BLACK SPOT IDENTIFICATION USING ACCIDENT SEVERITY INDEX METHOD

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Abstract

Traffic safety plays a major role in sustainable transportation development. The main negative impact of modern road transportation systems are injuries and deaths in road accidents. Traffic crashes in India are increasing on a steady rate. It results in property damages as well as death of road users. Blackspots are the locations in a road where crashes are common or places in which road crashes results in fatal injuries. Therefore the identification and analysis and of road accident black spots are regarded as one of the most effective approaches to road accidents. This paper aims to identify the accident prone zones within Cochin City, using Accident Severity Index Method and to locate the hotspots using Arc GIS software. For this purpose, the road accident data for the past three years 2014, 2015 and 2016 pertaining to Cochin City is collected. Road Safety Analysis was carried out in the top accident prone locations to find out the causes for accident.

Index Terms: Accident Severity Index, Black Spot, Road Safety Analysis

I. INTRODUCTION

The increase in the number of motor vehicles is due to the population growth and advances in technology. As the mobility increases, the probability of accidents also increases. Blackspots are the locations where a number of accidents repeatedly occur. The basic elements in traffic accidents are road users, vehicles, road condition, road geometry, environmental factors etc. The main cause of road accidents are road parameters such as road width, deficiency in super elevation, deficiency in site distance, radius of horizontal curve etc. Road accidents cannot be totally prevented, but by using suitable traffic engineering safety plan and management measures, the accident rate can be reduced. Even after an accident occurs, the common city roads have to face many problems such as traffic jams which cause loss of valuable time. This paper describes the identification of blackspots in Cochin City, Kerala and its representation using Geographical Information System.

The identification of black spots can help in better scheduling road safety policies. Severity index method was used for finding the hotspots. In this method, a severity value was obtained for each crash location based on number of people died, number of people severely injured, and number of people who got minor injuries and so on. Thus Accident Severity Index (ASI) can be defined as a dimensionless value indicating the hazardousness of a spot in the road.

II. LITERATURE REVIEW

Anitha Sevasofia (2016): has done the hotspot identification within Coimbatore city. The analysis was conducted by establishing some control points. Analysis was done with the data from 2010 to 2014. Critical crash rate factor method was used to identify the hazardous locations. The more accidents were found near to the important landmarks. They listed the suggestive measures for each zones in the city after the analysis. The main reasons for the

accidents were also identified in the study. Inadequate footpaths, problem regarding drainages were some of the main reasons identified through this study.

Dr. A. S Kananalakshmi (2016**):** examined the National highway 5, the major highway connecting southern parts of India for the analysis of road accidents. They collected monthly and annual variation in accident rate on selected stretch. Weighted severity index method was used for the analysis of secondary data. Analysis of primary data was carried out by doing road inventory survey, traffic volume count and speed and delay study. After the analysis of identified black spots using GIS, final weights were further prioritized. They concluded that signalling system and advanced marking can be used for the prevention of road accidents.

Snehal U Bobade et.al (2015): identified the accident prone zones on Pune – Solapur National Highway (NH-9) and Mumbai-Pune Expressway by the ranking method. They identified the major factors causing accidents. The main reasons for accidents were narrow bridges, absence of curve indicator, and erosion of shoulders due to cart tracks and cattle crossing, passenger pickup sheds at junction, trees by road side, small subsidiary road meeting the main highway in a steep slope etc. The most important parameter had given the minimum rank and based on that blackspots were identified. Detailed analysis of the identified blackspots was also carried out.

III. STUDY AREA AND DATA COLLECTION

A. Study Area

The study area selected was Cochin City, which is the largest city in Kerala. Also, Cochin City has the highest number of vehicles with the highest accident rates in Kerala. The data released recently by district crime records bureau (DCRB) showed an increase of 62% in the number of road accidents in Cochin City over the past five years.

B. Data collection

The road accident details of past three years (2014-2016) were collected from city police records. The spots with higher number of accidents were identified. Table 1 Accident details

Place of accident	No. of accident cases	No. of fatal accidents	No. of serious accidents	No. of minor accidents
Cheranallor signal	32	10	10	12
Vytilla junction	23	5	5	13
Kundanoor junction	22	4	10	8
Edappilly toll junction	21	5	14	2
Kalamassery toll junction	23	6	7	10
Maradu	27	8	12	7
Palluruthi-veli Edakochi-Pall uruthi road	21	6	13	2
Vathuruthi bus stop Thevara-Thop pumpadi road	18	2	4	12
Atlantis junction MG road	17	5	7	5
Mulavukad container road	12	3	4	5
S N junction	10	3	3	4

IV. METHODOLOGY

Based on the data collected, the Accident Severity Index (ASI) value was calculated. The blackspots were prioritized according to the severity of the location and road safety analysis was done in the identified hotspots. The concept of this method is that the number of fatal or injury accidents at a location is given a greater weight than property damage-only accidents. Accident Severity Index (ASI) is a dimensionless value indicating the hazardous of a location. The following equation has been used:

$$ASI = NfWf + NsWs + NmWm \quad (1)$$

Where,

Nf =No. of fatal accidents at the spot in the last 3 years

Wf=Weight assigned to fatal accident=6

Ns=No. of serious accidents at the spot in the last 3 years

Ws=Weight assigned to serious accident=3

Nm=No. of minor accidents at the spot in the last 3 years

Wm=Weight assigned to minor accident=1

Table 2 Accident Severity Index

Place of accident	ASI
Cheranallor signal	102
Vytilla junction	58
Kundanoor junction	62
Edappilly toll junction	74
Kalamassery toll junction	67
Maradu	91
Palluruthi-veli Edakochi-Palluruthi road	77
Vathuruthi bus stop Thevara-Thoppumpadi road	36
Atlantis junction MG road	56
Mulavukad container road	35
S N junction	31

For each location the equation was applied and calculated. After obtaining those severity values the hotspots were ranked according to these values. The places were arranged in ascending order of the severity value. Table 3 Ranking of black Spot

Place	Rank
Cheranallor signal	1
Maradu	2
Palluruthi-veli Edakochi-Palluruthi road	3
Edappilly toll junction	4
Kalamassery toll junction	5
Kundanoor junction	6
Vytilla junction	7
Atlantis junction MG road	8
Vathuruthi bus stop Thevara-Thoppumpadi road	9
Mulavukad container road	10
S N junction	11

V. ROAD SAFETY ANALYSIS

Road Site safety analysis was conducted at all the hotspots to know the condition of the road. It included drop off measurement, sight distance measurement, clear zone measurement, road width and footpath measurement, checking the visibility of signs and signals, checking the illuminance of the road, measuring the road surface distress and lastly night time visibility.

A. *Drop off*

The drop off was measured using a measuring tape. It was measured at various points at the hotspot location and the maximum value was considered as the observed drop off value.

Some of the hotspots such as Cheranallor signal, Maradu, Palluruthi-veli Edakochi-Palluruthi road, Edappilly toll junction, Kalamassery toll junction and Vytilla Junction had drop off value more than the maximum allowable limit whereas the drop off values at rest of the places where within the allowable limit. This allowable limit is AASHTO recommended value. When a vehicle leaves the travel lane, pavement edge drop-off possess a potential safety hazard because significant vertical differences between surfaces can affect vehicle stability and reduce a driver's ability to handle the vehicle

B. *Sight distance*

The sight distance was measured from the blackspots by using target rod and sighting rod of required dimension. The recommended sight distance on the main road is based on the speed limit of vehicles on the main road. Actual sight distance of the main road was measured. Traffic collision at an uncontrolled intersection is more if the actual sight distance in the field is less than the recommended sight distance suggested by AASHTO.

The sight distance obtained at every black spots are lesser than the recommended values. The vision of the driver on the road approaching an intersection was blocked by trees, building or any other objects. So the chances of an approaching vehicle to stop a vehicle to prevent collision got reduced. These locations are more prone to collisions due to insufficient sight distance.

C. *Clear zone*

Length of clear zone was measured using tape. It is the length from the edge of carriageway to a vertical obstruction on the road side. The values of the observed clear zones were measured and compared with AASHTO recommended value.

All the hot spots were having insufficient clear zone due to obstructions like trees, buildings, construction materials, flux boards or any other stationary objects which in turns affects the safety of vehicles. The clear zones are necessary in emergency situations and also at places were road width is less. During monsoons the condition of these clear zones are very bad, water gets collected at the potholes there and due to this pedestrians tend to occupy more space on the roads which may lead to pedestrian accidents.

D. *Road width and footpath*

The foot path width was measured using a measuring tape and the road width was calculated by checking the number of lanes provided at that location. Then the width of the foot path was compared with the IRC recommended values. Some spots were having sufficient width of footpath for pedestrian safety and at majority of the spots, foot paths were not provided. But parking on the footpaths and poor condition were the major problems in most places. At some places the foot paths were occupied by foot path vendors and in some areas they were occupied by auto rickshaws. The bad condition of footpaths can cause threats to the pedestrians and also they might occupy the road spaces which are meant for vehicles and this may lead to traffic jams and accidents.

E. *Road markings and signals*

The road signs and signals were observed visually.

The traffic signs were not easily visible to the drivers in most of the places due to the shrubs, advertisement boards etc. The road markings were not clearly visible in most of the places.

F. *Illumination of street light*

The illumination of street light was measured using lux meter.

Most of the road experienced reduction in illumination value than the recommended value suggested by illumination hand book and hence the night time visibility reduces.

G. *Night time visibility*

Driving vehicle during night time has greater chance for crashes because driver has lesser idea about the road due to insufficient road illuminance. Night time visibility studies were performed using photography to capture the lighting condition and visibility available to a driver.

Glare was one of the major causes for traffic crashes as well as pedestrian crashes. Exposure of glare was very much intense at locations were divider was not present. Retro reflectivity of sign board has to be increased. Sign board was not visible at some locations. Illumination level of street light was very poor in all of the sites.

H. *Road conditions*

The conditions of roads were examined visually.

In most of the hotspots the traffic condition was bad, especially during monsoons. This shows improper construction and maintenance.

Table 4 Road inventory data

Place	Edge drop (m)	Sight distance (m)	Clear zone (m)	Foot path width (m)	Illumination (Lux)		
					Below	Middle	Opposite
Cheranallor signal	0.096	8	0.97	I.50	10	6	5
Maradu	0.000	5	0.50	0.00	4	3	1

Palluruthi-veli Edakochi-Palluruthi road	0.094	10	0.30	2.00	7	4	0
Edappilly toll junction	0.084	6	0.60	1.50	4	2	1
Kalamassery toll junction	0.092	11.5	0.40	2.00	9	6	3
Kundanoor junction	0.067	13	1.30	0.00	6	2	1
Vytilla junction	0.065	9	1.20	0.00	15	11	3
Atlantis junction MG road	0.000	12	0.83	1.50	5	2	4
Vathuruthi bus stop Thevara-Thoppumpadi road	0.000	14.2	0.77	0.00	4	3	1
Mulavukad container road	0.000	16	1.37	1.50	6	4	2
S N junction	0.070	7	1.30	0.00	8	4	3

VI. WORK DONE IN GIS

Hot spots were located by using latitude and longitude of a place. All hotspots marked contain separate attribute tables. Here each hotspot was labeled with its corresponding name and shape files were cut. Similarly crash location attribute table contained road width, clear zone, drop off, median width, kerb and road condition details. These details were given in to attribute tables after creating it.

Fig 1 Shape file with attribute table in GIS

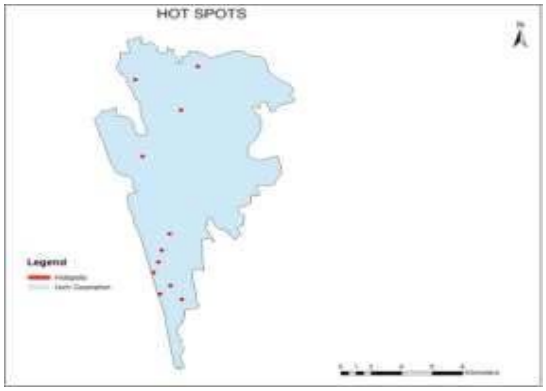

Fig 2 Representation of black spot in GIS

VII. CONCLUSION

The study was an attempt to find out the black spots in Cochin City. The Accident Severity Index (ASI) method was used to rank the accident locations. This method was found to be effective in identifying the blackspots. As the

result is given in map format, it is easy to interpret result. Based on the analysis, Cheranallur signal was identified as most vulnerable accident prone area and Road Site safety analysis was conducted at all the hotspots to know the condition of the road. Road Safety analysis can be used to find out factors influencing crashes and hence to give remedial measures.

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