International Journal of Research in Engineering, Science and Management
Volume 4, Issue 11, November 2021
https://www.ijresm.com | ISSN (Online): 2581-5792

Traffic Congestion Analysis Using Indo-HCM, IRC Method and Modelling of Data Using Q-GIS

H. J. Shivashankar[1*], Vivek R. Das[2], Nitin Kumar[3], Preethi Raj[4]
[1]*M. Tech. Student, Department of construction Technology & Management, Dayananda Sagar College of Engineering, Bengaluru, India*
[2]*Professor, Department of construction Technology & Management, Dayananda Sagar College of Engineering, Bengaluru, India*
[3]*Assistant Professor, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, India*
[4]*GIS Researcher and Trainer, Eco Spatial Research Technologies, Bengaluru, India*

***Abstract*: The biggest problem in the growing urban areas is the traffic congestion. It is due to the increasing in population and vehicle. This will breakdowns the traffic flow rate, reduces the speed of the vehicle and increases the congestion at intersections. This intern results in excess delay and reduces the safety. It has become the main reason for increasing in the transportation costs and ultimately results wastage of fuel. This problem really needs a solution and transportation system needs to be maintained properly. This project is to study the level of congestion in unsignalized T-intersection using Indo- HCM and IRC methods. Analysis is carried in different ways mainly by collecting traffic and geometric data selected intersection. Geometric data includes the road network of the intersection along with the directions of the traffic, approach width availability of free left turn and availability of bus bays. Traffic data includes passenger's car units (PCUs), peak one- hour traffic volume, number of buses stopping at intersection etc., analysis is done using appropriate IRC codes (IRC SP:41- 1994, IRC: 65-1976) and Indo-HCM. Then LOS of different movements in intersection are determined the movement which get LOS F is needs to improve or upgrade. For this intersection, the conflict point is blocked, a U-turn is suggested, and the parking area should be shifted to a convenient location. This solution is represented in Q-GIS.**

***Keywords*: Indian road congress (IRC), Indo-HCM, passenger car unit (PCUs) and level of service (LOS).**

1. Introduction

As per contemplates, mysoreans goes through an extra 243 hours in rush hour gridlock every year and Mysore assumed top position in 2019 with drivers in the southern Indian city spending normal of 71% of additional movement time trapped in rush hour gridlock. In 2005 rush hour gridlock moved with a speed of 35 km/h yet in 2014 it got decreased to 9.2 km/h. The revised master plan 2031 delivery by Mysore Development Authority revealed that 1.18 crores individuals squander 60 crores hours out of every year which brings about the loss of 3700 crore rupees which incorporates 1350 crore rupees of fuel alone. The primary driver for the horrible traffic stream can be because of the messed-up streets, unreliable drivers, un-kept up traffic structures, combination, and coordination between various vehicle offices. As indicated by the Department of Transportation 25% of the gridlock happens because of the occurrences, 10% because of quality of work zones, 15% because of awful climate and unique functions or capacities represent 5%. Street blockage, clogged streets, mishaps, lacking limit of the street, flighty interest for the street and insufficient administration can be explanation behind the gridlock in Mysore. These outcomes in delay in the movement time, wastage of fuel, expands the odds of impact, harms the vehicle, builds the transportation costs and disappoints the traveler's and drivers. This issue has become the overall issue, and everybody is searching for an answer. Wide scopes of explores and arranging are going on all through the world. This undertaking is to break down the blockage level and to give a potential answer for alleviate the issue. Graphical portrayal of information is finished utilizing GIS, consequently, result can be imagined.

2. Literature Review

A literature search focused on information this project is to study the level of congestion in unsignalized T- intersection using indo-HCM and IRC methods.

Madhav N. Kulkarni et al. authors performed various studies related to traffic and transportation mainly Travel time and delay, Automatic vehicle location, Dynamic route guidance and Advanced traveler information systems. They developed GPS-GIS integrated system using Trans CAD.

Sruthy S. Kumar et al. authors used latest GIS technology to find the alternative routes when there is a congestion in the selected route and showed their results in the form of map. They have considered and calculated different parameter like traffic volume to select the alternative routes.

Mazloh Al-Enazi et al. author evaluates the traffic congestion spot during the busy hours. They demonstrated the values of GIS in Traffic network analysis, evaluated the direction of routes andprovided the reference of different tools which can be

*Corresponding author: shivashankarhj878@gmail.com

used to measure the traffic congestion.

Anitha Selvasofia S. D (2017) et al. Here, author used different GIS functions such as network analysis, overlay analysis and Kernel analysis to determine the traffic congestion spot during the busy hours. They determined different parameter which causes the traffic congestion, pointed the congestion point by developing a model and suggested ways to use a GIS tool to effectively manage the traffic congestion.

R. Chandra Prathap (2011) et al.GIS Application in Traffic Congestion Management Here, author determined various factors that influences the traffic congestion, predicted a traffic congestion point by developing a model. From this study they found out that in the study area during working hours, the average speed of traffic flowing out from the study area is much greater than the traffic flowing towards, and it is vice versa during holidays.

M. Sureshkumar. (2019) et al. Application of GIS for Traffic Congestion Evaluation Studies Here, author identified the traffic volume at the selected congestion point and analyzed the causes of that congestion. They provided the results in thematic maps by using GIS to show the current causes for increasing in traffic volume. After finding the causes, they suggested parking locations and alternative routes. They also suggested to avoid establishment of commercial stores in the roadside of study area.

Saad Yousif and Purnawanet al. A Study into On- Street Parking: Effects on Traffic Congestion Here, author analyzed three different on-street parking and explained which type of parking results in traffic congestion. Here they considered e different parking such as Parallel, angle parking and illegal parking such as parallel parking.

Metwally G. M. Altaher et al. Traffic Congestion Control for Unplanned Cities This study aims at decreasing the volume of running vehicles and increase the level of service. This study provides an information that a microbus will contribute 38.94% of total trips recorded in the study area. Similarly, 40.37% contribution is form walking, 2.35% from bicycle, 8.08% from car, 6.31% from Taxi and sum of two wheelers and three wheelers contribute 3.95%. Different utility options are providing to public to reduce the vehicle volume. Data collections are done before and after adding the public buses to study area. After adding the buses for the trips, they found a great reduction in traffic volume and also increase the running speed of the vehicle.

Thomas Woltron and Brigitte Rudelet al. Design of a GIS-based traffic congestion forecast information system This paper shows how the traffic data can be broadcasted the details of road to all the drivers. So that driver can take the necessary diversion and use appropriate roads if the broad casted result shows any traffic congestion. To build the Information system, they analyzed meteorological data, published traffic event data and traffic congestion census data of the study area.

3. Methodology

A. Introduction

This section deals with the brief overview of three different methodologies those have been adopted to estimate the Capacity, DOS-Degree of Saturation, LOS, average delay, and Queue Lengths of all selected three types of at-grade Intersection namely, Unsignalized Intersection, Signalized Intersection, and a roundabout. The following Flowchart gives a brief idea of how the study and analysis are carried down in this work.

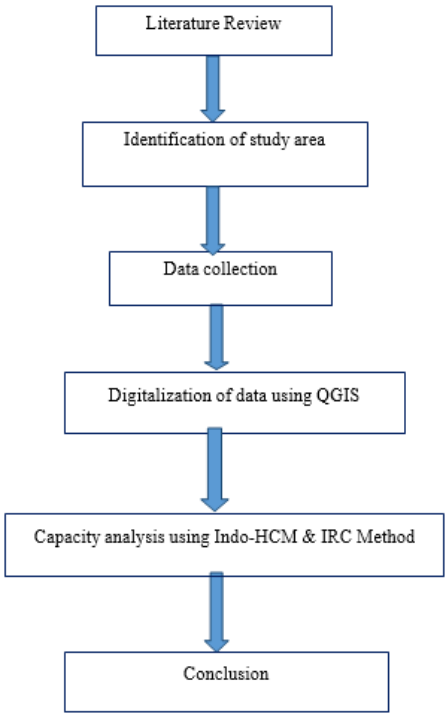


Fig. 1. Methodology

B. Identification of Study Area

After conducting series of investigation to find out the stretch that consists of more congestion, we selected Vani Vilas Road as study area. This route is well known for Government buildings like, Civil Court, DC office, Zilla panchayat, RTO, etc. Commercial buildings like Shopping complex, Market, Hotels, etc. hence huge movement of people and vehicle can be expected here. So, survey is conducted in this route for a length of 1.5kms i.e., from Civil Court to Agrahara Circle. Details of study area are provided below. This Fig. 2 shows the complete stretch of the study area i.e., Vani villas road.

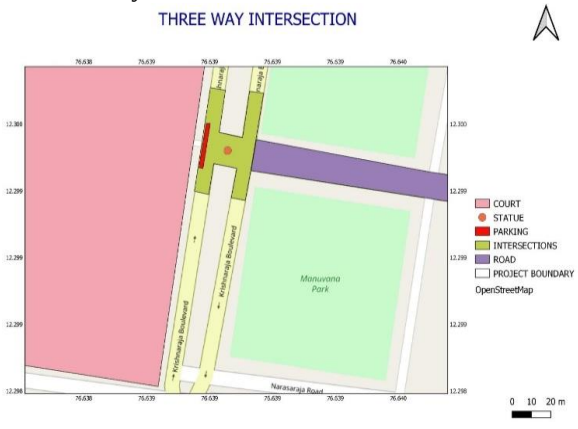


Fig. 2. Three-way intersection

The fig. 2 shows the intersection near to the Civil Court. This is an unsignalized three-way intersection formed by Vani Vilas Road, and Krishna raja Blvd roads. Here congestion occurs due to the movement of people who visits Civil court, Brand Factory, DC Office, and RTO. And Parking of vehicles in front of civil court road.

C. Data Analysis

After collection of Geometric data, traffic data and control data, analyzing the collected data through different performance measures is necessary. Details of data analysis are explained below.

- Capacity analysis using indo-HCM
- Capacity analysis using IRC Method.

4. Analysis and Results

A. Unsignalized T-Intersection – Civil Court Intersection in Mysore

The selected unsignalized intersection is analyzed for present scenarios by IRC and Indo-HCM and results are tabulated in table.

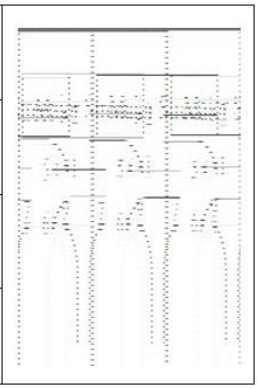
B. Estimation of capacity of three-legged intersection by using INDO-HCM

A three-legged unsignalized Intersection having four lane divided configuration on each of the approaches and the associated turning CVC data is presented in Table. Determine the capacity and level of service of the candidate intersection.

Step 1: Collect geometry and traffic volume data:

Step 2: Traffic volume to PCUs. Classified traffic volume has to be converted into total PCUs based on the PCU values given in Table.

Table 1
Traffic volume and Three-Legged Intersection

Approach	Number of lanes	Divided/ undivided	
Approach 1	4 lanes	Divided	
Approach 2	4 lanes	Divided	
Approach 3	4 lanes	Divided	

C. Data Collection at Unsignalized Intersection

There is only one unsignalized intersections in the study area. Name of that intersection and details of data collections are explained below.

D. Civil Court

Traffic converted into PCUs.

Table 2
Data collection at unsignalized intersection

Movement	Total (in PCU/h)
1	455.12
2	758.24
5	659.02
6	393.24
7	322.82
9	325.32

Step 3: Convert movement volumes to flow rates and calculate conflicting flow, which is presented in table.

Table 3
Calculation of conflicting flow

S.No.	Movement	Conflictingflow equation	ConflictingFlow
1	Movement 2	-	-
	Movement 3 (incase of 4-leggedintersection)		
	Movement 5		
	Movement 6		
2	Movement 1	v_5	659.02
	Movement 4 (incase of 4-leggedintersection)	v_2	-
3	Movement 7	$v_4 + v_5 + v_1 + 0.5*v_2$	1493.26
	Movement 10 (incase of 4-legged intersection)	$v_1 + v_2 + v_4 + 0.5*v_5$	-
4	Movement 8	$v_4 + v_5 + v_1 + v_2 + v_{10}$	-
	Movement 9		
	Movement 11 (incase of 4-legged intersection)	$v_1 + v_2 + v_4 + v_5 + v_7$	-
	Movement 12		

Table 4
Critical gap values

Movement	Base Critical Gap ($t_{c,base}$)	Adjustmentfactor for light and heavy commercial vehicles (f_{LV})	Proportionof heavy vehicles in the conflicting traffic stream (P_{LV})	Criticalgap tc, x = tc, base + fLV× ln (P_{HV})
Movement 1	2.70	0.457	4.99	3.48
Movement 7	3.80	0.885	4.94	5.19

Table 5
Capacity calculation

Movement	Critical gap tc, x (s)	Follow-up time tf,x = 0.6*col-2	Conflicting flow vc,x	Adjustment factor "a"	Adjustment factor "b"	Capacity
Col-1	Col- 2	Col-3	Col- 4	Col- 5	Col-6	Col-7
Movement 1	3.48	2.09	659.02	0.8	1.3	1116.66
Movement 7	5.19	3.11	1493.26	1.0	2.16	585.99

Step 4: Determine critical gap values from associated tables and table.

Step 5: Calculate the capacity of each turning movement at the candidate intersection based on equation (1) and the capacity thus estimated is presented in table.

$$C_x = a \times V_{c,x} \frac{e^{-V_{c,x}(t_{c,x}}}{1 - e^{-V_{c,x}}}$$

Step 6: LOS

Table 3
LOS

Movement	Volume/Capacity	LOS
1	0.59	D
7	2.5	F

LOS for movement 7: Volume/Capacity = 2.5 which implies that the above movement is overloaded and operating at LOS.

It requires geometric improvements at the intersection, which can be in the form of converting into a roundabout because such intersections can be quite efficient in handling the right turning traffic.

E. Estimation of capacity of three-legged intersection by using IRC-SP:41

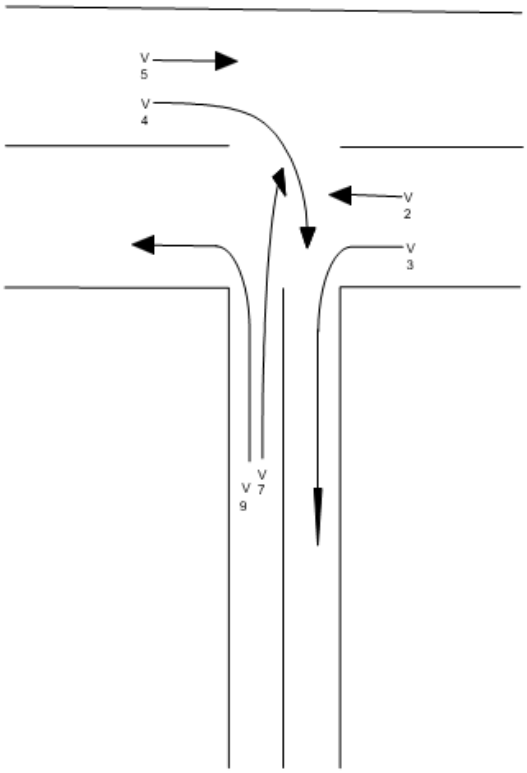


Fig. 3. Three-legged intersection

The page layout shows that the arrow with red head movement have more conflict points and parking space is represented in the image which consumes 30% of the paved way this is the reason for more congestion in this intersection.

Volume Adjustments						
MovementNo.	2	3	4	5	7	9
Volume in(Vph)	988	672	808	1270	604	698
Volume in(pcph)	633	257	454	696	402	-
Step 1: LT FROM MINOR STREET						
Conflicting Flow. Vc= ½ V_3+V_2 =1324 vph(V_9) Critical Gap. Tc. and Potential Tc = 5.3 sec (Table 2) cp_9 = 240 pcph Capacity. cp Actual Capacity. Cm_9 = 240 pcph						
STEP 2: RT FROM MAJOR STREET						
Conflicting How. Vc = V_3+V_2 =1660 Vph Critical Gap. Tc and Potential Tc = 5.4 sec =160 pcph Capacity Cp Per cent of Cp Utilized and (V4/Cp_4) x 100 = 2.9 % P_4 = 0.9 Impedance Factor Actual Capacity: $CmCm_4$ = Cp_4 = 160pcph						
STEP 3 : RT FROM MINOR STREET						
Conflicting flow Vc= ½ V_3+V_2+V_5+V_4 =3402ph (Vs)Critical Gap. Tc and Potential Tc = 6.7 sec cn = 40 pcph Capacity. Cp Actual Capacity. $CmCm_7$ = Cp_7*P_4 =0.97 = 36 pcph						

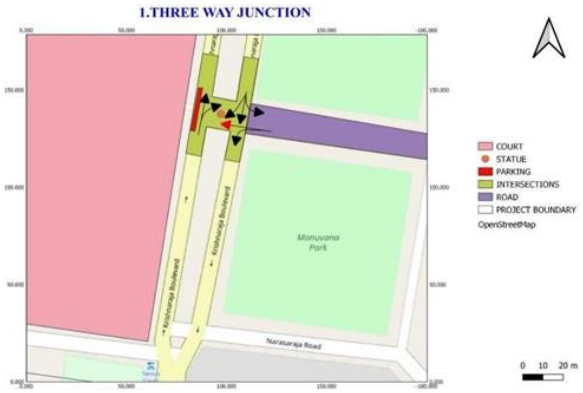


Fig. 4. Analysis of three way unsignalized intersection

5. Conclusion

The performance of at-grade intersections namely unsignalized Intersection is assessed in this study. In all 2 methodologies of analysis. Based on the analysis, we can conclude as follows.

- The critical gap for unsignalized intersection is about 3.48 and 5.19 (In seconds) for movements V1 and V7 respectively from the Indo-HCM methodology.
- LOS is D and F for movements V1 and V7 respectively by method of Indo- HCM.
- The critical gap for unsignalized intersection is about 5.3,5.4 and 6.7 (In seconds) for movements V_7, V_4 and V_9 respectively from their IRC method (as per IRC: SP41 - 1994).
- LOS are C, D and C for movements V_7, V_9 and V_4 respectively by method of IRC: SP 41-1994.
- For this intersection, the conflict point is blocked, a U-turn is suggested, and the parking area should be shifted to a convenient location. This solution is represented in Q-GIS.

The page layout represents the solution as shown, the conflict point is blocked and a U-turn is suggested, and the parking area must be shifted to a convenient location.

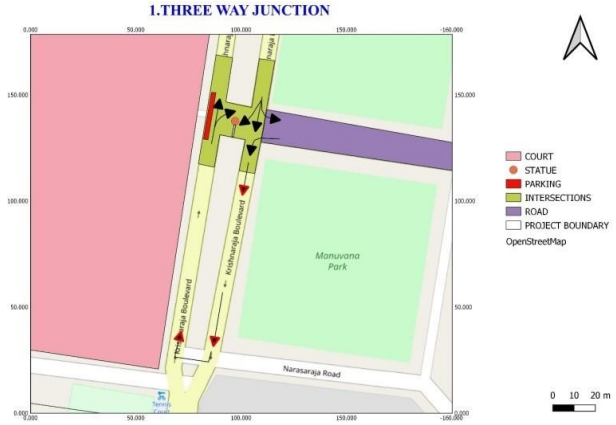


Fig. 5. Proposed solution page layout of three-way unsignalized intersection

References

[1] Arfanara Najnin, Jianhong (Cecilia) Xia and Graeme Wright and Ting (Grace) Lin (2017) "Spatio-temporal Analysis and visualisation of incident induced traffic congestion. using real time online routing information."

[2] Waheeda Mustafa Omer and Abdul Khalik A. M. Al-Taei "Traffic congestion in urban roads network using gis technology".

[3] Madhav N. Kulkarni and Mahendra Kamath. (2007) "GPS-GIS integration for effective traffic management".

[4] Mazloh Al-Enazi (2016), "Traffic congestion evaluation using GIS case study: Jeddah City".

[5] Anitha Selvasofia. S. D (2017) "A GIS based traffic congestion evaluation for Coimbatore city".

[6] Saad Yousif and Purnawan "A study into on-street parking: effects on traffic congestion".

[7] Mohammed Najm, Hassan A. Jeiad and Sarah Saad Hamid (2018), "Investigative study on controlling the congestion in road traffic".

[8] Sruthy Henry and Bino I. Koshy (2016) "Congestion modelling for heterogeneous traffic".

[9] Metwally G. M. Altaher, Ahmed Mohamady Abdallah, Mohamed Abdelghany Elsayed and Mohamed Abdelghany Elsayed (2019)," Traffic congestion control forunplanned cities".

[10] Stefano Avallone, Giulio Iannello "Congestion control for UDP traffic".