Effective Traffic Management Using GIS Technology

Pralove Shrivastava[1], Dr. G. Manikandan[2], Dr. Kapil Malviya[3]

[1]PhD scholar, Department of civil engineering, Sarvepalli Radhakrishnan University, Bhopal (M.P), India
[2]Associate Professor, Department of civil engineering, Sarvepalli Radhakrishnan University, Bhopal (M.P), India
[3]Associate Professor, Department of civil engineering, Sarvepalli Radhakrishnan University, Bhopal (M.P), India

ABSTRACT

For effective traffic management, route optimization is one of the essential needs. This can be achieved by several means. This paper approaches towards proposing a model that can lead route optimization which results in effective management of traffic based on Geographical information system (GIS). Finding the optimal path is not the only task of route optimization but to make the utilization of each and every route effectively is also route optimization. Nowadays, heavy traffic, multiple vehicles are common at each and every place especially during working hours. Optimizing the route especially at that time is essential. In this study, a survey was conducted in those entire routes which are highly congested during these crucial hours and system fails to fulfil its need. To achieve the same Global positioning system (GPS) is used to collect the spatial location. The survey was also used to collect the data of employees in nearby workplaces regarding the number of employee and their route so that an expected vehicle can be counted at the route. Images generated by satellite were used to create base map and other thematic maps. On the basis of aforesaid information an alternate routes have been advised to the user via GIS analysis.

Keywords: Traffic management, GIS, GPS, Congestion and route optimization.

1. INTRODUCTION

With increase urbanization and rapid growth especially in developing countries like India, Traffic management is one of the essentials. It is one of the major concerns, as unnecessary traffic and poor management leads to severe situations like accident, pollution and long waiting in long queues even in emergencies.

Moreover 80% of people prefer their private vehicles at their workplace so that time can be managed easily for individual. This is also a reason of high congestion on routes. Adapting latest technologies for effective traffic management and route optimization can be achieved. The appearance of new technologies like cloud computing, IoT and machine learning have brought directions for the development of smart traffic, smart parking and smart route suggestion system. One of the technologies is Geographical Information System (GIS).

GIS is a powerful computer system that analyzes and displays geographically referenced or spatial location information. In general, it actually allows the user to effectively analyze the data

collected from the geo locations. This information along with GPS system can be used for effective traffic management.

1.1 Need of the study

The present road and traffic management system leads to severe traffic congestion, long waiting time, increase air pollution. Also the road development and metro line development in the cities is also a point of concern. So space for metro line on or over the road is also a point of consideration. To handle the traffic effectively keeping the future perspective for roadways, this study is required

2. LITERATURE REVIEW

It is done on various topic related to the traffic management and that leads to better utilization of routes via different means.Othman et.al in his paper [7] stated that the unfair and less transparent relation between road congestion and partial correlation have generated new research field in the area of traffic management and finding the optimal routes. The authors completed his work by proposing a model that provides an eco-traffic management.

Hansen in [8] has stated that an effective traffic management is essential and that can be achieved by real-time monitoring. The paper concludes that by gathering the data or traffic volume from real-time scenarios either the alternative routes or rescheduling for railway can be done, so that a better road management can be provided.

Luca et.alin [9] his study has presented a framework on the basis of two strategies namely traffic control (TL) and route guidelines (RG). The study very well concludes that by proper framework and integration of both the strategies can improve the traffic. The result of the study have been evaluated on the basis of different parameters like performance of the network, system convergence and analysis of the stability

Gao et.al in his study have proposed a route prediction model based on the congestion at a time on an outgoing link. In [10] a method has been proposed for the traffic management based on the cumulative prospective theory (CPT). The model suggest route to the customers by analyzing the behaviour of traffic in a stochastic network.

One more study done by Bielli in [11] have stated the need of traffic management, route optimization, route guidance and demand management of traffic in urban cities.

All the above mentioned work and further other studies shows an emergent need of strategies that can help in effective traffic management or route optimization. Considering the scenarios and suggestion from the aforesaid literature review, this study has proposed a way that suggest route to daily workers of a specific route based on the departure and halt time of train on the station nearby

3. MATERIALS AND METHODOLOGY

The following materials and methodology was adopted for the study:
- Preparation of base map
- Identification of traffic congested routes.
- Data gathering of employees from the respective routes.
- GIS analysis
- Identification of alternate routes

The base map is prepared via images generated by satellite and CCTV that have been installed on road. Reconnaissance survey was also conducted aiming to get the locations having high congestion. Based on the survey two locations from all over Bhopal has been considered from the city namely MP nagar and Habibganj as these two locations have Banks, Hotels, Coaching's, railway station and all the major market which cause traffic and especially during peak hours. The data gathered has been analyzed on GIS platform. This analyzes on GIS leads to the development of new routes which results in effective traffic management. GIS is implemented in Jeddah, city of Saudi Arabia:
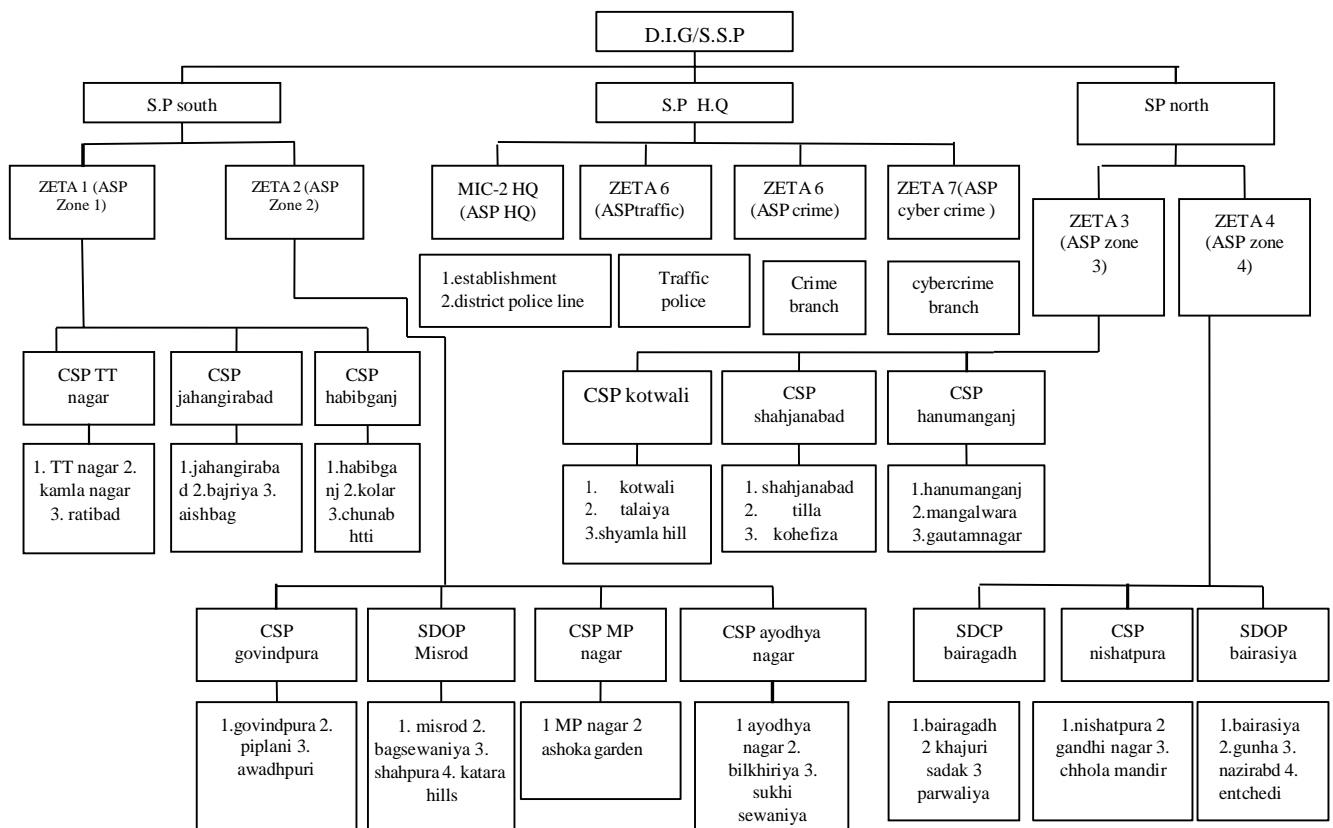

Fig. 1 Zones In Bhopal

Study location

Bhopal is considered as the heart of Madhya Pradesh. Also known as 'City of lakes". The city is famous around the globe for lakes and its natural beauty covering an area of 2,772 Square Km. [1]. All the zones and areas of the city have shown in figure-1.The route from Habibganj station to MP nagar is of 2Km by both road and rail. The route map can be seen in Figure-2 Due to the presence of station the road is highly congested at times. Around 118 trains passed by the station on a daily basis among them 58 trains passed via Habibganj station on Monday. However, the route also explores direction towards new market, 10. No. Market and Baghsewaniya.

Data Acquisition

It refers to an extensive survey of an area in order to get the status of area in terms of route traffic, population and pollution level. The survey was conducted in the aforementioned area on Monday

for 24 hrs. High amount of flexibility is observed in traffic volume on the route. By using a handheld GPS locations can be captured by means of coordinate mapping. The data collected through GPS is taken as input to GIS system. Traffic volume has been observed at two different locations via CCTV surveillance installed on Mansarovar tiraha and Board office square. Category of vehicles includes two wheeler, three wheeler and four wheeler
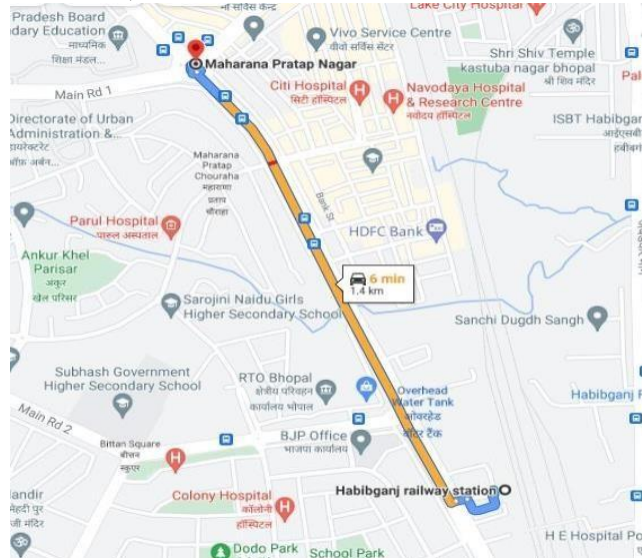

Fig. 2 Route/ location map via GPS

Category is further expanded in terms of Light motor vehicle (LMV) and high motor vehicle (HMV). The volume of the traffic is observed on June 7, 2021 and the data is represented in the graphical format below.The data shown in table 1 represent that two-wheelers passed by the routes more as compare to rest of the categories whereas HMV vehicles passes by the route at the time of "No entry" means late at night for their transportation purpose

Table 1 Volume of the Traffic at Mansarovar

DATE: 7TH June 2021			Location: Mansarovar Tiraha		
TIME SLOT	**TWO WHEELER**	**THREE WHEELER**	**LMV**	**HMV**	**NO.OF TRAINS THAT HALT**
1:00 PM to 3:00 PM	58742	2783	837	255	5
3:00PM to 6:00 PM	35977	1564	1693	142	7
6:00 PM to 9:00 PM	54248	2368	1469	152	6
9:00 PM to 12:00 Midnight	45986	2456	1253	164	5
12 MN to 3:00 AM	25698	1152	650	210	7
3:00 AM to 6:00 AM	35689	1365	753	189	2
6:00 AM to 9:00 AM	25698	856	653	85	3
9:00 AM to 12:00 Noon	45689	2656	556	56	7

Design Engineering
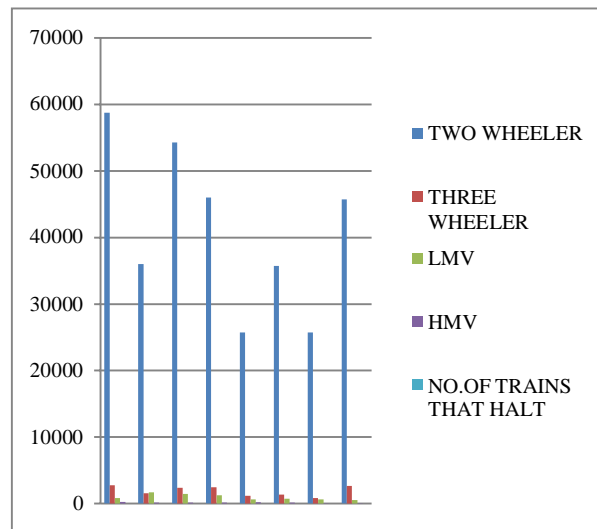
Graph-1 pictorial representation of traffic volume.
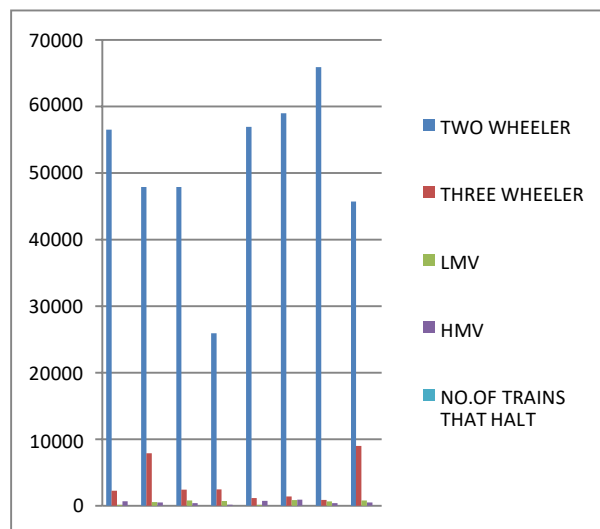
Graph-2 Pictorial Representation of Traffic Volume

Table 2 Volume of the Traffic at Board Office Square

DATE: 7TH June 2021				Location: Board office square	
TIME SLOT	**TWO WHEELER**	**THREE WHEELER**	**LMV**	**HMV**	**NO.OF TRAINS THAT HALT**
1:00 PM to 3:00 PM	56456	2233	123	658	5
3:00PM to 6:00 PM	47878	7878	568	459	7
6:00 PM to 9:00 PM	47869	2368	784	357	6

9:00 PM to 12:00 Midnight	25899	2456	698	125	5
12 MN to 3:00 AM	56895	1152	145	698	7
3:00 AM to 6:00 AM	58987	1365	842	882	2
6:00 AM to 9:00 AM	65897	856	657	386	3
9:00 AM to 12:00 Noon	45689	8976	789	456	7

4. SPATIAL ANALYSIS

Since most of the data and result of this study depend on the location of vehicles so it is concluded that spatial analysis will be the effective option to get the result of the analysis. Moreover, the purpose of carrying the spatial analysis is to gather the data about volume of the traffic as it has been embedded in GIS system as an input. It plays a crucial role that play significant role in effective traffic management. Based on the result of the analysis generated by GIS, Three alternatives routes have been suggested and traffic is diverted towards those directions. The proposed route suggests the deviation of those employees who work their daily at their workplaces. Adopting the suggestion and result of the study customers can leave their workplace on the basis of time to avoid traffic due to train departure and halts at the station. Prediction of route on the basis of train halt and departure time is essential for the city development especially in the concerned area:
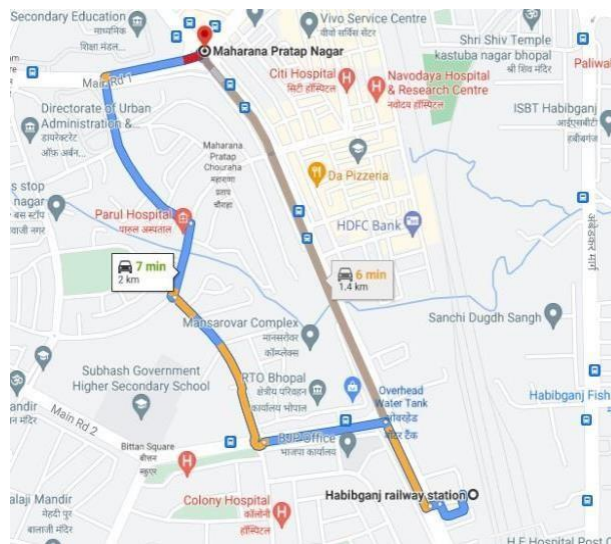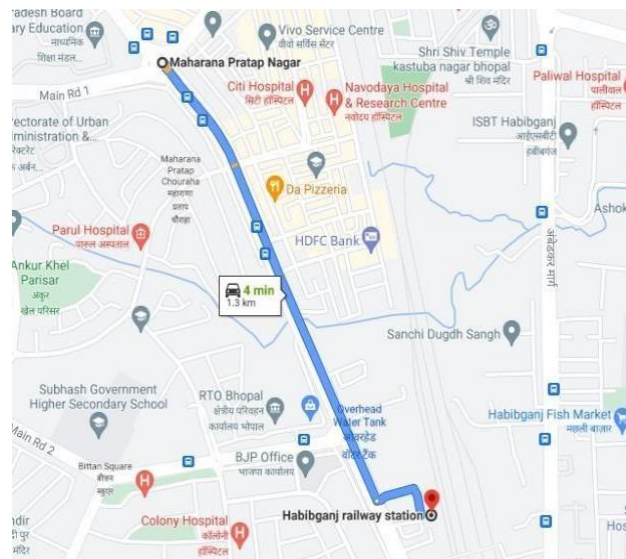

Fig. 3 Alternate Route-1

Fig. 4 Alternate Route-2

5. CONCLUSION

There is a need of proper and effective traffic management is noticed and keeping this in mind, to overcome the situation, this study is done. The study majorly aims to achieve route optimization by using GIS analysis system through data gathering by GPS system. The data collected was in the form of spatial location. Our study has generated best result for alternative route suggestion to daily workers of the area as it decreases the long waiting time. The acceptance towards the approval for the suggested alternate route. In future, the study can be extended by considering more routes and propose segregation of route among the people of concerning area.

References

1. https://bhopal.nic.in/en/demography/ (Bhopal details)
2. https://www.cleartrip.com/trains/stations/HBJ/ (Railway details)
3. Hegyi A., De Schutter B., Babuska R, Hoogendoorn S., 2000. A fuzzy decision support system for traffic control centers, Proceedings of the TRAIL 6th Annual Congress 2000 Transport, Infrastructure and Logistics, Part 2, The Hague/Scheveningen, The Netherlands; 10.
4. M, SureshKumar, GIS Based Route Optimization for Effective Traffic Management, International Journal of Engineering Research And Management (IJERM), 2017; 4:3.
5.] Casey, Robert F., Lawrence N. Labell, Simon P. Prensky, and Carol L. Schweiger, advanced public transportation systems: the state of the art, The National Academies of Sciences, Engineering, and Medicine No. UMTA-MA-06-0196-91-2: 1991.
6. Aljoufie, Mohammed, Development of a GIS Based Public Transport Composite Social Need Index in Jeddah, Journal of Geographic Information System, 2016: 8; 4: 470.
7. Othman, Bassel& De Nunzio, Giovanni Ecological traffic management: A review of the modeling and control strategies for improving environmental sustainability of road transportation, Annual Reviews in Control. 10.1016/j.arcontrol.2019.09.003; 2019.
8. I. A. Hansen, Railway Network Timetabling and Dynamic Traffic Management, International Conference on Recent Advances in Railway Engineering (ICRARE); 2009; 27-28.

9. De Luca, Stefano & Di Pace, Roberta &Memoli, Silvio &Pariota, Luigi, Sustainable Traffic Management in an Urban Area: An Integrated Framework for Real-Time Traffic Control and Route Guidance Design, Sustainability. 12. 10.3390/su12020726, 2020.

10. Gao, Song &Frejinger, Emma & Ben-Akiva, Moshe, Adaptive Route Choices in Risky Traffic Networks: A Prospect Theory Approach. Transportation Research Part C: Emerging Technologies. Vol. 18. 727-740, 2010.

11. MaurizioBielli, A DSS approach to urban traffic management, European Journal of Operational ResearchVol. 61, No.1–2; 106-113; 1992.