ROAD TRAFFIC ACCIDENT ANALYSIS AND PREDICTION MODEL: A CASE STUDY OF VADODARA CITY

FSHATSYON BRHANE GEBRETENSAY[1], JAYESH JUREMALANI[2]

[1]PG Student, Dept. Civil Engineering, Parul University, Gujarat, India
[2]Assistance professor, Dept., Civil Engineering, Parul University, Gujrat, India

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Abstract— *India is a developing country and safety of road is still in a hasty stage. Accident severity is increasing due to increasing in vehicle and population. Accident leads to deactivation, death, harm to health and property, social suffering and general deprivation of environment. The road traffic accident situation in India is shocking. Registers show that there is one death at every 2.75 minutes because of road traffic accidents. Road Safety is obligatory to reduce accident involving both human and vehicles there by making the road more safe and user friendly to traffic. The number of accidents is rising up every year due to increasing vehicles population. To develop road accident prediction model each and every parameter related with the accident is considered and a micro level analysis of road accident is performed. For micro level analysis road traffic accident data of last seven year (2010 to 2016) from police station is collected and a detailed analysis is performed on basis like Hour, year, location, type of collision, type of road, physical feature of road, age group, sex, weather condition etc. On basis of this analysis effect of accident is identified. After analysis road traffic accident prediction models is developed based on different parameter.*

Key words: **traffic accident, safety, fatal, accident severity and black spot**

1. INTRODUCTION

Road accidents take away the right to life of 3,000 people every day. This is a global humanitarian disaster, and it is man-made. (Global Road Safety Partnership Annual Report 2011) Road safety is one of the furthermost serious problems in our society. Every year around 1.2 million of people are killed and between 20 and 50 million people are injured in road traffic accidents. If current tendencies continue road traffic accidents are estimated to be third top provider to the global burden of Disease and injury by 2020. Accidents are a trench on the general economy and may clue to deactivation, damage, death to health and property, social grief and general deprivation of environment. To reduce the no of accidents by any kind method and severity expected to occur on the entity during a specific period is known as road safety. Accidents and the fatalities on road are the outcome of inter-play of a number of influences. Road users in India are mixed in nature, reaching from pedestrians, rickshaws, bi-cycles, hand carts and tractor trolleys, to various categories of two/three wheelers, cars, trucks, buses, and multi-axle commercial vehicles etc., The vehicle population has been gradually increasing because of change in the grace of living of people and urbanization. Increase in vehicle population with limited road space used by a large diversity of vehicles has sensitive the need and urgency for a well thought-out policy on the issue of road safety. In India the rate of accident is increasing with increasing vehicle population. Road traffic accidents are a human disaster, which involve great human pain. They enforce a huge socioeconomic cost in terms of untimely deaths, injuries and loss of potential income. The consequences of road traffic accidents can be huge and its negative impact is handled not only on individuals, their health and welfare, but also on the economy. Therefore, road safety has become a matter of national concern. Road Safety is a multi-sectorial and multi-dimensional issue. It incorporates the advance and supervision of road infrastructure, providing of safer vehicles, rule and law enforcement, mobility planning, provision of health and hospital services, child safety and urban land use planning etc. In additional words, its range extents engineering features of both, vehicles and roads on one hand and the facility of health and hospital services for trauma cases in post-crash scenario.

1.1 Road accident scenario in India

Table 1.1: Number of Road Accidents and Number of Persons affected: 2005-2015

Year	Number of Accidents		Number of Persons		Accident Severity
	Total	Fatal	Killed	Injured	
2005	4,39,255	83,491	94,968	465,282	21.6
2006	4,60,920	93,917	105,749	496,481	22.9
2007	4,79,216	1,01,161	114,444	513,340	23.9
2008	4,84,704	1,06,591	119,860	52,.193	24.7
2009	4,86,384	1,10,993	125,660	515,458	25.8
2010	4,99,628	1,19,558	527,512	134,513	26.9
2011	4,97,686	1,21,618	1,42,485	5,11,394	28.6
2012	4,90,383	1,23,093	1,38,258	5,09,667	28.2
2013	4,86,476	1,22,589	1,37,572	4,94,893	28.3
2014	4,89,400	1,25,828	1,39,671	4,93,474	28.5
2015	5,01,423	1,31,726	1,46,133	5,00,279	29.1

Source: information supplied by states/UTS (police department)
*Accident severity: number of peoples killed per 100 accidents

1.2 Objective of the study

- To Perform a micro level analysis of traffic accident
- To develop accident prediction model for road accidents by using statistical analysis.

- To propose integrated permanent solution using traffic sign, make awareness in a society and change a geometry and pavement of the road.

1.3 Need of the study

In India there are over 100000 deaths occur on roads due to accidents. The death include young and old people, people walking, people driving, people traveling in buses, cars, trucks, two wheelers and three wheelers. It also consider people on bicycles and people not traveling at all but simply passing the time of the day by the side of the road. Given that the population is increasing every day and the number of vehicles are coming on to the roads is increasing fast the future looks very miserable unless something is done. Accidents cannot be totally restricted but through scientific analysis and proper engineering measures their frequency and severity can be decreased. Therefore, traffic engineer has to identify systematic accident studies to explore the causes of accidents and to take preventive measures in terms of design and control. It is needed to analyze every individual accident and to keep zone wise accident records. The statistical analysis of accidents carried out periodically at critical locations for the region or road stretches or zones will help to arrive at suitable improvements to decrease the accident rate effectively.

2. LITERATURE REVIEW

Many researchers have studied and research related to accident study and road safety improvements for a particular place or select stretch in a different manner. Some of the reviews are carried out Regarding Accident Data Analysis, Identification of Black Spot and Accident Prediction Model Development.

Alkeshumar B labana, et al conducted accident analysis and identification of black spot its objective was analysis of road traffic accident data and identify black spot. In this study accident analysis was carried out for five years (2010-2014). The result shows 509 accidents occurred in the year 2010-2014. Identified the black spot based on maximum number of accident rate on the study area. And finally they concluded the following estimations from accident analysis

- Estimates maximum number of accident occurs due to head collision there was no facility median on center of lane.
- Two wheelers (20.62%) and four wheelers (27.5%) involve the highest share of percentage in total road traffic accident.
- Highest number of accident occurred in month of March and April.
- Majority of accidents have been occurred in summer season (42.63%) [1]

Patel savankumar et al carried out analysis of road accident its aim was to analyze the traffic accidents occurring in a selected stretch by statistical method which is facing strain as diminished level of administration and increment in numerous quantities of accidents because of vast number of road user clients, specially four wheelers. It achieves exploratory inspection of the mishaps information and suggests remedial measures for reduction in accidents on stretch. Accident data was collected from various police stations along the study area stretch. The collected data are analyzed according to the following Parameters: yearly variation of accident, classified according month, according day ,according collision type, according accident spot, according to vehicle type, according to time, according vehicle maneuver , according drivers error , according drivers age, according weather and according alcohol/drugs. Have finalizes their work by proposed safety measures. [2]

R. V. Jadhav, et al studied related with identification of black spot and its objective was to gather accident data on Islampur and Ashta road for last five year, to identify the black spots on Islampur Ashta road, to transfer out the surveys on black spots area and to give remedial measures for reduction in accidents on selected road. The methodology of the review was Data Collection In order to determine the accident prone locations, following data were Collected and used.

1. Limit map from police stations obtained from the office of super indented of police.
2. Accident reports for the year's from 2007 to 2011.
3. Survey of India topological map at a scale 1:1, 50,000.

Road network of the study area was digitized as line features. Accident locations are digitized as point features. The above spatial data were organized in a personal geo database and feature class. The exact location of accidents was identified by using measure|| tool in QGIS. Generally it identified black spot by Critical Crash Rate Factor Method.[5]

Rajan J Lad et al studied identification of black spot in Ahmedabad city and its objective was to carry out study of existing condition and to identify the black spots in the study area. Accident data carried out from the Sola-high court police station last five years from the 2008 to 2012. Inventory survey was carried out five different locations. The road width, footpath, Median and Service lane are also measured at those locations. The summary of Inventories of five locations on the study area, Spot speed survey is carried out between Thaltej cross road to Umiya Campus. Pedestrian survey carried out between Thaltej cross road to Umiya campus evening peak hour at Five locations. Among these, Thaltej circle is having highest number of Pedestrian Volume 1325 / hour, Classified volume count survey carried out between Thaltej cross road to Umiya campus in morning and evening peak hour and identified black spot based on the accidents recorded, Speed observed, Deficiency of the Geometry and Pedestrian volume. Finally concluded

1. The black spots are identified based on police record, deficiencies of geometric like Non Availability of speed breaker, non-availability of footpath Advertisement board at intersection, improper zebra crossing, other parameter like absence of traffic police, not working traffic signal, illegal parking at intersection etc.

2. Thaltej cross road pedestrian volume is too high and no facilities for pedestrian to crossing the road, so its create the black spot.

3. Based on the road accident data majority of accident occurred between Two wheeler - Four wheeler and Pedestrian – Four wheeler because over speeding of by four wheeler and no facility for pedestrian to crossing the road.

4. There is absence of foot-path at Sola over bridge and BMW show room increase the Pedestrian accident. [3]

Rakesh Kumar Singh, et al accident and prediction of model its objective to study the monthly and annual variation in accident rate on selected stretch, to study the effect of traffic volume on road accident rate and to develop an accident prediction model based on AADT and road condition. Methodology adopted including collection of data from traffic police station and public work department. The busiest NH-77 passing through two cities namely Hajipur and Muzaffarpur, the stretch of this road has length 70km is selected for data collection and statistical analysis of accidents. Accident, Fatality and Injury data were collected month wise in every year from each police station records during year 2000 to 2010. The type of vehicles elaborate in accidents as recorded in the FIR was also noted down. P.W.D. (Public works Department) records are the main source for traffic volume data & road map. Finally developed model using the AADT of the selected stretch of the road and road and shoulder condition rank (CR) are assigned as per site visit. The estimated values from the accident prediction model remained tested by Chi squared test. [4]

3. FINDING FROM LITERATURE

Our world is endorsing serious, fatal and injury accidents in recent years. The World Health Organization (WHO) puts the number of fatalities and injuries due to road traffic accidents are around 1.2 million and 50 million respectively. This study evaluates and analyzes road traffic accident and safety concerns in case of Vadodara city, as Vadodara is one of the cities where severe road traffic accident.

The road traffic accident number or rate for both fatal and injured people increased from time to time. Hence this study will find out the main cause of road traffic accident in Vadodara city and evaluate the safety condition.

Speeding killed 13 people on Gujarat roads every day in 2014, according to, Accidental Deaths and Suicides in India‟ (ADSI)-2014, a report by the National Crime Records Bureau (NCRB).

In fact, Gujarat recorded the third highest number of deaths, 4,830, due to fast-moving in India. Maharashtra (6,953) and Tamil Nadu (6,533) took the first two spots on the list. Gujarat noted 7,857 deaths in all in road accidents in 2014, of which the 4,830 were caused due to speeding, the report says.

Due to those above problems this study helps to minimize and solve the problems.

In Vadodara city there is no availability of foot path, Advertisement board at intersection, improper zebra crossing, absence of traffic signal, illegal parking at intersection due to those problems road accident is increasing and this study propose safety measures.

4. METHDOLOGY

To achieve the objectives a methodology is to be done. Accident data is collected from different all police stations and accident prone stretches on the area. Accident models will be developed considering various factors. For this work study area is to be identified for collecting the required data.

5. COLLECTION OF DATA

For the present study accident data, vehicle registration data and other data of study area are required. Global and national level data are obtained and from various websites, journals and technical published papers. Vehicle registration data is collected from Regional Transport Office of Vadodara city. The accident data of last seven years were collected from different police stations for the work.

6. RESULT AND DISCUSSION

6.1. Preliminary analysis

6.1.1 Accident severity:

It shows the number of persons killed per 100 accidents.

Table 6.1 Accident severity of Vadodara city 2010 to 2016

Year	Total accident	Persons killed	Accident severity
2010	1335	188	14.08
2011	1343	172	12.80
2012	1196	171	14.29
2013	1170	183	15.64
2014	1161	217	18.69
2015	1164	229	19.67
2016	1046	214	20.45

6.1.2 Road accident statics

Table 6.2 Total number of accidents 2010 to 2016

Road accident statistics							
Year	Type of accidents					Number of persons	
	FATAL	GI	MI	NI	TOTAL	Killed	Injured
2010	180	357	570	228	1335	188	1121
2011	164	335	446	398	1343	172	908
2012	156	355	397	288	1196	171	1071
2013	175	404	376	215	1170	183	1051
2014	201	366	372	222	1161	217	990
2015	216	387	332	229	1164	229	984
2016	203	362	292	189	1046	214	878
Total	1295	2566	2785	1769	8415	1374	7003

6.1.3. Accident rate and fatality rate based on population

AR = TA * 100000 / P

Where AR – Accident Rate per 100000 population

TA – Total Accident

P – Population

FR = FA * 100000 / P

Where FR –Fatality Rate per 100000 population

FA – Fatal Accident

P – Population

Table 6.3 Accident rate and fatality rate based on population

Year	Population	Total accident	Fatal accident	Accident rate	Fatal rate
2010	1704375	1335	180	78.32	10.56
2011	1756507	1343	164	76.45	9.33
2012	1808997	1196	156	66.11	8.62
2013	1864086	1170	175	62.76	9.38
2014	1919793	1161	201	60.47	10.45
2015	1977195	1164	216	58.87	10.92
2016	2036314	1064	203	52.25	9.97

6.1.4. Accident rate and fatality rate based on vehicle ownership

AR = TA * 100000 / V

Where AR – Accident Rate per 10000 Vehicles Registered

TA – Total Accident

V – Vehicle Registered

FR = FA * 100000 / V

Where AR – Accident Rate per 100000 Vehicles Registered

FA – Fatal Accident

V – Vehicle Registered

Table 6.4 Accident rate and fatality rate based on vehicle ownership

Year	Vehicle registered	Total accident	Fatal accident	Accident rate	Fatal rate
2010	955943	1335	180	139.65	18.82
2011	988124	1343	164	135.91	16.60
2012	1016149	1196	156	117.70	15.35
2013	1112590	1170	175	105.16	15.72
2014	1220632	1161	201	95.11	16.46
2015	1313997	1164	216	88.58	16.43
2016	1398189	1064	203	76.10	14.51

6.2 MICRO LEVEL ANALYSIS

6.2.1 Monthly analysis

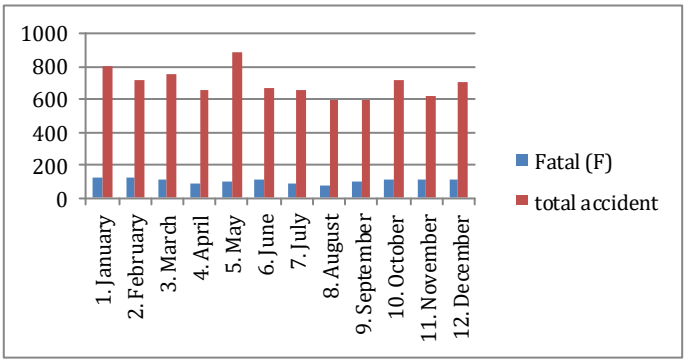

Fig 6.1. Monthly analysis of accident of Vadodara city 2010 to 206

6.2.2. Location wise analysis of accidents

Table 6.5 Accidents details according to location year 2010 to 2016

Location	Total accident
1. Near School or College	396
2. Near or inside a village	481
3. Near a factory / industrial area	446
4. Near a religious place	358
5. Near a recreation place / cinema	148
6. In bazaar	706
7. Near office complex	792
8. Near hospital	251
9. Residential area	1623
10. Open area	767
11. Near bus stop	405
12. Near petrol pump	317
13. At pedestrian crossing	543
14. Affected by encroachments	83

6.2.3. Weather spectrum of accidents

Table 6.6 Weather spectrum of accidents year 2010 to 2016

Weather condition	Total accident
1. Fine	5670
2. Mist / Fog	123
3. Cloudy	178
4. Light rain	297
5. Heavy rain	307
6. Flooding of slip ways / rivulets	9
7. Hail / sleet	0
8. Strong wind	35
9. Dust storm	53
10. Very hot	298
11. Very cold	221
12. Other extraordinary weather conditions	457

6.2.4. Vehicle wise distribution of accidents

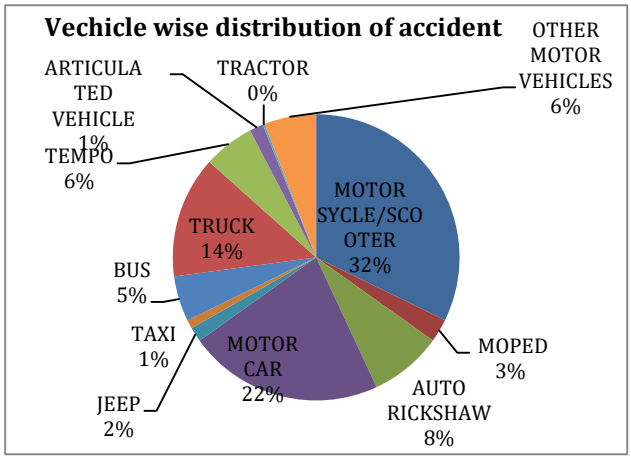

Fig 6.2 accident based on vehicle wise

6.2.5. Accident details according to nature of accident

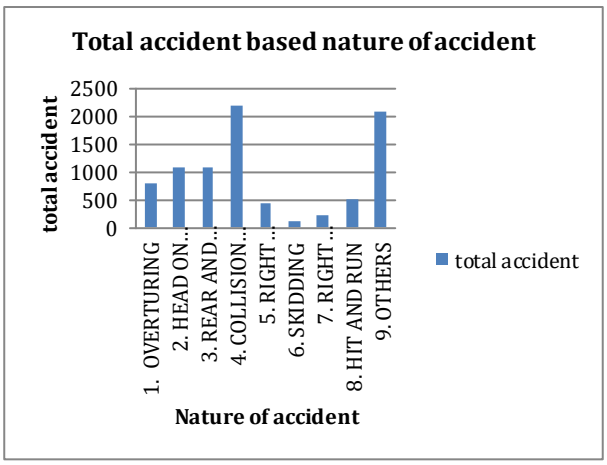

Fig 6.3 Accident analysis based on nature of accident

6.2.6 Hourly spectrum of accidents

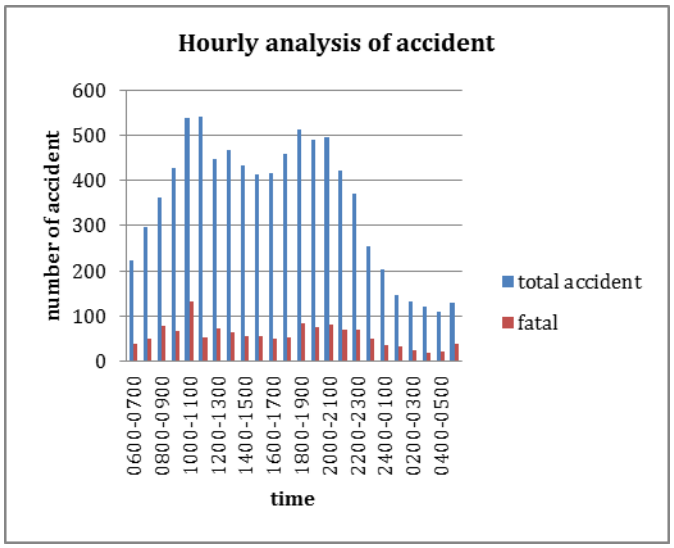

Fig.6.4 Hourly analysis of accident

6.3. ACCIDENT PREDECTION MODEL

In this study the parameter for the prediction of model are vehicle –population ratio and vehicle growth of the city.

6.3.1. Development of prediction model based on vehicle ownership to population (v/p) ratio

The linear regression models are developed for prediction of total accidents, considering number of total accidents as dependent variable (Y) and vehicle ownership to population (V/P) ratio as independent variable(X). The models developed will take the following form:

$$y=a+bx$$

Where y = number of total accidents

x = vehicle ownership to population ratio (for year2010 to 2016)

b = Coefficient for Independent variable

a = Constant (Estimated parameter)

Model for total accident

y=2237.864-1686.605x

6.3.2. Development of prediction model based on vehicular composition

The multiple linear regression models are developed for prediction of total accidents considering number of total accidents as dependent variable(Y) and vehicular composition as independent variable (X). Data for vehicular composition for year 2010 to 2016 from RTO is considered. 2W, 3W, 4W, Bus, LCV, HCV is considering as an independent variable and the multiple linear regressions are carried out.

The Models developed will take the following form:

Y = b1x1+b2x2+b3x3+b4x4+b5x5+b6x6+a

Where y = number of total accidents per year

X1 = Volume of Two wheeler

X2 = Volume of Three wheeler

X3 = Volume of Four wheeler

X4 = Volume of LCV

X5= Volume of HCV

b1, b2, b3, b4, b5 are coefficient

a = Estimate Parameter (Constant)

Model for total accident

y=0.003x1+0.099x2-0.15x3-o.11x4-0.67x5+1166.121

7. CONCLUSION

In this project we analysis road traffic accident (preliminary and micro level) and we predict model based on the parameters of vehicle ownership –population ratio and vehicle composition of the city. We concluded.

1. During the last seven years the number of killed peoples (accident severity) of the city is increasing year to year with increasing population.

2. The highest cause of the accident is fault of driver and 2W type of vehicle in the city.

3. Accident is increasing with increasing of type of vehicle and population.

Accident prediction model was validated by Chi squared test and found to have a good linear relationship between vehicle ownership –population ratio and vehicle composition.

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