Estimation of Level of Service for Heterogeneous Traffic in Urban Area - A case study of Ahmedabad city

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Abstract—*The Highway Capacity Manual (HCM 2010) has defined Level of Service (LOS) mostly for the developed countries having leading contribution of motorized vehicles. Speed ranges of Level of Service (LOS) categories of urban streets are not well defined for highly heterogeneous traffic flow condition on urban streets in Indian context. The boost in urban traffic affects the quality of facility provided on the road. The flow of traffic on urban roads is highly complex & differs from rural roads.The existing models does not reflect the true traffic flow behavior on urban corridors.*

The present study includes the perception of road users in estimating the level of service criteria for heterogeneous traffic in urban corridors. For quantifying the quality of travel, the speed variation, delay etc. characteristics of different vehicles are studied on the urban roads. A sub-arterial road of Ahmedabad city is selected for estimating LOS criteria. Considerable variation is observed in the criterion values for different vehicle types under the automobile category. The observed capacity on Vijay cross road to Panjrapol cross road is varying from 3500 to 5000 PCU/hr. Speed-Flow relationship is developed for selected stretches. Revised LOS criteria for the observed traffic condition is suggested for the sub-arterial roads of Ahmedabad city.

***Keywords**-Level of Service, Heterogeneous traffic*

I. INTRODUCTION

Population of urban area is increasing rapidly due to shifting of people from rural to urban area, which increases vehicular traffic on urban streets. It causes problem of congestion in urban area. Road traffic congestion poses a challenge for all large and growing urban area. Congestion affects the traffic movement, reduce capacity of urban roads and causes effects such as air and noise pollution. Beside these, it also causes economic impacts by travel time reduction, excess fuel consumption, loss of productivity, high energy consumption and increase in accident rates. Hence, facilities are to beplanned and designed to provide a better Level of Service to the road users. In the present study,existing Level of Serviceof selected stretch is determined. The estimated Level of Service depends upon space mean speed and volume to capacity ratio i.e. V/C. The suggested LOS can be used for providing required traffic facilities to the road users.

II. OBJECTIVE OF THE STUDY

Followings are the objective of the present study:
1. To study the existing traffic conditions on the selected stretch.
2. To carry out study of traffic volume, capacity and space mean speed on the selected stretch.
3. To determine observed speed ranges for existing traffic.
4. To determine various parameters influencing the level of service.
5. To suggest criteria for defining level of service for selected stretch.

2.1 Background

Level of Service is a quantitative stratification of a performance measure that represents quality of service. The measures used to determine LOS for transportation system elements are called service measures (HCM 2010). LOS defined by HCM uses travel speed and the ratio of volume to capacity i.e. V/C ratio as performance measures. Six LOS are defined by HCM which is designated from LOS A to LOS F, with LOS A representing the best operating condition while LOS F as worst operating condition.

III. METHODOLOGY

The present study is an attempt to determine capacitybased on speed-flow behavior under heterogeneous traffic condition and establish Level of Service criteria for observed traffic condition. Followiong traffic parameters are considered for determining LOS for observed traffic condition.
- Space mean speed
- Flow
- Capacity
- V/C ratio

Followings are the steps performed for determining LOS.

1. Defining study area.
2. Classify urban street type and class.
3. Determining flow, space mean speed and capacity.
4. Determine V/C ratio.
5. Analysis of data to determine LOS.
6. Comparison of existing LOS criteria and observed LOS criteria.

IV. STUDY AREA AND DATA COLLECTION

4.1. Study Area

The stretchis selected from the Ahmedabad city for the data collection and its analysis. Ahmedabad lies at 23.03°N 72.58°E in western India at 53 meters (174 ft.) above sea level on the banks of the Sabarmati River, in north-central Gujarat. It covers an area of 464 km². A six-lane divided sub-arterial road with signalized intersectionhaving length of 2 km is selected as study stretch. The selected stretch starts from Vijay Cross roadand ends to Panjarapol Cross road in Navrangpura area of Ahmedabad city. The stretch is divided into two segments having similar geometric characteristics. The stretches are selected such that it does not have any effect of intersection on the mid-block.

4.2. Data Collection

To determine the criteria for LOS, traffic surveys are conducted for collecting data on classified volume count and speed of the vehicular platoon. Road Inventory surveyis carried out for collecting data regarding road geometry including number of lanes, lane markings, footpath, shoulder etc. The surveys are conducted on weekdays during morning and evening peak and during off-peak hours having wide ranges of traffic conditions and flow behavior. Traffic surveys are conducted by videography technique as well as manually. Traffic count is made at 5-minute interval and it is converted into flow i.e. PCU/hr by using PCU as per IRC-106[4].

Table 1. Road Inventory Data

Road type	Stretch	Carriage way Width-one way (meter)	Shoulder type & width	Foot-path width (meter)	Width of BRTS way (meter)	Median width (meter)	Road condition	Remarks
Six lane divided Sub-arterial road	Vijay cross road to LD Hostel	10.5	Bituminous 4.0m	2.2	-	1.5	Good	Varying shoulder width
	LD Hostel to Panjarapol cross road	10.5	Bituminous 1.0m	2.2	7.0	1.5	Good	Encroachment and Vehicles parked across the street so mostly 4 lanes are available for vehicular traffic

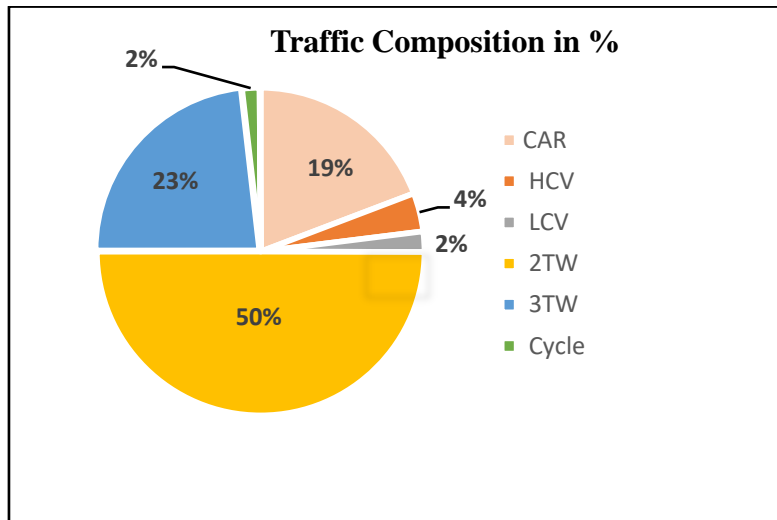The vehicle composition for observed traffic condition is shown in figure 1.

Figure 1. Vehicle composition chart

The vehicle composition for observed traffic condition is shown in Figure 1. Itis observed from figure 1 that traffic composition of two wheelers, auto and car is 50%, 23% and 19% respectively. The proportion of vehicular traffic significantly affects to the volume and speed, which ultimately varying the observed capacity.

Table 2. Observed Traffic flow

Time	Vijay cross roads to LD hostel			LD hostel to Panjrapol cross road		
	Towards Vijay cross road PCU/hr (one way)	Towards L.D. hostel PCU/hr (one way)	Total Flow observed PCU/hr (two way)	Towards Panjrapol PCU/hr (one way)	Towards LD hostel PCU/hr (one way)	Total Flow observed PCU/hr (two way)
09:00-10:00	3063	3830	6893	3124	3425	6549
10:00-11:00	3677	4512	8189	2937	3623	6560
17:00-18:00	3575	3560	7135	2793	2994	5787
18:00-19:00	4377	3837	8214	3036	3160	6196

Space mean speed is calculated using the following relationship. It is recorded from the extraction of video in 5-minute interval.

$$Space\ mean\ speed = \frac{n}{\Sigma \frac{1}{t_i}}$$ (1)

Where, n= no. of vehicles observed in 5 minute interval
ti= time mean speed of vehicles passing in 5-minute interval.

*Table 3.Observed Space mean speed*

Time	Vijay cross road to LD hostel		LD hostel to Panjrapol cross road	
	Towards Vijay cross road Km/hr	Towards L.D. hostel Km/hr	Towards Panjrapol Km/hr	Towards L.D. hostel Km/hr
09:00-10:00	32.96	34.95	35.97	33.85
10:00-11:00	33.02	34.48	34.63	32.93
17:00-18:00	31.07	31.92	34.19	31.44
18:00-19:00	31.92	31.49	32.49	34.48

It is inferred from Table 3 that space mean speed of vehicles is in the range of 31.44 kmph to 34.95 kmph in both direction. Due to congestion, the space mean speed of vehicular platoon is quite low in the area.

4.3 Speed-Flow relationship
The Speed-Flow relationship is established using the data collected in peak and off-peak hour. The speed data and volume data are obtained for the forced flow and free flow condition. The Speed-Flow relationship is shown in Figure 2.
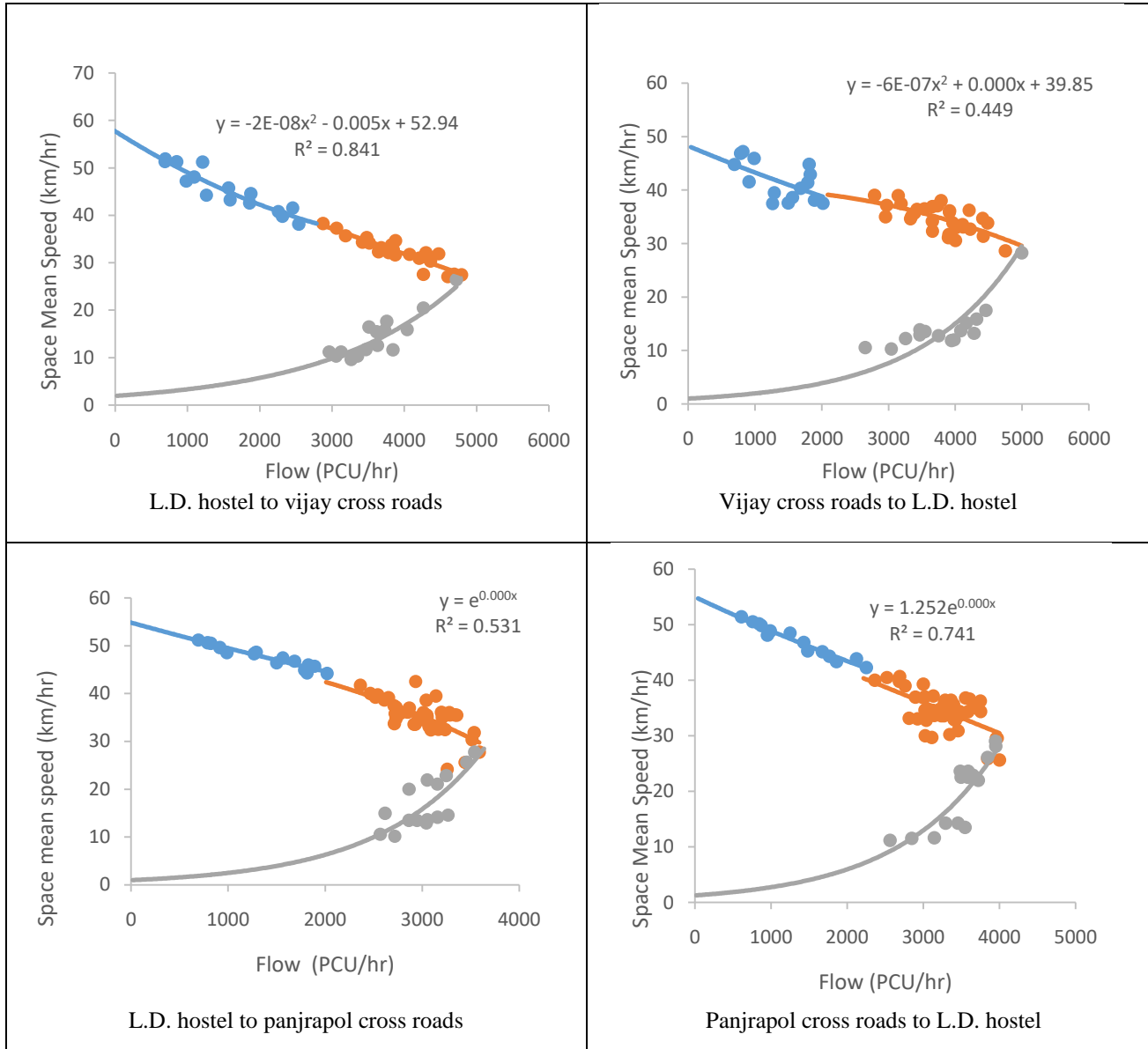
Figure 2. Speed-Flow relationship

Capacity standards are normally fixed in relation to level of service. Capacity is the maximum hourly volume (PCU/hr) at which vehicles can reasonably expected to traverse a point or uniform section of a lane or roadway during a given time under the prevailing roadway, traffic and control condition. The highest traffic volume observed in the selected mid-block section is considered as capacity of the road.

Table 4. Observed Capacity

Vijay cross roads to LD hostel		LD hostel to Panjrapol cross road	
To vijay cross road PCU/hr	**To L.D. hostel PCU/hr**	**To panjrapol cross road PCU/hr**	**To L.D. college PCU/hr**
4789	4996	3587	4002

Table 4 shows observed capacity of selected stretch from Vijay cross road to L. D. from L. D. hostel to Panjara pole cross road. The observed capacity in the selected sections is in the range from 3587 PCU/hour to 4996 PCU/hour. Capacity on Vijay cross road to L.D. hostel stretch is found more than stretch from L.D.hostel to Panjrapol cross road.

4.4 Establishment of Level of Service (LOS)

Volume to Capacity ratio is determined for each stretch and graphs of V/C vs Space mean speed are plotted. The highest and lowest speed observed on the upside curve are divided into equal intervals of speed for defining LOS. LOS 'A' to LOS 'F' has been defined from the graphs, which gives different ranges of V/C ratio and space mean speed for defined LOS. The downward curve represents LOS F.
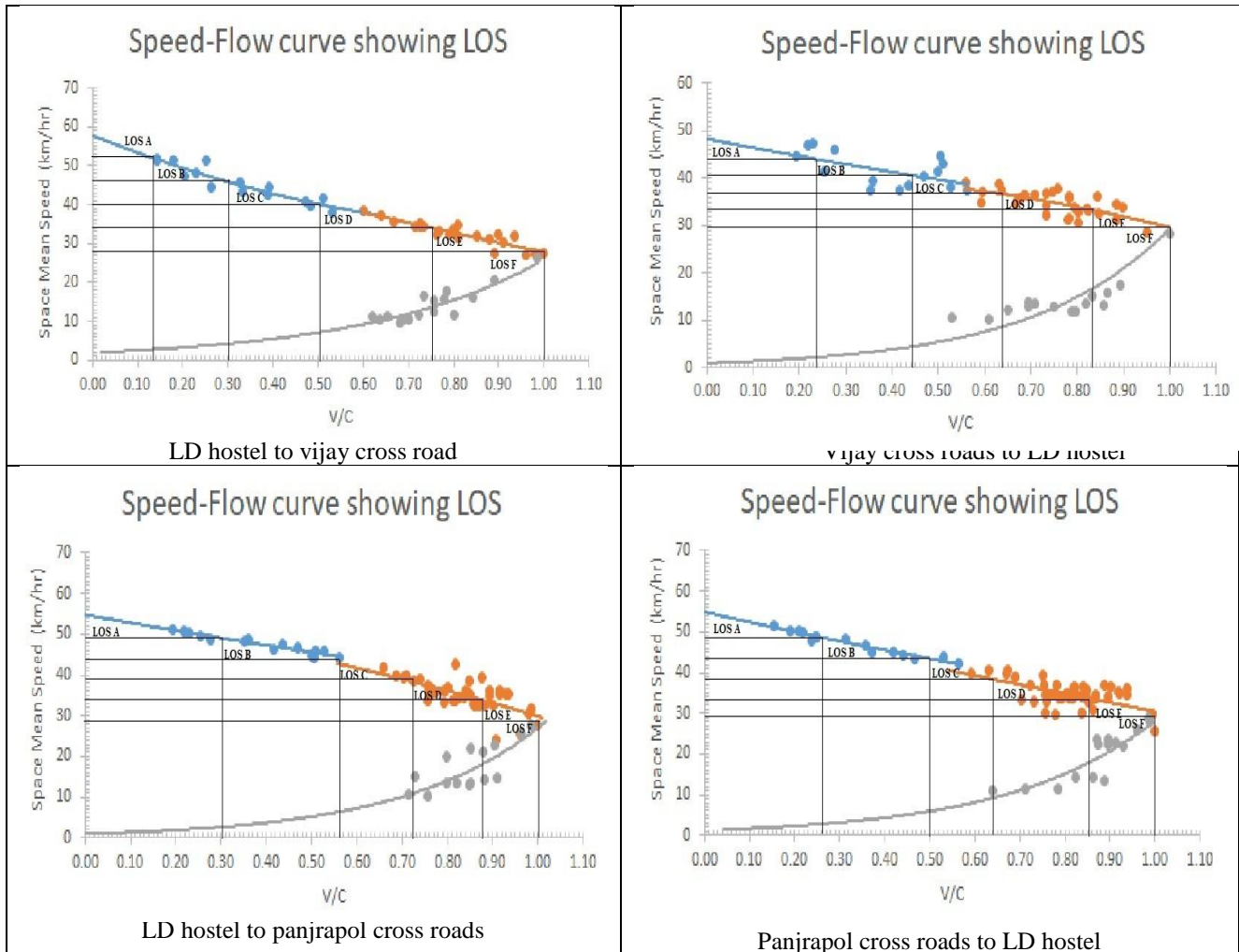
Figure 3.Curves showing proposed LOS criteria for Ahmedabad city

The LOS is suggested based on the v/c ratio and space mean speed. The range of v/c ratio and space mean speed are described in the Table 5 and 6. The v/c recommended for various LOS by Indo HCM and observed v/c for sub arterial road are compared and tabulated in Table 5.

Table 5.Comparison of LOS criteria

Level of Service	V/C ratio as per Indo HCM	V/C ratio suggested
A	<0.15	< 0.24
B	0.15-0.45	0.24 - 0.45
C	0.45-0.75	0.45 - 0.62
D	0.75-0.85	0.62 - 0.82
E	0.85 – 1	0.82– 1
F	> 1	> 1

It is concluded from Table 5 that V/C ratio plays significant role in deciding level of service. The LOS 'A' is considered while v/c ratio is less than 0.24, but Indo HCM suggest LOS 'A' while v/c ratio is less than 0.15. It is observed that criteria suggested by Indo HCM for LOS 'B' to 'F' is almost nearly to the suggested v/c ratio for Ahmedabad city.

Table 6. Comparison of Range of average stream speed

Level of Service	Speed range as per Indo HCM Km/hr	Speedrange for Vijay cross roads to LD hostel Km/hr
A	> 64	> 48
B	64 – 58	48 – 43
C	58 – 45	43 - 38
D	45 – 31	38 – 34
E	31 – 17	34 - 29
F	< 17	< 29

It is inferred from Table 6 that space mean speed is also an important parameter for determining level of service. The LOS 'A' is considered while space mean speed is greater than 48 kmph but Indo HCM suggest LOS 'A' while space mean speed is greater than 64 kmph. It is observed that criteria suggested by Indo HCM for LOS 'A' to 'E' is higher than the LOS suggested for Ahmedabad city. The suggested space mean speed for LOS 'F' is 29 kmph, which is higher than space mean speed recommended by Indo HCM.

V. SUMMARY AND CONCLUSION

Level of Service generally describes various conditions in terms of factors such as speed, travel time, freedom to manoeuvre, traffic interruption, comfort, convenience and safety. Six level of service are normally recognized designated from A to F. Level of service A represents best operating condition and F represents worst. In the present study, space mean speed and v/c ratio are analyzed and criteria are determined for predicting level of service. The ranges of v/c and space mean speed are determined from the speed-flow relationship. The suggested level of service criteria is compared with Indo HCM. The variation is observed for LOS 'A' condition considering v/c ratio. The variation is observed for LOS 'A' condition considering space mean speed.

VI. REFERENCES

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