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ESTIMATION OF INFLUENCE ON TYPE OF COLLISION FOR ROAD ACCIDENTS USING LOGIT MODELS IN CYBERABAD – HEDERABAD -INDIA

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Abstract

In most of the metropolitan cities in India, the road use patterns are very different from those in developed countries. Globalization had brought in significant changes in lifestyles and occupation. Migration from rural to urban in search of better livelihood, increasing population, urbanization and modern infrastructures have made man more and more dependent on motorized vehicles. This resulted in the increase in economic activities and there has tremendous growth of motor vehicles which is considered as one of the primary factors responsible for increasing road accidents in many metropolitan cities of developing countries, including Hyderabad, India. In our country nearly 4.7 lakhs of lives are met with road accidents in the year 2008; a significant share of it is from the major cities. In this paper an assessment of the current level of road safety in Cyberabad city is done by utilizing the data obtained from secondary sources. Using severity data for Cyberabad City, a mixed logit model is estimated. Estimation findings indicate that volume-related variables —while roadway characteristics such as the number of horizontal curves, number of grade breaks per km, type of vehicle and condition of the driver are best modelled for severity as fixed parameters. It was observed that head on severity and swipe is significant for non fatal accidents. Our results show that mixed logit model has considerable promise as a methodological tool in accident analysis.

Keywords: Severity, Collision, Logit Model

*1.0 Intr*oduction

India is undergoing major economic and demographic transition coupled with increasing urbanization and motorization. In India, 11% of deaths due to non communicable diseases are due to injuries and 78% of injury deaths are due to road traffic accidents (NCRB 2011). The growing travel demand and heavy concentration of population have resulted in high volume of passenger and vehicular flows on urban roads.

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1.1 Accident Scenario

1.1.1 In India

The magnitude of road accidents in India has gone up to an alarming proportion. About 4,97,686 were killed in road accidents in India in the year 2011[1]. The total number of road accidents and fatalities has gone up significantly resulting in an increase of 22.2% and 5.5% respectively over a period of decade. As compared to an all India level, the total road accidents in the seven metropolitan cities namely Ahmadabad, Bangalore, Mumbai, Kolkata, Delhi, Hyderabad and Chennai were about 16.5% of the total accidents during 2010, which marginally came down by 5% to 9% 2011[1]. In India, 60% of total accidents take place during nights though the night traffic is hardly 15% of 24 hours volume which means that the accidents in India during night is 8 times greater than the day traffic. Road accident statistics in India for the last decade[1] is summarized in Table 1.1

Table 1.1 Road accident statistics[1] in India

Year	Total number of accidents	Estimated Mid year population (in Lakh)	Rate of Accident per lakh of population
2001	405637	10332	39.26
2002	407492	10561	38.58
2003	406726	10682	38.08
2004	429910	10798	39.81
2005	439255	11013	39.89
2006	460920	11142	41.37
2007	479216	11310	42.37
2008	484704	11476	42.24
2009	486384	11741	41.43
2010	499628	11905	41.97
2011	497686	12150	40.96

Source: MORTH 2011, New Delhi

1.1.2 In Andhra Pradesh

Hyderabad city and Cyberabad registered highest number of Road accidents followed by East

Godavari, Guntur and Nalgonda. The road accident statistics during 2001 – 2011 are given in Table 1.2

Table 1.2 Accident Scenarios In Andhra Pradesh

Year	Road Accidents	Persons killed	Persons injured
2001	28902	8248	37931
2002	34133	9523	46808
2003	34826	9679	47477
2004	38937	11046	50439
2005	38339	11076	53666
2006	42855	11176	546711
2007	43594	12421	57457
2008	44675	12742	59153
2009	46891	13129	62948
2010	47649	13631	64735
2011	49254	13825	65482

Source: Hyderabad Police 2011

1.1.3 In Hyderabad

A City with population of more than 9.5 million as per 2011 census spread over banks of the River Moosi, the Hyderabad Metropolitan Development Authority (HMDA) is the major urban aggressively positioning itself as hub for Administrative, Financial, Industrial, Educational, Medical, Cultural activities resulting in high growth rate, founded in the year 1591 by Mohd. Quli Qutub Shah. The existing street network in Hyderabad consists of arterial roads, sub arterial roads and local streets. HMDA is spreads over an area of 650 Sq.km as shown in Fig 1.1.

Fig 1.1 Map of Hyderabad Metropolitan

The highway passenger transport system of Hyderabad mainly consists of cars, buses, minibuses, auto rickshaws (three-wheeled motorized vehicles), Motorbike, taxis and bicycles. The Hyderabad transport system also includes Metro Rail Transit System (MRTS), suburban rail and Andhra Pradesh State Road Transport Authority (APSRTC). In Hyderabad there were 10,44,200 registered motor vehicles in 2001 which increased to 30,33,000 in 2011, indicating a total growth of 190% over a decade period. Between 2010 to 2011, the number of buses increased by 13.2%, cars(including jeeps, Omni buses and taxis) by 11.3%, two-wheelers by 11.5% and three wheelers by 9.3% . The Traffic operation in HMDA is managed by the Hyderabad Traffic Police. In the present study the data obtained from Hyderabad & Cyberabad Police within its jurisdiction have been used.

1.2 Objectives of the study

Traffic data in Hyderabad include Cyberabad city for 5 years period is taken for analysis. Initially Phase I of the study is a comprehensive review of the state of the art in highway traffic safety. The goal of Phase II is identify factors that affecting traffic safety in Hyderabad by analyzing the accident data and to identify courses of action that will lead to improved road safety in Hyderabad. The study is focused on development of a tool that can measure how well alternative courses of action can improve road safety under heterogeneous conditions.

The following are the specific objectives of the present study:

a. To identify major contributing factors to the severity of road accidents in Hyderabad.
b. To comprehend the type of collision influence on road accident in Hyderabad and Cyberabad cities.

Mathematical models enable highway designer to select design standards that are essential to highway safety and to allow comparison among alternative designs that will optimize the overall safety of the highway system under limited resources and other constraints.

2.0 Literature Review

Joseph Fazio (1965) has studied unique feature of large South Asian cities is the composition of their urban street traffic. **Kadiyali et.al (1983)** developed an accident model based on accident data for 20 years (1960-1980), population and number of motor vehicles India using regression techniques. **Mohamed et.al (2000)** has developed model with frequency of accident occurrence and involvement. **Matthew G. K et.al (2002)** have developed a relationship between rural road

geometric characteristics, accident rates and their prediction, using a rigorous non-parametric based Regression. **Sudeshna Mitra (2002)** has explained studies dealing with the effect of road geometry on accidents by vehicle maneuvers have been reported, mostly for western countries and a few for Asia. B**.S. Rao et.al (2005)** studied on NH – 16 (old NH-5) between Anakapalli to Visakhapatnam during the year 2003 and it runs through urban, semi urban and rural areas. **Parida, et.al(2006)** has taken spot speed, shoulder width, traffic volume, percentage of heavy vehicles, lane width, intersection density as influencing variables they found accident severity as output. A good quantitative research was carried on road accident models throughout the world. Majority of the studies were made in western cities are through development of regression models. But limited studies were conducted in India specifically metropolitan city like Hyderabad. A Logit model is used to estimate the influence of collision type on accident severity.

3.0 Methodology

The study includes review of available literature on road accidents, safety & prevention analysis. This process has helped for better conceptualization of the study for Cyberabad city. The preliminary surveys are performed for identification of suitable study stretches. These include all the police station limits of Cyberabad city and finding the influence of collision type on road accidents in Cyberabad city.

4.0 Results and Discussion

4.1 Yearly Variation of Accidents During 2009 to 2011

A total 3911 accidents were recorded in the year 2011, in these 1143 were fatal accidents and 2768 were non-fatal accidents. More number of accidents occurred in Balanagar division of police station

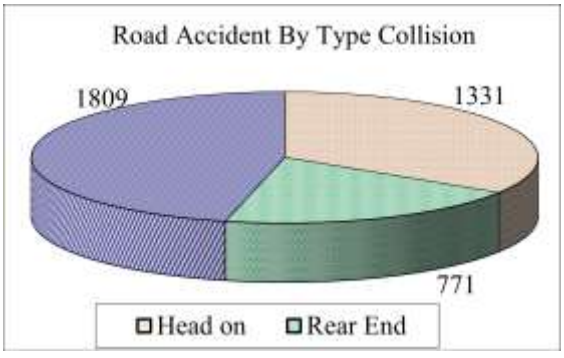

Fig. 4.1 Composition of Accidents on Type of Collisi for Cyberabad city

statistical methodology known as hierarchical tree-

region than remaining police station regions. These include all the police station limits of Cyberabad city and finding the influence of collision type on road accidents in Cyberabad city.

4.2 Monthly Variation of Accidents During 2010 to 2011

The analysis of month wise distribution of accidents indicates that most of the accidents were occurred in the months of June & July. The Table 4.1 shows the distribution during the years from 2010 to 2011.

Table 4.1 Monthly Variations in Accidents for two year period in Cyberabad

Month	2010		2011	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Jan	74	190	81	217
Feb	69	191	79	178
Mar	88	213	89	202
Apr	85	205	100	195
May	81	186	119	222
Jun	105	251	121	**341**
Jul	110	243	99	**311**
Aug	64	169	93	237
Sept	67	186	71	220
Oct	81	191	99	202
Nov	81	196	93	220
Dec	90	185	99	223
Total	995	2406	1143	2768

4.3 Nature of Accident Occurred

The Head on collision and swipe collision are more due to misjudgment of speeds between following and opposing vehicles, as shown in Table 4.2 and Fig. 4.1

Table 4.2 Nature of accidents occurred in Cyberabad (2011)

Nature Of Accident	No. Of Accidents
Rear end collision	771
Swipe collision	1809
Total	**3911**

4.4 Cause of Accident

The following Table 4.3 indicates that the cause of accident is mainly due to the fault of the driver which is 58%

Table 4.3 Cause of the Accident in Cyberabad (2011)

Cause Of Accident	No Of Accident
Fault Of Driver Of Motor Vehicle	2281
Fault Of Pedestrian	62
Fault Of Driver Of Other Vehicle	581
Poor Light Condition	946
Defective In The Mechani Condition	41

4.5 Analysis of Road Accidents Using SPSS for Cyberabad City

Logistic Regression is used for development of models based on severity for three year period (2009 – 11) which is given by

$$Y = \frac{e^{\beta_0+\beta_1 X_1}}{1+e^{\beta_0+\beta_1 X_1}} \quad (4.1)$$

Where y = Dependent Variable

x = Odd against even Fatal and Non-Fatal

A) Head on collision:-

Odd ratio is determined where n_{11}, n_{12}, n_{21} & n_{22} are sample considered for the analysis

n_{11} = 110; n_{21} = 221;

n_{12} = 5756; n_{22} = 11828;

Odds ratio = $\frac{n_{11}\times n_{22}}{n_{12}\times n_{21}} = \frac{110\times 11828}{5756\times 221}$ = 1.02

Odds ratio (OR) = exp (β_1)

where exp (β_1) = 1.02

β_1 = log (1.02) = 0.008(a)

Confidence Interval (CI) =

$$\exp\left\{(\beta_1)\pm Z-\frac{\delta}{2}\times SE\left(\hat{\beta}_1\right)\right\} \quad (4.2)$$

SE ($\hat{\beta}_1$) = $\sqrt{\frac{1}{n_{11}}+\frac{1}{n_{12}}+\frac{1}{n_{21}}+\frac{1}{n_{22}}}$ (4.3)

= $\sqrt{\frac{1}{110}+\frac{1}{5756}+\frac{1}{221}+\frac{1}{11828}}$ = 0.117 (b_1)

Confidence Interval = exp $\{(a)\pm(1.96)(b_1)\}$

where $z-\frac{\delta}{2}=1.96$ (4.4)

= exp {(0.008) ± 1.96 (0.117)}

= exp {0.008 ± 0.22)} = exp {0.3,-0.14}

= (1.34, 0.86)

The Odds Ratio between Head on accident and Severity of the accident is computed and found to be 1.02 which indicates that the Odds against even is around 90 percent Severity. After computation of Confidence internal for Severity of accident it was found that the interval is (1.34, 0.86) indicating that the confidence interval values is skewed towards right side the normal curve.

B) Rear end collision type:

n_{11} = 5708; n_{21} = 11742;

n_{12} = 158; n_{22} =307

Odds ratio = $\frac{5708\times 307}{158\times 11742}$ = 0.9445

Odds ratio = exp(β_1) where exp (β_1) = 0.9445

β_1 = log (0.9445) = - 0.02

Confidence Interval after calculation is obtained (1.190, 0.807)

From the above analysis of Rear end Severity it is observed that accidents are very less in occurrence with an Odds Ratio (-0.02). This is observed in during 2009-2011. Also with respect to Confidence Interval (CI) the distribution is not much skewed.

C) Swipe end collision type:-

n_{11} = 48; n_{21} = 86;

n_{12} = 5818; n_{22} = 11963

Odds ratio = $\frac{48\times 11963}{5818\times 86}$ = 1.147

Odds ratio = exp (β_1)

where exp (β_1) = 1.147

β_1 = log (1.147) = 0.05

Confidence Interval after calculation is obtained as (1.49, 0.74)

From the above calculations it is observed that the Severity of Swipe end accidents is 41- 46 percent during 2009-2011 indicating there are good amount of Swipe end accidents taken place. With respect to the Confidence Interval (CI) the Swipe end accidents are skewed towards right side of the normal curve. This infers that lane driving is important parameter for the cause of swipe accidents.

A Cross Tabulation between Severity of accident is carried and its chi-square test results are shown in Table 4.4

Table 4.4 Pearson Chi-Square Tests Results for severity & type of collision (Fatal)

Type of Collision	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Head on Severity	8.101[a]	1	.51	Significant	
Rear end on Severity	.545[a]	1	.000	Not Significant	
Swipe on Severity	18.154[a]	1	.24	Significant	

From the above chi – square test results it is observed that the fatal severity is influenced by Head on and Swipe collision patterns. A value of 8.01 & 18.154 is observed for Head on and Swipe end collision patterns, whereas Rear end is 0.545. This indicates that the rear end collision has a low influence on fatal severity type of accidents in Cyberabad city The Collision Type Functions for the above logistic regression is obtained as

Head on Collision $y = e^{\beta}_{1} = e^{0.008}$
Rear end Collision $y = e^{\beta}_{1} = e^{-0.02}$
Swipe end Collision $y = e^{\beta}_{1} = e^{0.05}$

5.0 Conclusions

The following are conclusions of the study

a) It is observed that day time accidents are marginally lesser than night time accidents.
b) More number of accidents occurred in Balanagar division of police station region than remaining police station regions
c) Swipe & Rear end accidents are more significant for non fatal accidents occurrence in the city having chi-square of 18.15.
d) Swipe end, Rear end and Head on collision is evaluated using the logistic regression. Odd's against Fatal to Non Fatal were evaluated and found that rear end swipe is significant for non fatal accidents.
e) The Rear end Severity (fatal) in accidents seem to be very less with a Odd's Ratio of -0.022 and is not much during 2009-2011. This infers that rear end accidents are not much influencing the fatal accidents.

6.0 References

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