Table V shows that 54% of road accidents occurred on straight roads (Not at junction). In 29% and 8% of road crashes, the T junction and the Y junction occur respectively.

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TABLE VI
Junction Wise Distribution Of Road Accident Varachha-Kamrej Corridor

Severity	Not at junction	T-junction	Y-junction	Bridge	U-turn	Total
Fatal	77	29	19	6	19	77
Serious	53	48	17	7	13	53
Minor	17	19	8	7	9	17
Total	147	96	44	20	41	147

Table VI shows that 51% of road accidents occurred on straight roads (Not at junction). In 19% and 13% respectively of road accidents the T-Junction and Y-Junction occur.

V. MODELING METHODOLOGY

In many cases, an expected quantity can be modelled as a linear mix of a number of different variables and general linear models can be used. But linear relationships can be inappropriate if the dependent variable is restricted to binary or counting numbers. In addition, it cannot be ideal to describe the phenomena of the real world when residues are normal. Homozedasticity, for example where variance depends on mean, is sometimes an inacceptable assumption. Thus, assumptions of linearity, normality and homoscedasticity restrict the application range of general linear models. In order to address these issues, the generalized linear model GLM extends the general linear pattern.[4]

VI. POISSON REGRESSION

Poisson regression analysis is the fundamental model to determine the relation between independent variables and independent variables. In the face of a problem where the result of the random variable Y can only take the count values, the distribution Y only takes the count data into account[5-6]. The distribution of Poisson is one distribution that meets this criterion and comes from the exponential range.

Let Y be random, let Yi, I = 1,2,…,k be their results[7]. The variable Y is said, if the probability function is given, to follow the Poisson distribution with the $\mu > 0$.

$$\mathbf{P(Y = n)} = \frac{e^{-\mu}\mu^{n}}{n!}, \qquad (1)$$

where n = 1,2,… is the number of occurrences of an event and $\mu = E[Y]$ by definition.
A useful feature of the distribution of Poisson is that the variance depends on the mean, where the variance is the same as the mean.

VII. MODEL DEVLOPMENT

Poisson regression, which belongs to the general linear model class (GLM), is the usual way of analysing count data. Many data scenarios in the real world, however, defy the assumptions of the Poisson model. [8] For instance, the Poisson model implies that the mean and variance of the response are identical.
This means that events are happening at a consistent rate throughout an observation period; an occurrence during the entire period is equally likely. The Poisson model is probably distributed over when the data are heterogeneous. If the variance of a response exceeds its mean, excess dispersion is indicated. The dispersion can also be checked by submitting data to a model from Poisson, and observing the dispersion statistics based on Chi2 or Deviance. The model is over-dispersed if the value of the dispersion is larger than unit.
We must first determine if the data is heterogeneous to use the Poisson regression model. Table 7 shows descriptive statistics, and the variance of the response variable (number of people who died during the accident) can be observed to be a little greater than the mean. Therefore, the results of the Poisson regression should be carefully considered.

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TABLE VII
Descriptive Statistics Of The Response Variable

Corridor	n	Minimum	Maximum	Mean	Std. Deviation	Variance
Udhana-Sachin	10	15	51	31.20	14.274	203.733
Sahara-Kadodar	13	9	45	22.00	10.669	113.833
Varrach-kamrej	13	14	37	26.77	7.026	49.359

With respect to the fitness measurement for an Udhana Sachin path, the deviance/df value is 0.164 and is below 1. Sahara Kadodar fits, the deviance/df value is 1.574, which means that the model is overdispersed with Poisson. The value of Varachha Kamrej is 1.275 and lower than 1. The pattern is over-dispersed by poisson.

TABLE VIII
Parameter Estimates Using Poisson Regression Udhana-Sachin

Parameter	B	Std. Error	Hypothesis Test		Sig.@ 0.005 level
			Wald Chi2	Sig.	
Intercept	-1.425	.9728	1.852	.167	No
No. of junction	0.43	.1653	1.301	.004	Yes
Carriageway	-0.26	.0680	.149	.700	No
ADT	0.0543	.0787	47.424	.000	Yes
Shoulder width	-.358	.0400	13.714	.005	Yes
Light condition	.037	.0189	3.731	0.058	No
Speed	0.0541	.0128	.000	.997	No

TABLE IX
Parameter Estimates Using Poisson Regression Sahara-Kadodara

Parameter	B	Std. Error	Hypothesis Test		Sig.@ 0.005 level
			Wald Chi2	Sig.	
Intercept	-.235	2.1537	.011	.915	No
No. of junction	-.233	.1549	2.297	.130	No
Carriageway	.009	.0675	.018	.893	No
ADT	0.0048	0.0017	7.734	.005	Yes
Shoulder width	-.304	.0897	11.502	.001	Yes
Light condition	-.219	.2276	.925	.336	No
Speed	-.059	.0158	14.190	.000	Yes

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TABLE X
Parameter Estimates Using Poisson Regression Varachha-Kamrej

Parameter	B	Std. Error	Hypothesis Test		Sig.@ 0.005 level
			Wald Chi2	Sig.	
Intercept	1.153	1.5129	.581	.446	No
No. of junction	-.146	.0508	8.225	.004	Yes
Carriageway	.158	.0376	17.732	.000	Yes
ADT	.0094	.0012	.776	.378	No
Shoulder width	-.077	.0747	1.064	.302	No
Light condition	.163	.0792	4.212	.040	No
Speed	-.019	.0041	21.228	.000	Yes

Presents the estimates of parameters by using the regression model Poisson. Parameters of the Carrier width, Junction Number, ADT, Shoulder width, Light condition and Speed variables Signification. At the level of 0.05, these variables are important.

VIII. CONCLUSION

In the based on the aforementioned gaps, this study focuses on increasing safety on the Indian urban roads. In this study, a generalised linear modelling methodology was used to evaluate the rates of accident for each sector using the Poisson log link function (log-linear), and association rules were used to detect particular parameters related to accidents in each area. This study adds a simple method for calculating the rate of accidents on multi-roads to the current state of the art in model accident prevision models. The results indicate that a more accurate estimate of accident numbers can be obtained. The study findings suggest that a wide range of issues can be addressed by the modelling methodology proposed in this research. The Udhana-Sachin model is not exaggerated. The Sahara-Kadodar model has been exaggerated. A dispersed model is the Varachha-Kamrej. Statistical models are helpful in predicting road accidents, but are limited in their ability to fully reflect the characteristics of each part because of the variability in accidents and the concentration of incidents in particular areas. It fails to consider the reasons for clustering accidents in some areas. This research could help improve driving safety on Indian urban roads.

IX. FUTURE RESEARCH

This paper provides an overview of Indian road accidents. It is important to remember, however, that the data available have intrinsically restricted this work. There is limited information from the police records concerning road accidents and traffic accidents, such as speed and road conditions, have not been recorded. Geometric features like gradient, horizontal and vertical curvature were missing for the analysis. The current work will be further enhanced if these data are available. There is a need for research in order to propose different areas.

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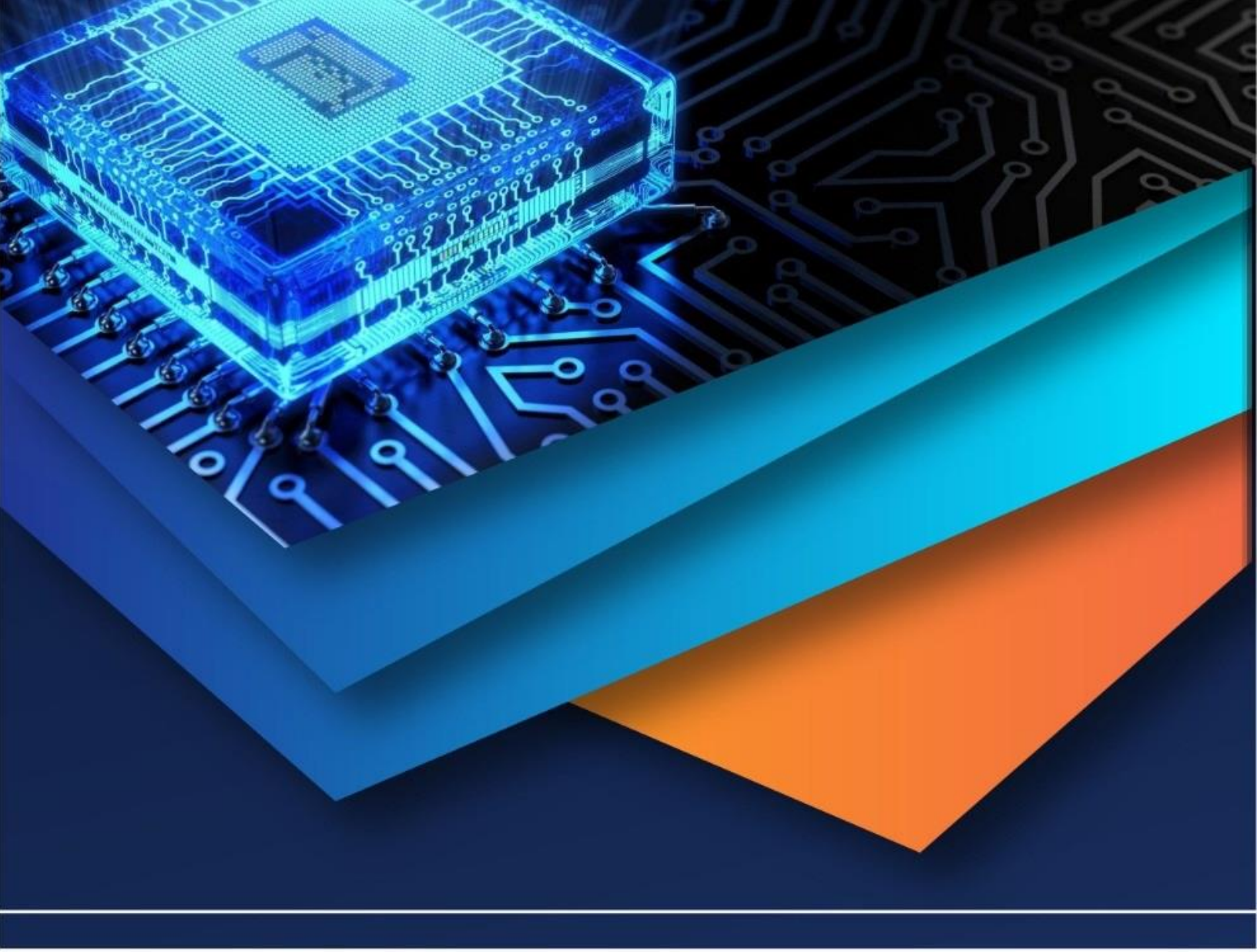

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