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Congestion Modelling and Level of Service Assessment of Urban Roads in Mixed Traffic Conditions

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ABSTRACT- In urban locations around the world, traffic congestion is a problem. Congestion has increased as a result of inadequate public transportation, stalled development of the road infrastructure, and increased use of private transportation by the public to meet the demand for travel. In developing nations like India, the issue has become more complex due to heterogeneous traffic on subpar road and control conditions. Travel delays and greater vehicle emissions are a result of traffic congestion. In developed nations, studies have been done to quantify congestion in order to assess the current condition and project possible future scenarios. Planning for extra infrastructure facilities and initiatives needed to reduce congestion has been done successfully using these strategies. The current explanations for the congestion caused by the varied traffic conditions used in India are insufficient. Due to the set PCE values used for the vehicles and the capacity norms provided for urban roads, the widely used v/c ratio and LOS to evaluate the quality of travel in urban environments have some limitations. The goals of the current study are to develop a mathematical model to calculate traffic congestion for heterogeneous traffic as well as to assign LOS to the studied route segments. Data collecting involves the use of video graphic techniques. On the Jahangir Chowk–Skims Soura length, several sections have been designated for study. By taking the pertinent information out of the digital video clip, the traffic's characteristics have been examined.

KEYWORDS- Congestion, Urbanization, Congestion Index, Free Flow Speeds (FFS), Heterogeneous Traffic, Level of Service (LOS), Quantifying Congestion, Passenger Car Equivalents (PCE), Free Flow, Travel Time, Capacity, Speed-Flow Relationship

I. INTRODUCTION

The amount of urbanization in India has led to a dramatic increase in traffic on city streets.The transportation system has been overloaded due to the globalization of the Indian economy and improvements in income and social standing. Increased usage of private means of transportation has caused the road network to become congested due to public transportation's growing inefficiency and inadequateness, rising rates of automobile ownership, and population movement to urban areas[1]. Urban roadways have experienced numerous pauses to the flow of traffic, which has caused a sharp drop in speed and created congestion [2]. Traffic on the roadways has increased significantly as automobile ownership has become more widespread, particularly in emerging nations [3][4]. The rate at which new road amenities are being added and existing road facilities are being improved is substantially slower than the rate at which traffic is increasing on the roadways. The public transit system, on the other hand, might be quite ineffective, inadequate, and unreliable depending on the location [5]. A rise in the ownership of personal vehicles may have been caused by the current way of living, which forces people to make the most of their lives by saving constantly. All of these causes have led to an enormous increase in traffic on the roads, which frequently exceeds capacity, makes it challenging for the traffic to move smoothly, and thus leads to traffic congestion [6].

II. MATERIALS

A. Study area and data collection

A number of complex components that interact with one another make up traffic flow parameters. Because complete research must consider a variety of criteria, including time headway, volume, density, delay, speed, etc., typical manual techniques of data gathering cannot fully meet these needs. For congestion modelling, precise measurements of vehicle headways and speeds on road networks are a prerequisite. It is important to collect vehicle flow-related parameters accurately to the highest degree possible. The information needed includes lane-by-lane traffic flow, vehicle speed, time headway, and vehicle composition[7].

B. Study area (Srinagar)

The Srinagar Metropolitan Region (SMR), which has a total size of 416.25 km2 and is situated between 34o0' and 34o20'N and 74o40' and 75o05'E longitudes, now houses 1.7 million people. It is located in India's far north and serves as the state's summer capital for Jammu & Kashmir[8]. The metropolis in Jammu and Kashmir with the fastest growth is Srinagar. The city is situated on both banks of the River Jhelum in the Kashmir Valley. It is the nation's primary hub for foreign tourism. Its lengthy history proves that Srinagar has been a significant commercial and tourist hub for a very long time. The city enjoys a special natural setting with several attractive lakes, including the well-known Dal

Lake, Anchar Lake, and Nigeen Lake. Despite the obstacles the surroundings and physiography of the area present to the city's physical growth, it has gained higher degree of centrality due to its advantageous location in the Kashmir valley. Being the state's largest metropolitan area and the summer capital, it serves as the Centre of important administrative, political, economic, and commercial activity[9][10][11]. It makes up 38% of the State's urban population as well as 64% of the urban population in the Kashmir valley. It has a very intricate natural setting, with hills guarding the east, preventing the city from growing from this direction. The Jhelum River runs through the Centre of Srinagar, one of Kashmir's largest cities, and as a result, locals and tourists must routinely cross it. This causes one of Kashmir's worst traffic jams. Those who reside near the famous Dal Lake's banks, as well as those who wish to visit the Mughal Gardens and Hazratbal Shrine, must travel around the city along its banks[12].

C. Study stretch selection

In order to gather accurate data, it is crucial to choose the right research lengths and data collection techniques. The study's data collection site was chosen from five sections of the Jahangir Chowk–Skims Soura Road in Srinagar[13]. When choosing the locations to gather the necessary data, the following factor was taken into account:

- The most crucial route for the health care of Kashmiris in Srinagar is from Jahangir Chowk to Skims. The SMHS hospital and SKIMS are the two main tertiary care facilities along this route. This path is taken by almost all patients going to these two hospitals (particularly patients from south and north Kashmir and uptown Srinagar plus a part of downtown Srinagar). Since this route is frequently clogged, I decided to model the congestion along it in order to suggest some solutions for its decongestion[14].
- The majority of the time, patients who are sent to these tertiary care facilities are in extremely bad shape. Decongestion techniques described in this study could therefore save lives even if just for a few minutes[15].

III. TESTING METHODS

A. Model development methodology

About the software: SPSS (Statistical Package for Social Sciences) is a software package used for interactive, or batched, statistical analysis. Long ago produced by SPSS Inc., it was acquired by IBM in 2009. The current versions (2015) are named IBM SPSS Statistics.

For data manipulation and analysis, SPSS is a very helpful tool. Several statistical techniques are available for use in SPSS, including:

- Descriptive statistics, such as descriptive ratio statistics and approaches like frequencies.
- Bivariate statistics, including nonparametric tests, means, correlation, and analysis of variance (ANOVA) techniques.
- Prediction of numerical outcomes using linear regression

A dataset is produced in the current study using the provided data. With the aid of IBM SPSS, a statistical analysis software programme, linear and exponential multivariate models are created for the dataset. Based on independent variables, a multiple linear regression model is used to forecast the value of the dependent variable (travel duration) [16].

IV. RESULTS & DISCUSSIONS

A. Traffic flow analysis

For the morning and evening peak hours, traffic flow analysis was carried out while separately examining the video graphic data gathered from the camera on a PC. Less than 0.5 percent of the traffic was driven by people or animals, so it was excluded from the analysis. However, as was already noted, the impact of non-motorized transportation was considered as a qualitative measure, and the rating for each stress was provided by the rating committee's experts. The following graphs and tables show the analysis findings for classified volume in pcu/hr.

Table 1: classified volume (pcu/hr.) For morning peak

STRETCH	4W (Pcu/hr.)	2W (Pcu/hr.)	3W (Pcu/hr.)	LCVs (Pcu/hr.)	HCVs (Pcu/hr.)	%Of 4w+2w+3w in the traffic
A	893	479	293	80	87	91
B	900	411	282	83	75	91
C	1038	407	301	89	93	90
D	989	463	289	72	69	92
E	923	419	203	69	66	92
F	890	316	222	60	72	91

Speed: Additionally, the stream speed was computed in the morning and the evening. For each stretch, the free flow and actual speeds were computed. By noting the entry and exit points of the vehicles entering the stretch and dividing by the stretch length, the actual speed was determined by video graphic analysis. To provide an exact measurement of stream velocity, trials were also done in a personal automobile. Below are the speed values.

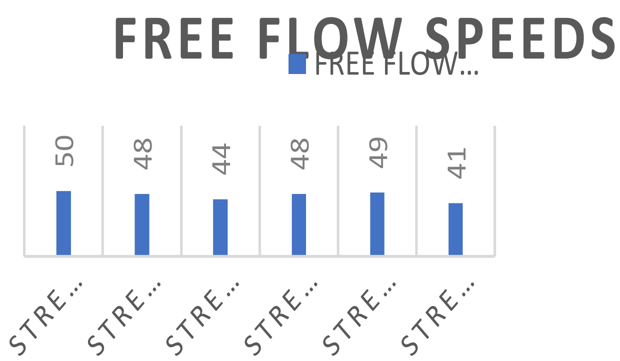

Figure 1: Free flow speeds for each stretch.

Travel time: For each stretch, the value of the actual travel time and the free flow travel time were computed. Making travel laps through the stream allowed us to determine the actual travel time during the morning and evening rush hours. To prevent uploading duplicate data, the values will be uploaded in this chapter later.

Number of intersections: Each study stretch's junction count was tallied. There were no controls or signals at any of the junctions that were counted during the data collection. Each length has the following number of intersections:

Table 2: Classified volume (pcu/hr.) for evening peak

STRETCH	4W (Pcu/hr.)	2W (pcu/hr.)	3W (Pcu/hr.)	LCVs (Pcu/hr.)	HCVs (Pcu/hr.)	%of 4w+2w+3w in the traffic
A	1059	393	299	87	84	91
B	962	411	289	81	96	90
C	1076	470	292	95	108	90
D	923	447	389	81	93	91
E	837	445	281	75	84	91
F	850	420	187	72	81	90

V. CONCLUSION

Following data analysis, it was discovered that 2 wheelers, 3 wheelers, and 4 wheelers made up about 90% of the traffic. This implies that public transportation isn't used too often. This could be due to an ineffective public transit system and the associated fears among the general populace. Additionally, a sizable number of vehicles were observed parked in undesignated parking spaces, and street sellers frequently took up the entire carriageway width. Due to the rush of people heading to the CBD after work and journeys made for leisure, the volume during the evening peak hour was noticeably higher. The following are a few of the suggestions made:

i. An effective public transportation system that takes into account the concerns of the average person by reducing in-vehicle wait times, reducing vehicle congestion, allocating seats for the elderly and disabled, ensuring easy accessibility for everyone, charging reasonable fares, and making frequent trips between routes to reduce traffic congestion.

ii. Parking spaces must be made available to those who are out shopping for their daily necessities and way of life. ii. Identification of parking spots for shoppers in the CBD zone. In locations where the width of the road is sufficient to accommodate vehicles without causing traffic congestion, on-road parking may be considered as an alternative. For the purpose of preventing the abuse of on-street parking, particularly in the CBD area, fees should be levied every 30 minutes.

iii. Shifting of street vendors: Street vendors are the foundation of each city's economy. Practically all socioeconomic classes' daily needs are met by them. They must be allowed space for their booths in a convenient location with access to on-street parking and where traffic would be noticeably less backed up. Travel time would be greatly shortened, and key road parts would be decongested.

iv. Staggering of office/business establishments and educational institutions' timings: This strategy has been used to reduce traffic in several cities with great success. Timing variations would significantly reduce peak hour traffic. Additionally, there won't be as many big cars in the peak hour volume, which will improve traffic stream manoeuvrability. As a result, individuals won't have to worry as much about getting trapped in traffic while they go shopping or engage in leisure activities.

v. Improving the road infrastructure: To accommodate additional automobiles, the current road infrastructure could be enhanced. You can achieve this by enlarging. However, many locations have site restrictions that prevent widening. In order to prevent speed reduction due to surface distress, routine maintenance should be performed to check for cracking and potholes. To relieve the congestion, security checkpoints should be eliminated from the pavement's width.

vi. To develop strategies and long-term plans for traffic management, a distinct department of traffic must be established, working in tandem with the traffic police. Engineers with expertise in traffic engineering should make up the department. This will significantly aid in controlling traffic in the city and throughout the state. This has to be prioritised for implementation.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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