IDENTIFICATION OF BLACK SPOT AND SAFETY IMPROVEMENTS: A CASE STUDY OF VADODARA CITY (FATEPURA AREA)

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Abstract: ***Transportation gives to the economic, industrial, social and cultural development of any country. Transportation by road is the only mode which could give maximum service to one and all. Due to the increase in population, number of vehicles is increasing day by day which leads to the increase in road network. It has been estimated that over 30,000 persons die and over 10 to 15 million persons are injured every single year in road accidents throughout the world. The present work intended in identifying various black spots (accident prone location) in Vadodara (fatepura area). The road traffic accident data were collected from city police station of the last 5 years (2013 to 2017) and the causes of accidents are studied and suggested different remedial measures to reduce number of accidents in the selected area.***

Index Terms – Black spot; Accidents; Road network

I. 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 multidimensional 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.

Black Spot

The term black spot is used to describe locations that have a higher average accident rate. The identification, analysis and treatment of road crash black spots are widely regarded as one of the most effective approaches to road crash prevention. Black spots could be at an intersection, mid-block section or a short section of the road with a proven history of high crash density. Generally hazardous locations are selected on the basis of formal road safety audits.

Road accident scenario in India

The below table shows the number of accidents, number of peoples killed, number of peoples injured and accident severity of the country from 2005 to 2015.

Table 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					

II. LITERATURE REVIEW

Srinivasan et al. (1987) [1] developed a scientific method for the identification and improvement of accident prone locations on national highways (nhs) in kerala. three methods were used in their study to identify the black spots, i.e. i) quantum of accident method; ii) accident prone index (api) method and iii) wsi method. the study concluded that the method based on wsi was found to be most suitable in identifying black spots.

Reshma and sheikh (2012) [2] in their study prioritized some of the major accident spots generally referred to as black spots in south bangalore by using arcgis software by assigning possible weights for various accident components.

Binu b pillai and dr. kurian joseph (2011) [3], in their study on causes and consequences of road accidents in kerala, pointed out the main causes of accidents in kerala and suggested remedial measures. according to them, the main causes of road accidents in kerala are over speeding and unhealthy competition of vehicles, poor surface conditions, road cutting, lack of pedestrian crossing facilities, uncontrolled access streets and unmanned junctions, bad driving habits and lack of discipline by road users, haphazard parking on road side, absence of proper bus bay and shelter, visual acuity of drivers, encroachments/dumping of materials on road, and protruded lamp post, unscientific check barriers, speed breakers etc.

Rinivas rao. b et al (2005) [4], conducted an accident study on nh - 5 between anakapalli to visakhapatnam during the year 2003 and it runs through urban, semi urban and rural areas. the accident data for the last five years were collected from the concerned police station and analyzed thereafter. various traffic studies such as details of road inventory, signage inventory, traffic volume, pedestrian volume count, spot speed, speed and delay, accident study were also conducted for suggesting the improvement measures.

Alkeshumar b labana, et al 2015) [5] 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 to 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]

III. STUDY AREA

The study area is Gujerat state Vadodara city and vadodara city one of the highly developing city of india. Population number and number of vechicles are increasing and accident is increasing .the study area is concern Fatepura area..

Fig1 satellite image of study area

IV. COLLECTION OF DATA

Road accident data has been collected form the respective police stations (city police station Vadodara city). Major accident prone locations (Black Spots) have been identified based on the number of accidents, severity of accidents and number of fatalities. For the present study accident data, 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 five years were collected from city police station of Vadodara city for the work.

V.ANALYSIS AND DISCUSSION

5.1. **Accident severity**: It shows the number of persons killed per 100 accidents. Table 5.1 shows the accident severity of the area 2013 to 2017.

Table 2. Accident severity of fatepura area 2013 to 2017

year	total accident	Killed	ASI
2013	24	3	12.5
2014	25	4	16
2015	26	6	23.07
2016	28	7	25
2017	30	9	30

5.2 Road accident statics: table 5.2 shows the road accident statics of the area 2013 to 2017.road accident statics includes minor accident, grievously accident and fatal accident.

Table 3 Road accident statics fatepura area 2013 to 2017

YEAR	MI	GI	FATAL
2013	7	12	3
2014	9	11	3
2015	6	13	4
2016	8	13	5
2017	11	11	7

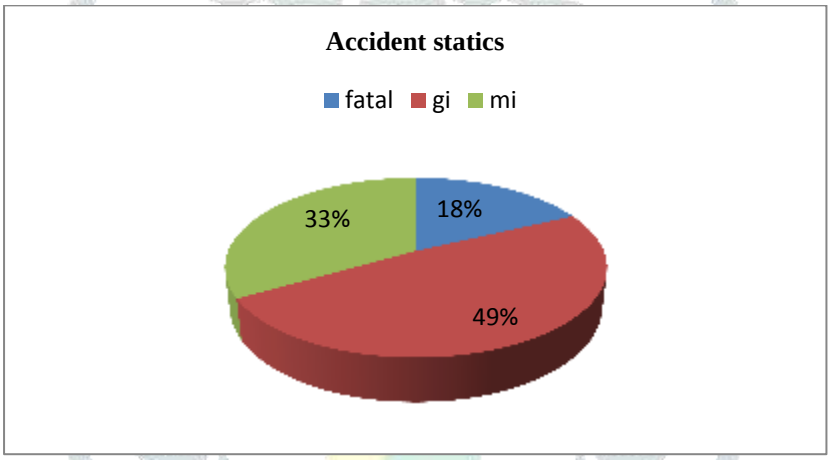

Fig.2 Road accident statics of the area

The above figure describes the percentage of fatal accident, grievously accident and minor accident of the area from 2013 to 2017. Fatal is 18%, grievously injured 49% and minor injured is 33%.

The figure below describes the number of persons injured, killed and non-injured of the area during 2013 to 2017 .

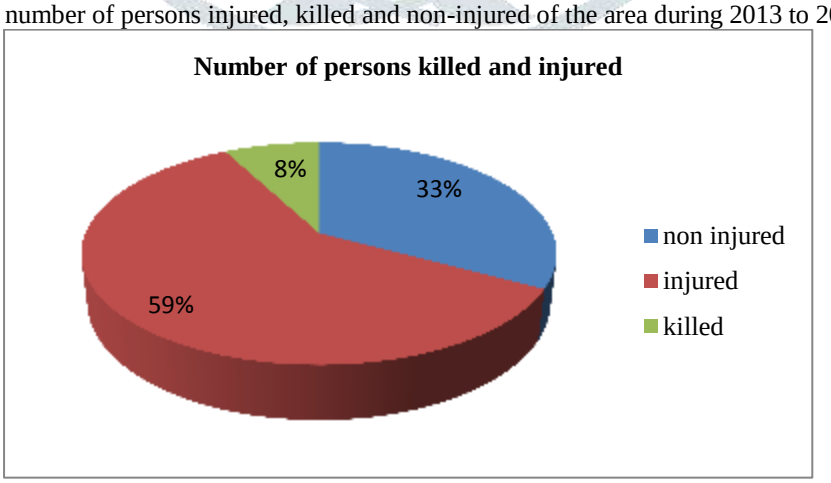

Fig.3 Number of persons killed and injured

5.3 Accident analysis based on cause: the cause of the accident is not only one factor. The cause of accident are driver, pedestrian, weather etc.. And the table below shows the accident analysis based on the cause for the selected area.

Table 4 Accident based on cause

Cause	2013	2014	2015	2016	2017	Total
Driver	14	15	16	17	18	80
Pedestrian	5	6	8	6	6	31
Poor light condition	1	1	1	1	1	5
Cyclist	3	1	1	3	2	10
Defect road	1	1	0	0	0	2
Weather	0	1	0	1	1	3

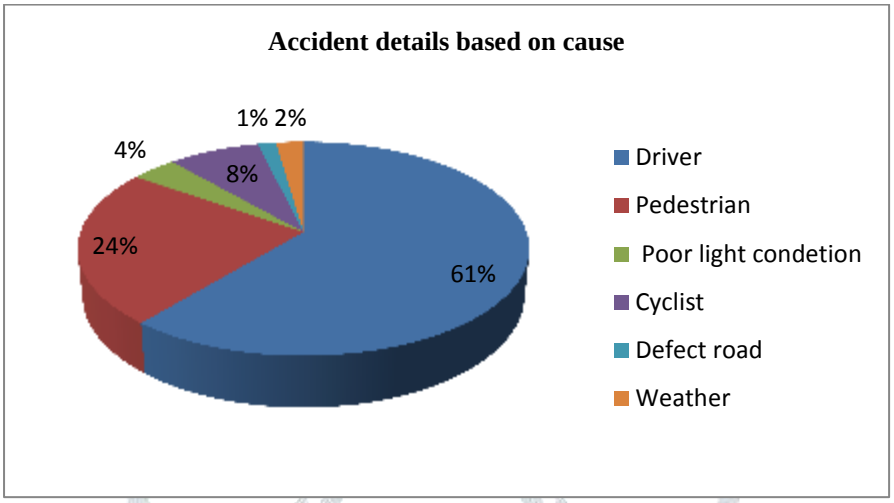

Fig 4 Accident details based on cause

6.4 Accident analysis based on vehicle: different types of vehicles are involved in the accident and the table below shows vehicles involved in the accident.

Table 5 Accident type of vehicles

Vehicle type	2013	2014	2015	2016	2017	Total
2w	9	10	6	5	7	37
3w	3	4	8	3	7	25
car	14	11	12	19	13	69
truck	0	2	1	1	1	5
bus	0	0	0	0	1	1

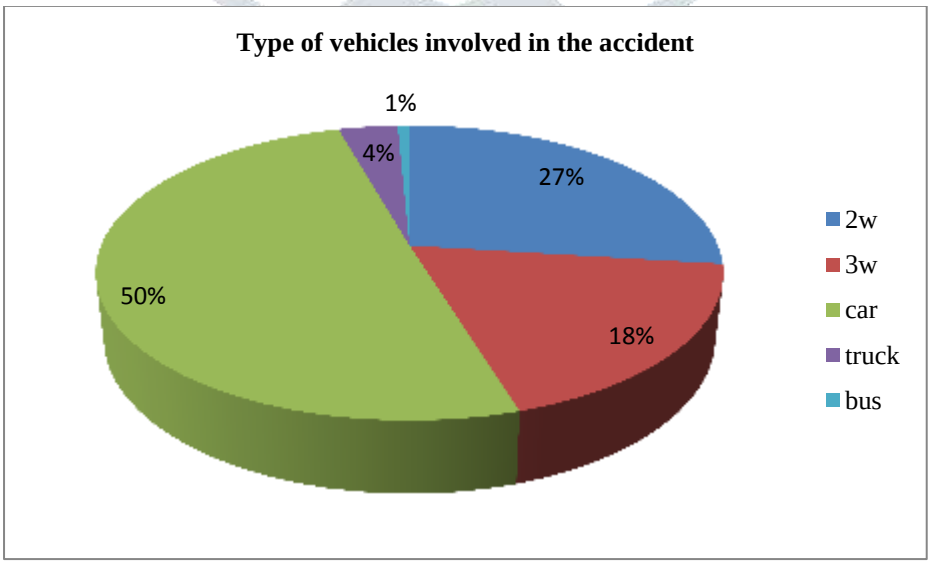

Fig 5 Accident analysis based on the vehicle

5.5 Black Spot Analysis

The point where accident occurs frequently is known as black spot or accident point. Analysis is required for improving traffic environment.

Table 6 places with high number of accidents

Place	2013	2014	2015	2016	2017	Total accident
1.dhaval cross road	1	0	3	1	5	10
2.variysia ring road	8	2	2	2	4	18
3.panigate cross road	1	0	0	1	3	5
4.fatupera cross road	1	1	2	2	3	9
5.pancheel cross road	1	0	0	4	2	7
6.new vip road	3	2	0	0	0	5

Table 7 Accident point, problems and safety improvements

Accident point	**Number of accident**	**Problems**	**Safety enhancement**
Variysia ring road	18	Un signalized , improper shoulder, no pedestrian crossing,	Junction improvement, shoulder and pedestrian crossing.
Dhaval cross road	10	Un signalized, shoulder problem and median problem.	Junction improvement, shoulder and median maintenance
Fatupera cross road	9	Un signalized, improper shoulder, on street parking, lack of zebra crossing.	Junction improvement, shoulder improvement, and making zebra.
Pancheel cross road	7	Un signalized , improper road marking	Junction improvement and road marking
Panigate cross road	5	Un Signalized, no shoulder, zebra crossing	Improvement of zebra crossing, shoulder improvement and junction improvement.

Identification of black spot by Weighted Severity Index

i. WSI follows a system of assigning scores based on the number and severity of accidents at that particular location.

ii. Severity of an accident is classified as Fatal (K), Grievous injuries (GI) and minor injuries (MI).

iii. WSI is calculated by formula, WSI = (41 x K) + (4 x GI) + (1 x MI)

iv. Locations having WSI more than or equal to 41 are termed as accident black spots.

v. Criteria for choosing limit of WSI

In the WSI formula a fatal accident has been given 10.02 times more weightage than grievous accident (4 << 41) also minor accident has been given a unit coefficient. (1 << 41). For grievous and minor accidents to be comparable with fatal accidents while calculating WSI more data is required and hence in this specific research limit of WSI is chosen as 41 i.e. coefficient of K.

Table 8 Accident point and their accidents

Accident point	**Total accident**	**Fatal**	**GI**	**MI**
Variysia ring road	18	2	9	7
Dhaval cross road	10	1	6	3
Fatepura cross road	9	1	5	3
Pancheel cross road	7	1	2	3
Panigate cross road	5	0	1	4

Variysia ring road: WSI= (41 x K) + (4 x GI) + (1 x MI)
K=2, GI=9, MI=7

WSI= (41*2) + (4*9) + (1*7)
WSI=125
Dhaval cross road: WSI= (41 x K) + (4 x GI) + (1 x MI)
K=1, GI=6, MI=3

WSI= (41*1) + (4*6)+(1*3)
WSI=68
Fatepura cross road: WSI= (41 x K) + (4 x GI) + (1 x MI)
K=1, GI=5, MI=3

WSI= (41*1) + (4*5) + (1*3)
WSI=63
Pancheel cross road: WSI= (41 x K) + (4 x GI) + (1 x MI)
K=1, GI=2, MI=3

WSI= (41*1) + (4*2) + (1*3)
WSI=51
Panigate cross road: WSI= (41 x K) + (4 x GI) + (1 x MI)
K=0, GI=1, MI=4

WSI= (41*0) + (4*1) + (1*4)
WSI=8

VI.CONCLUSION

From the above analysis may be conclude

- The highest cause of the accident in the selected area is driver (61%), pedestrian (24%) and cyclist (8%) respectively.
- The total accident, fatal and accident severity accident of selected area is continuously increasing from 2013 to 2017.
- The highest type of vehicle involved in the accident are car (50%), 2W (27%) and 3W (18%) respectively.
- The black spot places of the area are variysia rig road, dhaval cross road, fatepura cross road and pancheel cross road.

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