Traffic Congestion Analysis and Solution Proposal in Mannarkkad-Perinthalmanna Route

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***Abstract*- Traffic congestion is one of the most visible, pervasive, and immediate transport problems plaguing not only Kerala but also most of the cities of India on a daily basis. It affects all modes of transportation especially roads and all socioeconomic groups. Rapid population growth, increasing urbanization, inadequate/unplanned transport infrastructure, poor public transport systems and the rising number of personnel vehicles are some of the primary causes of congestion. In this project, two spots of traffic congestion are selected. Reconnaissance survey, traffic volume and time mean speed studies are conducted. By SPSS Factor analysis, the factors that cause congestion are analyzed, and its significance is observed. Suitable solutions for the specific problems are determined based on the analysis.**

***Index Terms*- Traffic Congestion, Traffic analysis, Transportation system**

I. INTRODUCTION

Traffic congestion refers to the condition characterized by the slower speed of vehicles, longer trip times, and increased vehicular queueing. In some cities, congestion is still an unsolved issue and happens throughout the day. The spontaneous increase in the number of vehicles on the road is attributed to the generation of traffic problems like accidents, traffic congestion, and delay. Traffic congestion causes adverse effects such as rise in vehicle maintenance costs, operation costs, fuel wastage, etc. The time spent by people entrapped in traffic is miserably wasted. As a result, drivers are more likely to become frustrated and engage in road rage. The interrelation between traffic congestion and accidents is of great importance for facilitating sustainable mobility in urban environments. The rise in traffic congestion also paved way to other problems such as blockage of emergency vehicles. This calls for an Intelligent Transportation System (ITS) which improves traffic flow and safety of the passengers. A proper study and understanding of latest cutting-edge developments in communication technology has to be carried out for successful implementation of ITS thereby reducing fatal accidents, provide an efficient means of travel which satisfies human needs, and support the movement of trade and commerce.

In this paper, the traffic condition on the Mannarkkad-Perinthalmanna Route is analyzed by conducting reconnaissance and pilot surveys, followed by calculating the traffic volume and speed. The communication via traffic police confirmed that Kodathipadi & Perinthalmanna Central junction are congested places along Mannarkkad-Perinthalmanna Route. So, these two spots have been chosen as the areas of study. The influencing factors that affect the speed of vehicles on the road include the width of the road, the structure of the road, construction work on roads, various land uses that attract motorized / pedestrian traffic bound to hospitals, institutional, commercial areas, etc. Suitable remedial measures to reduce congestion have been proposed by examining various factors of congestion in these areas. The scope of this paper includes the following:

- Conduct reconnaissance survey to identify two congested areas.
- Conduct pilot survey, traffic volume and time mean speed studies.
- Analyze and predict the congestion governing factor in SPSS software.

II. ORGANIZATION OF THE PAPER

The paper is organized in the following order. The first section provides a general introduction to the topic, and the scope. The third section deals with the methodology of the work employed. Fourth section deals with the data collection details and its results. The consolidated data are analyzed in SPSS software and the results of which are discussed in fifth section. The remedies by analyzing the factors are proposed in the seventh section. Finally, the conclusion of the study is addressed in the eighth section.

III. METHODOLOGY

The proposed methodology of the work consists of reconnaissance survey to select study corridor after which preliminary data collection containing questionnaire survey, traffic volume and time mean speed studies. It is followed

by analyzing the factors of congestion by using Factor Analysis in SPSS software. This helps to predict the congestion factor in the respective spots. After data analysis, suitable remedial measures to reduce congestion are suggested.

IV. DATA COLLECTION

Reconnaissance Survey

A reconnaissance survey was conducted to study the traffic conditions along the Mannarkkad – Perinthalmanna route. Two congested spots, Kodathipadi & Perinthalmanna Central junction, were selected as the areas of study based on the information received from traffic police of respective places. The distance between the two places is approximately 28 km, which was considered for data collection. It was observed that the traffic in the given stretch of area is of mixed in nature and consists of both heavy and light vehicles.

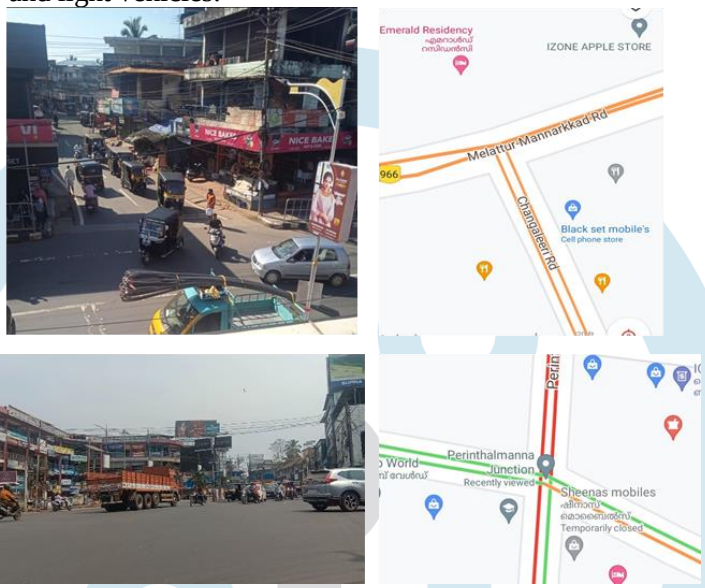


Fig. 1: Location and Google Map of Spot 1 - Kodathipadi and Spot 2 – Perinthalmanna Central junctions respectively

Preliminary Data Collection

The preliminary data collection includes Questionnaire survey, Traffic Volume and Traffic Time Mean Speed.

I. Questionnaire Survey

A questionnaire survey was conducted to know the people's opinion on the traffic congestion condition of the spots. The seven Likert scale questions marked as per the preference of the people along with Traffic Time Mean Speed and Traffic Volume were then taken for Factor Analysis in SPSS Software.

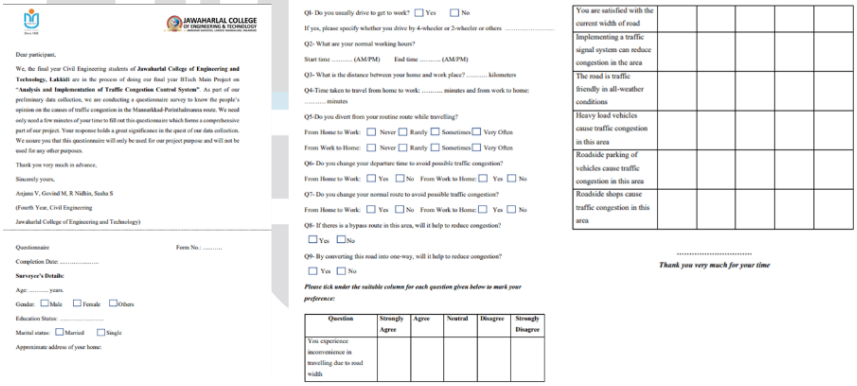
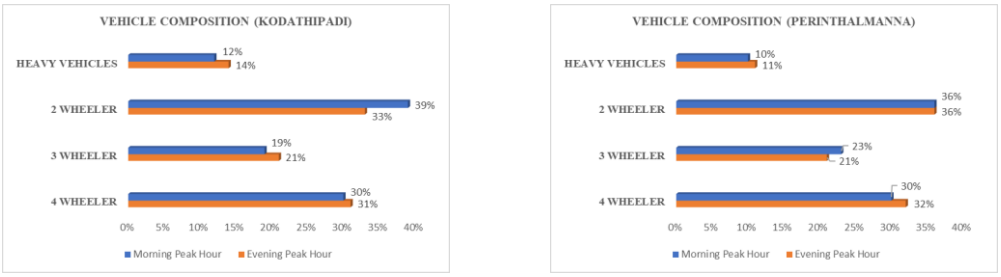


Fig. 2: Questionnaire

II. Traffic Volume

Traffic Volume is defined as the procedure to determine volume of traffic moving on the roads at a particular section during a particular time. Here, volume is taken using Manual Counting and Video Image Detection method during morning peak hours [9:30 to 10:30 AM] and evening peak hours [4.30 to 5.30 PM]. The volume count at the selected 2 spots has been carried out and is converted into PCU as per IRC: 106-1990.



(a) (b)

Fig. 3: Vehicle Composition Graph of (a) Kodathipadi Junction (b) Perinthalmanna Central Junction

III. Traffic Time Mean Speed

Time mean speed is the average of all vehicles passing a point over a duration of time. It is the simple average of spot speed. A road stretch of 200m along the selected area of study is chosen to measure the time mean speed of the vehicles.

The time mean speed (in ms^{-1}) is calculated by using Eq. 1:

$$Time\ Mean\ Speed = \frac{1}{N}\sum_{i=0}^{N} V_t \qquad (1)$$

where, N is the number of vehicles, V_t is the speed of the vehicles at time 't'.

The data is collected on the same day along with that of traffic volume during morning peak hours [9:30 to 10:30 AM] and evening peak hours [4.30 to 5.30 PM].

Table 1 Time Mean Speed

Place	**Heavy vehicles**	**4-wheeler**	**3-wheeler**	**2-wheeler**
Kodathipadi JuntionTime Mean Speed (m/s)				
Morning	7.33	6.44	5.26	5.21
Evening	8.28	7.8	4.7	4.37
Perinthalmanna Central Junction Time Mean Speed (m/s)				
Morning	5.17	4.73	4.67	4.65
Evening	5.43	7.42	7.42	7.12

From the results, it can be inferred that evening rush hour is experiencing more traffic congestion in both the places. The possible reasons for this to happen may be due to the following reasons:

- School and other extracurricular events
- Commute from work
- Scheduled appointments and works
- Poor road capacity
- Public Transport commute timings, etc.

V. DATA ANALYSIS

For identifying and predicting the factor that causes gridlocks in the study areas, SPSS software is used. It is utilized by many researchers since it furnishes exceptional charting, reporting and presentation tools. The responses from the questionnaire along with traffic speed and traffic volume are organized in MS-Excel. It is then applied as input to the software to conduct Factor Analysis.

Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

Table 2 KMO and Bartlett's Test of Kodathipadi Junction

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.567
Bartlett's Test of Sphericity	Approx. Chi-Square	50.866
	df	28
	Sig.	0.005

Table 3 KMO and Bartlett's Test of Perinthalmanna Central Junction

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.292
Bartlett's Test of Sphericity	Approx. Chi-Square	42.277
	df	28
	Sig.	0.041

For Kodathipadi junction, the value of KMO for 8 factors was 0.567. This value indicated that the sample taken to process factor analysis was statistically significant. However, for Perinthalmanna Central junction, the KMO value is 0.292, which is not statistically significant.

The Bartlett's Test of Sphericity is proved to be significant in both the cases and all the communalities were over the required value of 0.5. In Kodathipadi, an overall variance of 78.993% is explained among the factors in the study, whereas in Perinthalmanna, 82.634% of overall variance is explained. The percentage of variance is above 60%, therefore the model is significant.

Rotated Component Matrix

Table 4 Rotated Component Matrix of Kodathipadi Perinthalmanna Central Junction

Rotated Component Matrix[a]			
	Component		
	1	2	3
Road width	0.967		
PCU	0.905		
Weather	0.894		
Heavyload vehicles		0.891	
Roadside parking		0.844	
Roadside shops	– 0.409	0.758	
Traffic Signal			0.780
Traffic Speed	0.375		0.649
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.[a]			
a. Rotation converged in 5 iterations.			

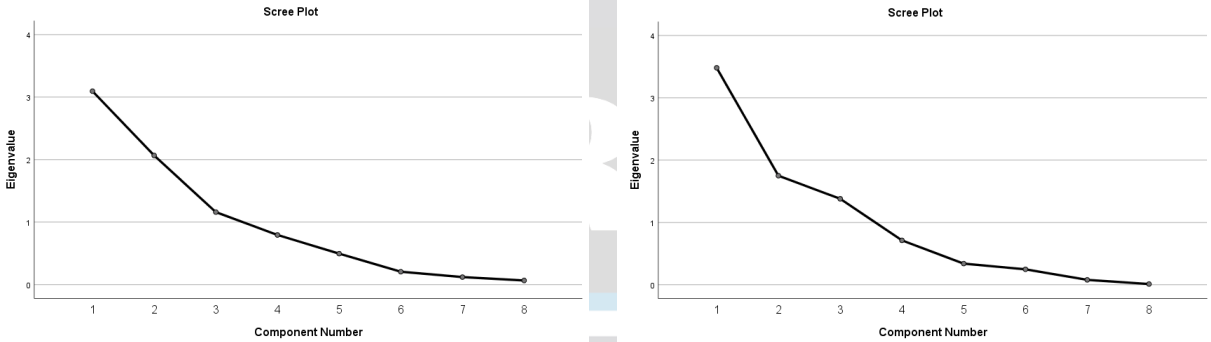
Table 5 Rotated Component Matrix of Kodathipadi Perinthalmanna Central Junction

Rotated Component Matrix[a]			
	Component		
	1	2	3
PCU	0.891		
Roadside parking	0.828	0.407	
Road width	0.811	-0.397	0.347
Heavy load vehicles	0.673		-0.561
Roadside shops		0.819	
Traffic Signal		-0.744	0.539
Weather		0.692	0.366
Traffic Speed			0.938
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.[a]			
a. Rotation converged in 6 iterations.			

Under Kodathipadi junction analysis, the rotated component matrix results show that in factor 1 road width, PCU and weather are included. Factor 2 gathers heavy load vehicles, roadside parking and shops. And, factor 3 includes traffic signal and traffic speed. On the other hand, in Perinthalmanna Central junction analysis, the rotated component matrix results show that in factor 1 PCU, road width and roadside parking are included. Factor 2 gathers roadside shops and weather. And, factor 3 includes traffic signal and traffic speed. The values above 0.52 are considered and shows strong correlation.

Scree Plot

Scree plot consists of plotting the eigen values as per the order of extraction. Here, 3 optimal factors are extracted, which shows eigen values more than 1.



(a) (b)

Fig. 4: Scree Plot of (a) Kodathipadi & (b) Perinthalmanna Central Junction respectively

VI. SUGGESTED REMEDY

Based on the results of the analysis, the possible solutions that can be proposed to both Kodathipadi and Perinthalmanna may include the following:

For Kodathipadi Junction

- Providing adequate road width
- Avoiding congested roadside shops
- Providing parking areas for vehicles
- Providing a separate lane for heavy vehicles
- Bypass road

For Perinthalmanna Central Junction

- Implementing an adaptable timing signal system

- Proper drainage system for passage of water during rainy season
- Avoid congested roadside shops

VII. CONCLUSIONS

Traffic congestion is mainly created by traffic users misbehaving on the road and violating the rules. In this project, we conducted reconnaissance survey and two spots of traffic congestion are selected. Traffic volume and time mean speed studies are conducted. By SPSS Factor analysis, the factors that cause congestion are analysed, and its correlation is observed. Suitable solutions for the specific problems are determined based on the analysis. Since the values are just above the threshold, the analysis calls for development. The KMO value in the Perinthalamanna central junction is below the accepted value. Therefore, the accuracy of the analysis can be further improved by expanding the input area of the questionnaire, which was earlier limited to the area of the survey. Although traffic congestion cannot be avoided totally, by following traffic rules and regulations and implementing an intelligent transportation system, the congestion can be minimised to a great extent.

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