



EVALUATION OF CAPACITY AND QUALITY OF SERVICE FOR URBAN ARTERIAL ROUTE IN JABALPUR CITY

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Article History: Received: 12.12.2022

Revised: 29.01.2023

Accepted: 15.03.2023

Abstract

India is a booming nation, and as a result, its cities are also going through major urbanisation and development. The outcome is a considerable increase in traffic on the highways. Indore is one of India's largest and fastest-growing cities. The city's major thoroughfares have seen a steady increase in vehicle traffic, and as a result, they are beginning to fill to capacity, creating a particularly confusing traffic pattern. Four road segments are taken into consideration for the study, and data should be gathered from all four segments. After determining the road level of service, the values are compared to those in the highway capacity manual, and deductions are made.

Keywords: Highway Capacity Handbook, Indian Road Congress, Jabalpur, Standard of Service, Roads

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DOI: 10.31838/ecb/2023.12.s3.125

1. Introduction

One of central India's most important and rapidly expanding cities is Jabalpur. It is the only metropolis in the state of Madhya Pradesh. Due to the growth of the city's economic and industrial sectors, as well as its population, the city's traffic has become more congested in recent years. The city's metropolitan roads have seen an unceasing increase in vehicle traffic, which has led to a number of problems including narrower lanes, traffic jams, a lack of parking spaces, signal delays, lower road capacity, air pollution, and traffic accidents, to mention a few. The complexity of traffic is growing as the city's roads are getting close to their intended capacity. Other major factors affecting traffic flow on the roads include a lack of lane discipline, a large range of vehicle sizes and kinds, and a wide range of vehicle speeds. As a consequence, in order to somewhat improve the traffic condition of the present roads, it is required to grasp the nature of traffic flow while taking into account the current traffic flow on the roads and to adapt the traditional features that were used to create the roads.

There have been several studies on the relationship between road capacity and service levels. (Patel & Joshi, 2012) in Surat, Gujarat, India, used cluster analysis to establish service level criteria based on traffic to capacity ratio. The results of this study are very helpful in determining the level of traffic on urban arterials with access controls and mixed traffic. For 22 road links, (Joseph & Nagakumar, 2014) calculate the Roadway Congestion Index and Road Level of Service. The study also found that the methodologies for estimating LOS specified in IRC 106:1994 and HCM are not appropriate for use on urban roads. The study found that the pedestrian movement and speed parameters for creating LOS on urban streets needed to be updated in the code. (Janwari et al., 2016) A thorough analysis of the road capacity on key metropolitan routes was done in Mumbai, Maharashtra. According to the study, the throughput per lane on several major motorways in Bombay has well beyond its limit. It's interesting that despite the heavy traffic, no significant congestion issues were found on these roads. According to (Gajjar & Mohandas, 2016), the actual capacity established in the field is less than the suggested capacity value provided by the Indian Road Congress (IRC) based on design service volume.

The Highway Capacity Manual is a collection of cutting-edge techniques for determining the degree of service for transportation assets and determining capacity. The Highway Capacity Handbook is where the term "Level of Service" first appeared (HCM). The concept of LOS and other related performance parameters that precisely represent a

roadway's operating characteristics were introduced for the first time in The Highway Capacity Manual (HCM) (1965). (Singh & Goyal, 2015) Six LOS were suggested based on performance parameters including average traffic speed, peak hour factor, volume to capacity ratio, load factor at crossings, and flow circumstances (stable, unstable or forced). Five LOS were advised as a consequence of density being selected as the main factor for assessing performance in HCM (1985). (Biswas et al., 2016) HCM (2000) suggested that the only criterion for estimating the LOS of a city route be average travel speed (ATS). For each of the four urban street classes, six LOS criteria were offered based on the ATS value, while the urban street class was determined by the free flow speed. The most recent version of HCM (2010) provided six LOS and threshold values of % free-flow speed as the main performance criterion for LOS evaluation of urban roadways for the car mode.

2. Research Objectives

These are the goals of the current study:

1. To carry out an analysis of the selected segments' traffic volume, capacity, and spatial mean speed.
2. To determine the mix of vehicles along each section.
3. To measure traffic flow during peak and off-peak hours.
4. To establish the link between flow, density, and speed in the study region.
5. To suggest better Level of Service requirements for the observed traffic for the entire segment.

3. Research Domain

The roads below were taken into consideration for the study in Jabalpur City, Madhya Pradesh. The route under consideration begins with a 4.4 km length from "Bada Phuhara" to "Rampur Chowk". The city's main flea market, "Bada Phuhara," is located next to Hanuman taal. There is heavy traffic in this region because of the flea market and temples close to Bada Phuhara. The next location to be covered is "Malviya Chowk." Here is where the city's book market is located, and it is also close to the Samdariya Mall and the police control station. The next significant location is Bloom Chowk, which has showrooms like Lotus, Reliance Digital, and others. Bloom Chowk is also known as the city's medical centre. We go on in the direction of Chotiline Square and Rampur Chowk. They include little flea markets and temples, all of which are close to the city's railroad station.

The road's capacity to handle traffic was diminished due to the volume of traffic and the variety of vehicles on this section's route, which caused vehicle travel times to be prolonged,

particularly during peak hours. This route is used mostly by intercity and local buses, which frequently causes traffic backups and delays in moving traffic, which ultimately reduces the road's capacity to handle traffic.

It is divided into four sections that total 4.4 kilometres. For the sake of clarification, the path from Rampur Chowk to Bada Phuhara is considered up whereas the route from Bada Phuhara to Rampur Chowk is considered down.

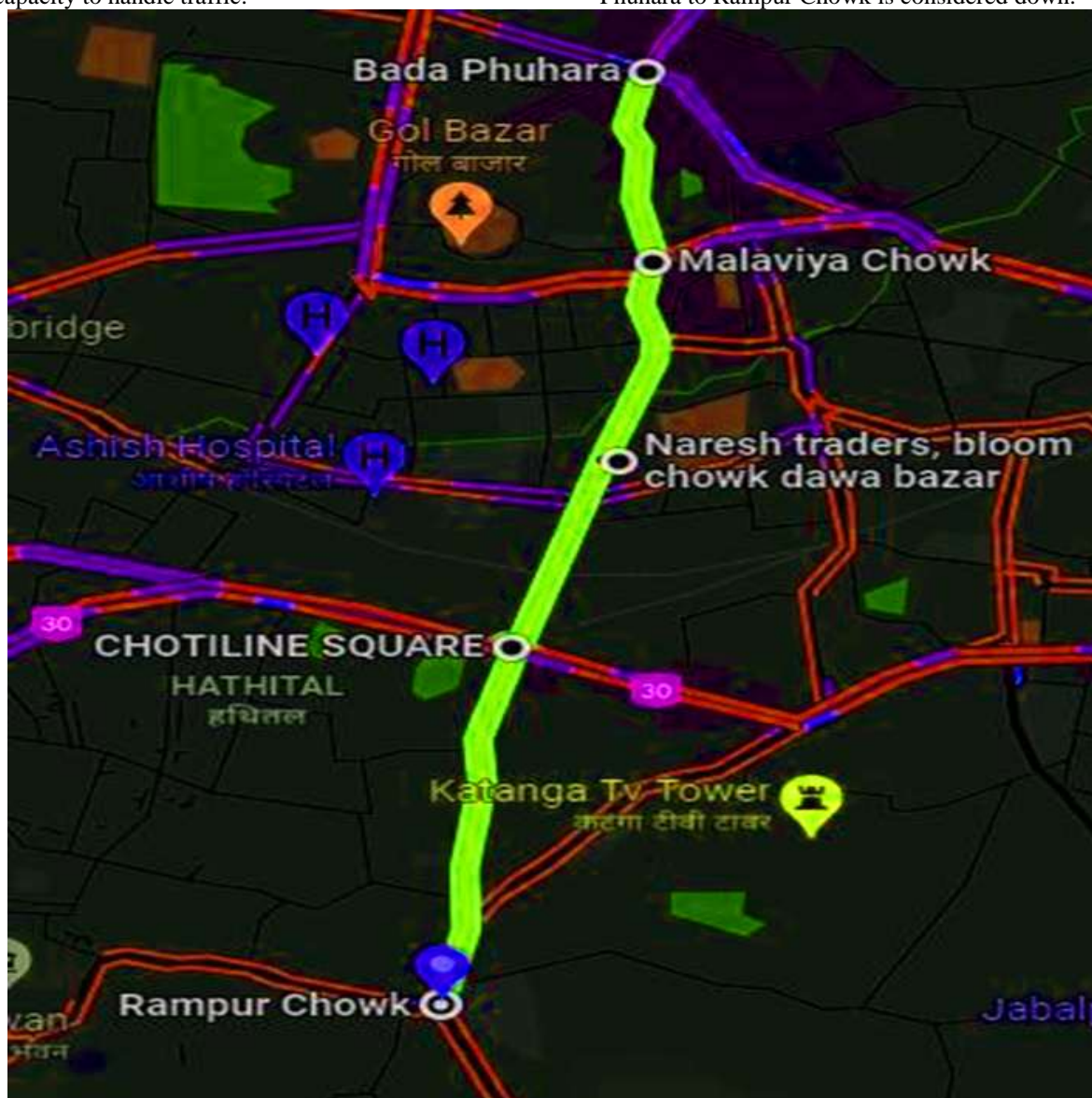


Figure 1: Area's Map for Consideration



Figure 2: Site Pictures

4. Adopted Data Collecting and Methods

The traffic volume study was done using the cameras that were placed in the centre of each of the four sections. In order to collect statistics on flow throughout both peak and off-peak weekday hours, traffic volumes were videotaped. It takes a lot of time to manually count and classify all of the different cars in the traffic, hence slow motion replay of recordings is employed. According to this, the section's morning and evening peak hours

are respectively between 10 and 11 a.m. and 6 to 7 p.m.

All of the data acquired in the field is combined and processed to better understand the fluctuations in traffic and vehicle composition during peak and off-peak hours in both directions. For both peak and off-peak hours, the data contains the number of vehicles, trip time, average journey time, and average flow speed for 5 minutes intervals. The steps in the study are as follows:

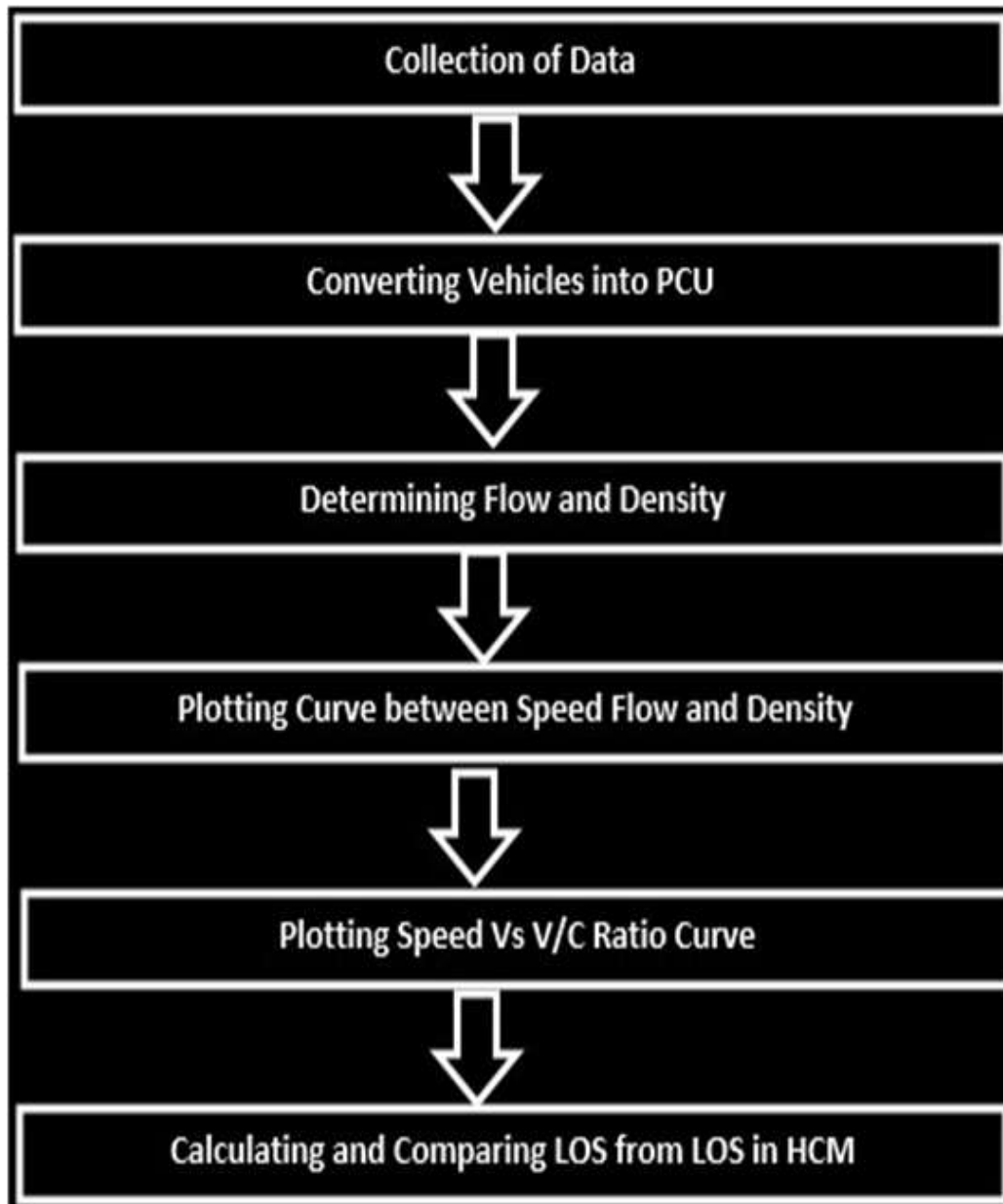


Figure 3: adopted a method

5. Results

The speed-flow relationship for the Greenshields is represented as a parabolic curve. This parabolic curve is used as a conceptual representation of Level of Service in the speed vs. flow domain. The operating range on this curve up to LOS E is split into three tiers of service according to the Highway Capacity Handbook (HCM). The level of service ranges were calculated using the speed-flow relationship, and the requirements in the Highway Capacity Manual were utilised to define the thresholds for each level of service (HCM). The

volume to capacity ratio is determined for each section, and speed vs V/C graphs are created. The highest and lowest values found on the rising curve are divided into equal intervals to determine level of service ranges. To define LOS "A-F," the graphs, which display a variety of speed ranges and V/C ratios, were employed. The findings from the study for each section are listed below:

5.1 Choti Line Square Part, Rampur Chowk

This segment has a 3654.6 PCU/hr capacity in the up direction and a 3016.2 PCU/hr capacity in the down direction.

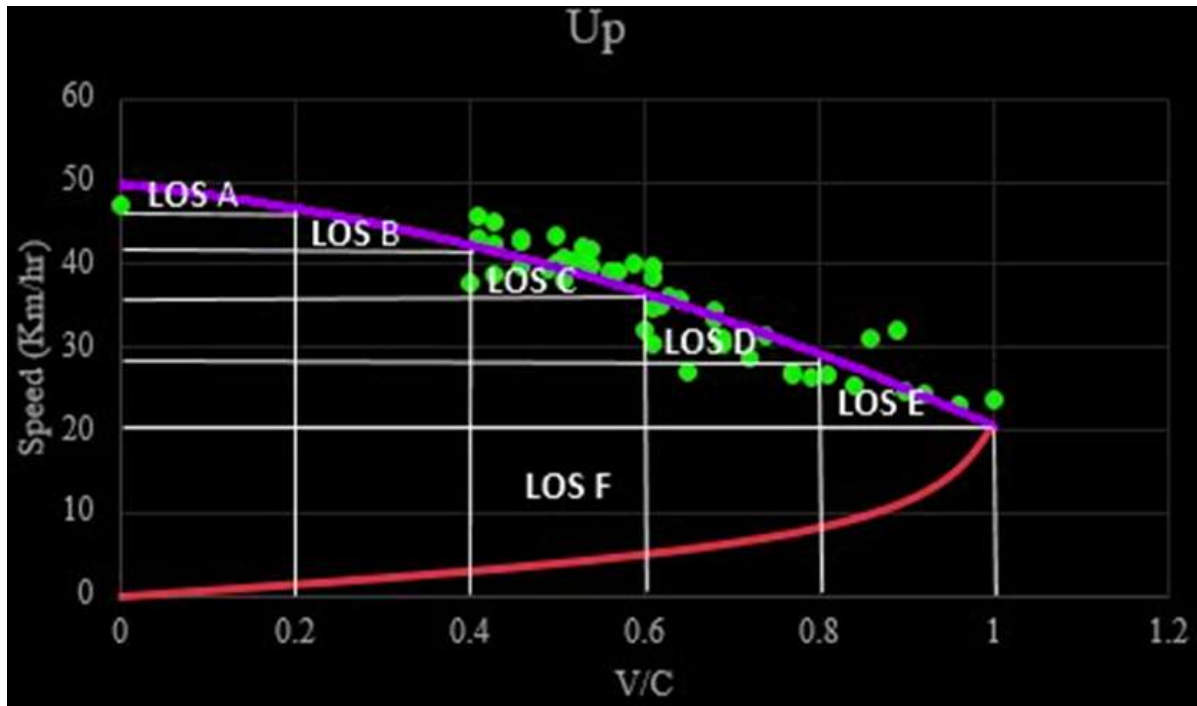


Figure 4: At Rampur Chowk to Choti Line Square, revised Loss Criterion (Up)(Solanki et al., 2016)

Table 1- Speed and V/C Ranges for Rampur Chowk to Choti Line Square (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>46
B	0.20-0.40	41-46
C	0.40-0.60	36-41
D	0.60-0.80	29-36
E	0.80-1.00	20-29
F	>1	<20

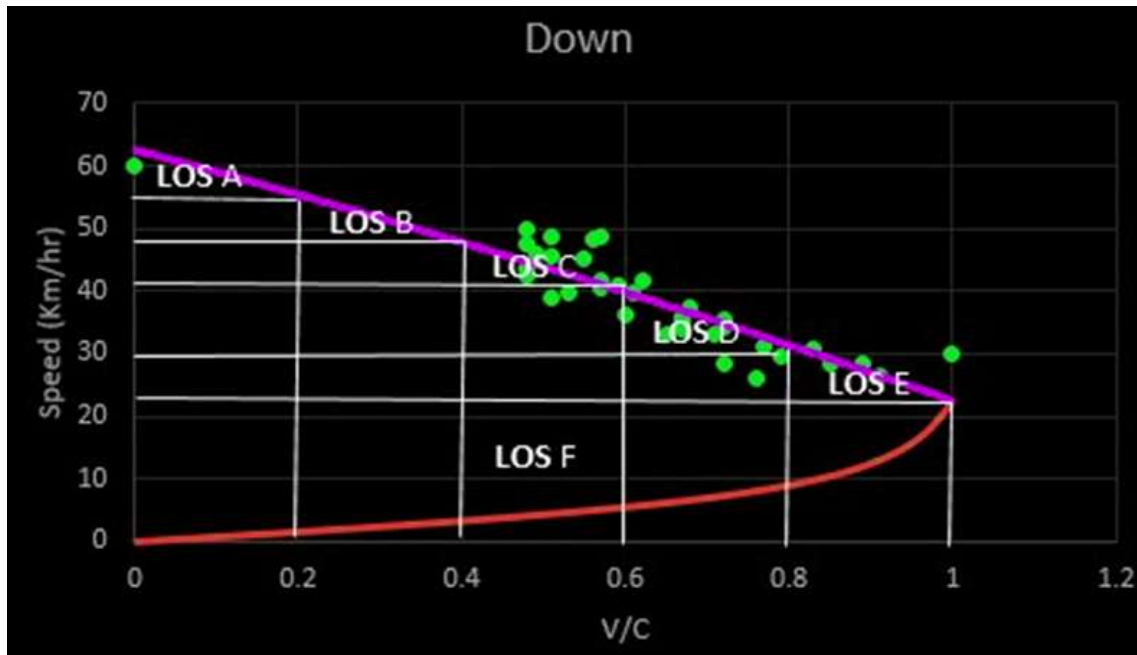


Figure 5: Rampur Chowk to Choti Line Square Section Amended LOS Criteria (Down)(Kapre et al., 2014; Nabiev et al., 2018; Raval et al., 2017)

Table 2: Rampur Chowk to Choti Line Square speed and V/C ranges (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>55
B	0.20-0.40	49-55
C	0.40-0.60	41-49
D	0.60-0.80	30-41
E	0.80-1.00	23-30
F	>1	<23

5.2 Choti Line Square, section of Bloom Chowk
The highest capacity for this section during nighttime peak hours is 4161 PCU/hr, while the

capacity for this segment in the downward direction is 2892 PCU/hr.(Biswas et al., 2016)

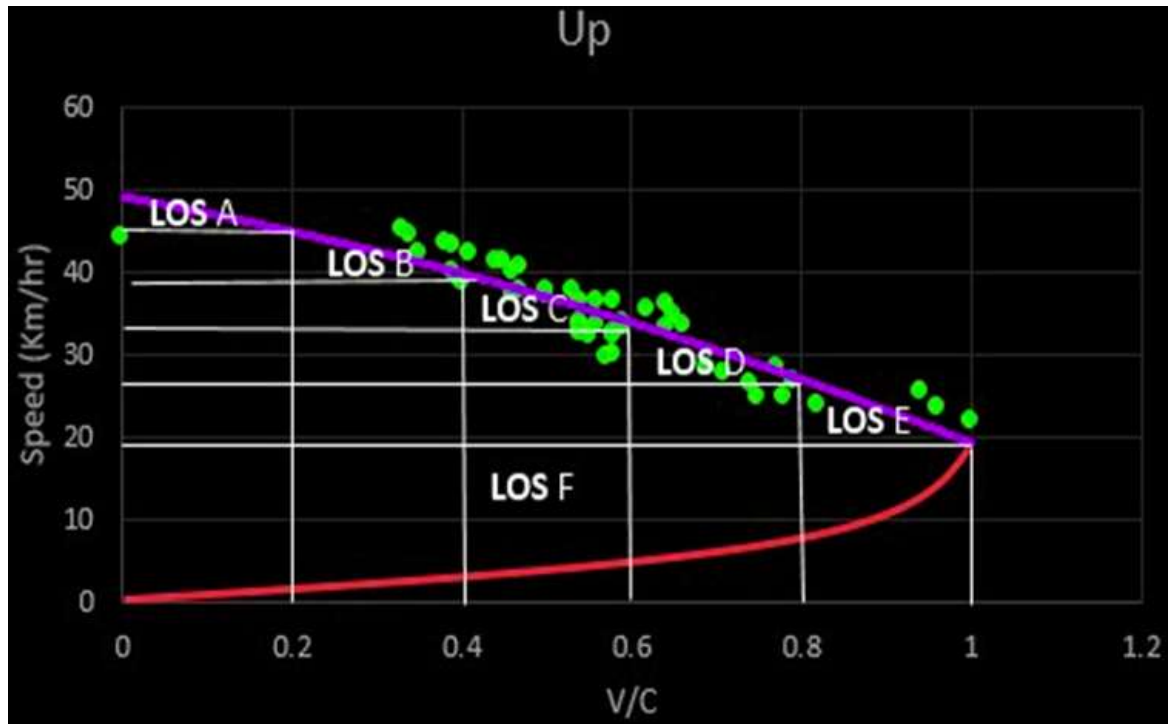


Figure 6: Choti line Square to Flower Chowk Part Amended LOS Criteria (Up)(Mujtaba, 1994)

Table 3 shows the Choti line Square to Bloom Chowk speed and V/C ranges (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>46
B	0.20-0.40	38-46
C	0.40-0.60	33-38
D	0.60-0.80	27-33
E	0.80-1.00	19-27
F	>1	<19

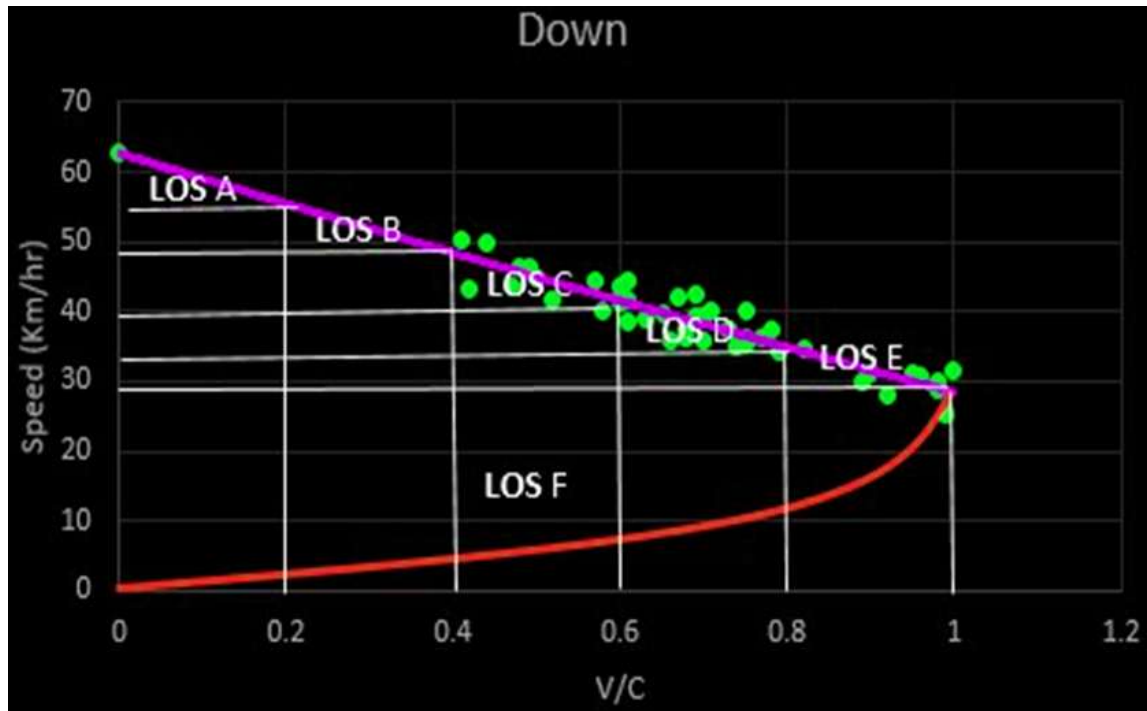


Figure 7: Choti line Square to Flower Chowk Part Amended LOS Criteria (Down)(Gautam & Jain, 2018)

Table 4- Choti line Square to Bloom Chowk Speed and V/C Ranges (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>54
B	0.20-0.40	49-54
C	0.40-0.60	40-49
D	0.60-0.80	32-40
E	0.80-1.00	29-32
F	>1	<29

5.3 Part of Bloom Chowk and Malviya Chowk

The capacity is attained at 3221.4 PCU/hr in the up direction and 3774.6 PCU/hr in the down direction during the evening peak hour.

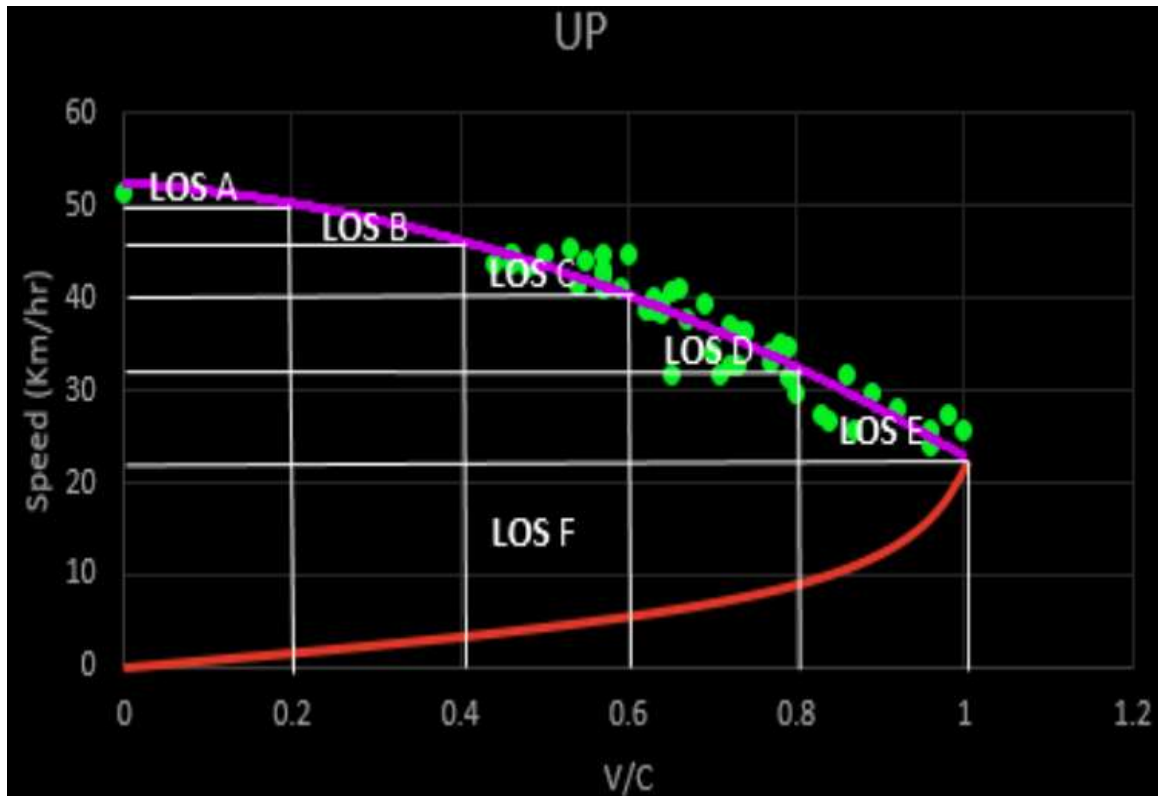


Figure 8: New LOS Standards for the Section from Bloom Chowk to Malviya Chowk (Up)

Table 5- Choti line Square to Bloom Chowk Speed and V/C Ranges (Up)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>50
B	0.20-0.40	46-50
C	0.40-0.60	40-46
D	0.60-0.80	32-40
E	0.80-1.00	22-32
F	>1	<22

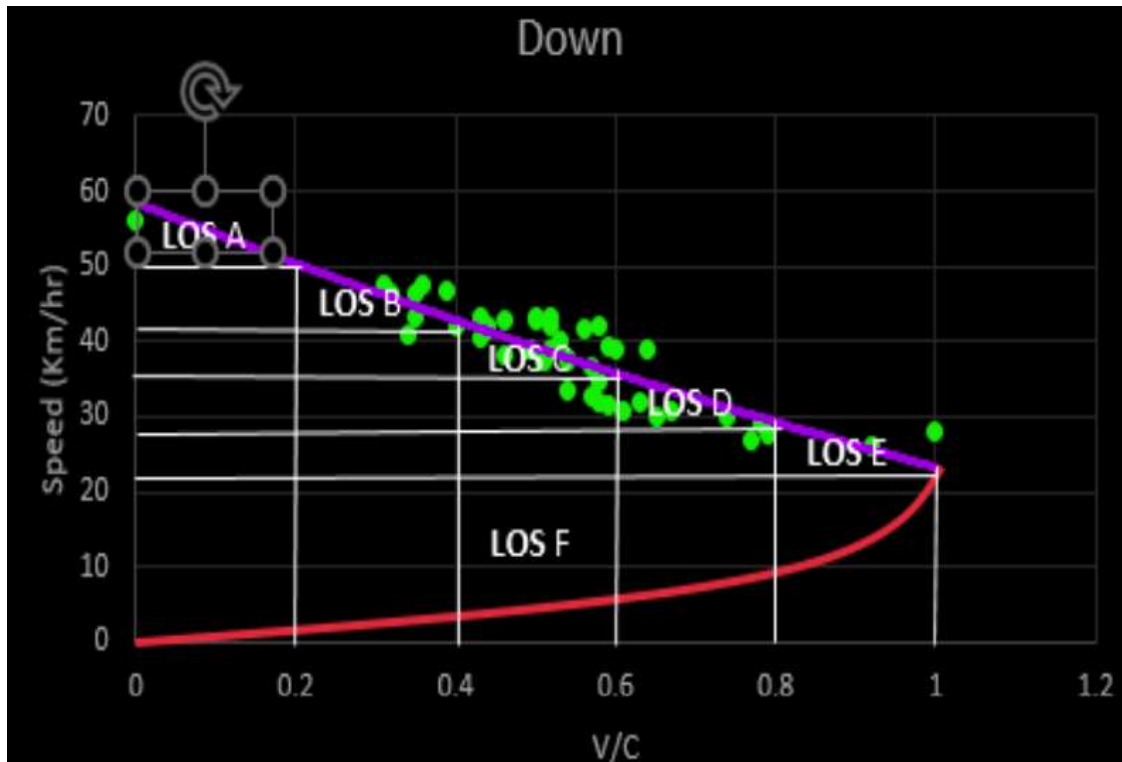


Figure 9: New LOS Standards for the Section from Bloom Chowk to Malviya Chowk (Down)

Table 6 shows the Choti line Square to Bloom Chowk speed and V/C ranges (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>50
B	0.20-0.40	41-50
C	0.40-0.60	36-41
D	0.60-0.80	28-36
E	0.80-1.00	22-28
F	>1	<22

5.4 Bada Phuhara Part of Malviya Chowk

The capacity attained during the evening peak hour is 3909 PCU/hr (Fig. 11—Revised LOS Criteria for Malviya Chowk), which is likewise the second-

highest capacity seen at Bada Phuhara Section (Down) in this complete stretch, whereas the capacity attained in the down direction is 3583.2 PCU/hr.

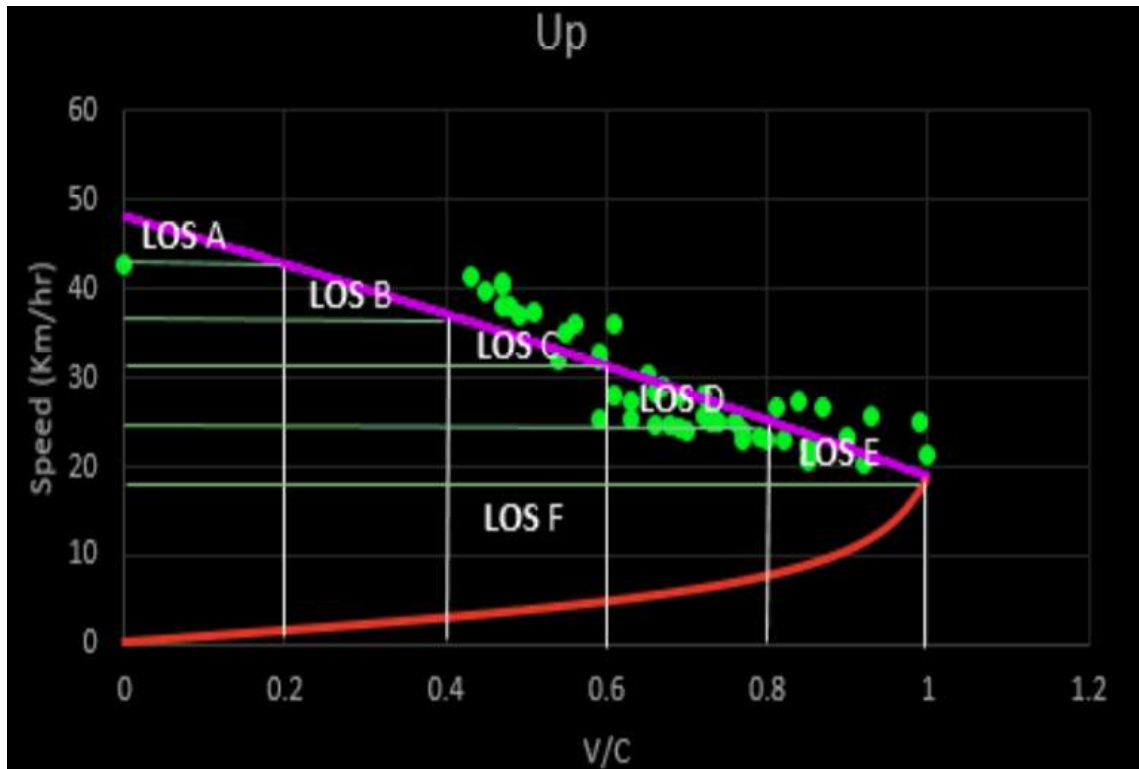


Figure 10: Bada Phuhara Part of Malviya Chowk

The capacity attained during the evening peak hour is 3909 PCU/hr (Fig. 11—Revised LOS Criteria for Malviya Chowk), which is likewise the second-highest capacity seen at Bada Phuhara Section

(Down) in this complete stretch, whereas the capacity attained in the down direction is 3583.2 PCU/hr.

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>43
B	0.20-0.40	37-43
C	0.40-0.60	31-37
D	0.60-0.80	24-31
E	0.80-1.00	18-24
F	>1	<18

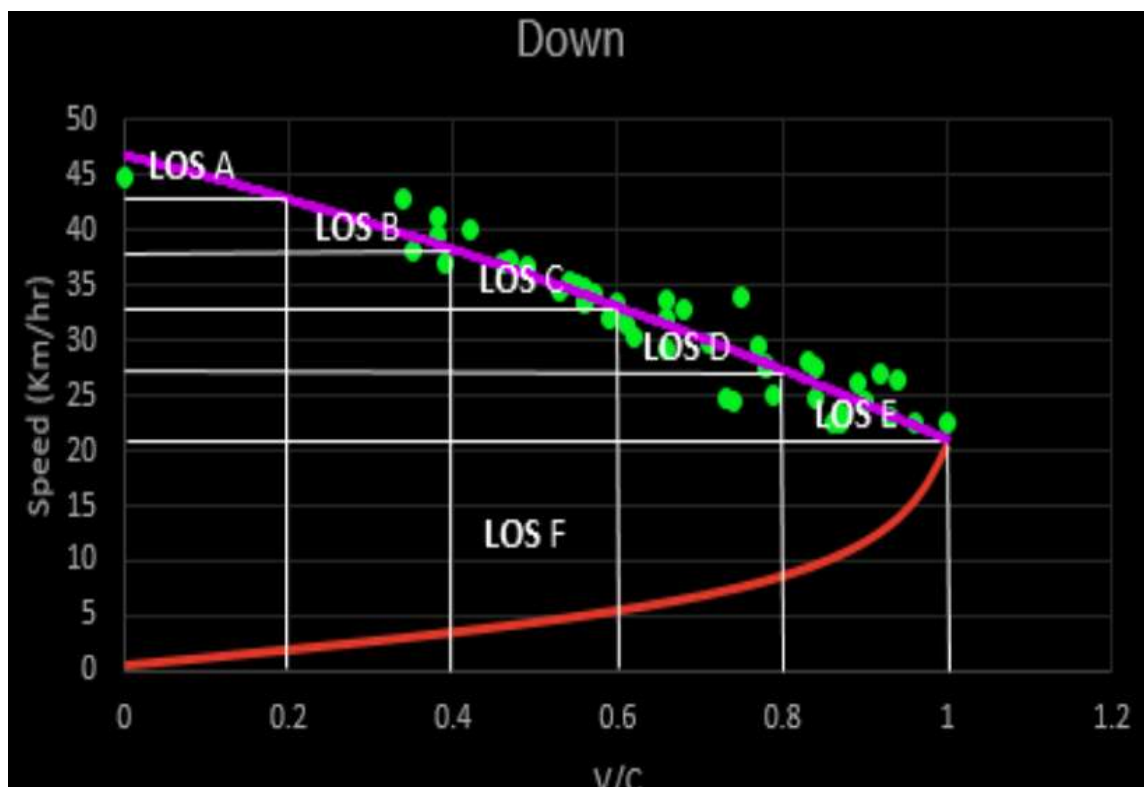


Figure 11: Malviya Chowk to Bada Phuhara Section Updated LOS Criteria (Down)

Table 8 gives the sectional speeds and V/C ranges from Malviya Chowk to Bada Phuhara (Down)

Level of Service	V/C Suggested	Speed (Km/hr)
A	<0.2	>50
B	0.20-0.40	41-50
C	0.40-0.60	36-41
D	0.60-0.80	28-36
E	0.80-1.00	22-28
F	>1	<22

6. Conclusion

The study's conclusions are listed below.

- For the portion of the chosen urban arterial route, a Speed-Flow relationship is built. The graph displays a second order polynomial quadratic relationship with a very high R square (0.903–0.7203), illustrative of an outstanding correlation between the reported speed and flow.
- Also developed is the speed-density relationship for the selected segment, which has a linear form and a R square that lies between (0.8448-0.9384).
- The majority of the traffic is composed of two-wheelers and vehicles, which account for 68% and 24% of the total volume of the stream, respectively. Other vehicle classes, such as 3-wheelers, buses, and light commercial

vehicles, have had a considerable influence on the capacity of the selected category.

- During the evening peak hour of 6 to 7 pm, the Choti Line Square to Bloom Chowk segment (up direction) has a maximum capacity of 4161 PCU/hr at a stream speed of 22.5 km/hr. The Malviya Chowk to Bada Phuhara length likewise works at a comparable capacity of 3909 PCU/hr with a stream speed of 20.2km/hr during the evening peak hour, giving both segments a v/c ratio >1 and placing them both under LOS F in compliance with IRC 106-1990.
- The greatest stated capacity at the Malviya Chowk to Bloom Chowk stretch (down direction) comes within the LOS F category, with 3774.6 PCU/hr and a stream speed of 23.5km/h, according to IRC 106-1990.
- At a density of around 188.2 PCU/km on the section between Choti Line Square to Bloom

chowk, the evening peak has the highest density.

- The HCM speed parameters for LOS A and LOS B, which range from 59 to 46 kilometres per hour, are lower than the speed parameters determined in this research for LOS A and LOS, which range from 51.5 to 44 kilometres per hour. Also, it's crucial to keep in mind that the permitted speed limits for this urban arterial road roughly correspond to the LOS "C to F" norms.

7. References

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