Accident Prediction Models On Major Arterial Roads Under Heterogenous Traffic Conditions

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ABSTRACT

Accidents account to a huge loss economically and morally. India stands among the leading countries with respect to death due to road accidents. By 2020 it is estimated that road accidents shall be the 3rd leading cause of deaths. Several organizations and research centers are working on the direction of creating awareness, improving safety standards, understanding the causes of accidents and how to mitigate them. One such effort is this research work.. For our project, 6 major roads GTK road, Ring Road, MB Road, Mathura Road, Outer Ring Road and NH-24 were selected as area of study.

The collected data were analyzed to evaluate the effect of influencing parameters on accident rate and provide a relationship between the simple and fatal accidents. The main aim of the project is to develop an accident prediction models to predict the accident rates under heterogeneous traffic conditions. The road accident prediction models were developed by using multiple tests like Correlation analysis, ANOVAs test, F test, Descriptive statistics, Chi square test of contingency and Simple linear regression analysis. The accident rates were found to be significantly related to road design parameters of study stretch area. The developed model is useful for the prediction of fatal and simple accidents.

INTRODUCTION

Over 1, 37,000 people were killed in road accidents in 2013 alone and 1, 39,671 people died in 2014 on Indian roads. That is more than the number of people killed in all our wars put together. There is one death every four minutes due to a road accident in India. Drunken driving is one of the leading causes of road fatalities. 41% Indian children die because of road accidents, which are an alarming situation.377 people die on Indian roads every day, which is 1682 times more than terrorism. Majority of deaths due to unsafe driving and carelessness.

Total accidents in 2014 were counted to be 489400 and in 2015 there was a 2.6% increase which accounted to total accidents of 501423 and the number of deaths in 2015 were 1, 46,133, as against 1, 39,671, marking an increase of 4.6%.

The total number of deaths in 2014 was 12 times greater than in 1970 with an annual compound increase rate of 6%. The fatality rate in 2014 was 52.2 times greater than 1970 with an AACGR of 3.9%.there have been a few periods when the growth in RTI fatalities has decreased briefly and for a small amount, but the causes are not known.

As per official statistics 141,526 persons were killed and 477,731 injured in road traffic crashes in India in 2014 (NCRB, 2015). However, this is probably an underestimate, as not all injuries are reported to the police (Gururaj, G., 2006, Mohan, D. et al., 2009). The actual numbers of injuries requiring hospital visits may be 2,000,000-3,000,000 persons. The root for these estimates is given in later section. The situation in India is worsening and road traffic injuries (RTI) have been increasing over the past twenty years. This may be partly due to the increase in number of vehicles on the road but mainly due to the absence of coordinated evidence-based policy to control the problem.

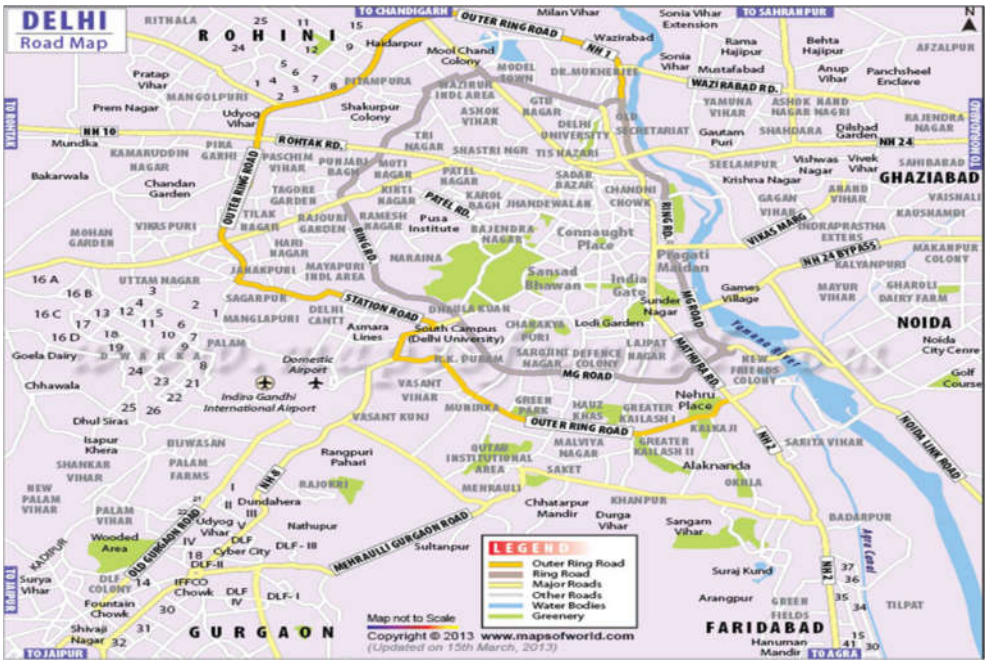
Victor and Vasudeman (1998) made a detail study and examination on transport related accident in Tamil Nadu taking information from fine Transport Organizations. It is analyzed that the accident every now and again and pattern of transport related accidents with unique references to open Street Transport under takings in India [7]. A street accidents in Nashik Civil partnership zone and highlighted the conveyance and accidents design in the city at smaller scale level amid the period 1980-1989 [9]. Saija et al (2000) had made a point by point examine on street accident investigation of Gujrat. Singh and Misra (2000) dissected the street accident range for the city of Patna. Chakra borty et al (2001) concentrated the animosity to hazard taking practices that leads a danger to street security. Jenna et al (2001) built up a model for forecast of accidents in Indian urban streets taking field information from Ernakulum. PallaviPriyaand et al in their paper "Street Accident Investigation, Assessment and Improvement of Option Security Administration Methodologies" in 2004 learned about how street accidents get influenced because of street variables. Rakesh Kumar Singh and S.K.Suman in their paper titled "Accident Investigation and Forecast of Model on National Roadways" in 2012 concentrated the extend of NH-77 has been chosen from Hajipur to Muzaffarpur. The accidental information was gathered for most recent eleven years, 2000-2010. The gathered information was investigated to assess the impact of affecting parameters on accident rate. Substantial vehicles like truck are included in most extreme number of accidents on the chose extend. It is evaluated that an overwhelming vehicles is included in very nearly 48% accidents took after by bikes 16%, auto 12% and transport 10%. There is no distinct pattern for month to month variety in accident on a review area however the accidents in month of July and January are for the most part higher. Accident rate as far as number of accidents per km-year increments with activity 7 volume procedures and future recommendation are prescribed. P. Bhat et al. (2013) built up an accident show for Bangalore city including the components like street qualities (viz. carriageway width, bear sort, number of minor intersections, street condition, etc.

DATA COLLECTION

For this project, 6 major roads GTK ROAD, RING ROAD, MB ROAD, MATHURA ROAD, OUTER RING ROAD and NH-24. The accidental data was collected for last eight years, 2008-2015 from the Delhi Police and Delhi Traffic Police Department. The collected data were analysed to evaluate the effect of influencing parameters on accident rate and provide a relationship between the simple and fatal accidents.

METHODOLOGY AND RESULTS

Accident data collected has been segregated and processed. And the data has analyzed carefully to understand the accident trend. The map below is the area that has been studied for accident analysis.



The data gathered has been analyzed using mat lab to understand the statistical significance. Below table summarizes the statistical results of the accident data for the chosen study area.

Non Injurious Accident		Simple Accident		Fatal Accident	
Mean	160	Mean	5646.625	Mean	1906.125
Standard error	33.66908289	Standard error	238.8615063	Standard error	85.57232478
Median	145.5	Median	5390.5	Median	1918.5
Mode	N/A	Mode	N/A	Mode	N/A
Standard Deviation	95.23054732	Standard Deviation	675.6023635	Standard Deviation	242.0350845
Sample Variance	9068.857143	Sample Variance	456438.5536	Sample Variance	58580.98214
Kurtosis	2.715583314	Kurtosis	-1.035634169	Kurtosis	-1.179262257
Skewness	1.46173993	Skewness	0.726820156	Skewness	0.037329759
Range	299	Range	1785	Range	690
Minimum	63	Minimum	5000	Minimum	1582
Maximum	362	Maximum	6785	Maximum	2272
Sum	1280	Sum	45173	Sum	15249
Count	8	Count	8	Count	8
Largest(1)	362	Largest(1)	6785	Largest(1)	2272
Smallest(1)	63	Smallest(1)	5000	Smallest(1)	1582
Confidence level (95.0%)	79.61472994	Confidence level (95.0%)	564.8177106	Confidence level (95.0%)	202.3463944

Table 1. Statistic Analysis of the Accident Data

Sl. No.	Type Of Accident	Mean	Standard Deviation	Standard Error	Median	Variance	Coefficient Of Variation (C_v)	Rank
1	Non Injurious Accident	160	95.23	33.66	145.5	9068.85	59.51	3
2	Simple Accident	5646.62	675.6	238.86	5390.5	456438.55	11.96	2
3	Fatal Accident	1906.12	242.03	85.5	1918.5	58580.98	12.69	1

Table 2. Ranking of type of accidents

The correlation analysis on the above data table depicts that there is a correlation between Simple and Fatal accidents, which have been found to be 0.9511, which implies there exists a strong linear relationship between two accidents. Then Anova test and simple regression analysis have been performed to understand the parameters which have statistical significance on the accidents and frame a equation.

For Anova test, two hypotheses were assumed to understand the relationship between Simple and Fatal accidents and correlate the results mathematically.

H_0:$\mu 1 = \mu 2$ i.e. there is no significant difference between Simple and Fatal accidents.

H_1: $\mu 1 \neq \mu 2$ i.e. there is a significant difference between Simple and Fatal accidents.

Then, the possibilities are, either $\mu 1 > \mu 2$ or $\mu 1 < \mu 2$ (two tailed test)

From analysis it was found that $F_{calculated}$ value less than F_{table} i.e. $4.14 < 4.96$ (at α=0.05 and degree of freedom= 1, 10). The above results depict that there does not exist enough evidence in the sample information against H_0. Hence, H_0 is correct and accepted. Therefore, It was found that estimated accident rate from accident prediction model were significant at 5% level of significance. Civil structure related phenomenon (road structural environment) do not sufficiently guide us about the two types of accidents in present work. Then coefficient of variation Cv has been calculated and was found as follows.

Parameter	Simple Accident	Fatal Accident
Mean	133.66	51.83
Standard deviation	92.91	32.69
Coefficient of Variation (Cv)	69.51	63.07
Rank	2	1

Table 3. Cv of Simple and Fatal accidents

. It was found that fatal accidents have smaller value of **Coefficient of Variation (Cv).** Hence concluding that fatal accidents are more consistent compared to Simple accidents, which is considered a serious issue for the society. There is an urgent need/emphatic need to reduce the level of consistency of occurrence of fatal accidents.

Then linear regression models where developed to understand the accident trend, relation between simple accidents and fatal accidents and develop an accident prediction model

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
SIMPLE ACCIDENTS	6	802	133.6666667	8633.866667
FATAL ACCIDENTS	6	311	51.83333333	1068.966667

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	20090.08333	1	20090.08333	4.141075631	0.06922793	4.964602701
Within Groups	48514.16667	10	4851.416667			
Total	68604.25	11				

Figure 1. Anova Test Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.951136742
R Square	0.904661102
Adjusted R Square	0.880826377
Standard Error	11.28683437
Observations	6

ANOVA

	df	SS	MS	F	Significance F
Regression	1	4835.262813	4835.262813	37.95559292	0.003523094
Residual	4	509.5705207	127.3926302		
Total	5	5344.833333			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	7.098534453	8.599821873	0.82542808	0.455512187	-16.77839883	30.97546774	-16.77839883	30.97546774
SIMPLE ACCIDENTS	0.334674306	0.054323092	6.16081106	0.003523094	0.183849223	0.485499388	0.183849223	0.485499388

RESIDUAL OUTPUT

Observation	Predicted FATAL ACCIDENTS	Residuals	Standard Residuals
1	74.70274423	16.29725577	1.614348653
2	99.46864286	-13.46864286	-1.334156239
3	24.83627266	-3.836272663	-0.380007634
4	33.87247892	-0.87247892	-0.086424683
5	57.29968033	5.700319671	0.564653554
6	20.82018099	-3.820180993	-0.37841365

PROBABILITY OUTPUT

Percentile	FATAL ACCIDENTS
8.333333333	17
25	21
41.66666667	33
58.33333333	63
75	86
91.66666667	91

Figure 2. Simple Linear Regression analysis

From the above figure/ description,

R^2 = Coefficient of Determination = 0.9046, which implies that there exists a strong degree of dependency between the response variable (Fatal Accidents) and independent variable (Simple accidents)

The accident prediction equation is as follows:

$$Y = \beta_0 + \beta_1 (X) + \varepsilon$$

$$\text{Fatal Accidents} = \beta_0 + \beta_1 (\text{Simple accidents}) + \varepsilon$$

Pre fitted Regression line will be; E(Y) = 7.098 + 0.334 (X)

Where, E(Y) = Expected no. of Fatal accidents

X= No. of Simple accidents

Hence the above equations can be used to predict the number of fatal as well as simple accidents knowing one or the other variables. In other words, fatal accidents happen because of simple accidents i.e. simple accidents lead to fatal accidents. In the above equations, we have mathematically proved that simple accidents lead to fatal ones because of the poorly designed roads or the Driver/ vehicle characteristics. In addition, suppose we want to predict that at any location, there occur 10 simple accidents in a selected time period. Then, according to above fitted regression model, we may estimate about possible number of fatal accidents. Thus the research paper accomplishes the predicting accidents on the Delhi arterial roads.

CONCLUSIONS

- There should be road safety audits of major accident prone roads from time to time.
- We have mathematically proved that simple accidents lead to fatal ones because of the poorly designed roads or the Driver/ vehicle characteristics. Therefore, we should try to minimize the number of simple accidents so that number of fatal accidents would automatically decrease.
- R^2 = Coefficient of Determination = 0.9046, shows that there exists a strong degree of dependency between the response variable (Fatal Accidents) and independent variable (Simple accidents)
- Coefficient of Variation (Cv) proved to us that fatal accidents are more consistent compared to Simple accidents, which is considered a serious issue for the society. There is an urgent need/emphatic need to reduce the level of consistency of occurrence of fatal accidents.
- By ranking analysis, we concluded that Simple accidents are more consistent (Rank 1) than fatal accidents (Rank 2). Therefore, when simple accidents would be decreased then fatal accidents would automatically decrease.

This likewise builds the dissatisfaction in the brains of driver and the person on foot which some of the time prompt them to take an uneasy step or try to overtake which results in an accident.

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