IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 13, Issue 3 Ver. VII (May- Jun. 2016), PP 48-51
www.iosrjournals.org

Estimation of Expected Number of Accident on a RoadSection and its Relationship with Other GeometricVariables

Atul Soni[1], Laukush Kumar[2],
[1](*Department of Civil Engineering, GLA University, India. atulsoni102@gmail.com)*
[2](*Department of Civil Engineering, ApeejayStya University, India. lovewith.civil@gmail.com)*

Abstract:*The objective of this paper is to identify the effective method to find the expected number of accidents on a section of road. Literature review was conducted and Statistical method (Empirical Bayes) was identified as the best model for the study of accident on the roadway as it takes into consideration of the effects of random variation in events. Number of accidents, AADT, width of road, number of accesses, average speed and the length of the section were used for the analysis.*

Keywords:*Accident Study, Blackspots, Empirical Bayes Method, Expected number of accidents, Negative Binomial Regression,*

I. Introduction

Road Safety Improvement is becoming a major policy for the road authorities because of the increasing population simultaneously increasing number of vehicles. While improving the road safety using counter measures it is also important to consider the budget limitations, so the best optimum method has to be selected. Locations with high frequency of accidents compared to the other locations are considered as Black Spots. Black Spots are related to the local factors, as well as, driver behavior, traffic conditions and weather. This work helped in to identify the expected number of Accident (Black Spots)on the selected section of Ring Road of Nagpur, Maharashtra.

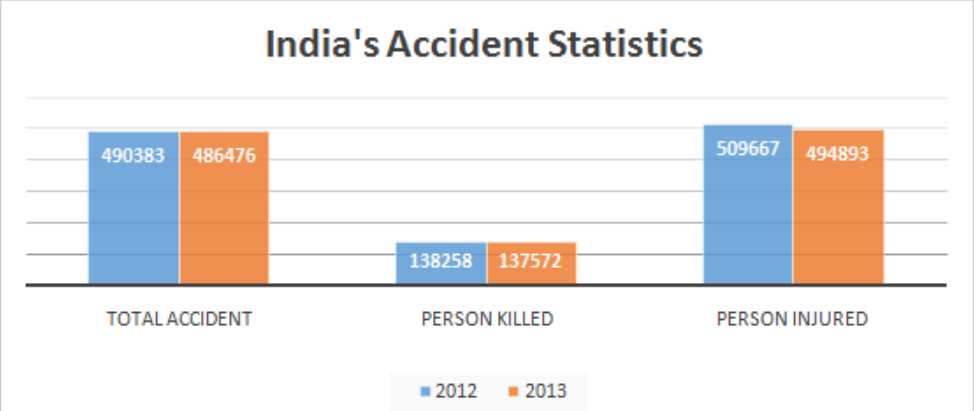

Figure1: Accident data of India for the year 2012 and 2013

According to *Ministry of Road Transport & Highways, Government of India* during the year 2013 [1], there were 4,86,476 road accidents, which resulted in deaths of 1,37,572 people and injury of 4,94,893 persons in India. These numbers translate into one road accident every minute, and one road accident death every four minutes. The States of Tamil Nadu, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, Kerala, Uttar Pradesh, Gujarat, Rajasthan, Chhattisgarh, West Bengal, Haryana and Bihar together accounted for 88.4 percent of all road accidents in the country.

Now, the objectives and methodological approach adopted for the study is discussed further. This follows with a discussion of selection of study area, data collection and analysis, variables used in the model, modeling techniques. The paper concludes with results and discussion and direction for future research.

II. Study Area And Scope

Study area selected for the analysis was Ring Road from the Hingna T-Point to the ChatrapatiShivaji square in Nagpur city. This Ring road is a 6 lane facility with median separator. Most of the intersections are already provided with channelization and all the intersections have pedestrian crossing and traffic signals. These road sectionsare divided by 8 intersections - Hingna T-Point, Mangalmurti square, Trimurti Nagar square,

Sambhaji square, Padole Hospital square, Pratap Nagar square, Orange City Hospital square, ChatrapatiShivaji square.

Figure 2 : Location of the selected site on map

III. Data Collection

Data collection for any accident related studies usually have two types of data set. One of which have data regarding the accidents- like number of accidents, location of accident, time of accident, severity and casualty happened in accident and while on the other hand, second set of data have the information regarding roadway facilities- like geometric details of road, traffic data, location of the road, etc.

3.1 Accident Data

The only information available for accident data is the FIR (First Information Report) lodged in the police stations. Accident data was collected from the Pratap Nagar Police Station. The data from these records of three years (2013-2015) were extracted from the FIR records.

Table 1: Accident data for the road sections of the study area

Road Section	No.s of Accidents In year			Total no. of accidents in Past 3 years
	2013	2014	2015	
T-Point to Mangalmurthi Square	3	3	3	9
Mangalmurthi Square to Trimurti Nagar Sq.	1	3	2	6
Trimurti Nagar Sq. to Sambhaji Sq.	2	1	2	5
Sambhaji Sq. to Padole Hospital Sq.	1	1	4	6
Padole Hospital Sq. to Pratap Nagar Sq.	2	2	4	8
Pratap Nagar Sq. to Orange City Hospital Sq.	4	3	3	10
Orange City Hospital Sq. to Chatrapati Square	4	2	4	10

1.2 Road Characteristics Data

Road characteristics data was collected for all the road sections between two intersection on ring road. Numbers of accesses were counted for the both ways of road. Width of roads were measured, Speed of vehicles were taken using speed gun, Distance between two intersections was measured in the kilometer unit.

Table 2: Road characteristics data for the road sections of the study area

Road Section	No. of accesses	AADT (x1000)	Road Width (one way in m)	Avg. speed (kmph)	Length of section (km)
Hingna T-Point to Mangalmurthi Square	6	12	11.8	39	.62
Mangalmurthi Square to Trimurti Nagar Sq.	4	15	12.8	38	.73
Trimurti Nagar Sq. to Sambhaji Sq.	5	14	12.0	36	.53
Sambhaji Sq. to Padole Hospital Sq.	2	15	11.7	34	.30
Padole Hospital Sq. to Pratap Nagar Sq.	7	17	11.8	42	.84
Pratap Nagar Sq. to Orange City Hospital Square	7	18	11.6	44	.87
Orange City Hospital Sq. to Chatrapati Square	5	18	12.6	48	.54

IV. Analysis Based on The Data Collected

To use Empirical Bayes method, first the regression was performed for the collected data of the study area. Among all the regression method Negative binomial regression method proved to be practical because accident data related to the selected site does not have large number of zero values.[2]

Regression analysis on accident data was done using IBM SPSS Statistics. Accident data was used as dependent variable and other variables data (AADT, road width, length of sections, and numbers of accesses) was entered into the software. Analysis was done at confidence level of 95%.

Table 3 : Coefficients of Negative Binomial Regression for the Road Sections

Variables	**Co-efficients**
Intercept	2.237
No. of Access	-0.306
AADT(x1000)	-0.196
Road Width	-0.431
Speed	0.168
Length	2.128
Alpha	0.680

Empirical Bayes method uses the Safety Performance Function (SPF) [3]. The SPF is an equation giving an estimate of the average accidents/km/year (λ), as a function of some trait values (e.g., ADT, Lane width, . . .) and of several regression parameters.

$$SPF\ (\lambda) = e^{(Intercept+Access.\beta1+AADT.\beta2+Roadwidth.\beta3+Speed.\beta4+Length.\beta5)} \quad (1)$$

Where,β1, β2, β3, β4, β5 are the coefficient of the regression for variables.
SPF was calculated for each variable (No. of Access, AADT, Road Width, Speed,Length). Now based on these calculated SPF's – Weight, Estimated numbers of accidents, Standard deviation σ and Estimated Accidents with standard deviation is calculated below in the table using following equations.

$$Weight = \frac{1}{1+\frac{(\lambda * Y)}{\alpha}} \quad (2)$$

Estimated expected number of accidents = weight * λ + (1−weight) *r(3)
Where r = last recorded number of crash

$$\sigma\ (estimate) = \sqrt{(1 - Weight)\ X\ Estimate} \quad (4)$$

Table 4 : Calculation of Expected number of accidents with standard deviation on each road section

Road Section		**SPF(1)**	**Weight(2)**	**Estimated no's of Accidents (3)**	**σ(est)(4)**	**Expected Accident/ km/year ± σ(est)**
A	T-Point to Mangalmurthi Square	2.338	0.225	2.851	1.4	**2.85±1.4**
B	Mangalmurthi Square to Trimurti Nagar Sq.	1.664	0.29	1.902	1.1	**1.90±1.1**
C	Trimurti Nagar Sq. to Sambhaji Sq.	0.981	0.409	1.583	0.9	**1.58±0.9**
D	Sambhaji Sq. to Padole Hospital Sq.	1.007	0.404	1.001	0.7	**1.00±0.7**
E	Padole Hospital Sq. to Pratap Nagar Sq.	1.712	0.284	1.918	1.1	**1.91±1.1**
F	Pratap Nagar Sq. to Orange City Hospital Sq.	2.291	0.228	2.838	1.4	**2.83±1.4**
G	Orange City Hospital Sq. to Chatrapati Sq.	2.668	0.203	2.932	1.5	**2.93±1.5**

Here, the calculated value of α = 0.68 is used and Y = 1 (the number of year for which expected number of accident is to be calculated.)

V. Result

The result of the analysis of selected study area of ring road of Nagpur represents the expected number of accident on the selected road section. This model can further be implemented for the any similar road facilities in any other city. The expected number of accident were analysed on the basis of AADT, Road Width, Speed and the Length of the road sections.

Table 5 : The above table shows the Expected Number of Accidents per km/year on the respective road sections

Road Section	**Est. Accident ± σ(est)**	**Length of section (km)**	**Eexpected Accidents/km/yr**
T-Point to Mangalmurthi Square	2.85±1.4	0.62	**4.59**
Mangalmurthi Square to Trimurti Nagar Sq.	1.90±1.1	0.73	**2.60**
Trimurti Nagar Sq. to Sambhaji Sq.	1.58±0.9	0.53	**2.98**
Sambhaji Sq. to Padole Hospital Sq.	1.00±0.7	0.30	**3.33**
Padole Hospital Sq. to Pratap Nagar Sq.	1.91±1.1	0.84	**2.27**
Pratap Nagar Sq. to Orange City Hospital Sq.	2.83±1.4	0.87	**3.25**
Orange City Hospital Sq. to Chatrapati Sq.	2.93±1.5	0.54	**5.42**

With the help of the regression coefficients and the dependent variables (Road Width, Length of the sections. Speed, AADT and Number of accesses) relationships were also established between the number of Accidents and the geometric dependent variables, which are shown in the form of the figures below –

Figure 3 :(3.1) Relationship between Accident and Road width, (3.2) Relationship between Accident and Speed (kmph), (3.3) Relationship between Accident and Number of accesses, (3.4) Relationship between Accident and Length of section (km)*

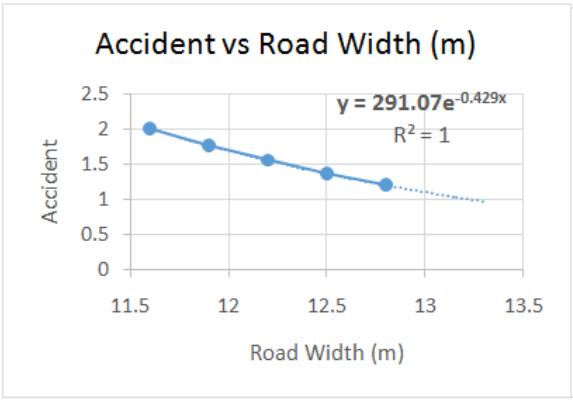

Fig. (3.1)

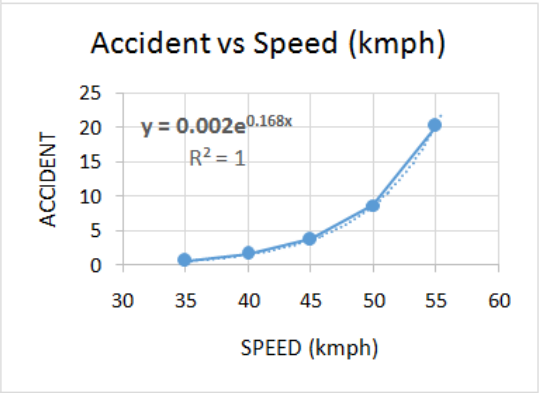

Fig. (3.2)

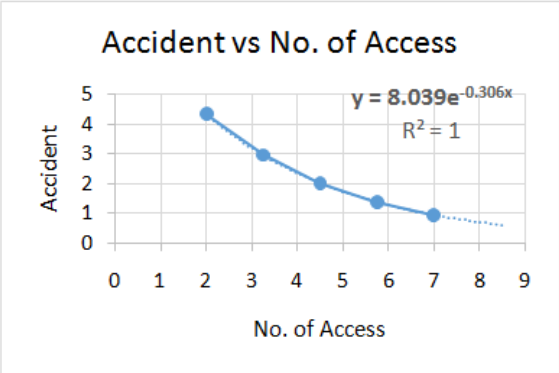

Fig. (3.3)

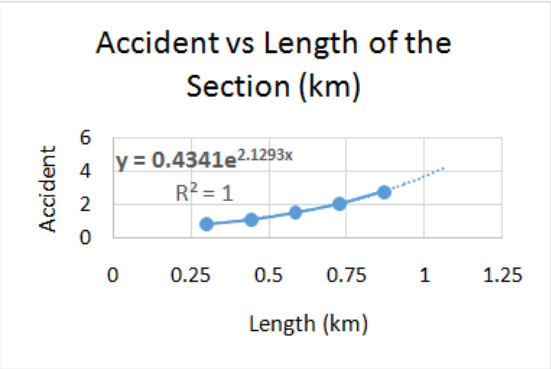

Fig. (3.4)

*The above graph were drawn between the accident and the selected variables assuming that the other variable are fixed at mean and the range of the collected data of the selected variable was used to draw graph.

References

[1]. Road Accidents in India 2011-2013, *Ministry of Road Transport & Highways, Government of India, www.morth.nic.in/*

[2]. A.K. Sharma, V.S. Landge, : "Zero Inflated Negative Binomial for Modeling Heavy Vehicle Crash Rate on Indian Rural Highway", *International Journal of Advances in Engineering & Technology, Jan. 2013.*

[3]. Ezra Hauer, : "Estimating Safety by the Empirical Bayes Method: A Tutorial", *Transportation Research Board 1784 Paper No. 02-2181*

[4]. Ezra Hauer, : "Identification of sites with promise", *Transportation Research Board 75th Annual Meeting, 1996.*