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Transportation Accessibility Evaluation of Hospitals in Thiruvananthapuram Corporation

Sneha J P[1], R. Padma Kumar[2]

M.Tech Student, Civil Engineering, College of Engineering Trivandrum, Thiruvananthapuram, India [1]

Assistant Professor, Civil Engineering, College of Engineering Trivandrum, Thiruvananthapuram, India [2]

Abstract: Transportation, an unavoidable factor for a growing economy has in turn resulted in the growth of road networks. This resulted in the increase of vehicles on road which increased the number of road accidents. These accidents happen because of the improper planned roads. To reduce the accidents, studies are often conducted, identifying the accident hotspots but the measures to be taken on occurrence of one is not often considered important. Time is the major constraint in case of emergency response thus helping the affected people within the Golden hour. Emergency response management systems ensure safe transfer of victims to the best possible hospitals within the golden hour. In this study, GIS techniques are used to improve the emergency response system available at accident locations. GIS analysis is used to do accessibility evaluation and to find out the shortest path from hospitals to the accident sites or from the site to the hospitals using closest facility in network analyst. The hospitals, junctions and the road stretches has been mapped.

Keywords: Golden hour, Emergency Response Management System, Shortest Path, Closest Facility, Network Analyst.

I. INTRODUCTION

Transportation is a necessity for a developing community. It plays a vital role in the economic growth of any country in this world. India, being a fast growing economy, has one of the largest highway and road networks on the planet with the total length of roads in the country exceeding 3.01 million kilometres. This labyrinthine network consists of 34,608 km of national highways, 128,622 km of state highways, and an informal network running to an astounding 2,737,080 km. [1] but, this large road network has its own ill effects of accidents and other significant problems.

In this road network, over 1, 37,000 people were killed in accidents in 2013 alone, which is more than the number of people killed in all our wars put together. 16 children die on Indian roads daily. 5 lives end on Delhi's roads every day. There is one death every four minutes due to a road accident in India. One serious road accident in the country occur every minute and 16 die on Indian roads every hour. 1214 road crashes occur every day in India. 20 children under the age of 14 die every day due to road crashes in the country. 377 people die every day, becoming a cause for concern [2]. Heterogeneity in the driving population, roadside features, weather, traffic conditions, and design considerations leads to heterogeneity in crash frequencies and rates.

Because of a desire and mandates to provide a safe driving environment, professionals are charged with identifying and improving "high risk" locations, called as "hotspots" or "black spots". Hot spot identification (HSID) aims to identify potential sites—roadway segments, intersections, crosswalks, interchanges, ramps, etc.—with disproportionately high crash risk relative to similar sites to ensure an effective response system, the identification of "hotspots" alone will not help, but the location of emergency response centres should also be known. With the locations available, emergency response simulation to the traffic accidents is needed for which accessibility evaluation can be done to find the shortest path for emergency response to hotspot from the nearest response centres. Accessibility evaluation also can be carried out in GIS. The study is conducted to identify and geo-reference the emergency response centres, to find the shortest path from the accident spot to the nearest hospital, taking time as the constraint and finally, generate a GIS based Emergency Response Management System

The present study is an unavoidable research, considering the current accident rates in Thiruvananthapuram Municipal Corporation. Emergency Response System can help in reducing the death rate and congestion in the road segments by helping in immediate response to the situation.

II. STUDY AREA

The study is done in the limits of Thiruvananthapuram Corporation, largest corporation in the state of Kerala in India (Fig. 1). It is a place of high accident death rates, caused due to the increased number of vehicles without proportional changes in the road infrastructure. Once an accident occurs in a place, the emergency response system should act on the situation immediately to avoid further

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problems, within the 'Golden Hour'. But unfortunately, the emergency response system in Thiruvananthapuram Corporation is not efficient. This calls for an immediate study and effective solution for this problem which is expected of the study.

Fig. 1. Thiruvananthapuram Corporation. (Source: Google Earth and NATPAC)

III. MATERIALS AND METHODOLOGY

A. Maps and other Data

The details of Hospitals in the study area were obtained [3] and their locations were identified using Google Earth. Traffic data for the year 2010 and the road map of the study area was collected from National Transportation Planning and Research Centre (NATPAC)

B. Methodology

The general methodology used for developing the accessibility evaluation of hospitals in the study area is presented by a flowchart shown in Fig. 2.

1) Preparation of Base Map

The base map consists of the representation of study area along with its road network which is prepared in GIS. In to this map, the junctions in the region were incorporated.

2) Mapping and Ranking of Hospitals

The details of hospitals in the study area were collected and their locations were identified to incorporate them in the already prepared GIS map. These were ranked according to priority.

3) Importing Traffic data

The 2010 traffic data was imported to the GIS database. It was joined to the road network attribute table for the roads the data are available.

4) Network Analysis (Closest Facility)

For doing network analysis, the network dataset was first created after which the analysis was done to find the closest hospital to an accident location based on the junctions.

a) Network Dataset Creation: A feature dataset is created with the road, junctions, hospitals and boundary shape files. From this dataset new network dataset is created.

b) Closest Hospital Identification: The Network Analyst toolbar was added to ArcMap from which new closest facility was selected. In this, junction locations were loaded as incident points considering these as the accident locations. Hospitals were considered as facilities and the analysis was done.

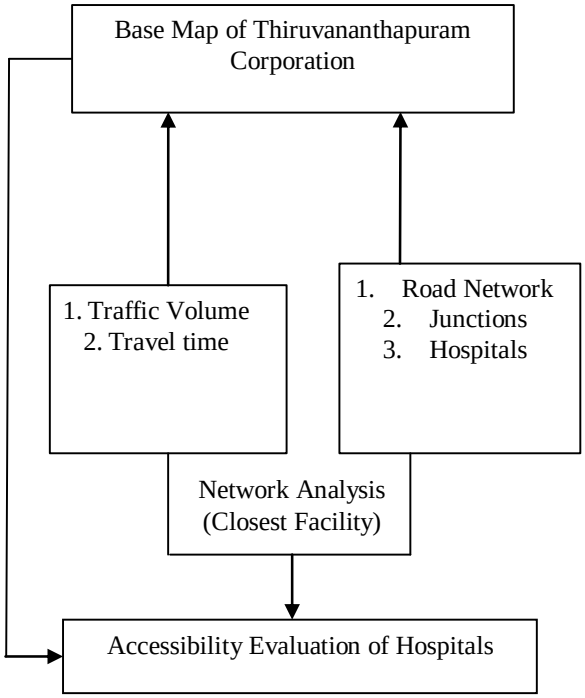

Fig2. Flowchart showing general methodology

IV. RESULTS AND DISCUSSION

The results from the study are discussed under following sessions.

A. Ranking of Hospitals

The 40 hospitals in the study area are classified as 24 hour hospitals, multi-specialty hospitals and others. The 24 hour hospitals are given more priority than the multi-specialty and other hospitals. The resultant map is shown in Figure 3.

B. Accessibility Evaluation of Hospitals

The network analysis identifies the hospitals closest to the incident points. The result obtained is shown in Figure 4 and the number of incident points that are closest to the hospitals are detailed in Table 1.

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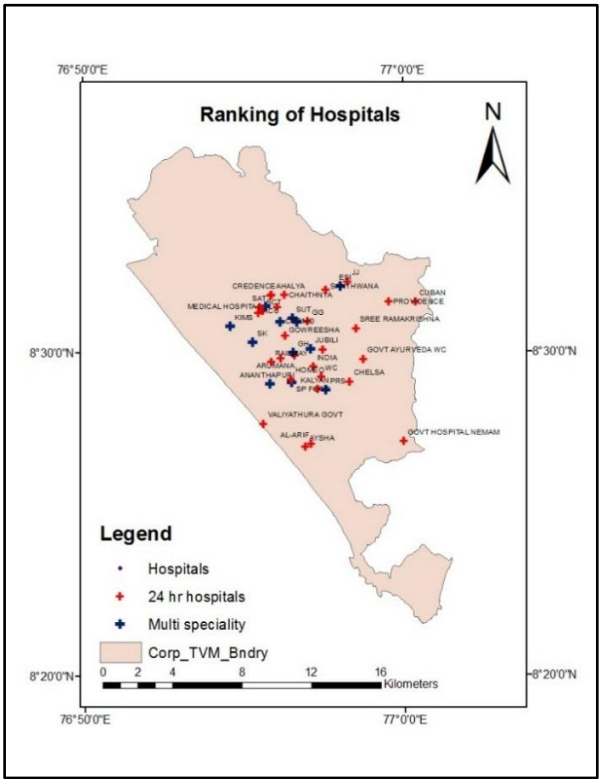

Fig. 3. Ranking of Hospitals

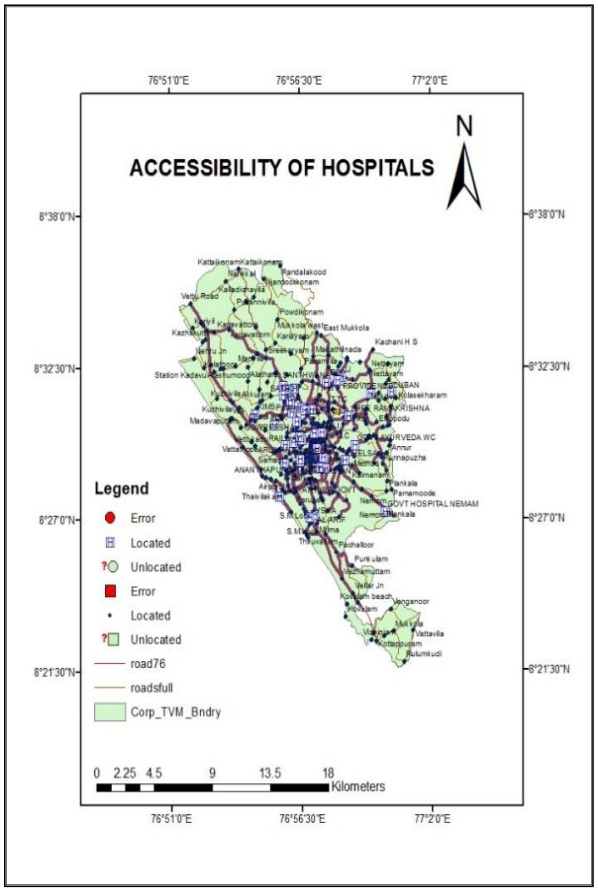

Figure 4: Accessibility Evaluation of Hospitals from incident points

From Table 1, it is evident that the rank of hospital is not given much significance during the analysis. While the hospitals like Jubilee Mission, Ahalya and Meditrina does not have even a single incident point, India hospital with lower rank has the highest number of incident points of 39. Most of the incident points are located near to the hospitals with less facilities.

TABLE I THE NUMBER OF INCIDENT POINTS CLOSEST TO THE HOSPITAL

Hospital	Number Of Incident Points	Rank
KIMS	2	1
Ananthapuri	1	1
PRS	17	1
COSMO	4	1
SUT	2	1
Medical Hospital	5	1
Jubilee Mission	0	1
SP Fort	28	1
Ahalya	0	1
Providence	1	1
ESI	12	1
Meditrina	0	1
Dr. Govindan	2	0
RCC	0	0
Chaithanya	0	0
Credence	0	0
GG	18	0
Geethanjali	10	0
Kalyan	37	0
Arumana	15	0
SAT	0	0
Al-Arif	21	0
Nirmala	3	0
Santhwana	11	0
Gowreesha	3	0
GH	0	0
SK	1	0
SCT	0	0
Sree Ramakrishna	17	0
Homeo	16	0
India	39	0
Valiyathura Govt	9	0
JJ	3	0
Aysha	11	0
WC	2	0
Railway	5	0
Chelsa	16	0
Govt. Ayurveda WC	24	0
Cuban	0	0
Govt. Hospital Nemom	3	0

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V. CONCLUSION

The creation of a GIS based accessibility evaluation system for hospitals during an accident is a step by step process. In this process lot many parameters can affect this system from the incident point till the hospital. The parameters that can affect are distance between hospital and the accident location, the traffic and road conditions and the availability of transport from the accident location (ambulance service). A system created without considering the traffic conditions or road parameters will become a failure. In this study, not only the ranking of hospitals based on their facilities is done but also the traffic conditions were considered.

The system developed is an effective one since the traffic conditions in the road is considered along with the distance. The system can be further modified by considering the transportation facility from its location to the accident location as well as to the hospital.

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