

Road Accidents Study Based On Regression Model: A Case Study of Ahmedabad City

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Abstract: The Paper discusses the development of an accident prediction model based on regression analysis. It is attempted to develop accident model. Ahmedabad city is taken as case study. The data set which is mainly fatal accidents and total accidents for last six years (2005 to 2010) for Ahmedabad city is brought from "Traffic Police Department" Shahibaug, Ahmedabad and Karanj bhadra, Ahmedabad. Accident data are related to hourly classified traffic volume per lane extracted from classified traffic volume count survey of Ahmedabad city. A liner regression model is developed in this study exhibits satisfactory goodness-of-fit and prediction success rate.

I. INTRODUCTION

Accidents are still thought of by some persons as "acts of God," or the result of luck or chance. Accidents are not as uncontrollable as the weather, nor do they defy systematic study. Study of accidents based on "macro" scale includes the tabulation of numbers and rates unrelated to true risk, which is meaningless to the general public, including drivers and passengers. In addition, micro analysis is still a manual, individualized activity, and has not been systematized or applied to any great degree to automated data-processing procedures. Thus, when accidents are seen as true incidents, which results from a combination of circumstances or a chain of related events, they lend themselves to engineering study and systematic analysis. Despite causing loss of human life and property, together with the associated trauma and suffering, road accidents are often not placed under the category of disasters. The magnitude of the problem is often not realized, and these are looked upon as stray incidences. This leads to lack of organized support for efforts to mitigate road accidents, and tolls keeps mounting with increases in road length and vehicular traffic.

II. GLOBAL SCENARIO OF ACCIDENTS

Too often, road safety is treated as a transportation issue, not a public health issue, and road traffic injuries are called "accidents," though most could be prevented. As a result, many countries put far less effort into understanding and preventing road traffic injuries than they do into understanding and preventing diseases that do less harm. Every day as many as 140 000 people are injured on the world's roads. More than 3,000 die and some 15,000 are disabled for life. Each of those people has a network of family, friends, neighbors, colleagues or classmates who are also affected, emotionally and otherwise. Families struggle with poverty when they lose a

breadwinner or have the added expense of caring for disabled family members [1].

In 1990, road accidents laid in ninth place out of over hundred separately identified causes of death and disability. It is forecasted that by the year 2020, road accidents will move up to sixth place [2]. The number of deaths and injuries has been reducing steadily in the developed countries whereas the number of deaths in the Asian countries is rising at an alarming rate. During 1981-1993, the number of road accident deaths has increased in Asia Pacific region by 95% whereas the total population increased only by 24%. Many countries are experiencing an annual vehicle growth rate of around 17%. Examples are India (17%), China (18%), Vietnam (18%) and Malaysia (15%) [3]. Almost 11% of worlds reported fatalities are due to road traffic accidents .Globally, it is estimated that on an average, Road traffic accident cost up to 1% of the country's Gross Domestic Product (GDP)[4].

III. ACCIDENT SCENARIO IN INDIA

Over the last two decades consequent to a rapid increase in the number of Motor vehicles and a phenomenal expansion of the road network, there has been a steep rise in the occurrence of road accidents in India. According to the experts at the National Transportation Planning and Research Centre (NTPRC), the number of road accidents in India is three times higher than that prevailing in developed countries. Comparing to world figures 6 to 7 percent of the total number of persons killed per annum, in the whole world are Indians. This causes huge loss in our economy due to fatalities, injury, property damages and insurance costs etc. Last ten years details of fatal accidents are given in table 1 and graph is developed as shown in figure 1. The graph shows increasing trend of road accident fatality in India.

Table1.1 Road Traffic fatality in India

Year	Fatality	Population (million)	Fatality/milli on persons
1997	77000	955	81
1998	79900	971	82
1999	82000	987	83
2000	78900	1002	79
2001	80900	1027	79
2002	84059	1051	80
2003	84430	1068	79
2004	91376	1086	84
2005	98254	1103	89

2006	105725	1120	94
2007	114590	1136	101

Source: national Crime Records Bureau, Delhi

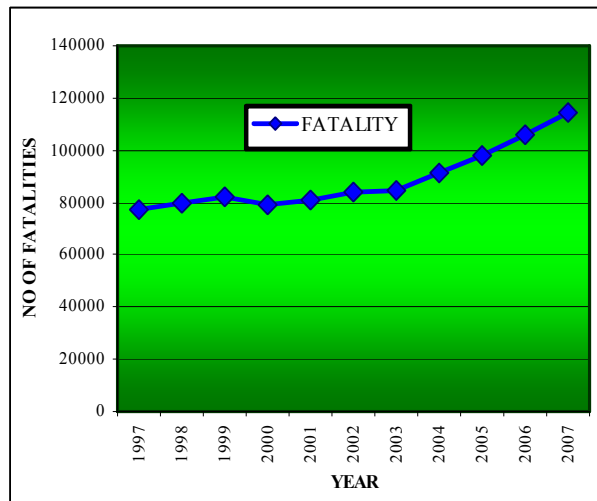


Figure 1.1 Road Accident Fatalities in India

Every hour, 13 people die due to road accidents, the highest in the world. Every 10th person who dies in road accidents is an Indian. Road fatalities in India have been rising at the rate of 8 per cent a year and, paradoxically, have only increased even as massive amounts of money have been pumped into improving roads and adding new highways, flyovers and expressways [5].

IV. SCOPE OF THE STUDY

In this study, the scope of work is to present the accident Scenario in Ahmedabad by road accident model based on regression analysis. Hour wise analysis of accident has been carried out using data of fatal accidents and Total accidents for last six year (2005 to 2010) of Ahmedabad city. The data is extracted from "Traffic Police Department" Shahibaug, Ahmedabad and Karanj bhadra, Ahmedabad. The model predicts total accident and fatal accident according to changing trend of traffic volume.

V. CLASSIFIED TRAFFIC VOLUME COUNT SURVEY TECHNIQUES

Classified traffic volume count survey was carried out by manual method on top three accident prone roads round the clock for 24 hours on Monday, Wednesday and Friday. Classified traffic volume count at 15 minutes interval is taken to compute peak hour traffic flow characteristics. The huge data have been compiled and converted into Passenger Car Unit (PCU). Kadiyali (1996) has given conversion factor as under:

Scooter /Motor cycle - 0.4
 Auto rickshaw - 0.5
 Car / Jeep - 1.0
 Bus / Truck - 2.2
 Tractor - 3.0

Bicycle - 0.7
 Cycle rickshaw - 1.5
 Hand cart - 4.6

These factors are used in the present study. Maximum hourly PCU per lane is computed for top three accident prone roads and average of it is taken as trend of city as given in Table 1.2. Hourly accident details are extracted from traffic data for the year 2001 to 2005. Average of it is computed and put up in Table 1.2

Table 1.2: Variation of Traffic Volume and Number of Accidents per Hour

Time Period	Traffic Volume in PCU per Hour per lane	No. of Accidents per Year	
		F	TA
6 TO 7	126	6.83	48.5
7 TO 8	699	7.83	72.83
8 TO 9	1137	8.17	89.67
9 TO 10	2155	7.5	115.8
10 TO 11	2822	9.17	160.2
11 TO 12	2177	9.33	141.3
12 TO 13	2446	11.8	135
13 TO 14	1669	12.2	124.7
14 TO 15	1531	11.8	130.8
15 TO 16	1313	11.3	134.3
16 TO 17	2063	9.17	128.2
17 TO 18	2057	8	136
18 TO 19	2574	12.3	168.8
19 TO 20	2354	16.7	162.7
20 TO 21	1732	15.3	163.7
21 TO 22	1472	14.2	138.7
22 TO 23	933	8.67	110.7
23 TO 24	527	8.33	74
24 TO 1	23	7.5	41.83
1 TO 2	25	5.67	29.83
2 TO 3	19	5.5	27.5
3 TO 4	35	4	16.17
4 TO 5	69	3	16.67
5 TO 6	116	4.33	23.5

Table 1.2 shows that traffic volume is high during 10 to 13 hours in the morning and 17 to 20 hours in the evening. It is also seen that the number of accidents is also high in the above hours. It is clear that during peak hours the chances of occurring accidents are high.

VI. MODEL FORMULATION BASED ON HOURLY TRAFFIC VOLUME

The regression models are developed for predicting total accidents and fatal accidents, both considering number of total accidents or fatal accidents as dependent variable and hourly traffic volume per lane as independent variable. The linear regression models developed will take the following form:

$$y = mx + b$$

Where

y= Number of fatal accidents or total accidents per year

x= Traffic volume in PCU per hour per lane.

m and b are parameter estimates.

The goodness of models is examined on the basis of three statistical values i.e. coefficient of determination R^2 , t-statistics and F-statistics. Regression model is useful for the following purposes.

- To describe how the response changes when one of the explanatory variables is changed;
- To describe the relation between the response and one or more explanatory variables;
- Or to predict the value of the response for a new observation with known variables.

The models developed with parameter estimation and different statistics are presented in Table 1.3 in Annexure. Based on the above findings, relationship was developed between total accident and traffic volume occurred at different time of day. It is observed from the table that for model 1 of total accidents, R^2 value is closer to 1, $t > t_{cr}$ and $F > F_{cr}$. For this model, parameters are found significant and therefore it is statistically good. For model 2 of fatal accidents, R^2 value is observed to be moderate. From this model it is seen that 47% fatal accidents occurred due to traffic volume.

Model for Total Accidents in form $Y=mx+b$

$$Y=0.0509x+32.69$$

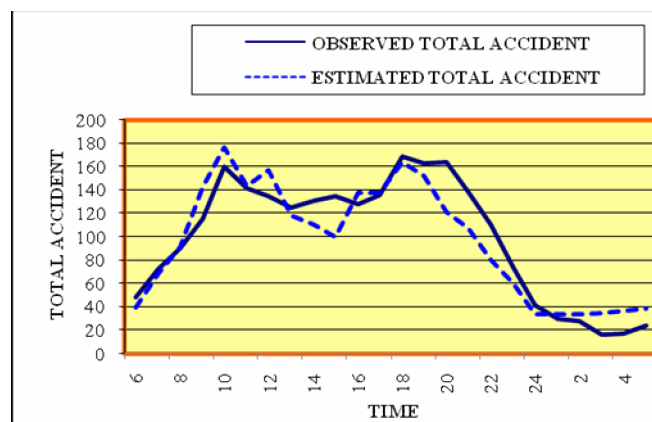


Figure 1.2 Total Road Accident details

Model for Fatal Accidents in form $Y=mx+b$

$$Y=0.0025x+5.95$$

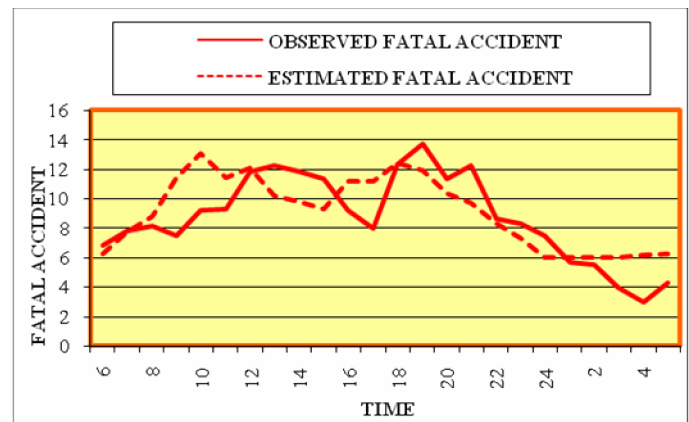


Figure 1.3 Fatal Road Accident details

The graph for model of total accidents is shown in figure 1.2. The observed and estimated total accident shows good relationship as high R^2 value. The graph for model of fatal accident is shown in figure 1.3. The observed and estimated fatal accident shows moderate relationship as moderate R^2 value. The graph shows fitting between observed and estimated values of total accidents and fatal accidents.

The choice of variables for model generation was guided by previous theoretical and empirical work on regression model and statistical significance of the variable and data availability.

The variables were found to be significant at 95% confidence interval. The goodness-of-fit of the models are assessed. The results of coefficient estimates and statistical validation of the model are presented in Annexure in table 1.4.

VII. CONCLUSIONS

The model developed and calibrated in this study exhibits good results in terms of goodness-of-fit measures. The X^2 statistic of the model indicates that the variable total accident and fatal accident relating to classified traffic volume are significant at 95 % confidence level in this regression model. In the prediction success test, the model has predicted the observed value closely. Therefore, it can be concluded that the model developed for the case city Ahmedabad is acceptable.

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Annexure

Table 1.3: Parameter Estimation and Statistics for Models based on Traffic Volume

Model	Parameter	Estimate	R ²	DOF	t-statistics		F-statistics		Standard error	Regression Sum of squares (ssreg)	Residual Sum of Squares (ssresid)	Remarks
					t	t _{cr}	F	F _{CR}				
Linear Regression Models												
Model 1 For Total Accidents	m b	0.05096876 32.6920575	0.87	22	11.994	2.074	798.6	4.3	0.0042 3.9475	55295.161	8455.71	Not Rejected
Model 2 For Fatal Accidents	m b	0.00252159 5.95044529	0.47	22	4.4312	2.074	19.63	4.3	0.0057 0.5359	135.3405	151.636	Not Rejected

Note: 95 % confidence level is taken for t-statistics and F-statistics

DOF = Degree of freedom

Table 1.4: Results and Validation of Linear Regression Models based on Traffic Volume

	PCU per Hour per Lane	Model 1 for Total Accidents				Model 2 for Fatal Accidents			
Time		Observed values	Estimated values	Chi-square (Estimated)	Chi-square (critical)	Observed values	Estimated values	Chi-square (Estimated)	Chi-square (critical)
6 TO 7	126	48.5	39.11	3.994447	35.17	6.83	6.26	0.643285	35.17
7 TO 8	699	72.83	68.31			7.83	7.71		
8 TO 9	1137	89.67	90.64			8.17	8.81		
9 TO 10	2155	115.8	142.52			7.5	11.38		
10 TO 11	2822	160.2	176.52			9.17	13.06		
11 TO 12	2177	141.3	143.65			9.33	11.43		
12 TO 13	2446	135	157.36			11.8	12.11		
13 TO 14	1669	124.7	117.75			12.2	10.15		
14 TO 15	1531	130.8	110.72			11.8	9.81		
15 TO 16	1313	134.3	99.61			11.3	9.26		
16 TO 17	2063	128.2	137.84			9.17	11.15		
17 TO 18	2057	136	137.53			8	11.13		
18 TO 19	2574	168.8	163.88			12.3	12.44		
19 TO 20	2354	162.7	152.67			16.7	11.88		
20 TO 21	1732	163.7	120.96			15.3	10.31		
21 TO 22	1472	138.7	107.71			14.2	9.66		
22 TO 23	933	110.7	80.24			8.67	8.30		
23 TO 24	527	74	59.55			8.33	7.27		
24 TO 1	23	41.83	33.86			7.5	6.01		
1 TO 2	25	29.83	33.96			5.67	6.01		
2 TO 3	19	27.5	33.66			5.5	5.99		
3 TO 4	35	16.17	34.47			4	6.03		
4 TO 5	69	16.67	36.20			3	6.12		
5 TO 6	116	23.5	38.60			4.33	6.24		

