# A Study an Road Accident Prediction Modeling for Hyderabad Area

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## Abstract

Accidents have been a major social problem in the developed countries of world for over fifty years. It is only in the past decade that developing countries like India have begun to experience large increase in the number of road accidents taking place and have found it necessary to institute road safety programs.

It is strongly felt that most of the accidents, being a multi factor event, are not merely due to drivers fault on account of driver's negligence or ignorance of traffic rules and regulations, but also due to many other related factors such as abrupt changes in road conditions, flow characteristics, road user's behavior, climatic conditions, visibility and absence of traffic guidance, control and management devices. In the above context an attempt is made to study various types of accidents including causative factors and black spot identification in Cyber bad area. The study involves collection of accident data from various police stations for the period of four years.

On the other hand a fuzzy logic technique used for development of accident prediction model with same data. Both the models are compared and from that fuzzy logic given the best prediction. Based on the data collected, the data analysis, Black spot identification has done. Models are built with the accident rate as a dependent variable and road geometrical parameters such as width of roadway, shoulder width, camber, horizontal and vertical curve details as independent variables. Finally, the study provides various causative factors for accidents and developed models can be used for prediction of accidents. Based on the prediction same action may be initiated to reduce accident rate.

**KEYWORDS:** Accidents, Black spot, prediction model, Fatal and non-Fatal.

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## I. Introduction

Accident is an unexpected event that interrupts the completion of an activity. The Predictable accidents are avoidable and unpredictable accidents are unavoidable. Road crash fatalities and casualties have been increasing over the past twenty years. The problem of road accidents around the world is increasingly becoming the main concern of the general public, particularly those in relevant government agencies such as the Ministry of Transport, Ministry of Works and the Traffic Police. It is a known fact that

India has one of the highest accident rates in the world because of the rapid growth of motor vehicles in the recent past and the inadequacy of road systems and narrow streets dominated by slow moving vehicles.

Road safety is considered as one of the most important problem facing in the modern society. It is mainly because of increasing in number of accidents due to increasing in personalized vehicles. According to WHO statistics (2009) about more than 1.2 million people die and 20 - 50 million people injured every year in road accidents around the world.

### I.I Accident Scenario in India

Road accident Studies have indicated that accident rate in developing countries are high compared with those in developed countries. In India, according to NCRB (2009) official statistics 118,239 persons were killed in road traffic crashes in 2008. According to these statistics 318,316 persons were killed in unnatural accidents in 2008. The National Crime Records Bureau (NCRB) and WHO states that at least 13 people dying every hour on Indian roads. India has topped the global list of deaths in road accidents, leaving behind the world's most populated country China. A study by the planning commission in 2002 estimated that the annual cost of road accidents is about 55,000 corers in India. Road accidents in India are a cause for growing concern and road accidents cost around 3% of Annual Gross domestic Product (GDP).

### I.IIRoad Accident Causative Factors

These areRoad related Factors, Vehicle related Factors, Road user related Factors, Environmental related Factors.

The present study is taken up with the following objectives.

- To analyze the accidents of the past from the records available and to study the trend of accidents.
- To identify the black spot locations.
- To find out the relationship between geometric variables (No of horizontal curves per km and No of Junctions/access points) to dependent variable (No of Accident per year per km)
- To develop the model by using Fuzzy Logic technique
- To estimate the future number of accidents with the help of modeling techniques

## II. Literature Review

In recent years the number of death and injury in the traffic accident is continue increasing year by year in China, which brings a great lost for social economy. **CHEN Bin & LUO Yong (2009),** studied on the data of traffic accident and follow volume in a certain section of road. This paper tries to adapt fuzzy theory to resolve the problems in traffic accident which quality is unclear. The result of fuzzy predicts has a fuzzy number with a certain fuzzy extent so it fits the real situation more. That mainly takes the direct influence of the traffic accident influenced by traffic volume into consideration. Developed the predict model by annals average of traffic accident and traffic volume according to the gathered traffic volume data and history data. Finally, making a fuzzy

predict for the accident number in 2010, and provide the scientific evidence for the road security reconstruction.

**Miao Chong (2005)** modeled the severity of injury resulting from traffic accidents usingartificial neural networks. The three most important factors in fatal injury are: driver's seat belt usage, light condition of the roadway, and driver's alcohol usage. The neural network using acombination of back propagation (BP) – 100 epochs, learning rate 0.01 – and conjugate gradient descent (CG) – 500 epochs – methods, trying to minimize the mean squared error

**Fuzzy Logic Techniques**: The fuzzy logic approach seems very suitable for dealing with uncertainty phenomena; although the use of probabilistic techniques was higher than the use of fuzzy techniques for safety issues (Serrano, et al. 1999). Serrano et al. also recommend to the researchers to use the fuzzy set technologies if the study must deal with vague knowledge or needs to communicate with the user in a more humanlike way. In General, the fuzzy logic might be helpful, for very complex processes, when there is no simple mathematical model for highly nonlinear processes. Fuzzy Logic is not needed whenever there is an analytical closed form model that, using a reasonable number of equations, can solve the given problem in a reasonable time, at the reasonable costs and with higher accuracy. The fuzzy approach requires a sufficient expert knowledge for the formulation of the rule base, the combination of the sets and the defuzzification

**Black Spot Identification Methods**: Accident prone locations on the roads are those places, where accidents often appear to cluster or concentrate. These stretches are termed as "Black Spots". Studies conducted in the developed countries show that identification and improvement of black spot locations reduces the occurrence of accident significantly. The broad techniques for the identification of black spot may be categorized as Statistical methods: Bio-medical engineering methods, Engineering methods, Subjective assessment techniques, Empirical Bayes method

## III. Methodology

The intent of this chapter is to explain the procedure which is going to adopt in this present study.

### III.ICollection of Accident Data

The accident data should be collected for six consecutive years. From police records the required data should be tabulated according to the date and day of occurrence, time of accident, type of area, nature of the accident, cause of the accident, vehicles involved, classification of accident, number of deaths, number of injured, type of maneuver, responsibility of the driver etc.

### III.II Collection of Road Geometrics

On the selected stretches detailed geometric data is collected from secondary sources and parameters are No of Junctions/Access points and No of Horizontal curves.

### III.III Tabulation and General Analysis of Accident Data

The collected data has to be tabulated in MS-Access and General analysis has to be carried out.

General analysis includes total number of accidents in police station regions by Year wise and severity wise, Composition of vehicles involved in the accidents, Nature of accidents occurred, time wise distribution of accidents, Accidents according to Drivers age, monthly wise distribution of accidents etc.

### III.IV Preliminary Analysis

Detailed analysis will be carried out to all stretches to know the annual, monthly and hourly variations of accidents. Data collected through field investigations will be analyzed and the details are tabulated. Initially different scatter plots using Microsoft Excel will be drawn between road geometric parameters and accident rate separately. From these graphs, relation of each and every parameter with accident rate will be assessed.

### III.V Black Spot Identification

| Year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|
| Cy bad | 3239 | 3716 | 3659 | 3506 | 3254 | 3333 | 3746 |
| Hyba d | 3239 | 3400 | 3322 | 3333 | 2967 | 2868 | 2745 |

From the accident data, the top ten black spots can be identified by using the Quantum of Accident method and the suitable remedial measures are to be given so as to reduce the accidents at the black spots. In the Quantum of Accident method, consequent three years of data is considered for analysis. If total numbers of accidents in three years are greater than nine, then the stretch is considered as accident-prone stretch.

### III.VIModel Development

To find an appropriate mathematical model that expresses the relationship between a dependent variable Y and a single independent variable X. Using Mat Lab software and SPSS software, different models will be generated based on the relation between road geometric parameters and accident rate.

## IV. Data Collection And Preliminary Analysis

### IV.I Study Area Description

Cyberabad consists of all the outskirts and semi urban areas of the Hyderabad. Areas such as Madhapur, Kondapur, Gachibowli, Uppal, Medchal and Shamshabad etc. come under Cyberabad. Cyberabad surrounds Hyderabad on all sides. In other words, the area around the Hyderabad that has been developing lately is called as Cyberabad. With the aggressive promotion of some areas of Cyberabad, there have been extensive investments in luxurious residential townships, technological infrastructure such as Hitech city and many other IT and ITES companies. Area and Population of Cyberabad is approximately 3600 sq.km and 70 lakh.

As per AP Crime Statistics records, Cyberabad registered highest number of road accident cases followed by Hyderabad city as per district wise from past 7 years and details shown in Table 1

Table 1 Accident Data of Cyberabad comparing with Hyderabad.

Mainly this area consists of three National Highways, five state highways and Outer

ring road. The national highways are NH-202, NH-9,NH-7. But NH-9 passes through two variations like NH-9 towards Vijayawada,

NH-9 towards as similar to NH-7 like towards to Nagpur and towards Bangalore. The details regarding road types in Cyberbad.In this study all National Highways and State Highways has taken as Main Stretches and each Highway divided into Sub Stretches for in depth analysis i.e., Micro Analysis. All Main Stretches like NH-202, NH-7(towards Nagpur), NH-7(towards Bangalore), NH-9(towards Vijayawada, NH-9( towards MUMBAI), SH-Bijapur, SH-Narsapur, SH-NagarjunaSagar Road, SH-Rajeev Rahadhari and SH-Srisailam.

**IV.II Preliminary Analysis of Accident Data for Cyberabad Area**

Total numbers of accidents registered in the Cyberabad Area as police station wise Yearly Variation of Police Station wise Accidents During 2009 to 2013(up to March)are represented in Table 4.4. Total **14319** accidents were recorded during 2009 to 2013(up to March), out of these **4472** were fatal accidents and **9847** were non-fatal accidents. More number of accidents occurred in **SaroorNagar Division** than remaining other divisions. In terms of police station wise LB Nagar has highest accident prone location and total accidents are 1068 from 2009 to 2013(up to March). The police station wise distributions of accidents are graphically presented in Figure 1.

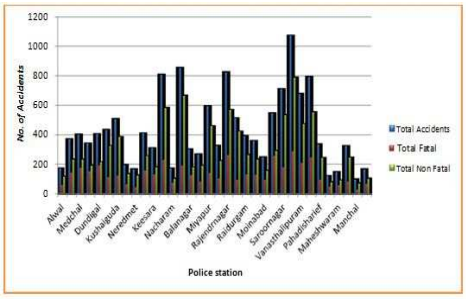


Fig. 1 Police station wise fatal and non fatal accidents during 2009 to 2013(up to March)

**Yearly variation of accidents during 2006 to 2013(up to March)**

The analysis of year wise distribution of accidents indicates that the numbers of the accidents were occurred in the each particular year. Fig. 2 shows Division wise fatal and non fatal accidents during 2009 to 2013(up to March).Fig 3 and Table 2 shows yearly variation of Total Accidents, total fatal and Non fatal

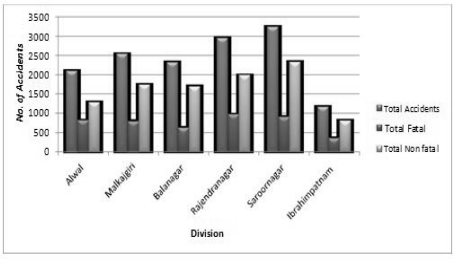


Fig 2 Division wise fatal and non fatal accidents during 2009 to 2013(up to March)

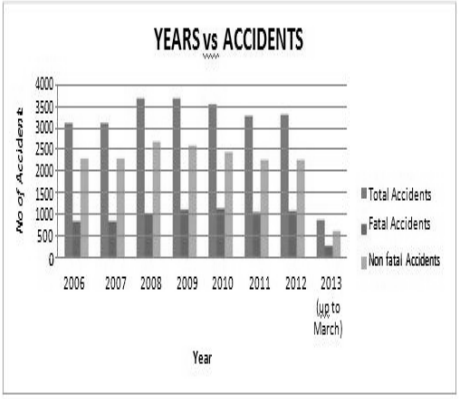


Fig 3 Yearly wise fatal and non fatal accidents during 2006 to 2013(up to March)

| Sl.No. | Year | Total Accidents | Fatal Accidents | Non fatal Accidents | Total No.of death | Total No.of injured |
|---|---|---|---|---|---|---|
| 1 | 2006 | 3084 | 818 | 2266 | 878 | 3143 |
| 2 | 2007 | 3091 | 820 | 2271 | 863 | 2731 |
| 3 | 2008 | 3657 | 1002 | 2655 | 1020 | 3620 |
| 4 | 2009 | 3660 | 1090 | 2570 | 1153 | 3178 |
| 5 | 2010 | 3524 | 1111 | 2413 | 1167 | 3145 |
| 6 | 2011 | 3254 | 1021 | 2233 | 1084 | 3168 |
| 7 | 2012 | 3283 | 1053 | 2230 | 1118 | 3256 |
| 8 | 2013 (up to March) | 857 | 260 | 597 | 276 | 853 |

Table 2 Yearly wise fatal and non fatal accidents during 2006 to 2013(up to March)

### IV.IIITypes of Vehicles Involved in the Accident

The analysis about the type of accused vehicle and victim vehicles involved in the accident reveals that as much as 24% of accused vehicles are Lorries/trucks and 19% are 2Wheelers. As much as 37%of victims are Pedestrians and 32% are Motor Cyclists. The distribution of accused vehicles and victim vehicles are summarized in table 3and presented graphically in fig 4 and 5.

| Victim | Total Fatal | % | Accused | Total Fatal | % |
|---|---|---|---|---|---|
| Pedestrian | 396 | 37 | Pedestrian | 0 | 0 |
| Motor Cyclist | 341 | 32 | Motor Cyclist | 209 | 19 |
| Auto | 33 | 3 | Auto | 75 | 7 |
| Lorries / Tanker | 15 | 1 | Lorries / Tanke | 267 | 24 |
| Cyclist | 29 | 3 | Cyclist | 0 | 0 |
| Vehicle inmates | 51 | 5 | Vehicle inmates | 0 | 0 |
| Car / Jeep | 23 | 2 | Car / Jeep | 147 | 13 |
| DCM | 5 | 0 | DCM | 61 | 5 |
| Self | 127 | 12 | Self | 0 | 0 |
| RTC | 5 | 0 | RTC/BUS | 112 | 10 |
| Tractor | 3 | 0 | Tractor | 34 | 3 |
| Unknown | 39 | 4 | Unknown | 189 | 17 |
| Pvt. Bus | 1 | 0 | Pvt. Bus | 10 | 1 |
| | 1066 | 100 | | 1102 | 100 |

Table 3 Number of Accused and Victim vehicles involved in the accident

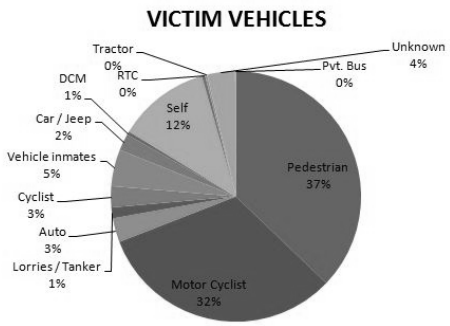


Fig 4 Composition of Victim vehicles involved in the accident

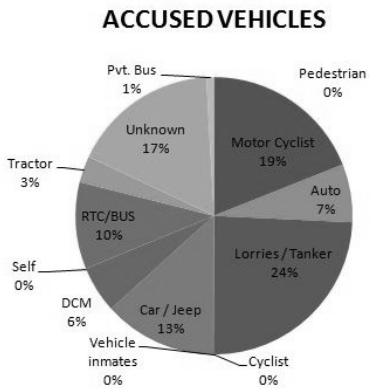


Fig 5 Composition of Accused vehicles involved in the accident

## IV.IV Identification of Black Spot by Quantum of Accident Method

In the Quantum of accident method, consequent three years data is considered for analysis. If the total number of accidents for three years in a particular location is greater than nine, then the location is said to be accident-prone.

For this study the accident data has taken from 2009 to 2012 i.e., four years data. From these two combinations were taken, the first combination is 2009 – 2011 and second combination is 2010 – 2012. From these combinations, a combination which has more accidents was taken for Quantumof accident method. The various combinations of every three consecutive years of accident data

The accident data of the various combinations of three years was analyzed and the locations where there is more number of accidents happened are identified. These locations are observed and the geometrical data was collected from these black spot locations.

## V Model Development

Some of the factors responsible for the occurrence of accidents in India are Traffic volume, Speed, Number of horizontal curves, Number of access points, Number of junctions, Number of lanes, Carriageway width, and Shoulder width etc. In this chapter an attempt has been made to relate Geometric parameters i.e., No of Horizontal Curves per KM and No of Junctions/access points, with number of accidents and obtain relationship.

## V.I Relation of Accident Rate with Road Geometric Parameters

An attempt has been made to develop the relationship between accidents and different Traffic and road geometrical related parameters using MATLAB (Fuzzy Logic) and SPSS Software. The relation between the accidents and parameters is justified by having a greater $R^2$ value. Therefore the relation between them is chosen by considering the greater $R^2$ value. The relations between the accidents and the parameters are explained below.

| S.No | Parameters | Trend Line Equations | | | |
|---|---|---|---|---|---|
| | Stretch Name | No. of Junctions/Access points/KM | $R^2$ | No of Horizontal Curves per KM | $R^2$ |
| 1 | NH-202(towards Warangal) | $y = 0.2552x^{2.1872}$ | 0.9824 | $y = 1.1236e^{0.5249x}$ | 0.8419 |
| 2 | NH-9 (towards VIJAYAWADA) | $y = 0.3967e^{0.6669x}$ | 0.723 | $y = 0.3967e^{0.6669x}$ | 0.723 |
| 3 | NH-7(towards NAGPUR) | $y = 0.0801e^{0.9179x}$ | 0.8527 | $y = 20.854x^{2.5563}$ | 0.9234 |
| 4 | NH-9(towards MUMBAI) | $y = 1.6496e^{0.3227x}$ | 0.7059 | $y = 1.6496e^{0.3227x}$ | 0.8179 |
| 5 | NH-7(towards BANGALORE) | $y = 0.16e^{0.8933x}$ | 0.824 | $y = 0.5246e^{3.4483x}$ | 0.8556 |
| 6 | SH- Bijapur(towards Vikarabad) | $y = 0.0557e^{0.6375x}$ | 0.7845 | $y = 6.5354x^{2.2831}$ | 0.8596 |
| 7 | SH- Naraspur (towards Medhak) | $y = 1.8461e^{0.2277x}$ | 0.7766 | $y = 5.7332x^{0.4633}$ | 0.9478 |
| 8 | SH- Rajeev Rahadari (towards Karimnagar) | $y = 0.0111e^{0.9808x}$ | 0.9532 | $y = 5.75x^{0.9223}$ | 0.8424 |
| 9 | SH- Srisailam | $y = 0.2726e^{0.479x}$ | 0.7688 | $y = 5.8237x^{3.2469}$ | 0.8007 |
| 10 | SH- Nagarjuna Sagar | $y = 0.1694e^{0.522x}$ | 0.6463 | $y = 10.127x^{2.4876}$ | 0.8911 |

Table 4 Relation between the parameters w.r.t accidents per year per km(y)

**V.IIModel Development**: The relation developed between the road geometrical parameters with the number of accidents shows that the data may be fitted either polynomially or exponentially as show in the Table 4 Based on past studies and field inventory studies, for this case study some of following parameters are considered as independent variables in the analysis.

### No. of Horizontal curves per km, No of Junctions/Access points per km

Modeling has done separately for National Highways and State Highways. From the Figures 6 to 9 developed for National Highways and State Highways, the curve fitted of accidents/year/km is Power series or exponentiallyw.r.t number of horizontal curves/stretch and number of junctions/access points per km.

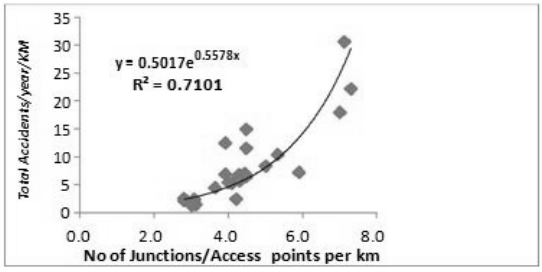


Fig 6 Accident/year/KM as a function of No of Junctions/Access points per KM to total Stretches of National Highways

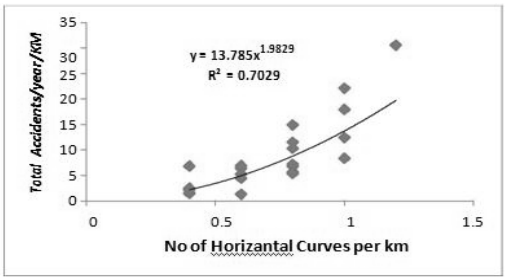


Fig 7 Accident/year/KM as a function No of Horizontal Curves per KM to total Stretches of National Highways

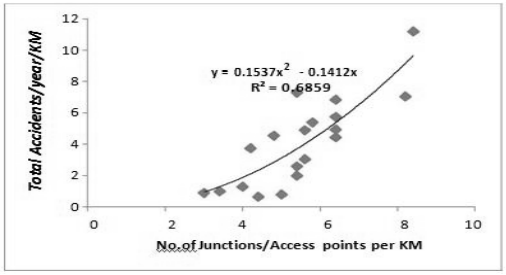


Fig 8 Accident/year/KM as a function No of

Junctions/Access points per KM to total Stretches of State Highways

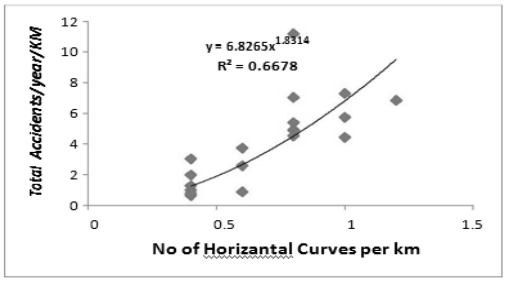


Fig 9 Accident/year/KM as a function No of Horizontal Curves per KM to total Stretches of State Highways

**VIConclusions:**

The following conclusions are drawn from the Study:

- Maximum numbers of accidents are reported in the months of January, February and May on the roads of the city.
- Most accused type of vehicles causing accidents are the 2-wheelers and 3-wheelers and the victims are two wheeler riders and pedestrians.
- SaroorNagar Division has highest Accident rate.
- Almost 96% of the causes of accidents is occurred due to the fault of the driver.
- Fuzzy Logic has given best Significance results to predict accidents on NH

and SH

- **Limitations of the Study**
- The effect of traffic composition on the road is also an important factor for accident occurrence. Since the study is focusing on road geometry only, the traffic factors have not been considered.
- In this study, two road geometric parameters have considered which are number of junctions/access points per km and number of horizontal curves per km.

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