Estimation of Dynamic PCU values at Signalized Intersection in Ahmedabad city

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Abstract : **Different classes of vehicles having broad range of characteristics travel on most of the roads in India. Heterogeneous traffic flow or mixed traffic flow is formed due to uncontrolled mixing of such vehicles on the roadways, having much complicated characteristics when compared to homogeneous traffic flow which consists of only single class of vehicle. Analysis of the heterogenous traffic flow is difficult unless these different classes of vehicles are transformed to one common standard vehicle unit. It is a general practice to consider the passenger car as the standard vehicle unit to convert other classes of vehicles called the Passenger Car Unit (PCU). The fundamental idea behind this practice is that different types of vehicles offer different degrees of impedance and hindrance to the traffic stream. The usual practice in India as per Indian Roads Congress is to set up the Static PCU values based on composition of different types of vehicle in the traffic stream as it affect the speed and other related parameters. But at the same time, Static PCU values do not portray the actual scenario of its variation along with the varying vehicular composition and flow rate. This is because different roads offer varying operating and vehicular characteristics. Taking this into consideration, it is advisable to estimate the PCU values based on the varying characteristics of vehicles by linking dynamism to it.**

In this paper, the traffic volume data collected through video recording method on multilane divided roads in a metropolitan city like Ahmedabad has been adopted for determining the Dynamic PCU values. The Dynamic PCU values are calculated with the help of two methods and the same is estimated with respect to flow and speed.

Key Terms **– Dynamic PCU, Signalized intersection, Heterogenous traffic, Dynamic factors, Traffic behavior, Classified Volume.**

1. INTRODUCTION

In India, the reckless pace of urbanization has affected various sectors of the country amongst which the transportation sector is in the limelight because of urban vehicular growth and this effect is felt in terms of traffic congestion, delays, and transport inefficiency. When compared to the rural areas, the range and nature of traffic problems of urban areas are completely different. Therefore, urban areas always exist at the core of the research sphere of traffic engineering with all its concepts associated to the traffic characteristics. Knowledge of roadway capacity is of extreme importance for the proper understanding of traffic characteristics. Traffic in India is extremely heterogeneous consisting of vehicles having broad range of static characteristics such as length, width, etc., and dynamic characteristics as speed, acceleration, etc. Therefore, the heterogeneous traffic flow characteristics are very much complicated when compared to homogeneous traffic consisting of passenger cars only. Now to overcome this difficulty it is necessary to bring all vehicle classes to a common unit called passenger car unit. The concept of passenger car unit has been in use in several countries abroad, as car contributes to a major share of the traffic flow. The thought of considering car as the basic vehicle on urban roads is followed in the Indian context so as to account for the effect of varying vehicle types. Current practice in India is to use different PCU values based on the composition of various vehicle types in the traffic stream regarding 5 % and 10 % of any particular vehicle type. These values are called Static PCUs as they remain constant across varying conditions of traffic volume irrespective of variation in other parameters of traffic stream. But the roads located in different cities including Ahmedabad, exhibit varying operating and vehicular characteristics. Thus, PCU values are estimated based on dynamic characteristics of vehicles which would represent a more factual scenario.

2. STUDY AREA

Shyamal Cross roads located in Ahmedabad city of Gujarat, India, is selected as the study area for the purpose of present study. This is a four-legged junction denoted by "A" for convenience. Similarly, the approach lanes are named A1, A2, A3, A4 with respect to north direction. The exact location has been shown in Fig. 1.

Figure 1. Location-Intersection A

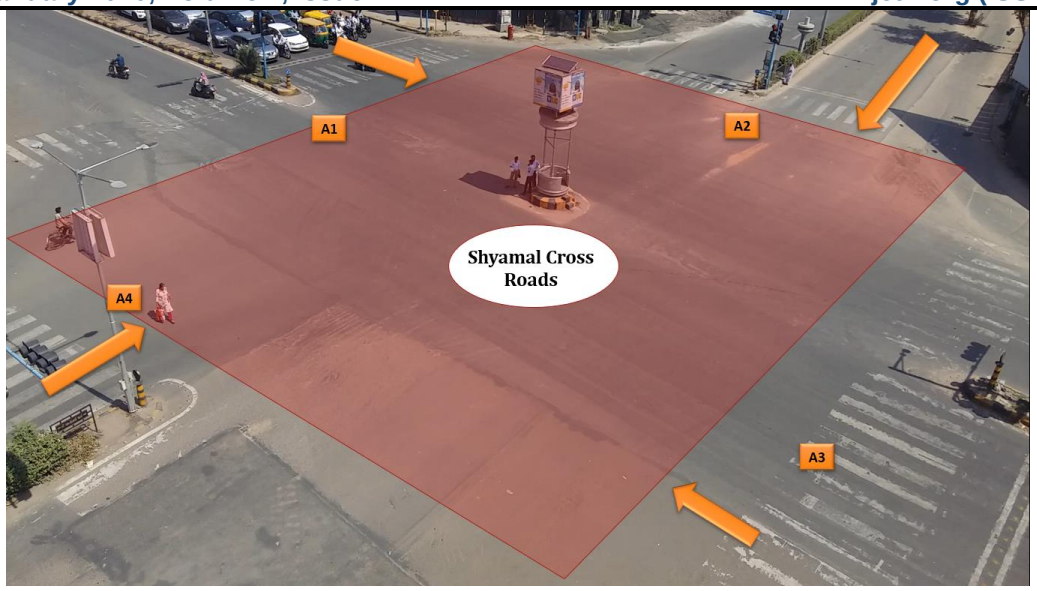

Figure 2. Intersection A

3. METHODOLOGY

Road Inventory data of all the four approaches is collected. For collection of traffic volume data, video recording method is used. Morning and evening peak hours are taken into account for this study. Traffic volume study is recorded in terms of turning movements and speed. Data is presented in the form of pie charts showing hourly % vehicular composition. Based on these values Static PCU values are calculated as per IRC 106-1990 for different classes of vehicles. The dimensions i.e. length and width(m) and projected area of vehicle on the road(m^2) are obtained from the video recording. Also the average velocities(km/hr) on the roads of selected intersection are calculated likewise.

Dynamic PCU values are estimated with the help of two methods viz. Homogenous Co-efficient method and S. Chandra's method. Finally, Static PCU values and Dynamic PCU values (estimated by both methods), is compared.

4. DATA COLLECTION

Two types of data are needed for this study viz. (1) Road Inventory data and (2) Traffic Volume data. For the estimation of Dynamic PCU values, the effective road widths are extremely important along with approach length and type of road, which is given in Table.1. Figure 3. portrays clearly the approach lanes and respective traffic movements.

Table 1: Road Inventory Data

Junction	Approaches	Road Type	Approach Length (m)	Approach Width (m)
A	A1	4-lane divided	500	30
	A2	4-lane divided	340	18
	A3	4-lane divided	452	30
	A4	4-lane divided	462	18

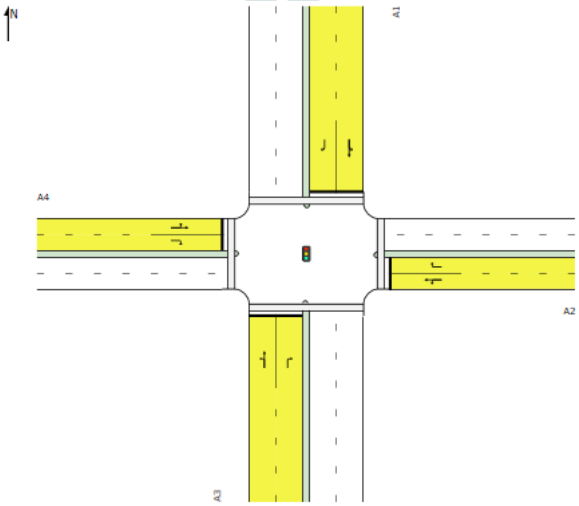

Figure 3. Diagrammatic representation of A

5. DETERMINATION OF STATIC PCU VALUES

The total number of vehicles are calculated on the basis of the data obtained with the help of video recording. Based on that, hourly % composition of different classes of vehicles are calculated and represented in the form of pie charts. According to IRC 106-

1990, Static PCU values are calculated based on 5% and 10% and above vehicular composition. The calculated values of Static PCU are shown in Table 2.

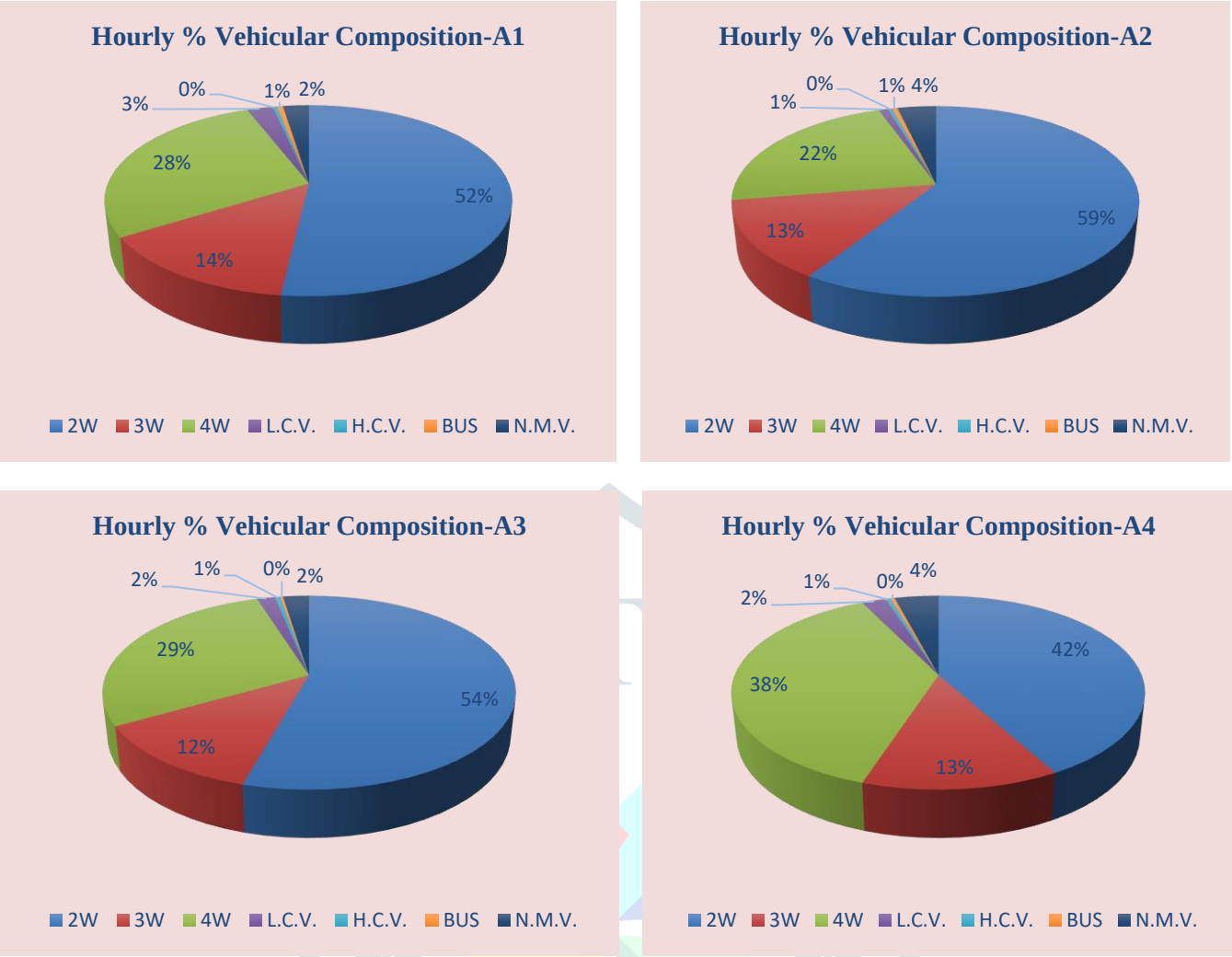

Figure 4. Hourly % vehicular compositions at A

Table 2: Static PCU values as per IRC 106-1990

Vehicle Category	2W	3W	4W	LCV	HCV	Bus	NMV
Static PCU	0.75	2.00	1.00	1.40	4.00	3.70	0.50

6. Estimation of Dynamic PCU values

There are different methods of estimation of Dynamic PCU values at a signalized. Out of these methods, two widely used methods are selected for present study. In Homogenization Coefficient Method and Chandra's Method the PCU value is directly proportional to the speed ratio. The difference between these methods is that the PCU value in the former method is inversely proportional to the length ratio and in the later method the PCU value is inversely proportional to the projected area ratio.

1. **Homogenous Co-efficient method**
2. **S. Chandra's method**

1. Homogenous Co-efficient method

This method is mainly adopted by developed countries where homogeneous traffic conditions persist and lane discipline is followed. The DPCU value is determined by using equation

$$DPCU = \frac{L_i}{V_i} \div \frac{L_c}{V_c} \qquad (1)$$

Where, L and V are the length and speed of a vehicle; suffix i indicates a vehicle type and c indicates the car.

2. S. Chandra's method

This method is the modification of homogenization coefficient method in which the length of vehicle is considered for the PCU calculation while in here the length of vehicle is replaced by the projected area of the vehicle. The PCU value is determined by using following equation:

$$DPCU = \frac{V_c}{V_i} \div \frac{A_c}{A_i} \quad (2)$$

Where, V_c and V_i are speeds of car and vehicle i respectively and A_c and A_i are their projected rectangular area.

Table 3: Static and Dynamic characteristics of Vehicles as per observation

Vehicle Category	Length (m)	Width (m)	Projected Rectangular Area (m2)	Average Speed(km/hr)
2W	1.87	0.64	1.16	35
3W	3.20	1.40	4.48	30
Car	3.72	1.44	5.36	45
LCV	4.30	1.56	6.71	30
HCV	6.70	2.30	15.41	35
Bus	10.10	2.43	24.54	50
NMV	1.90	0.45	0.86	15

7. Result and Discussion

Following Table 4. shows the comparison of Static and Dynamic PCU values for different categories of vehicles.

Table 4: Comparison of Static and Dynamic PCU values

Vehicle Category	SPCU	DPCU	
	Static PCU (IRC 106-1990)	Homogenous Co-efficient method	S. Chandra's method
2W	0.50	0.65	0.28
3W	2.00	1.29	1.25
4W	1.00	1.00	1.00
LCV	1.40	1.29	1.88
HCV	4.00	2.32	3.70
Bus	3.70	2.44	4.12
NMV	0.50	1.53	0.48

- Homogenization Coefficient Method gives higher PCU values for smaller vehicles as 2W, 3W when compared to S Chandra's Method.
- S Chandra's Method gives higher PCU values for larger vehicles as Bus, LCV, HCV when compared to homogenization coefficient Method.
- S Chandra's method is more accurate and reliable as it takes into account the projected area of vehicles unlike Homogenous Co-efficient method, which considers only the length of vehicles.

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