

IDENTIFICATION AND MAPPING OF ACCIDENT BLACKSPOTS AND NEARBY HOSPITALS IN ALAPPUZHA DISTRICT USING GIS

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Abstract - Road accidents are a global cataclysm with ever raising trend which possesses public health and development challenges and greatly affect the human capital development of every nation. There seems to be no let up in the number of fatal and non fatal accidents taking place in the state. The success of traffic safety and the need for highway improvement hinges on the analysis of accurate and reliable traffic accident data. Traditional methodologies of analysing the accident prone areas do not provide consideration to the road improvements and result in misidentification of locations that are not truly hazardous from the road safety perspective. Rash and negligent driving, blatant violation of speed limits and drunken driving are major reasons for the growing road mishaps. With road accidents snuffing out the lives of youngsters especially those in their productive age group, these deaths are not only a huge loss for their families but to the entire nation. The present study attempts to identify the most vulnerable accident black spots in Alappuzha district using Geographic Information System followed by identification and mapping of the geographical distribution of hospitals (trauma care facilities) and their proximity to accident prone areas in the district. The study includes collection of accident data and prioritizing the accident-prone locations using ARCGIS 10.2.

Key Words: Black spots, GIS Applications, Prioritization, Proximity, Road Traffic Accidents (RTA), Traffic Volume Count, Weighted Overlay Method

1. INTRODUCTION

Despite many feathers in its cap like high literacy rate, better socio-health indicators and good road connectivity, there are issues that still bother the State as a whole. One of the major causes of concern at this juncture is the alarming rate of road accidents in the state which is quite high compared to the national average. Today Kerala stands 3rd in India, in terms of road accidents and causalities. Road traffic accidents are one of the major causes of death, injury and disability, in this state. The location in a road where the traffic accidents are likely to occur repeatedly is called a black spot. In these black spots, accidents are not a random event, but common due to varying factors. Expansion of road network, motorization and urbanization has been accompanied by a huge rise in road accidents leading to road traffic injuries

and fatalities as a major public health concern. Injuries due to road accidents are one of the leading causes of deaths, disabilities and hospitalizations with severe socio-economic costs across the world. As per a study conducted by the Kerala Road Safety Authority (KRSA), the maximum numbers of accident-prone stretches are in Alappuzha district. This project attempts to identify the most vulnerable accident black spots in Alappuzha district and finding the proximity of hospitals (trauma care) from the accident black spots using Geographic Information System. Identification, analysis and treatment of accident black spots have been considered as one of the most effective approaches to road accident prevention. GIS integrates hardware, software and data for capturing, managing, analysing, and displaying all forms of geo referenced information and the capability of GIS to link attribute data with spatial data facilitates prioritization of accident occurrence on roads. Hence the results can be used for planning and decision making.

1.1 Objectives

The aim of the study can be given specifically as the following:

- To identify various traffic and road related factors causing accidents and find suitable solutions.
- To carry out analysis of black spots using GIS.
- To find the top ranked accident black spot.
- To find the geographical distribution of hospitals (trauma care facilities) and their proximity to accident prone areas in the district.

2. SIGNIFICANCE

- The study will have paramount importance to the government, municipal authorities to determine the need for road improvements and vehicle inspections and in launching initiations in studying the complex problems of urban road transport in general and RTA in particular.
- The analysis will be helpful to gain information about the RTA black spots, trend, cause and impact

of RTA in the city, which in turn, could help to develop counter measures that could reduce the frequency and severity of road traffic accidents.

- The study will be used as a bench mark information to those scholars who want to conduct future detailed studies on RTA, road safety and other related issues.

3. TRAUMA CARE AND GIS

Evidence from developed countries indicates that properly coordinated early rescue and retrieval systems together with appropriate early, in-hospital trauma management will prevent 15-30 percent of road crash deaths. GIS and related spatial analytic techniques provide a set of tools for describing the spatial distribution of health care facilities and for exploring how health care facilities and distribution can be improved. Advances in computing power and graphics, as well as the development of GIS-based location analysis models and methods have stimulated innovative health care applications. Access to health care is an important issue in India. People face substantial barriers in obtaining right care at right time. GIS research emphasizes on the geographical dimensions of access.

4. STUDY AREA

Referred to as the Venice of the East, Alappuzha is one of the 14 districts in Kerala gifted with bountiful natural beauty. Alappuzha is fondly known as the "Venetian Capital" of Kerala. The district lies between north latitude 9° 05' and 9° 52' east longitude 76° 17' and 76° 48' and is bounded on the north-east by Ernakulam and Kottayam districts, on the east by Pathanamthitta, on the south-east by Kollam district and on the west by the Arabian Sea. Alappuzha is connected to other places by State Highways, National Highways and district roads. National Highway 66 (India) connects Alappuzha town to other major cities like Mumbai, Udupi, Mangalore, Kannur, Kozhikode, Ernakulam, Kollam, and Trivandrum. Alappuzha is blessed with many artefacts, but the accident rate increases dangerously throughout the district.

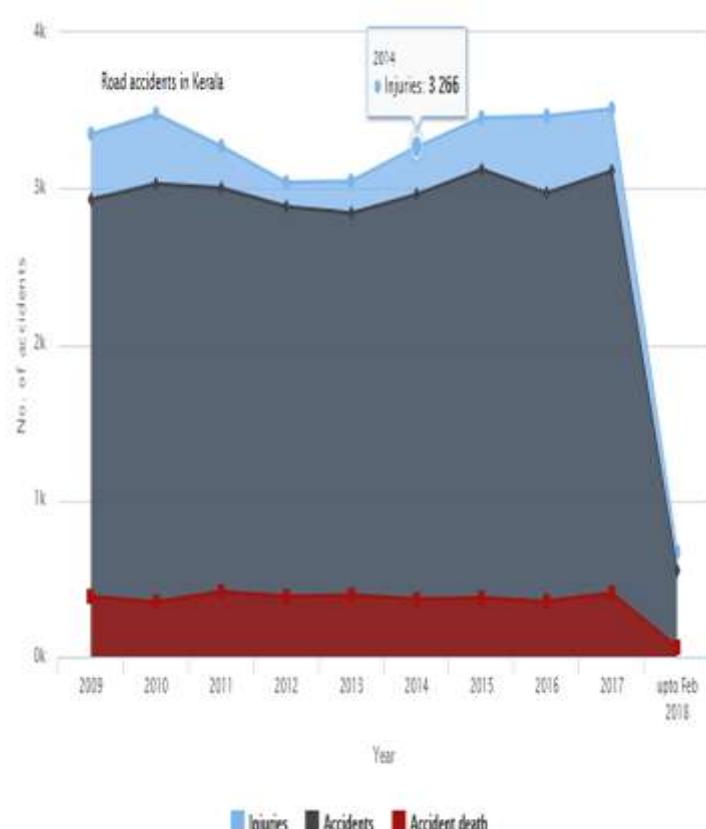
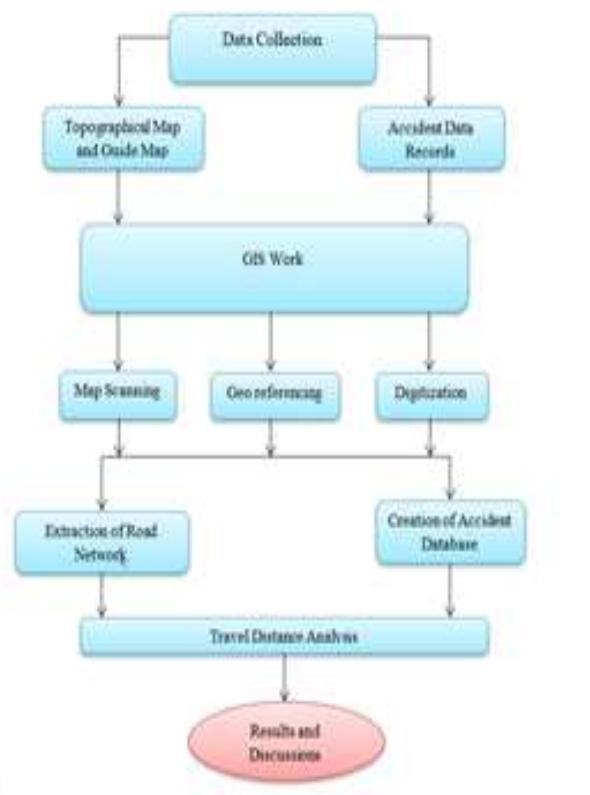


Fig -1: Road Accidents in Alappuzha 2009-2018(Feb)

Table-1: Accident records of Alappuzha during 2009-2018(Feb)

Year	No. of accidents	Deaths	Total Injuries
2009	2929	386	3350
2010	3029	350	3478
2011	3003	415	3271
2012	2884	385	3039
2013	2843	394	3049
2014	2962	367	3266
2015	3121	378	3454
2016	2971	354	3466
2017	3114	407	3511
2018	3466	373	4134

5. METHODOLOGY



The steps involved in the methodology, based on Weighted Overlay Method and GIS, used in the present study are explained as under:

5.1 Data Collection

Primary and secondary data needs to be collected for the study. Secondary data collection includes the collection of required accident data from the concerned police department. Primary data collection includes road inventory data collection, traffic volume count, speed and delay study and spot speed survey from the identified accident-prone stretches. The main accident black spots encountered in Alappuzha District are:

- Aroor
- Chandiroor
- Eramalloor
- Kalavoor
- Karuvatta
- Purakkadu

5.2 Analysis of Primary Data

Primary data analysis is done through Road inventory study, traffic volume count, speed and delay study at the identified accident black spots.

5.2.1 Road Inventory Survey

A detailed road inventory survey needs to be carried out on the entire identified spots to measure the roadway geometric parameters like the roadway width, footpath width, median, shoulders, surface type, surface condition, edge obstruction, road markings, road signs, drainage facilities and adjoining land use. The geometry of the road obtained from the road inventory survey needs to be analysed and causes of accidents can be identified. All the study stretches of taken are in National Highways. From road inventory survey it is observed that, the carriage way width of all stretches varies from 8m to 10m. It is not sufficient for accommodating huge traffic and the width is not satisfying the standards of national highways

5.2.2 Traffic Volume Count

The traffic volume count gives the measure of how many vehicles pass through a particular location during a specified period of time. According to the traffic volume, the time can be classified as peak hour and off peak hour. For any traffic infrastructure design and accident study peak hour traffic volume is usually taken. In the present study, traffic volume count per hour was taken for all the spots and peak hour traffic in terms of Passenger car Units (PCU) was found.

Table-2: Traffic Volume

Accident black spot	Peak Hour Traffic Volume
Aroor	4200
Chandiroor	3480
Eramalloor	3960
Kalavoor	4440
Karuvatta	2880
Purakkadu	3240

5.2.3 Speed and Delay Study

The speed and delay study can be carried out by using moving observer method on entire identified black spots in Alappuzha district to find out the average journey speed and delay of the traffic stream.

Table-3: Average journey speed

Place	Average journey speed(km/hr)	Average journey speed(km/hr)	
		Without Delay	With Delay
Aroor	52.09	47.44	
Chandiroor	37.91	36.82	

Eramalloor	35.68	34.89
Kalavoor	34.86	34.48
Karuvatta	36.86	36.07
Purakkadu	38.65	38.48

5.3 Analysis of Identified Black Spots Using GIS

After extracting the boundary and roads from DIVA-GIS, they are overlaid and the roads required for the analysis (NH 66) are drawn from google earth. The map required for the desired road network has to be digitized in a suitable form and certain specified road attributes to carry out prioritization are inputted to GIS. Then the identified black spots are further prioritized using GIS.

5.4 Prioritization

The following prioritization scheme can be used for the GIS analysis which involves assigning suitable weights to different factors that tend to influence the occurrence of accidents on identified study stretches in such a manner that the factors which tend to increase the probability of the accidents have lower weights. The final weight, assigned to each road link was obtained by adding all the individual weights and normalizing the value using maximum weight. The maximum weight assigned in this case is 100.

Table-4: Prioritization of Black spots

Sl. No.	FACTORS	POSSIBLE VARIATION	WEIGHT ASSIGNED
1	NO. OF LANES	1	4
		2	6
		4	10
2	WIDTH OF ROAD	<6m	1
		6-8m	3
		8-10m	5
		10-12m	7
		>12m	10
3	ROAD TYPE	NH	1
		SH	4

		PWD	8
		OTHER ROADS	10
4	SURFACE TYPE	BITUMINOUS	4
		CONCRETE	10
5	SURFACE CONDITIONS	GOOD	10
		SATISFACTORY	6
		POOR	1
6	SHOULDER	PAVED	10
		UNPAVED	6
		NO	1
8	MEDIAN	YES	10
		NO	4
9	VEHICLE TYPE	HEAVY VEHICLE	10
		BUS/TRUCK	8
		CAR	4
		TWO WHEELERS	1
10	NO. OF VEHICLES PER DAY	<10000	10
		10000-25000	7
		25000-50000	4
		>50000	1

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

$$100$$

5.5 Prioritization Scheme

Table-5: Prioritization Scheme

FINAL WEIGHT (%)	ACCIDENT PRONE LEVEL
100-80	Very low
80-60	Low

60-40	Medium
40-0	High

The road characteristics and traffic parameters of each spot is specified as attributes linked with each spot in the digitized road map. The various spots are 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.

6. RESULTS AND DISCUSSIONS

Various physical factors contributing to accidents are identified and suitable values are assigned to each factor in the prioritization table according to their accident proneness. The final result obtained from the GIS analysis indicating the accident prone levels of identified locations are represented below.

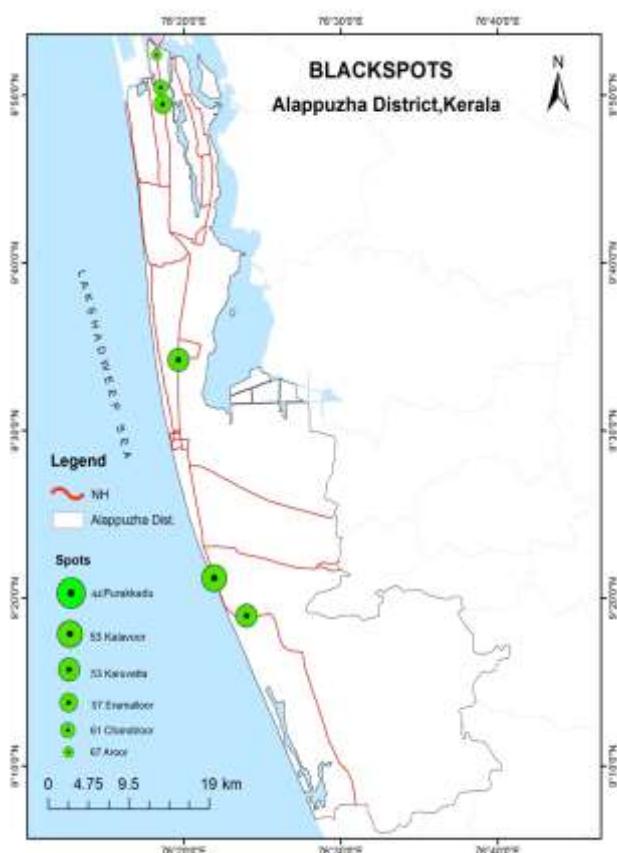


Fig-2: Most vulnerable accident stretches in Alappuzha District

Table-6: Accident prone levels of identified black spots

Blackspots	Final Weight (%)	Accident Prone Level
Aroor	67	Low
Chandiroor	61	Low
Eramalloor	57	Medium
Kalavoor	53	Medium
Purakkad	44	Medium
Karuvatta	53	Medium

From the analysis, **Purakkadu** is identified as the most vulnerable accident stretch of Alappuzha district. The identified accident stretch is a straight stretch with improper road markings. The width of the road is not satisfactory for accommodating the traffic during peak hours and the surface condition is poor.



Fig-3: Purakkadu

Suggestions for improvement of Purakkadu zone is given below:

1. Proper road markings have to be drawn.
2. Pot holes are slightly developing and so before it widens during rainy season regular maintenance on such pothole prone areas have to be carried out.
3. Take suitable enforcement measures to reduce over speeding of vehicles.
4. Provide footpath on both sides of the road for the safety of pedestrians.



Fig-4: Hospitals under a buffer zone of 15km radius

The road networks are analyzed and the distance between the hospitals and blackspots are calculated. The network analysis results are shown in Fig 6 and the distance between blackspots and the closest facilities are shown in Table 5. Buffer analysis is used to create a buffer polygon to find the in and around accident location. Here in this analysis, hospitals coming under a buffer zone of 1 km radius with respect to the identified accident black spots are located. Distances between the black spots and the nearby hospitals under the buffer zone are calculated and the short distant hospital(s) from the black spots are found.

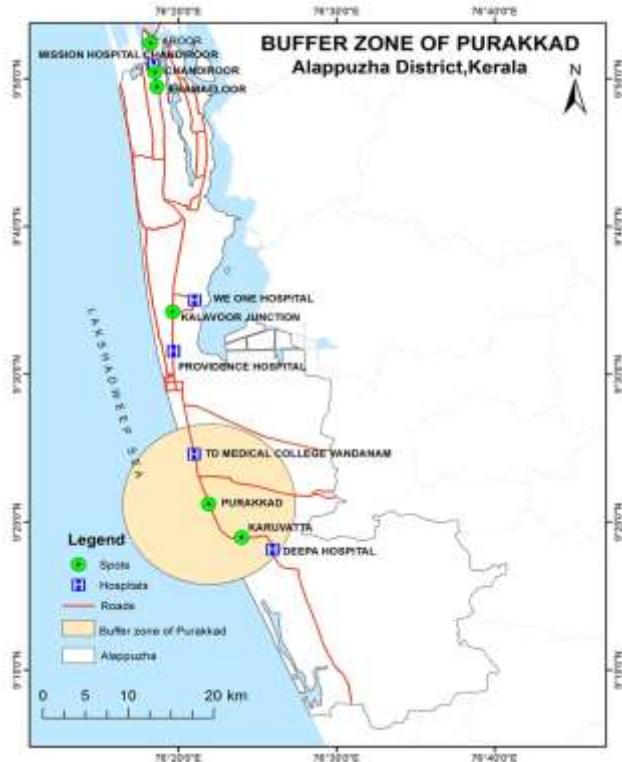


Fig-6: Buffer zone of Purakkad indicating the nearest hospital T D Medical College Vandananam

Table-7: Distance between blackspots and nearby hospitals

Name of Blackspot and Closest Facility	Distance
Eramallor to Mission Hospital	2.7km
Chandiroor to Mission Hospital	0.9km
Karuvatta to Deepa Hospital	4.8km
Purakkad to T D Medical College	6.5km
Purakkad to Deepa Hospital	11.1km
Aroor to Mission Hospital	2.7km
Aroor to VPS Lakeshore Hospital	6.0km
Kalavoor to We One Hospital	3.5km
Kalavoor to Providence Hospital	5.0km
Karuvatta to T D Medical College	12.9km

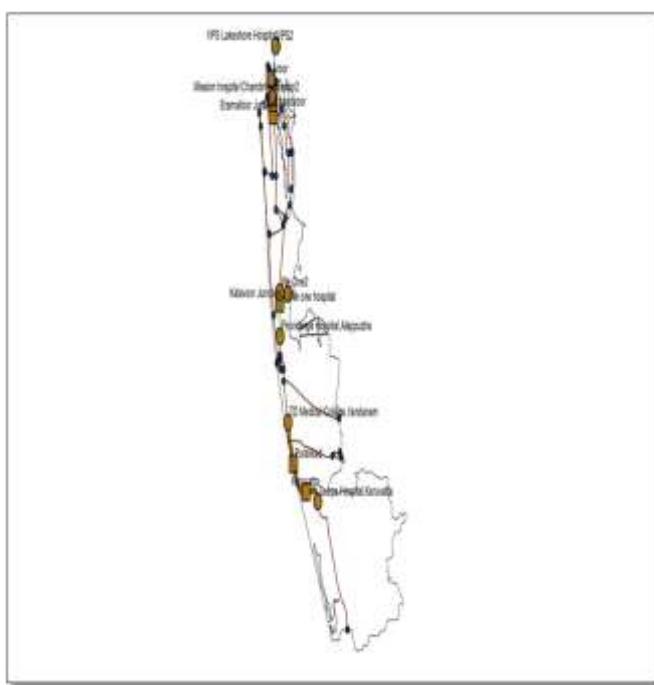


Fig-5: Road Network Analysis

7. CONCLUSIONS

The identification and analysis of accident black spots helped in identifying the stretches where accidents are more and these spots have less road safety in general. The mapping of nearby hospitals from the accident black spots helps in finding the short distant hospitals at times of emergency. The overall methodology would be effective for the identification, evaluation and treatment of accident black spots if sufficient data is available. The deficiencies like non availability of parking lane, improper road markings, unauthorized parking etc. are identified.

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