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Identification and Analysis of Accident Blackspots Using GIS

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Abstract – *An accident black spot is a hazardous or high risk location where a number of accidents repeatedly occur. The identification, analysis and treatment of road accident black spots are widely regarded as one of the most effective approaches to road accidents. Frequent occurrences of accidents in the black spots can be attributed to varying factors. As a major share of the accidents occur in such black spots, measures should be taken to reduce the number of accidents in these spots to improve the overall road safety. The present study aims to find the major accident black spots in the study stretch and to identify various traffic parameters and road factors causing accidents. The capability of GIS to link attributes data with spatial data facilitates prioritization of accident occurrence on roads.*

Key Words: **Accident black spots, GIS Applications, Weighted Severity Index (WSI), Passenger Car Units (PCU)**

1.INTRODUCTION

Nothing is more important to civilization than transportation and communication and apart from direct tyranny and oppression; nothing is more harmful to wellbeing of society than irrational transportation system. Worldwide, the transportation problems faced by various nations have increased manifold, necessitating search for methods or alternatives that ensure efficient, safe, feasible and faster means of transport. It has been estimated that India currently accounts for nearly 10% of road accident fatalities worldwide. In addition, over 1.3 million people are seriously injured on the Indian roads every year. Hence, road safety is a very serious issue in India and needs to be addressed with utmost priority. In Kerala, the scenario is not different; there were 4145 fatalities and 25110 grievous injuries in a total of 39014 accidents in the year 2015 (Kerala Police, 2016).

An accident black spot is a hazardous or high risk location where a number of accidents repeatedly occur. The identification, analysis and treatment of road accident black spots is widely regarded as one of the most effective approaches to road accidents.

Geographic Information System (GIS) is an effective tool to represent the black spots graphically. GIS integrates hardware, software, and data for capturing, managing, analysing, and displaying all forms of geographically referenced information. The capability of GIS to link attributes data with spatial data facilitates prioritization of accident occurrence on roads and the results can be displayed graphically which can be used for planning and decision making. Accident –prone locations can be identified using GIS by analysing spatial characteristics about identified locations, and also able to figure out the underlying factors causing accidents. Then reasonable actions can be taken to improve safety in the accident-prone locations. In many developed countries, GIS has been widely used for analysing the accident prone locations or the accident black spots. Many academicians and even government agencies are working on building new tools and improving the existing scenarios for road safety analysis. In this study, GIS analysis is performed using QGIS 2.18 software. This paper includes pilot study of identification of accident black spots in the region of MC road from Pulluvazhy to Velloorkunnam using Weighted Severity Index method.

2. SCOPE AND OBJECTIVE

The objectives of the project are as following:

1. To implement a methodology to identify and prioritize hazardous locations.

2. To find out the most vulnerable accident spots in MC road from Pulluvazhy to Velloorkunnam signal junction and represent it using GIS.

3. To identify various traffic and road related factors causing accidents and suggestion of possible improvements.

3. STUDY AREA

The study stretch is from Pulluvazhy to Velloorkkunnam signal junction along M C Road of SH -1. The study stretch is 14 km. This stretch consists of many steep horizontal curves and intersections with very poor visibility with ribbon development. The stretch is busy with more number of vehicles and over the years traffic density has gone up. In the recent years, fatal accidents are on the rise due to poor traffic management and over speed. The map of the study stretch is given below:

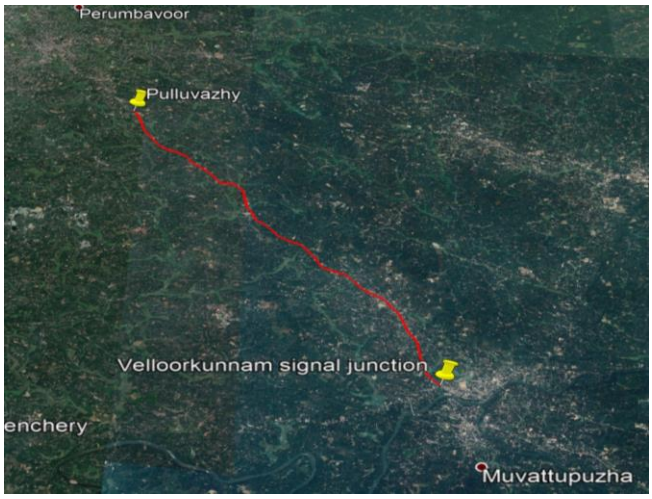

Fig -2: study stretch

4.COLLECTION AND ANALYSIS OF DATA

Secondary data is the data collected initially. The data collection involves the collection of accident data of the district for the past three years from the concerned police department. Detailed analysis of secondary data was carried out for the identification of top black spots.

Primary data collection includes road inventory surveys, traffic volume count, collection of traffic parameters etc. The various traffic parameters and road characteristics from these surveys were given suitable weights and were used in the prioritization of spots using GIS.

4.1 Collection and Analysis of Secondary Data

The last 5 years (2012, 2013, 2014, 2015, 2016, and 2017) accident data of the study stretch was collected from Muvattupuzha and Kuruppumpady police station. Secondary data was the basis for the identification of major accident spots

4.1.1Ranking of Accident Spots

The accident spots obtained after the sorting and detailed analysis of secondary data were prioritized to arrive at the top accident black spots using Weighted Severity Index Method.

Weighted Severity Index (WSI) = (41 x K) + (4 x GI) + (1 x MI)

K, GI, MI are the number of persons killed, number of grievous injuries and number of minor injuries respectively. WSI values of all the selected spots were calculated. The top five spots with the highest value of WSI were chosen for the project study.

4.2 Collection and Analysis of Primary Data

4.2.1 Road Inventory Surveys

A detailed road inventory survey was carried out on the entire identified spots to measure the roadway geometric parameters like the formation width, median, shoulders, surface type, surface condition, edge obstruction, road markings, road signs, drainage facilities and visibility.

All the identified spots are in SH-1. From the road inventory survey it is observed that, the formation width of all stretches varies from 11 m to 12.2 m. It is not sufficient for accommodating huge traffic and the width is not satisfying the standards of State highways. In Pulluvazhi, Keezhillam, Pezhakappilly and Vazhappilly there is no median for differentiating the direction of traffic. It may cause head on collision and night time road accidents due to glare problem. Bituminous surfacing is provided in all the spots and it is in good condition. The alignment of the road is straight in many places and it encourages drivers to take over speed while travelling through these spots. Drainage facilities are given in most places and it is not in good condition. Presence of advertising hoardings and illegal boards divert the attention of drivers while driving. The road signs and markings provided are faded and not clearly visible. Adequate shoulder width is not provided in many places. Regular maintenance is required for removing all the above ill effects of these spots and for providing safety for all road users.

4.2.1. Traffic Volume

Traffic volume survey was conducted and traffic volume count was taken for all the spots from 7AM -7 PM.(Since most accidents occurred between 7AM to 7PM) for seven days and peak hour traffic in terms of Passenger Car Units (PCU) was found.

The road stretches considered were found to be carrying mixed traffic. The most frequent type of vehicle in most of the spots was light motor vehicles and two wheelers. The average daily traffic volume values fall within the range 10000-30000 PCU.

5. GIS ANALYSIS

GIS has been widely used for analysing the accident prone locations or the accident black spots. In this study, GIS study is performed using QGIS 2.18 Software.

5.1.Prioritization Of Black Spots

Table – 1: Factors used in the prioritization

SL NO.	FACTORS	POSSIBLE VARIATION	WEIGHTAGES ASSIGNED
1	No of lanes in each direction	1 2 4	2 6 10

2	Width of formation	<6m 6-8 8-10 10-12 >12	1 3 5 7 10
3	Class of road	NH SH PWD Other roads	1 4 8 10
4	Surface type	Bituminous Concrete	4 10
5	Surface condition	Good Fair poor	10 6 1
6	Drainage facility	Good Satisfactory Poor No drainage	10 6 2 1
7	Vehicle type	Heavy vehicles Bus/truck Car Two wheelers	10 8 4 1
8	No of vehicles per day(PCU)	<10000 10000-30000 30000-50000 >50000	10 7 4 1
9	Shoulders	Paved unpaved	10 6
10	Edge obstruction	Yes No	4 10
11	Median	Yes No	10 4
12	Visibility	Very poor Poor Average good	2 4 6 10

$$\text{Total Weightage} = \frac{\sum \text{Individual Weightage} \times 100}{120}$$

5.2 Prioritization Scheme

Table – 2: Prioritization scheme

FINAL WEIGHTAGES (%)	ACCIDENT PRONE LEVEL
>60	Very Low
50-60	Low
40-50	Medium
0-40	High

The road characteristics as well as traffic parameters of each spot is specified as attributes and linked with each spot in the digitized road map. The various spots were then prioritized for accident occurrences using total weights assigned to every attribute, as a result of which the black spots were ranked on the basis of vulnerability (refer table 3).

Table – 3: Final weightage and accident prone level of each spot

Place	Weightage	Accident Prone Level
Pulluvazhi	53.3	Low
Keezhillam	49.2	Medium
Pezhakappilly	46.2	Medium
Vazhappilly	46.6	Medium
Velloorkunnam	60	Low

5.1 Mapping of black spots

The top five accident spots in the study stretch were plotted using QGIS 2.18. That is shown in the map given below (Fig - 2)

Fig -2: black spots mapped in Q GIS software

6.SUGGESTIONS FOR IMPROVEMENT

From detailed observations and analysis of each spot it was found that there is scope for improvements at each spot. Some suggestions for the possible improvements of the spots are made here.

1) Keezhillam

1. Removal of unnecessary edge obstructions like electric posts, hand rails, bushes.
2. Provide sign boards indicating staggered T intersection

3. Provide sufficient paved shoulders and raised pavement reflectors or rumble strips with reflectors.
4. Proper marking on roads or amber reflectors (Edge of pavement: white reflectors and center of pavement: amber reflectors).
5. Provide flashing amber lights indicating warning about accident zone.
6. Use of sign boards to inform the drivers about the turns, speed etc..
7. Installing speed cameras

2).Vazhappilly

1. Proper sign boards to indicate Y intersections
2. Flashing amber light
3. Land acquisition can be done for providing channelizing islands.
4. Edge obstructions should be cleared.
5. Provide sufficient shoulders.
6. Provide clear road markings (Edge of pavement: white reflectors and center of pavement: amber reflectors).
7. Provide pedestrian crossings.
8. Provide parking spaces
9. Proper patchwork should be done to remove the undulations and map crackings.
10. Provide raised pavement reflectors or rumble strips with reflectors.

3) Pezhakkapilly

1. Removal of visibility reducing factors such as advertising flex boards and edge obstructions.
2. Avoid on street parking and provide parking spaces (parallel or angle parking depending on space).
3. Provide enough sight distance.
4. Provide proper road markings.
5. Provide sign boards indicating speed limits and no overtaking signs.
6. Installing speed cameras.
7. Provide flashing amber lights.
8. Provide sufficient shoulders.
9. Provide rumble strips with reflectors.

4) Pulluvazhy

1. Installing speed cameras.
2. Providing reflectors on the culvert present at the spot.
3. Adequate traffic sign boards to be provided.
4. Provide road marking and pedestrian markers.

5) Velloorkunnam jn.

1. Installing speed cameras.
2. Provide parking facilities and rumble strips with reflectors.
3. Acquisition of land for widening median and providing shoulders.

7. CONCLUSION

The study was an attempt to identify the most vulnerable accident black spots in the study stretch from Pulluvazhi to Velloorkunnam on SH1. Black spots are high risk locations were a number of accidents repeatedly occur. Black spot management is an effective approach to reduce the accident rates of a place. The Geographic Information System can be utilized efficiently for the analysis, prioritization and representation of black spots.

The accident database from both Muvattupuzha and Kuruppampady police departments for last five years were collected. The accident spots were then prioritized using weighted severity index (WSI) method. WSI value of a place represents the hazardousness of the spot. Then top five spots with highest value of WSI were chosen for the study. All the identified spots were then visited and the accident scenarios were accessed.

In the next stage of the project, traffic as well as road inventory surveys of the selected spots were carried out. The required road characteristics and traffic parameters of the spots were obtained. For each parameter thus collected, weightage within the range of 0-10 was assigned such that least weightage was given to the factor that contributes least to the occurrence of accidents. All the spots were then again prioritized in GIS using the prioritization scheme.

After prioritization in GIS, possible improvement measures were suggested for all identified spots.

8. REFERENCES

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