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GIS Based Route Optimization for Effective Traffic Management: A Case Study of Srinagar City

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ABSTRACT-One of the most crucial requirements for effective traffic management in cities is route optimization. Geographical information system (GIS) spatial analysis technique is important for route optimization. Route optimization involves not only finding the shortest path, but also properly increasing the route's full efficiency. It is essential to use advanced traffic management techniques. Initially, reconnaissance survey was conducted in the study area to locate the congested locations and during the survey 3 locations were selected out of which one location was selected for traffic volume studies. The traffic volume survey was conducted in this study at the selected location where the transit system fails to meet its requirements. The spatial location information was collected using a global positioning system (GPS). The base map and various thematic maps were created using satellite imagery. Using GIS analysis, the causes of the transit issues were revealed, and alternative routes were proposed. . This study shows that overall number of cars travelling through Srinagar and its surrounding areas has expanded dramatically in recent years, resulting in increasing traffic volume and thus increasing traffic congestion and a reduction in the transportation efficiency and system integrity.

KEYWORDS- Alternate Routes, Congestion, Geographic Information System (GIS), GPS Traffic Volume

I. INTRODUCTION

A. General

Urban transportation networks are very complicated because they combine several modes of transportation in a constrained space in high-density areas with rising transportation demand [1]. Geographic Information Systems (GIS) are employed as a beneficial tool for the representation and analysis of transportation systems due to the variety of information required in the sector of transportation.GIS has shown to be a valuable tool for addressing transportation system demands. GIS has given an effective means of organizing essential transportation-related data in order to facilitate input, analysis, and display of findings, thanks to the well-established vector data format [2]. The use of geographic information systems (GIS) is critical in resolving traffic management issues. The spatial location of traffic congestion and other location-based spatial information was determined using GPS data [3].

B. Need for the Study

Due to significant traffic congestion, travel time delays even over short distances, air pollution, and other factors, the current traffic scenario in the study area needs to be upgraded [4]. The traffic volume research is vital to know the current situation and take the necessary steps to address it [5]. Adopting GIS analytic techniques can help with effective traffic management and can also meet the needs of road users[6].

C. Objectives of the study

This research has following objectives:

- To identify the traffic volume at congested locations in the study area.
- To develop a GIS database for the traffic volume.
- To determine the alternate routes for effective traffic management.

II. LITERATURE REVIEW

A literature review was conducted on a number of subjects relating to traffic management, traffic congestion modeling, and the use of geographic information systems (GIS) in traffic management. Some of which are mentioned below:

Sureshkumar et al., 2017studied about the use of GIS for effective traffic management in Kanchipurancity Chennai which is a famous tourist destination in south India. The objectives of the study were to analyze traffic volume at congested areas, develop a GIS database for the traffic volume and locate alternate routes for effective traffic management. As a result of this analysis, they proposed new routes for HMV. With the adoption of new routes in the study area may be useful to increase the transit service and it will also help in effective traffic management in the study area [6].

Mahavar et al., 2019 reviewed GIS based approach of surface transport network analysis. The main aim of the study was finding the least distant path between any two references, finding the provisions that are available near to the user defined area and identification of service area with user specified criteria. The study concluded that Geospatial innovation has transformed network planning and transportation system for day to day easy, secure and cost-efficient travel from one area to the other by using real time data through satellite on digital maps [7].

Advani et al., 2005 studied about the improvement in transit service using GIS of Bhavnagar State Transport Depot. The main motive of the study was to determine the optimization of transport service using GIS techniques for the study area. The final result of the study was that the overall travel distance reduced, Oil consumption also reduced and by the reduction of travel distance and oil consumption, a good amount of money is saved on yearly basis [8].

Satria and Castro, 2016 reviewed GIS tools for analysing accidents and road design. In this study various GIS tools were used to model accidents have been examined. The knowledge of these tools will help the researcher to make a better conclusion about which tool could be applied in different situations [9].

Paringit et al., 2019 studied about how GIS can be used for better transportation and transit. The study represents GIS as a potential decision-making tool for use in transportation planning. The research concluded that the potential of GIS to compile huge amount of data from different origins makes GIS a powerful tool. From volume data to population density, level of service and accessibility can be decided. From there route optimization and other transport planning may be further examined and expanded [10].

III. MATERIALS AND METHODOLOGY

For the study, the following materials and procedures were used:

- Creating a base map
- Identifying a traffic-congested area
- Data collection on traffic volumes
- GIS analysis and
- Identification of new routes

A high-resolution satellite images were used to create the base map. In the research region, a reconnaissance assessment was carried out to determine the sites where traffic problems exist. The traffic volume survey identifies three places based on the field study. The information gathered is entered into a GIS platform [11]. For optimal traffic management, a GIS analysis was performed to find alternate routes in the research region.

A. Study Area

Srinagar, the summer capital and biggest city of Jammu and Kashmir (J&K), is a symbol of old values and modern ambitions. It is situated on the banks of the Jhelum River, a tributary of the Indus, as well as the Dal and Anchar lakes, at an average elevation of around 1586 metres above sea level [12]. The city is known for its gardens, waterfronts, and houseboats, and it attracts a huge number of local and international visitors all year. Srinagar is around 290 kilometres north of Jammu, the winter capital of Jammu & Kashmir, on National Highway 44 (formerly NH-1A).

Figure 1: Study Area Location

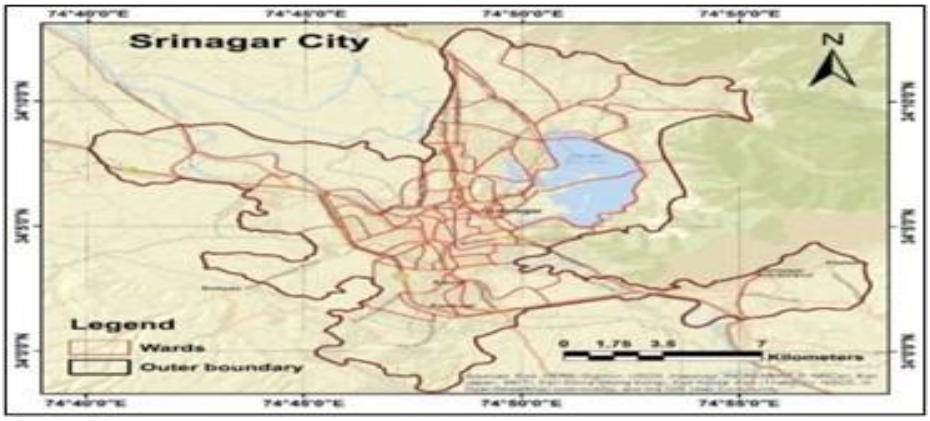

Figure 2: Study Area Location

Figure 3: Base map of the study area

IV. DATA COLLECTION

A. Reconnaissance Survey

During peak hour traffic, a reconnaissance assessment was undertaken in the research region. Huge traffic congestion and travel time delays have been noticed in a few spots. The coordinates of the sites are obtained using a portable GPS unit. For public transit accessibility, GIS analysis can be employed[13]. For additional analysis, the GPS data was imported to a GIS platform. In the reconnaissance survey three places were identified in the study region namely Jahangir Chowk, Lal Chowk and Rainawari Chowk but for traffic volume survey Jahangir Chowk was considered.

B. Traffic volume survey

Traffic volume study was carried out at the selected location in the Srinagar city through field bases data . The vehicles considered for the current study include two-wheeler, three-wheeler, light motor vehicle (LMV) and heavy motor vehicle (HMV) [14]. The 15-minute count was used to collect traffic volume data at the crossing (manual). The data in the tables represents peak hour data. The peak hour observed was during morning. The volume of traffic approaching the intersection during design hour is shown in tabular form below:

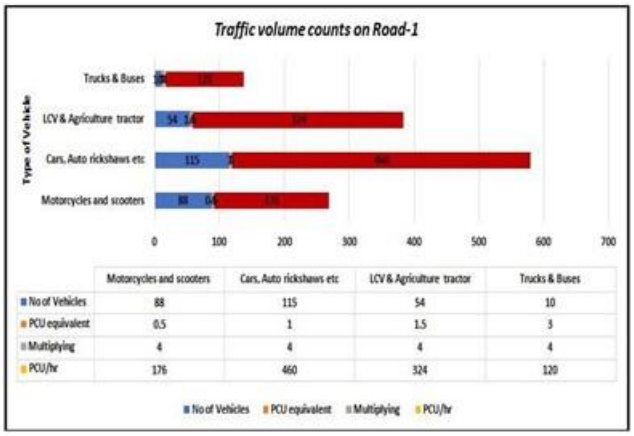

Figure 4: Traffic volume counts on Road-1 (from Secretariat Road towards intersection) (9:00am to10:00am)

It is inferred from the figure above that most of the vehicles on the traffic route 1 (from Secretariat Road towards intersection) at 9:00am to 10:00amcomprises of cars and auto rickshaws (115), two wheelers motor cycle and scooter (88), LCV and agriculture tractor (54) followed by trucks and buses (10). By applying PCU equivalent and multiplying factor PCU/hr comes 176 vehicles for motor cycle and scoters, 460 for cars and auto rickshaws, 324 for LCV and agriculture tractor and 120 for trucks and buses. Most of the vehicles flow to the studied location from the route 1.

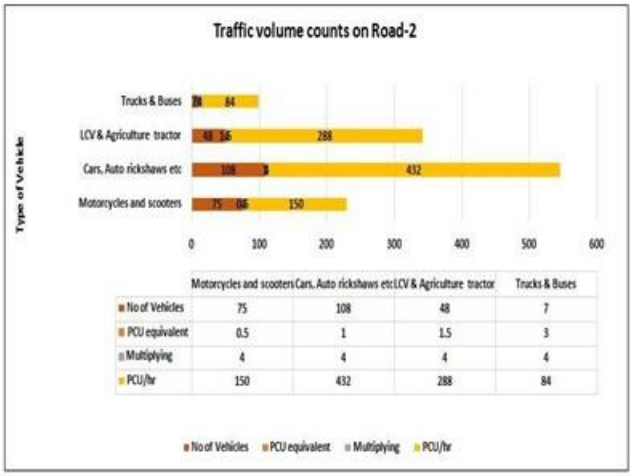

Figure 5: Figure 2 showing Traffic volume counts on Road-2 from (Shaheed Gunj Road towards intersection) (9:00am to 10:00am)

The analysis from the Figure above reveals that most of the vehicles on the traffic route 2 (from Shaheed Gunj Road towards intersection) at 9:00am to 10:00amconnecting the Jahangir chowk comprises of cars and auto rickshaws (108), two wheelers motor cycle and scooter (75), LCV and agriculture tractor (48) followed by trucks and buses (7). By applying PCU equivalent and multiplying factor PCU/hr comes 150 vehicles for motor cycle and scoters, 432 for cars and auto rickshaws, 288 for LCV and agriculture tractor and 84 for trucks and buses.

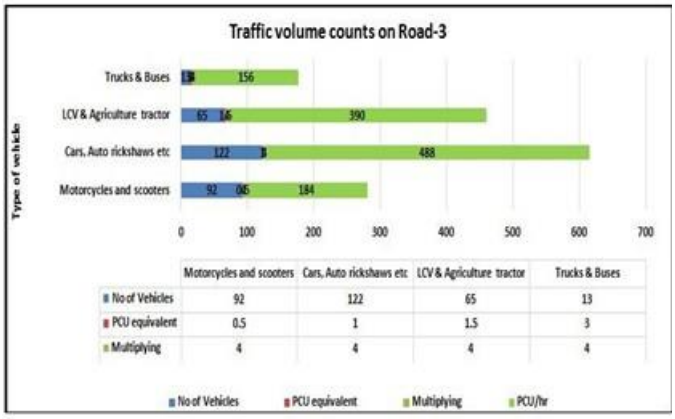

Figure 6: Figure 3Traffic volume counts on Road-3 (from Rambagh flyover towards intersection) (9:00am to 10:00am)

The Figure above shows the maximum number of vehicles from the route 3 (from Rambagh flyover towards intersection) at 9:00am to 10:00am connecting the Jahangir chowk includes the cars and auto rickshaws (122), two wheelers motor cycle and scooter (92), LCV and agriculture tractor (65) followed by trucks and buses (13). By applying PCU equivalent and multiplying factor PCU/hr comes 184 vehicles for motor cycle and scoters, 488 for cars and auto rickshaws, 390 for LCV and agriculture tractor and 156 for trucks and buses.

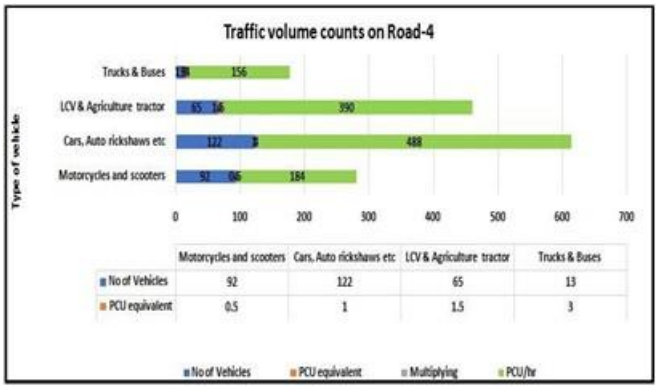

Figure 7: Figure 4 showing Traffic volume counts on Road-4 (from M.A Road & Harisingh high street towards intersection) (9:00am to 10:00am)

The Figure above shows the maximum number of vehicles from the route 4 (from M.A Road&Harisingh high street towards intersection) at 9:00am to 10:00amconnecting the Jahangir chowk includes the cars and auto rickshaws (122), two wheelers motor cycle and scooter (92), LCV and agriculture tractor (65) followed by trucks and buses (13). By applying PCU equivalent and multiplying factor PCU/hr comes 184 vehicles for motor cycle and scoters, 488 for cars and auto rickshaws, 390 for LCV and agriculture tractor and 156 for trucks and buses.

V. GIS ANALYSIS AND THE IDENTIFICATION OF NEW ROUTES

The better strategies to increase overall traffic efficiency are to suggest and compute alternative routes to minimize traffic problems. However, the primary problem is to do so in a reasonable amount of time so as to prevent introducing unnecessary overhead and, as a result, avoiding vehicles becoming stuck in traffic. Although relying on central entities (centralized approach) to compute and suggest alternative routes to all vehicles is more efficient due to better management and scenario overview, depending on the number of vehicles to be re-routed and the complexity of the algorithm used in alternative route computation, high overhead may be introduced, degrading performance. One solution to this challenge is to let each vehicle to calculate its own alternative route. The main difficulty is how to offer every vehicle with a complete scenario overview of the traffic situation so that they may calculate an effective route without overloading the network. Another issue is how to calculate an effective alternative route without causing traffic congestion in other locations in the near future, thereby improving traffic balance and management. In this sense, a trade-off between efficiency and complexity is necessary for good alternative route advice. The key objective of this study was to provide an alternate route for the identified congested location in the study area. With the help of remote sensing, GIS and field data two new route are proposed from Dargah Hazratbal to Lal chowk and from Dalgate to Nowgam bypass road to curb the traffic volume flow coming from Dargah and Dalgate towards the Jahangir chowk.

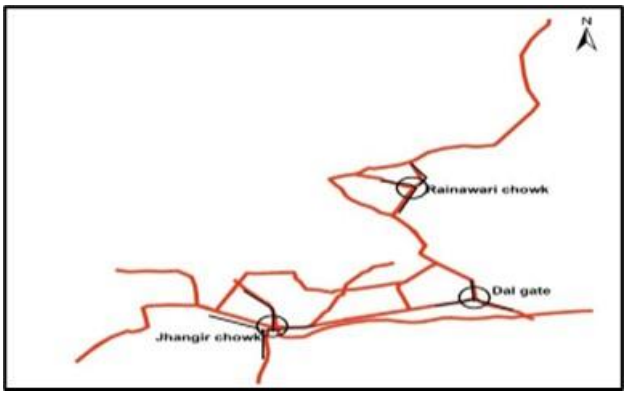

Figure 8: showing three traffic congested places

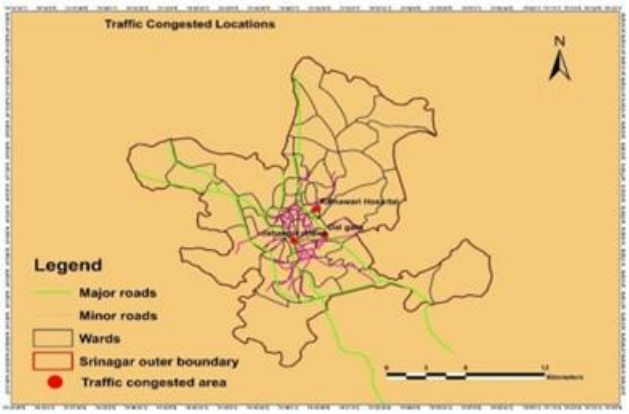

Figure 9: showing three traffic congested places

Vehicles coming from Dalgate via MA road towards the Lal chowk and Jahangir chowk supposed to go Nowgam bypass or hyderpora road should be diverted on the proposed route 1 mentioned in the Figure b. Whereas vehicles coming from Dargah Hazratbal via saidakadal,

Dalgate and MA road should be diverted towards Nowhata Khanyar road to limit traffic congestion at the Khanyar chowk and Dalgate as depicted in the Figure a.

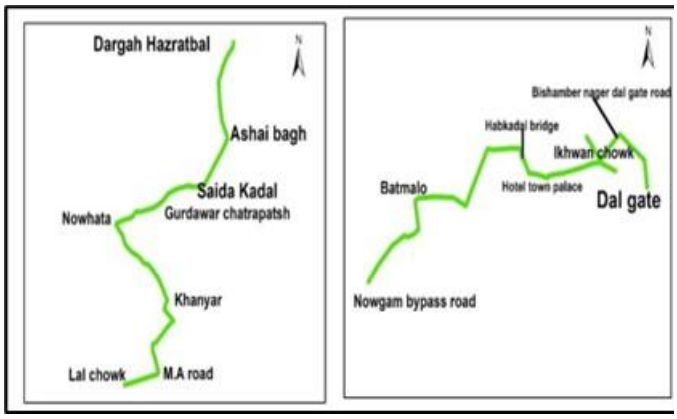

Figure 10: Proposed route a) from Dargah Hazratbal to Lal chowk b) From Dalgate to Nowgam bypass road

VI. CONCLUSIONS AND ECOMMENDATIONS

Road traffic jams continue to be a serious issue in most cities around the world, particularly in developing countries, causing significant delays, increased fuel waste, and financial losses. Small critical zones, which are popular hotspots for congestion, are a common by product of poorly constructed road networks in many developing locations; inadequate traffic management around these hotspots can potentially result in elongated traffic jams. When compared to the RITES survey, the socio-economic level of the inhabitants in Srinagar city is improving, as seen by the growth in the number of private vehicles in the household (2012).The majority of private car travels are work-related and are taken by men between the ages of 25 and 60, with 96 percent of them having a valid driver's license.The most important challenge for improving traffic conditions is to enlarge roads since connections are overburdened and parking facilities should be available on the roof or in the basement. On important roadways, sufficient walkways and footways with guard rails should be built to allow people to move freely without spilling into the carriageway. It is necessary to create the required number of speed breakers, zebra crossings, traffic signals, and light posts with street lights. Zebra crossings are required to be provided at approximately every 300 meters or less and pedestrian signals should be synchronized with the nearby traffic signals for safe manoeuvre of traffic along with safe pedestrian crossings. Rickshaws, buses, and trucks should be prohibited from parking on the road pavement, and substantial fines should be imposed. Major bus stands should be relocated to places of less traffic volume. Schools, colleges, and other government offices should also be moved out of the Lal chowk area to provide room for suitable parking and street vendors. Car ownership should be capped immediately, credit facilities offered by the J&K Bank should be restricted, and laws governing the issuance of driving licenses to car owners should be strengthened. People prefer public transportation in these areas, according to the research, despite the fact that the number of buses found in the study is lower than that of private vehicles. People are willing to use public transportation if it is given special attention, such as increasing the number of buses and optimizing routes to all of these areas at the lowest cost and in the shortest time. The condition of public transport should be improved and public should be encouraged to use public transport instead of their private vehicles to minimize traffic flow at peak hours to common work place Chartered buses (Institutional buses) should be used to serve areas of trip origins Jahangir chowk and its adjoining areas should be declared as No parking zones. Besides that, a strong coordination between the public works department, traffic police, and other traffic planners in Srinagar city is highly encouraged; there should be a perfect organization for traffic planning, traffic obedience, environmental protection, and traffic safety. The city's roads have become chaotic due to a lack of enforcement of traffic regulations and general ignorance of road safety norms – unlawful overtaking and parking, as well as disdain for lanes and driving on the wrong side of the road, are all widespread in Srinagar. Adequate steps should be taken such as imposing fines on defaulters, educating the defaulters about rules and regulations and also organizing traffic seminars. Traffic signals must be installed at intersections and at all important locations where traffic congestion occurs and the locations where traffic signals are installed should be repaired because they don't function. The planning body for the Srinagar Metropolitan Area should close existing gaps in service provision and, in the future, keep up with the city's rapid growth in both time and space. The city's road network requires a full overhaul in order to establish an efficient and sustainable transportation system that can meet future demand. Grade separated intersections should be constructed at intersections where congestions occur frequently. Public bike sharing project which was launched in Chandigarh and other cities of India should also be introduced in the study area. This will reduce some burden of private vehicles. Entry fees should be imposed to private car owners for entering congested locations. Restrictions on turning movements particularly right turns which causes jams and sometimes locks the flow. Separate right turning phase should be incorporated in the signal phase or to introduce early cut-off or late start arrangements.

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