Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 4, April-2016

TO DEVELOPE DYNAMIC PCU OF VEHICLES IN HETEROGENEOUS TRAFFIC STREAM ON MULTILANE ARTERIAL ROAD : A CASE STUDY OF VADODARA CITY

BAADAL SHAH[1], DR.L.B.ZALA[2], PROF.A.A.AMIN[3]

[1]*M.E. Transportation engineering, B.V.M. Engineering college vallabh vidhyanagar, Gujarat, India*

[2]*Head of civil department, B.V.M. Engineering college vallabh vidhyanagar, Gujarat, India*

[3]*Assistant professor of civil department, B.V.M. Engineering college vallabh vidhyanagr, Gujarat, India*

ABSTRACT : Present study is aimed to understand the mixed traffic characteristics of urban arterial roads and to arrive on equivalency factor for converting heterogeneity to homogeneity. Passenger Car Equivalent (PCE) or Passenger Car Unit (PCU) value is very important for any traffic flow studies of vehicles. Passenger car equivalents (PCE) are used as factors to convert a traffic stream composed of different vehicle types into an equivalent traffic stream composed exclusively of passenger cars (reference vehicles). Present study reviews the Chandra's method have been used to calculate dynamic PCU. The midblock section of Vadodara city is selected for study purpose. The study presents a methodology to convert a mixed traffic stream into a homogeneous equivalent unit without making use of static PCU factors. Traffic volume and speed data collected on urban arterial road of Vadodara by using Videographic Technique are analyzed to determine Dynamic PCU values of different categories of vehicles.

Keywords: Mixed traffic characteristics, Urban arterial roads, Midblock, Dynamic PCU.

I.INTRODUCTION

Nowadays congestion is one of the major problems prevalent on arterial roads, sub arterial roads of cities in India. In this respect, a better traffic management requires a clear understanding of traffic flow operations. In rapidly increasing growth of country like India requires well developed arterial roads, sub arterial roads and collector roads which require understanding of traffic flow characteristics. In an Indian context the traffic is heterogeneous in nature. All types of vehicles like two wheelers, three wheelers, four wheelers, LCV, bus, cycles, handcarts and pedestrian moves on the same road, with different speed. The speeds of vehicle vary from five kmph in the case of hand carts to sixty kmph in the case of two wheelers and four wheelers. The speed of different vehicles may vary on different roads in different traffic condition. Because of traffic is heterogeneous in nature in country like India the chances of congestion is increases which causes delay which affects on speed, environment, health, travel time and other relevant parameters. For understanding of traffic behavior in heterogeneous condition basic different traffic flow characteristics like traffic volume, speed, density, headway data are required. Data of traffic flow characteristics like volume, speed, and Dynamic PCU values are required for the planning and designing of road system. Hence, it is necessary to count traffic volume and spot speed study which is measured accurately by adopting appropriate methodologies like manual method and video-graphic technique.

The traffic system management basically depends on the two major stream flow parameters like speed and flow rate as they reflect on the delay time and travel time. So it is necessary to conduct surveys on multilane arterial road with mixed traffic composition. Two lane two way divided arterial road Jawaharlal Nehru marg of Vadodara city is been selected which carries high volume of traffic and heterogeneous in nature. The study of traffic flow is very necessary and useful for the designing and planning of any roads, highways or for providing transportation facilities for present condition and also for future aspect. Traffic is increasing drastically every year in all urban area of India because of the rapidly increase in privately owned vehicles like 2 wheelers, 3 wheelers and 4 wheelers. By knowing the flow characteristics one can easily determine whether a particular section of road is handling traffic much above or below its capacity. The knowledge of traffic characteristics is useful to the road engineer in developing roads, motorways and transportation plans, performing economic analysis, establishing geometric design criteria, selecting and implementing traffic control measures and evaluating the performance of transportation facilities.

The traffic congestion is problem on urban roads of Vadodara city. Jawaharlal Nehru marg of Vadodara city is proposed on which is highly congested area where the movement of vehicles like handcarts, 2W, 3W, 4W, buses, cycles and trucks is heavy. Traffic congestion and safety are serious problems, impacting on the economy, environment and quality of life in our cities. High proportion of two wheelers and three wheelers in the traffic composition raises the question mark for the suitability of passenger car as equivalent vehicle for expression of stream flow variables like volume and density. The study area includes the Jawaharlal Nehru marg from Lakshmi (Laxmi) Vilas palace to T-intersection of Vinoba Bhave road, Tilak road and Jail road (Janta chokdi). Due to heterogeneous traffic there is large amount of congestion in this area. The traffic in this area includes vehicular as well as pedestrian traffic. Therefore it is necessary to carry out traffic analysis in this region to design new facilities sand divert traffic to the routes which are less congested compared to the more congested ones. By removing violation in the area the existing conditions can be improved and road user can be benefited.

Objectives of the study are as follows:

- To obtain Dynamic PCU or Dynamic Vehicle Equivalent Factor (DVEF) for heterogeneous traffic.
- Study of macroscopic traffic flow characteristics.

Vikas Kumar Reddy studied the the mixed traffic characteristics of urban arterial road & arrived on equivalency factor for converting heterogeneity to homogeneity. Surat and Hyderabad were selected for study area. Traffic volume and speed data collected on arterial road by videographic technique were analyzed to determine Dynamic PCU for different vehicles. Focus of the study was to develop DCU. By using DCU vehicle composition, speed and flow rate were carried out. Effect of static characteristics is incorporated by comparing area ratio to speed ratio. It was concluded that PCU value for IRC:106 for 2w and 3w were more than DCU. It was found that DCU is appropriate to convert vehicle flow into equivalent term. Arasan et al. (2010) used simulation technique for four-lane as well as six-lane divided road and found that in the case of vehicles that are larger than passenger cars, at low volume levels, the PCU value decreases with increase in traffic volume and at high traffic volume levels, the PCU value increases with increase in traffic volume. In the case of vehicles that are smaller than passenger cars, at low volume levels, the PCU value increases with increase in traffic volume and at high volume levels, the PCU value decreases with increase in traffic volume. They concluded that the PCU value of the different categories of vehicles, due to change in traffic volume, under heterogeneous traffic condition, is directly influenced by the change in the speed difference between the reference vehicle (car) and the subject vehicle.

II.DATA COLLECTION

Traffic surveys like spot speed study, traffic volume count were carried out to collect data for the analysis on selected stretch which are helpful in deciding geometric features of road, and traffic control techniques for safe and efficient movement of vehicles on the road. These are the different traffic surveys are to be carry out on the selected stretch. i) Road Inventory survey ii) Classified Volume Count by manual counting method iii) Spot Speed study by videographic technique**.**

i)ROAD INVENTORY SURVEY

Road Inventory survey gives the details of geometric of roads and also the land use in the area. Table 1 gives the road inventory details such as Footpath width, median width, carriageway width and landmarks.

Table 1 Road inventory survey

JAWAHARLAL NEHRU MARG								
	FROM: LAKSHMI VILAS PALCE				TO: T- intersection of Vinoba Bhave road, Tilak road and Jail road of Vadodara city			
Sr no	Footpath width	Shoulder width	Carriage-way width	Median width	Carriage-way width	Shoulder width	Footpath width	Land-Marks (L.H.S/R.H.S)
1	2 m.	1.50 m	6.90 m	0.93 m	7.90 m	1.80 m	2 m	Lakshmi vilas palace
2	2 m	1.50 m	6.90 m	0.93 m	7.90 m	1.80 m	2 m	Polo Ground (L)
3	2 m	1.70 m	6.84 m	0.93 m	11.40 m	2 m	1.60 m	Akota Circle
4	2 m	1.10 m	6.80 m	1.70 m	6.70 m	-	2 m	Indira Gandhi T -intersection
5	2 m	1.10 m	6.40 m	1.70 m	6.30 m	-	2 m	Police Bhavan (R)
6	2 m	0.80 m	6.35 m	1.70 m	6.35 m	1.20	2.60 m	Madhyasth Jail (L)
7	-	0.80 m	6.40 m	1.60 m	6.50 m	-	2.60 m	T-intersection of Vinoba Bhave road, Tilak road and Jail road of Vadodara

III.CLASSIFIED VOLUME COUNT ANALYSIS

Traffic volume counting is the number of vehicles passing a point or entering a stretch is considered in the analysis of roadway operations. Here manual and videographic techniques were used for the measurement of volume. 16 hour classified traffic volume count is carried out from 6:00 AM to 10:00 PM. Classified traffic volume has been carried out on a 4-lane divided road on Jawaharlal Nehru marg of Vadodara. Total traffic Volume count from Lakshmi Vilas Palace to Akota Bridge Circle is shown in Figure1 and total traffic volume from Akota Bridge Circle to Lakshmi Vilas Palace is shown in figure 2.

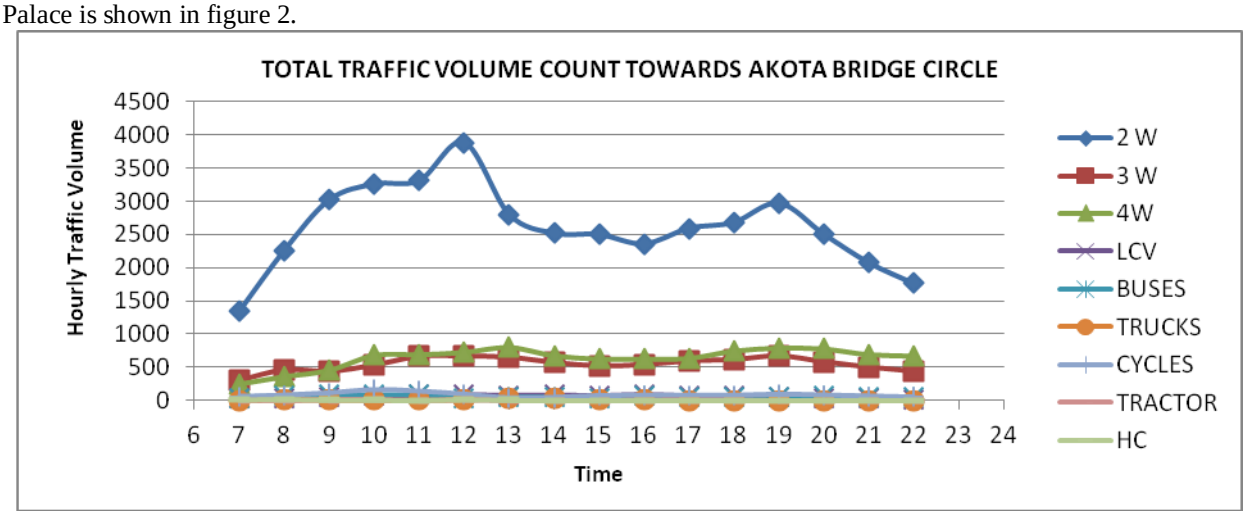


Figure1: Total traffic Volume count from Lakshmi Vilas Palace to Akota Bridge Circle

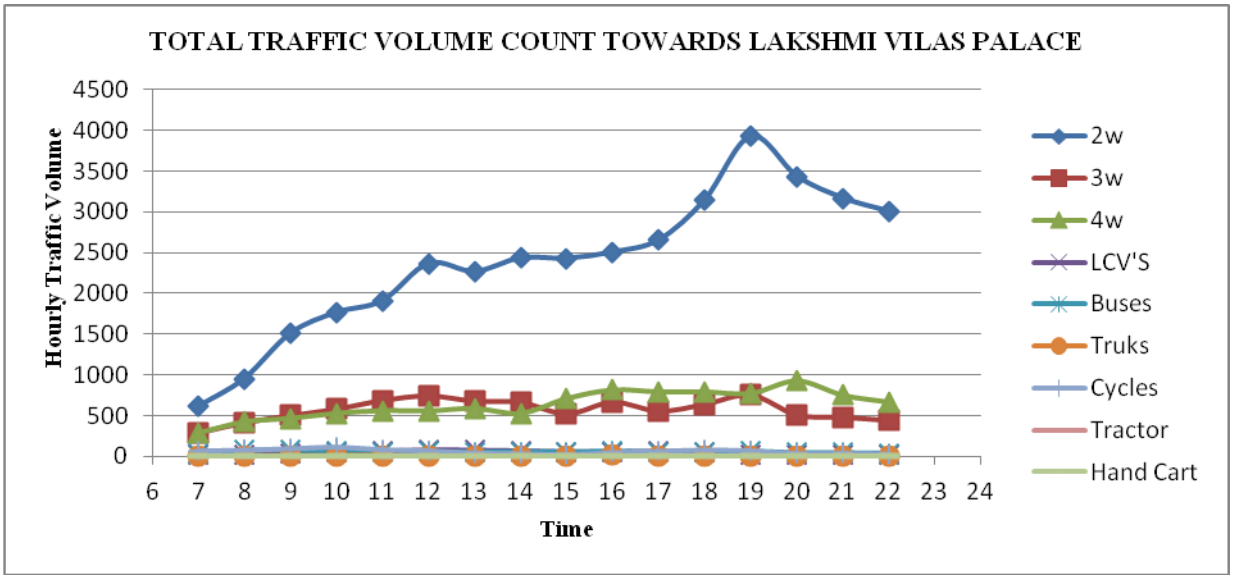
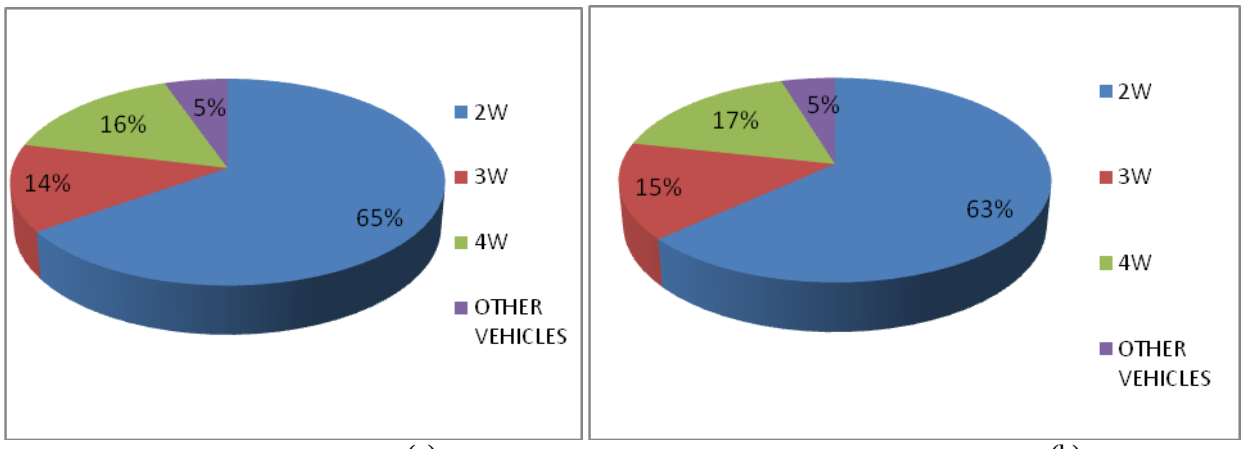


Figure 2: Total traffic Volume count from Akota Bridge Circle to Lakshmi Vilas Palace

The proportion of vehicles in a traffic stream is very important parameter for geometric and structural design of any pavement. Analysis of traffic composition gives the idea of proportion of wide verity of vehicles. So, it is crucial to know the traffic composition of various sections. Vehicle composition percentages from Lakshmi villas palace to Akota bridge circle is shown in figure 3 (a) and composition percentage from Akota bridge circle to Lakshmi villas palace is shown in figure 3(b). It is found that two wheelers has the highest percentage in the traffic stream. It is found that, truck, cycle, light commercial vehicle has the lowest percentage in the traffic stream and percentage of three wheelers and four wheelers shows slightly variation in volume of traffic. It is observed from figures that two wheelers traffic composition is predominant at both sides.



(a) (b)

Figure 3: (a) Traffic composition from Lakshmi villas palace to Akota bridge circle
(b) Traffic composition from Akota bridge circle to Lakshmi villas palace

IV. ANALYSIS AND RESULTS

i) SPEED ANALYSIS

Traffic performance on the roads is fundamentally measured by the speed under the given roadway design, demand and control conditions. Speed is highly sensitive to the interaction among vehicles in the stream. Relative and cumulative frequency analysis of classified spot speeds is carried out. On selected stretch Jawaharlal Nehru marg spot speed is carried out by videographic technique in morning peak hour at the time of 9.30 AM to 10.30 AM and in evening peak hour at the time of 5.00 PM to 6.00 PM. Spot speed study is also carried out in off peak hour at the time of 3.00 PM to 4.00 PM. Table 2 shows the 98th, 85th, 50th and 15th percentile speeds of all vehicles for the Jawaharlal Nehru marg. Two wheelers are travelling at higher speed compared to the other vehicles.

Table 2 : Spot Speed Analysis of Jawaharlal Nehru marg

Percentile Speed	2W	3W	4W	LCV	BUS	CYCLE	TRUCK
15th	18.35	16.7	18.6	17.7	14.3	11.1	
50th	24.67	21.3	24.9	21.9	19.9	12.5	17.6
85th	33.21	25.4	31.1	29.1	25	17.1	25
98th	38.96	29.3	35	32.1	27.8	19.9	31.8

ii) DYNAMIC PCU OR DYNAMIC VEHICLE EQUIVALENT FACTOR

The vehicle equivalent factor or dynamic PCU is most likely to vary as the flow rate and speed of the stream change from time to time. This is more relevant where hourly variations of flow rate are quite significant.

Under the circumstances, it is desirable to derive the vehicle equivalent factors which take care of the fluctuations in stream speed and also the speed of the individual vehicles for the road. Such vehicle equivalent factors vary dynamically as the speed of the reference vehicle in the mixed flow changes and hence are called Dynamic Vehicle Equivalent Factors (DVEF). In the present study, dynamic vehicle equivalent factors are found considering car as reference vehicle. Effect of static characteristics is incorporated by comparing projected area of reference vehicle and the other vehicle in terms of area ratio (α). Speed ratio; described as ratio of speed of reference vehicle to the subject vehicle; is adopted to include effect of speed differential as dynamic

characteristics. It may be noted that while area ratio (α) remains constant for a vehicle type under all the flow conditions, speed ratio (γ) varies dynamically with the flow rate.

Mathematically,

$$DVEFX = (\gamma/\alpha)$$

Source: Satish Chandra (2004)

Where, DVEFX = Dynamic Vehicle Equivalent Factor considering 'X' reference vehicle; γx-y = Speed Ratio during a time interval = VX/VY; αX-Y = Area Ratio = AX/AY; VX = Spot aped of 'X' reference vehicle during a time interval; VY = Spot aped of 'Y' subject vehicle during a time interval; AX= Projected area of 'X' reference vehicle; AY= Projected area of 'Y' subject vehicle. Area ratio (∞) is important criteria for finding Dynamic VEF or dynamic PCU in homogenization coefficient method as shown in above formula. In our case projected area for vehicles based on their average dimensions is given in table 2.The area ratios for vehicles considering 4w as reference vehicles are given in table 3.

Table 3 Vehicular dimensions, clearances and area

Vehicle type	Overall dimension (m)		Minimum lateral-clearance share (m)		Area of Vehicle (m^2)
	Length	Breadth	At zero speed	At a speed of 60 km/h	
Motorized 2w	1.8	0.6	0.1	0.3	2.88
Motorized 3w	2.6	1.4	0.2	0.4	7.48
4w	4.0	1.6	0.3	0.5	13
Buses	10.3	2.5	0.3	0.6	42.55
LCV	5.0	1.9	0.3	0.5	17.4
Bicycles	1.9	0.5	0.1	0.3	2.75
Tricycles	2.5	1.3	0.1	0.3	5.89

Table 4 Area ratios for vehicles considering 4w as reference vehicles

Vehicle	Reference vehicle
	4w
2w	4.51
3w	1.74
4w	1
BUS	0.31
LCV	0.75
Bicycle	4.73
Other NMT	2.21

ii) COMPUTATION OF DYNAMIC PCU: Here table 4 describes the average speed observation for peak hours and off peak hour during the every 15 minutes interval and table 5 describes the dynamic PCU or dynamic vehicle equivalent factor during every 15 minutes interval. Morning peak hour is taken from 9:30 to 10:30AM and evening peak hour is from 5:00 to 6:00PM while the off peak hour is from 3:00 to 4:00PM. Average speed ranges of two wheelers from 25.27 to 29.83 and a Dynamic PCU value of two wheelers varies from 0.18 to 0.28. Average Speed of three wheelers varies from 20.16 to 26.22 and Dynamic PCU value of three varies from 0.56 to 0.76. Average Speed of LCV's varies from 20.77 to 26.13 while the Dynamic PCU varies from 1.27 to 1.73. In the case of bus the average speed ranges from 17.91 to 23.97 and Dynamic PCU ranges from 3.47 to 4.97.In the case of cycle the average speed ranges from 12.95 to 15.96 and Dynamic PCU ranges from 0.30 to 0.47.

Table 4 Average Speed Observation

For Average Speed	SPEED						
	2W	3W	4W	LCV	BUS	CYCLE	TRUCK
9.30 to 9.45	29.37	20.16	25.74	24.02	21.70	14.29	18.45
9.45 to 10	26.07	21.46	27.00	25.10	23.37	14.36	
10 to 10.15	26.02	25.15	32.42	25.72	22.43	15.96	
10.15 to 10.30	26.61	20.55	21.16	20.77	19.66	14.76	16.39
3 to 3.15	29.83	26.22	25.76	26.13	23.58	13.95	24.96
3.15 to 3.30	28.71	23.66	24.75	25.40	21.06	15.68	17.56
3.30 to 3.45	28.73	23.40	28.38	25.35	20.84	14.92	
3.45 to 4.00	28.19	22.63	27.36	25.22	23.97	13.70	33.23
5 to 5.15	27.34	21.94	28.87	25.96	21.47	12.95	28.80
5.15 to 5.30	25.82	20.83	27.59	21.20	17.91	14.25	24.66
5.30 to 5.45	25.27	23.00	24.24	25.49	18.95	13.91	17.90
5.45 to 6.00	28.09	20.61	25.37	24.23	19.82	13.07	

Table 5 Dynamic PCU for Average speed

For Average Speed	Dynamic PCU						
	2W	3W	4W	LCV	BUS	CYCLE	TRUCK
9.30 to 9.45	0.19	0.73	1	1.43	3.83	0.38	4.50
9.45 to 10	0.23	0.72	1	1.43	3.73	0.40	
10 to 10.15	0.28	0.74	1	1.68	4.66	0.43	
10.15 to 10.30	0.18	0.59	1	1.36	3.47	0.30	4.16
3 to 3.15	0.19	0.56	1	1.31	3.52	0.39	3.33
3.15 to 3.30	0.19	0.60	1	1.30	3.79	0.33	4.55
3.30 to 3.45	0.22	0.70	1	1.49	4.39	0.40	
3.45 to 4.00	0.22	0.69	1	1.45	3.68	0.42	3.87
5 to 5.15	0.23	0.76	1	1.48	4.34	0.47	3.23
5.15 to 5.30	0.24	0.76	1	1.73	4.97	0.41	3.61
5.30 to 5.45	0.21	0.61	1	1.27	4.13	0.37	4.37
5.45 to 6.00	0.20	0.71	1	1.40	4.13	0.41	
Average Dynamic PCU	**0.22**	**0.68**	**1**	**1.44**	**4.05**	**0.39**	**3.95**

V. CONCLUSION

- From the analyzed data two wheelers are maximum in composition in both the direction.
- Composition of two wheelers is about 65% in both the direction while the composition of three wheelers and four wheelers is nearly about 17%.
- Effect of traffic composition is profound on vehicular speeds in morning peak hour, off peak hour and evening peak hour.
- Dynamic PCU are carried out by Chandra's method. The obtained values of Dynamic PCU suggest that as the speed increases the values of dynamic PCU decreases and as the speed decreases the dynamic PCU increases.
- Dynamic PCU values of two wheelers is 0.22 and for three wheelers is 0.68 which are less than suggested standard values of PCU while the Dynamic PCU values of bus is 4.05 and for trucks 3.95 which are more than standard values of PCU suggested in IRC:106(1990). The ratio of speed of the reference vehicle to other vehicles is observed that it have dominant effect on the equivalent vehicle factor. It is found that, for Indian mixed traffic conditions, Dynamic PCU is appropriate for converting vehicle flow into equivalent term.

REFERENCES

1. Arasan, V.T. and Arkatkar, S.S. (2010) Microsimulation Study of Effect of Volume and Road Width on PCU of vehicles under Heterogeneous Traffic. *Journal of Transportation Engineering*, Vol. 136(12), pp 1110-1119.

2. Praveen, P.S., and Arasan, V.T., "Influence of Traffic Mix on PCU Value of Vehicles Under Heterogeneous Traffic Conditions." *International Journal for Traffic and Transport Engineering*, pp. 302-330, 2013

3. T. Vikas Kumar Reddy, Chetan R. Patel,'' Dynamic Equivalency Factor Of Mixed Traffic Stream For Urban Arterial Midblocks"
4. Sen, R., Cross A., and Vashistha A., "Accurate speed and density measurement for road traffic in India", 2013

5. Kadiyali, L.R. (2009) "Traffic Engineering and Transport Planning". Khanna Publishers, New Delhi.

6. Arasan, V. T. and Krishnamurthy, K. (2008) Effect of Traffic Volume on PCU of Vehicles under Heterogeneous Traffic Conditions. *Road &Transport Research*, Vol.17-1, pp32-48.