

To Study Characteristics of Traffic Flow - A Case Study of South-East Nagpur

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Abstract- Unceremoniously increasing traffic has been a result of the population's rapid rise. The population of Nagpur, which is close to 3 million, has an immediate impact on the volume of traffic. When a result, there is a growing need for both long- and short-term traffic surveys and analyses when the volume of traffic exceeds the normal limit. Effective traffic planning and management in the city are required to accommodate the city's future traffic demands from the current road infrastructure. Moving people, commodities, and vehicles in a safe and efficient manner are key components of the traffic management system's effectiveness. In this work, we investigate the causes and remedies of traffic congestion. This study was conducted to determine characteristics of traffic flow in the Nagpur city and determine the presence of congestion in the selected stretches of the city, using level of service, peak hour factor, passenger car unit, degree of saturation, travel time ratio, etc.

Keywords: Level of Service, Peak Hour Factor, Degree of Saturation, Travel Time Ratio, traffic demand, congestion.

I. INTRODUCTION

Rapid urbanisation has led in a significant increase in the number of vehicles, which has resulted in an increase in traffic volume and considerable traffic congestion on roadways. Traffic is commonly described as the movement of people, goods, or vehicles between spatially separated sites, and so encompasses pedestrians and all forms of vehicles, mechanised, motorised, or nonmotorized. The demand for traffic surveys and analyses for future transport network development is expected to rise. The problem of measuring such diversified traffic has been addressed by converting the various types of vehicles into equivalent passenger cars and expressing the volume in terms of passenger car unit (PCU) per hour. The application of dynamic PCU values to convert heterogeneous flow to uniform flow. PCU values are complicated parameters that are affected by traffic and geometry conditions at the time of the field survey.

Budi Hartanto Susilo and Ivan Imanuel [3] investigated their chosen stretches in order to propose a modified classification on traffic congestion in order to alleviate congestion issues. Mr. Udit Batra and Mr. Mandar V. Sarode [4] conducted a survey and research of the traffic patterns on Sadar Main Road (Anjuman College Square and Liberty Square) and WHC Road (Law College Square and Shankar Nagar Square) for an origin and destination study. S. R. Samal, P. Gireesh Kumar, J. Cyril Santhosh, and M. Santhakumar [5] concluded from their analysis that congestion cannot be totally eradicated due to high population growth, resulting in an increase in the number of cars. Similarly various other research papers were also studied.

Congestion occurs when the number of cars on a road network exceeds its capacity, resulting in slower speeds, longer travel times, and increased driver irritation. It is a prevalent issue in cities, where significant numbers of automobiles congregate on congested roads during peak traffic hours. Population and economic growth: As a region's population and economy develop, more individuals buy automobiles and require transportation. This results in more automobiles on the road and increased traffic congestion. Because traffic congestion is a severe problem in most cities, it is believed that identifying congestion characteristics is the first step in developing a systematic approach to traffic congestion reduction solutions. Congestion in traffic wastes time and energy, contributes to pollution and stress, lowers productivity, and costs society money.

II. STUDY AREA

Road Selection:

The road stretches were selected from South – East zone of Nagpur city. The capacity of traffic varies in the selected respective road stretches. These three stretches are:

1. Bharatmata square to Itwari Chowk
2. Golibar square to Agrasen Chowk
3. Bhande Plot square to Jagnade square

To collect the traffic vehicle data two counting methods were used:

a. Manual Counting:

Manual counting is a traditional method of traffic volume survey that involves the physical counting of vehicles passing a specific location on a roadway.

b. Video Filming Method: Video filming is a modern technique for conducting traffic volume surveys. It involves the use of video cameras to record the traffic flow at a specific location on a roadway

For collection of data at the selected stretch both manual counting and video film method was used. A smart phone camera was used to shoot the video for determining the speed readings and traffic count. The smart phone was fixed at an angle so as to get a perfect video of road which covers all the parameters and also covers the length and width of road.

III. TRAFFIC DATA ANALYSIS

1. Passenger Car Unit (PCU):

To calculate the PCU values, the total volume of a vehicle category was multiplied by its PCU factor as per the IRC recommendation. Similarly all these values were added for all vehicle categories and the PCU value for that time duration is calculated. The PCU factor were taken as per table 4 of IRC 106 (2022) recommendation. Values were taken of Two lane bidirectional roads.

The calculation for PCU of all the stretches is done in same manner.

2. Level of Service (LOS) & Peak Hour Factor (PHF):

Level of service (LOS): Level of Service definition generally describes these conditions in terms of factors such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety.

Peak hour factor (PHF): Peak hour factor (PHF) is the hourly volume during the maximum-volume hour of the day divided by the peak 15-minute flow rate within the peak hour; a measure of traffic demand variation within the peak hour.

3. Degree of Saturation (DS):

Degree of Saturation (DS): It is defined as the ratio of the traffic volume on a roadway or network to its capacity.

$$\text{Degree of Saturation} = \frac{\text{Capacity}}{\text{Volume}} = \frac{C \text{ (PCU/Hour)}}{V \text{ (PCU/Hour)}}$$

4. Travel Time Ratio (TTR):

Using video film methods speed survey was done from which the speed of the vehicle was determined. From the video frame marking vertical lines to mark the distance (horizontal distance of road) of the vehicle traveling in the frame is done. The marking on the frame was as per the distance measured on the stretch (visible in the frame) by students. From this distance and the time required for vehicles to travel that distance speed was determined. And using this speed for the horizontal distance time required for vehicles to travel a complete stretch was determined.

Travel Time Ratio (TTR): It can be defined as the ratio of travel time of vehicles during peak hour by travel time of vehicles during off peak hour.

$$\text{Travel Time Ratio (TTR)} = \frac{\text{Travel time during peak hour}}{\text{Travel time during off peak hour}} = \frac{TT_p}{TT_o}$$

To obtain the travel time of vehicles, a speed survey using video film method was done from where the video frame was marked with two vertical lines as shown in the fig below, where the horizontal distance as much seen in the frame (travelling distance of road in video frame) is measured manually. Using that distance and noting time the vehicle requires to pass that particular horizontal distance from which we determined speed of the vehicle in meter per seconds. This was done for two road stretches Agrasen Chowk to Golibar Chowk (stretch 2) and Bharatmata Chowk to Itwari Chowk (stretch 3).

Using the speed of vehicle we determined the travel time of vehicles for the complete selected stretch. All data taken for speed and time determination is average of respective data taken during peak hour and off-peak hour.

A. Stretch 1 Bhande Plot Chowk to Jagnade Square

- Stretch: Bhande plot Chowk to Jagnade Chowk
- Distance: 2.5 km (2550 m)
- Direction of traffic:
 - UP – Bhande plot Chowk to Jagnade Chowk
 - DOWN – Jagnade Chowk to Bhande plot Chowk
- Time:
 - Morning - 10:00am to 12:00pm;
 - Evening - 6:00pm to 8:00pm (15 minutes intervals).
- Date : 04/04/2023

Data was collected at the time mentioned above at intervals of 15 minutes, for UP and DOWN going vehicles. The same is marked on survey sheet and at the same time video recording at respective angle was done for calculation of level of service and passenger car unit correct vehicle count.

For this study the vehicles were classified into 6 classes as passenger car, motorcycle, 3-wheeler vehicle (passenger), 3 wheeled vehicles (tempo), mini bus, cycle.

Analyzing the data in terms of Passenger Car Units (PCU), level of service (LOS).

The table.1 shows Peak Hour Factor (PHF) values, Passenger Car Unit (PCU) values and its corresponding Level of Service Values for stretch Bhande Plot Chowk to Jagnade Chowk.

Table.1 PHF, PCU and LOS values for stretch Bhande Plot Chowk to Jagnade Chowk.

Time	PHF		L.O.S	
	UP	DOWN	UP	DOWN

10:15am	0.92	0.99	E	F
10:30am				
10:45am				
11am				
11:15am	0.84	0.76	C	B
11:30am				
11:45am				
12pm				
6:15pm	0.81	0.82	C	C
6:30pm				
6:45pm				
7pm				
7:15pm	0.81	0.81	C	C
7:30pm				
7:45pm				
8pm				

As seen in table 1, average level of service for the particular stretch is LOS C. Therefore, as per the IRC 106 2022 explanation for LOS C can be given as:

LOS-C: This also is a zone of stable flow but marks the beginning of the range of flow in which the operation of individual drivers starts getting affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and on the part of the user. The general level of comfort and convenience starts declining at this level.

Table.2 PCU Values for morning hours for stretch 1.

Time	PCU	
	UP	DOWN
10:15am	84.87	92.66
10:30am	132.62	118.71
10:45am	112.36	95.44
11am	92.63	85.97
11:15am	79.83	56.42
11:30am	80.56	88.82
11:45am	95.63	57.88
12pm	83.65	67.75

Table.3 PCU Values for evening hours for stretch 1.

Time	PCU	
	UP	DOWN
6:15pm	89.27	78.16
6:30pm	93.37	83.84
6:45pm	94.69	95.5
7pm	113.47	107.71
7:15pm	86.27	105.5
7:30pm	61.1	57.22
7:45pm	73.81	69.81
8pm	105.52	87.43

Table.2 shows the PCU values for morning hours and Table.3 shows the PCU values for morning hours for stretch 1.

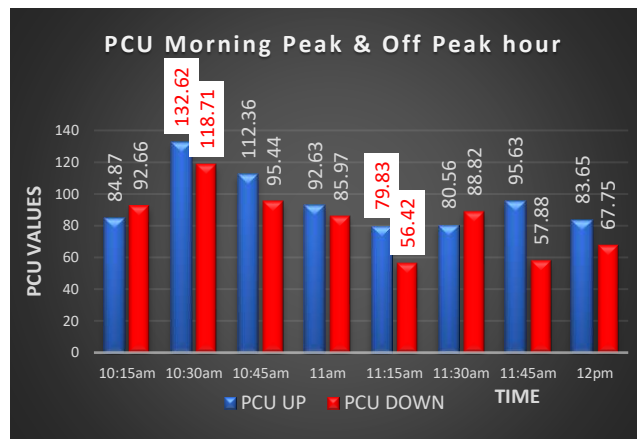


Fig.1 PCU Morning Peak & Off Peak Hour for stretch 1.

In Fig.1 chart represents Morning Peak Hour, where PCU Values on y axis and time in minutes (15 minutes interval) on x axis. It can be seen that 10:15 am to 10:30 am is the peak hour during morning hours. PCU values for UP flowing traffic is shown in Blue colour and DOWN flowing traffic is shown in Red colour. From 11:00 am to 11:15 am is the morning off peak hour. The total traffic flowing in UP direction is shown in the graph in Blue colour and total traffic flowing in DOWN direction is shown on graph in Red colour.

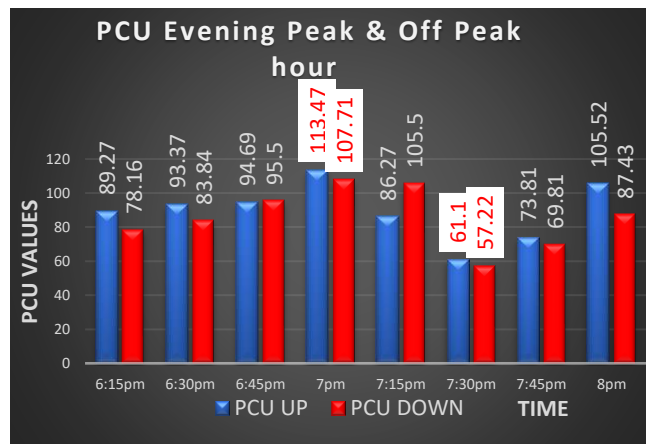


Fig.2 PCU Evening Peak & Off Peak Hour for stretch 1.

In Fig.2 chart represents Evening Peak Hour, where PCU Values on y axis and time in minutes (15 minutes interval) on x axis. It can be seen that 6:45 pm to 7.00 pm is the peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour. It can be seen that 7:15 pm to 7.30 pm is the off peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour.

B. Stretch 2 Golibar Chowk to Agrasen Chowk

- Stretch: Golibar Chowk to Agrasen Chowk
- Distance: 0.85 km (850 m)
- Direction of traffic:
 - UP – Agrasen Chowk to Golibar Chowk;
 - DOWN – Golibar Chowk to Agrasen Chowk
- Time:
 - Morning - 10:00am to 2:00pm;
 - Evening - 5:00pm to 8:30pm (30 minutes intervals).
- Date : 05/03/2023

Data was collected at the time mentioned above at intervals of 30 minutes, for UP and DOWN going vehicles. The same is marked on survey sheet and at the same time video recording at respective angle was done for calculation of TTR and correct vehicle count. For this study the vehicles were classified into 8 classes as passenger car, motorcycle, 3-wheeler vehicle (passenger), 3 wheeled vehicles (tempo), mini bus, bus, construction vehicle, cycle.

Analyzing the data in terms of Passenger Car Units (PCU), Travel Time Ratio (TTR), Degree of Saturation (DS) we finalized the Congestion Matrix of traffic.

Table.3 PCU Values for morning hours for stretch 2.

Time	PCU	
	UP	DOWN
10:30am	66.45	54.45
11am	61.68	55.9

11:30am	77.11	63.23
12pm	37.96	50.98
12:30pm	55.77	50.71
1pm	43.59	40.89
1:30pm	38.41	38.67
2pm	43.17	39.99

Table.4 PCU Values for evening hours for stretch 2.

Time	PCU	
	UP	DOWN
5:30pm	72.55	37.59
6pm	80.56	60.12
6:30pm	48.52	49.34
7pm	60.67	49.09
7:30pm	50.51	56.81
8pm	50.05	59.09
8:30pm	55.09	48.3

Table.3 shows the PCU values for morning hours and Table.4 shows the PCU values for evening hours for stretch 2.

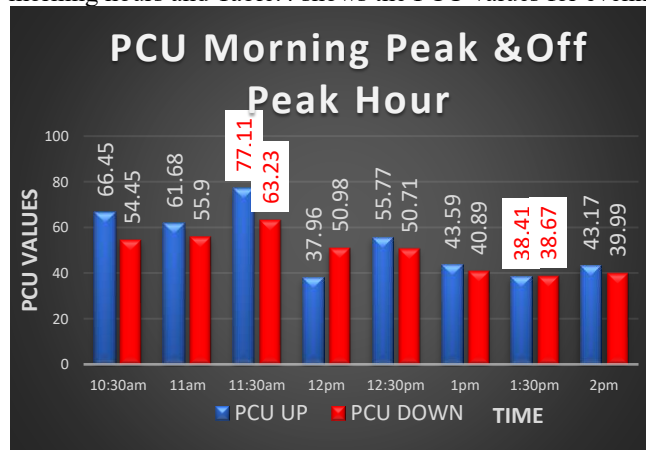


Fig.3 PCU Morning Peak & Off Peak Hour for stretch 2.

In Fig.3 chart represents Morning Peak Hour, where PCU Values on y axis and time in minutes (30 minutes interval) on x axis. It can be seen that 11:00 am - 11:30 am is the peak hour during morning hours. PCU values for UP flowing traffic is shown in Blue colour and DOWN flowing traffic is shown in Red colour. It can be seen that 01:00 p m 01:30 pm is the off peak hour during morning hours. PCU values for UP flowing traffic is shown in Blue colour and DOWN flowing traffic is shown in Red colour.

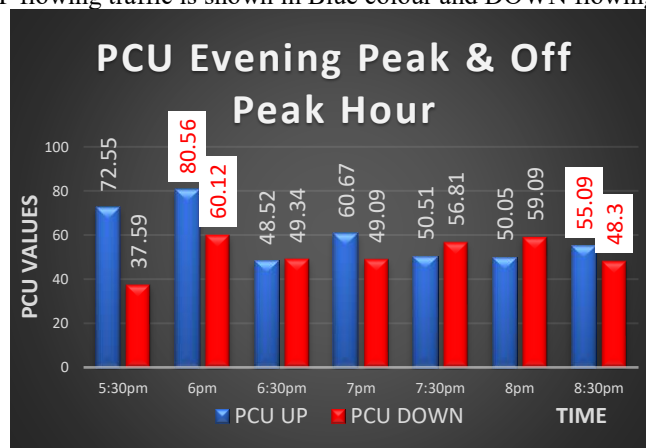


Fig.4 PCU Evening Peak & Off Peak Hour for stretch 2.

In Fig.4 chart represents Morning Peak Hour, where PCU Values on y axis and time in minutes (30 minutes interval) on x axis. It can be seen that 5:30 pm - 6:00 pm is the peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour. It can be seen that 06:00 pm - 6:30 pm is the off peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour.

Using the speed required for travelling the horizontal distance (27 m), time required for vehicles to travel complete stretch of 1.0km was determined.

The value of S is calculated by using formula $S=0.2V+6$.
 Where, S = Spacing between two consecutive vehicles.
 V = Speed in km/hr.

Table.5 shows the capacity and volume calculation values as per the mentioned formulas giving the degree of saturation values for this particular stretch.

Table.5 Degree of Saturation values.

Time	Total Capacity (C)		Volume (V)		Degree of Saturation (DS)
	UP	DOWN	UP	DOWN	UP
11:30am	9137.73	9182.68	138.79	119.13	0.010
6:00pm	10542.9	10619.6	153.11	97.71	0.014

Table.6 given below is the final values of DS, taken from average of DS of peak hour and off-peak hour for UP & DOWN flowing traffic in morning and evening hours respectively for stretch 2.

Table.6 Final DS Values for stretch 2.

Time	DS UP	DS DOWN	Final DS
Morning	0.010	0.012	0.011
Evening	0.014	0.010	0.011

The TTR calculation for the particular stretch is as shown below in table 7, where during morning hour peak hour taken is 11:00am to 11:30am and off-peak hour is 10:30am to 11:00am.

Similarly for evening hours peak hour taken is 5:30 pm to 6:00pm and off peak taken is 5:00 pm to 5:30 pm.

Table.7 Time and Travel time ratio values calculation for stretch 2.

Time	Total Time (sec)		TTR=TTP/T TO
	UP	DOWN	UP
11:00AM	14959.06	13628.31	1.51
11:30am	22691.5	22670.31	
5:30pm	15304.29	9262.37	1.46
6pm	22486.22	16115.68	

Table.8 given below is the final values of TTR, taken from average of TTR of peak hour and off-peak hour for UP & DOWN flowing traffic in morning and evening hours respectively.

Table.8 Final TTR Values for stretch 2.

Time	TTR UP	TTR DOWN	Final TTR
Morning	1.51	1.66	1.59
Evening	1.46	1.73	1.60

Table.9 Travel Time Ratio and Degree of Saturation values

Time	TTR	DS
Morning	1.59	0.0119
Evening	1.60	0.0118

Table.9 represents the calculated values of Travel Time Ratio and Degree of Saturation for the selected stretch.

For the selected stretch the traffic condition can be assessed as:

1. Morning: TTR value is 1.59, which is relatively High and DS value is 0.0119, which is also relatively low. Therefore, traffic condition can be assessed as ‘Peak Hour Congestion.’
2. Evening: TTR value is 1.60, which is relatively high and DS value is 0.0118, which is also relatively low. Therefore, traffic condition can be assessed as ‘Momentary Congestion.’

C. Stretch 3 Bharatmata Square to Itwari Chowk

- Stretch: Bharatmata Square to Itwari Chowk
- Distance: 1.1 km (1100 m)
- Direction of traffic:
- UP - Bharatmata Square to Itwari Chowk;

- DOWN - Itwari Chowk to Bharatmata Square
- Time:
 - Morning - 10:00am to 2:00pm;
 - Evening - 5:00pm to 8:30pm. (30 minutes intervals).
- Date : 12/03/2023

For this study the vehicles were classified into 8 classes as passenger car, motorcycle, 3-wheeler vehicle (passenger), 3 wheeled vehicles (tempo), mini bus, bus, construction vehicle, cycle.

Analyzing the data in terms of Passenger Car Units (PCU), Travel Time Ratio (TTR), Degree of Saturation (DS) we finalized the Congestion Matrix of traffic.

Table.10 PCU Values for morning hours for stretch 3.

Time	Total	
	UP	DOWN
10:30am	90.84	99.86
11am	115.72	103.53
11:30am	97.96	77.36
12pm	78.64	69.88
12:30pm	90.46	75.72
1pm	65.18	67.87
1:30pm	71.7	67.39
2pm	62.82	60.21

Table.11 PCU Values for evening hours for stretch 3.

Time	Total	
	UP	DOWN
5:30pm	53.89	66.7
6pm	95.32	69.34
6:30pm	98.24	111.58
7pm	86.58	86.94
7:30pm	92.06	93.96
8pm	87.61	83.09
8:30pm	84.94	82.9

Table.10 shows values of PCU for morning hours and Table.11 shows PCU values for evening hours for stretch 3.

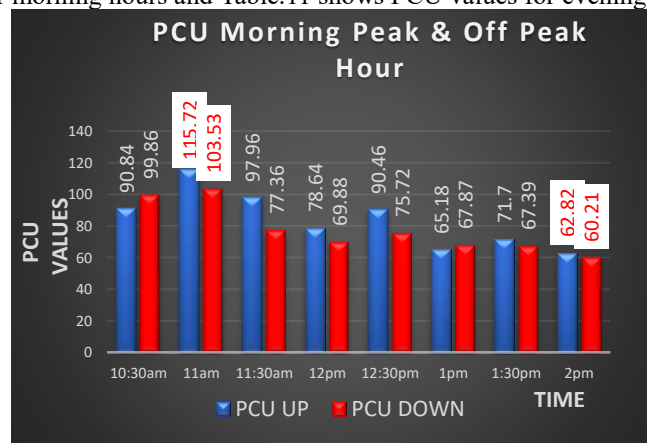


Fig.5 PCU Morning Peak & Off Peak Hour for stretch 3.

In Fig.9 graph represents Morning Peak Hour, where PCU Values on y axis and time in minutes (30 minutes interval) on x axis. It can be seen that 11:00 am - 11:30 am is the peak hour during morning hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour. It can be seen that 01:30 pm - 02:00 pm is the off peak hour during morning hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour.

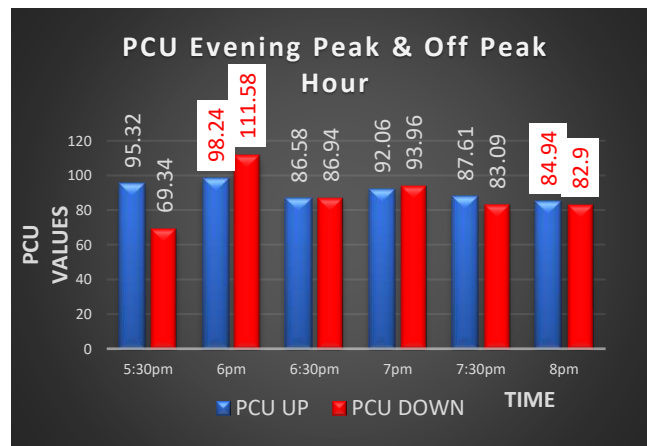


Fig.6 PCU Evening Peak & Off Peak Hour for stretch 3.

In Fig.6 chart represents Morning Peak Hour, where PCU Values on y axis and time in minutes (30 minutes interval) on x axis. It can be seen that 5:30 pm - 6:00 pm is the peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour. It can be seen that 07:30 pm - 08:00 pm is the off peak hour during evening hours. PCU values for UP flowing traffic is shown in Blue colour and down flowing traffic is shown in Red colour.

Using the speed required for travelling the horizontal distance (15.1 m), time required for vehicles to travel complete stretch of 1.1km was determined.

Where, S = Spacing between two consecutive vehicles.

V = Speed in km/hr.

Table.12 shows the capacity and volume calculation values as per the mentioned formulas giving the degree of saturation values for this particular stretch.

Table.12 Degree of Saturation values.

Time	Total Capacity (C)		Volume (V)		Degree of Saturation (DS)	
	UP	DOWN	UP	DOW N	UP	DOW N
11am	7169.4	7192.39	206.56	203.39	0.022	0.020
6:30pm	6954.75	7080.37	193.56	180.92	0.020	0.020

Table.13 given below is the final values of DS, taken from average of DS of peak hour and off-peak hour for UP & DOWN flowing traffic in morning and evening hours respectively.

Table.13 Final DS Values

Time	DS UP	DS DOWN	Final DS
Morning	0.022	0.020	0.021
Evening	0.020	0.020	0.020

The TTR calculation for the particular stretch is as shown below in table.14, where during morning hour peak hour taken is 10:00am to 10:30am and off-peak hour is 10:30am to 11:00am. Similarly for evening hours peak hour taken is 5:30pm to 6:00pm and off-peak hour taken is 6:00 pm to 6:30 pm.

Table.14 Time and Travel time ratio values calculation.

Time	Total Time (sec)		TTR = TTP/TTO	
	UP	DOWN	UP	DOWN
10:30am	61188.74	60389.77	1.16	0.99
11am	71216.52	60014.7		
6pm	61965.86	47272.53	1.11	1.39
6:30pm	69067.04	65765.45		

Table.15 given below is the final values of TTR, taken from average of TTR of peak hour and off-peak hour for UP & DOWN flowing traffic in morning and evening hours respectively.

Table.15 Final TTR Values

Time	TTR UP	TTR DOWN	Final TTR
Morning	1.16	0.99	1.075
Evening	1.11	1.39	1.25

Table.16 Travel Time Ratio and Degree of Saturation values

Time	TTR	DS
Morning	1.075	0.021
Evening	1.25	0.020

Table.16 represents the calculated values of Travel Time Ratio and Degree of Saturation for the selected stretch.

For the selected stretch the traffic condition can be assessed as:

1. Morning: TTR value is 1.075, which is relatively low and DS value is 0.021, which is also relatively low. Therefore, traffic condition can be assessed as 'Smooth Traffic.'
2. Evening: TTR value is 1.25, which is relatively high and DS value is 0.020, which is also relatively low. Therefore, traffic condition can be assessed as 'Momentary Congestion.'

IV.DATA ASSESSMENT

1. Congestion Matrix

For assessment of condition of traffic on the selected stretch Bharatmata Square to Itwari Chowk from Table.17 Congestion Matrix of Traffic Condition, as per research paper by Budi Hartington and Ivan Imanuel.

Where, TTR refers to Travel Time Ratio and DS refers to Degree of Saturation.

Table.17 Congestion Matrix of Traffic Condition

Parameter	High TTR	Low TTR
High DS	Peak hour congestion	Lengthy congestion
Low DS	Momentary congestion	Smooth traffic

By assessment of data of traffic on the road section the conditions of congestion based on DS and TTR can be classified into four types as shown in Table 1. Where;

1. Peak hour congestion: When the traffic characteristics as TTR is High and DS is also High this condition is determined.
2. Lengthy congestion: When the traffic characteristics as TTR is Low and DS is High this condition is determined.
3. Momentary congestion: When the traffic characteristics as TTR is High and DS is Low this condition is determined.
4. Smooth Traffic: When the traffic characteristics as TTR is Low and DS is also Low this condition is determined.

2. Comparison Table

Comparison table for selected road stretches, Golibar Chowk to Agrasen Chowk and Bharatmata Square to Itwari Chowk is as seen below in table. The comparison here is done on basis of factors Travel Time Ratio and Degree of Saturation from which the congestion is determined.

As seen in the table for road stretch Golibar Chowk to Agrasen Chowk the traffic congestion condition are Peak hour congestion and Momentary congestion in morning and evening hours respectively. Similarly for road stretch Bharatmata Square to Itwari Chowk the traffic congestion condition are Smooth traffic congestion and Momentary congestion in morning and evening hours respectively.

Table.18 Congestion Condition Comparison table for morning hours

Road Stretch	Time	Travel Time Ratio (TTR)	Degree of Saturation (DS)	Congestion Condition
Golibar Chowk to Agrasen Chowk	Morning	1.59	0.0119	Peak Hour Congestion

Bharatmat a Square to Itwari Chowk	Morning	1.075	0.021	Smooth Traffic Congestion
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Table.18 shows congestion condition comparison as observed for morning hours for the two selected respective stretches Golibar chowk to Agrasen chowk in white color and Bharatmata chowk to Itwari chowk in yellow color. Where stretch Golibar chowk to Agrasen chowk has Peak Hour congestion condition while stretch Bharatmata chowk to Itwari chowk has Smooth Traffic congestion. Figure 8.4.1 shows the line chart for comparison of TTR and DS for morning hours.

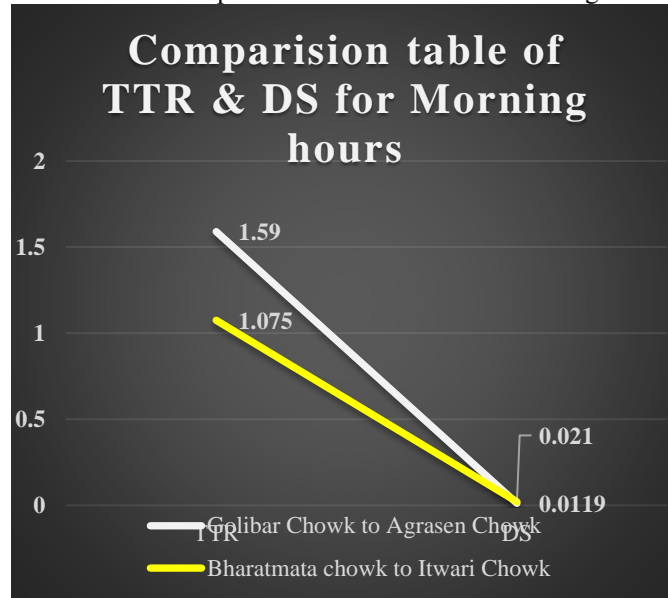


Fig.13 Comparison for TTR and DS for morning hours.

Table.19 Congestion Condition Comparison table for evening hours

Road Stretch	Time	Travel Time Ratio (TTR)	Degree of Saturation (DS)	Congestion Condition
Golibar Chowk to Agrasen Chowk	Evening	1.60	0.0118	Momentary Congestion
Bharatmat a Square to Itwari Chowk	Evening	1.25	0.020	Momentary Congestion

Table.19 shows congestion condition comparison as observed for evening hours for the two selected respective stretches Golibar chowk to Agrasen chowk in white color and Bharatmata chowk to Itwari chowk in yellow color. Where stretch Golibar chowk to Agrasen chowk has Momentary congestion condition while stretch Bharatmata chowk to Itwari chowk has Momentary congestion. Figure 8.4.1 shows the line chart for comparison of TTR and DS for morning hours.

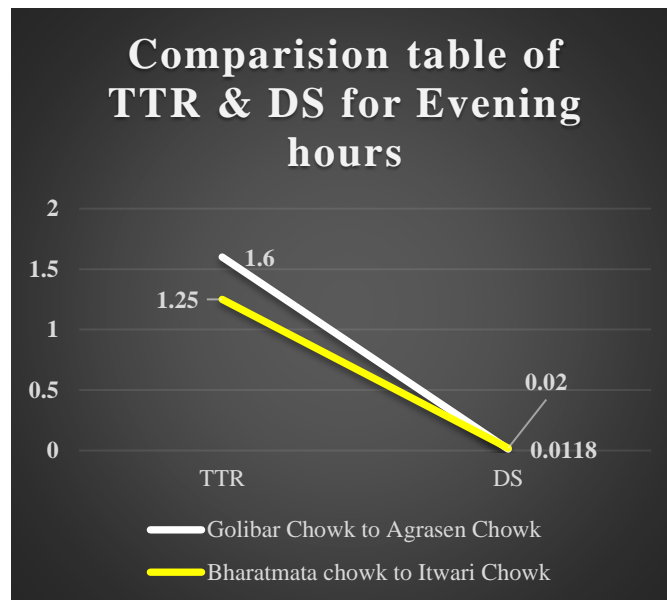


Fig.14 Comparison for TTR and DS for evening hours.

It is observed that both stretches have Momentary congestion condition during the Evening hours but vary from Peak hour congestion to Smooth traffic congestion in Morning hours.

V.CONCLUSION

- Based on the traffic volume survey of a selected road stretches, Bhande plot chowk to Jagnade chowk, Golibar chowk to Agrasen chowk and Bharatmata square to Itwari chowk, in Nagpur city the characteristics of traffic for congestion were analysed.
- It was concluded that Level of Service on stretch Bhande plot chowk to Jagnade chowk was overall found to be of 'LOS C'.
- The traffic congestion condition for the selected stretch Golibar chowk to Agrasen chowk were 'Peak Hour congestion' during morning hours and 'Momentary congestion' during evening hours respectively. For stretch Bharatmata square to Itwari chowk it was observed that 'Smooth traffic' during morning hours and 'Momentary congestion' for evening hours respectively.
- It was observed that the reason for traffic congestion in these particular stretch were encroachment and haphazard parking by shopkeepers and customers inspite of provision of sufficient design of road width. The careless parking and rash driving of autorickshaws and two wheelers also impacted the traffic.

Recommendations:

- Study and implementation of road architecture.
- Assigning of traffic signs, speed limit signs, etc.
- Coordination of traffic lights.
- Redesigning of intersections.
- Use of public transportation.
- Suggestion of roundabout routes.
- Heavy fines on haphazard parking and encroachment.
- Awareness amongst citizens for following traffic rules and problems it may led to.
- Cancellation of license.

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