Analysis of Congestion Using Advanced Traffic Instruments – A Case Study of Chandigarh, India

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ABSTRACT
In present scenario, transportation network provides the way for movements and medium for reaching destinations. It is the backbone of urban activity undergoing in cities.Inadequate transportation system hampers economic activities and creates hindrances for development. In most of the developing countries like India, obsolete methods like manual counting and stopwatch methods are being used for traffic related studies. Presently, there are more advanced and reliable traffic instruments like Metro Count, Radar Gun etc. available which can collect vast road usage information and can give large traffic data output in comparatively less time. These advanced methods are being used extensively in developed countries, but very few studies are available which shows use of these instruments in India. This paper presents amethodology to study the traffic flow characteristics and to analyse congestion on major roads (V-2 roads) of Chandigarh City using such advanced instruments. Traffic in Chandigarh has been increasing at much higher pace in tune with the vastly increasing commercial, industrial and manufacturing needs. Thus, with the help of advanced traffic survey instruments like Metro Count and Radar Gun, volume and speed study has been carried out to estimate congestion at various points on major roads of Chandigarh and Level of Service (LOS) was also determined for the same roads. The speed study has also been done using both Metro Count as well as Radar Gun for its comparative analysis. The findings of this study have revealed heavy congestion on approximately all the roads with Volume/ Capacity (V/C) ratio less than one but as traffic is increasing, they may approach their saturation point soon. LOS has been found out to be either 'C' or 'D' indicating stable flow conditions for now but small increase may cause a considerable reduction in the 'performance' or 'service' which demand efforts to be taken to maintain the existing performance. The speed study has shown that roads are not satisfying the present prescribed speed limits arising the need to either revise speed limits or to adopt remedial measures to lower the speed of moving traffic within speed limits. It has been observed that Metro Count and Radar Gun give more reliable and accurate data and results as compared to other conventional methods available. Therefore, the authors propose to use such instruments only in order to carry out different traffic studies.

Keywords: Congestion, Metro Count, Radar Gun, Level of Service

I INTRODUCTION

India being developing country has enormous need of infrastructure growth for improving the socio-economic status and productivity of the country, in which transport infrastructure plays a key role. In lieu of this, transport industry is being expanding rapidly fast to fulfil the present demands of the people of developing nation. As population is increasing rapidly, transport sector has also grown manifold in many metropolitan cities of India like Chandigarh, along with becoming source of other problems like pollution, health problems and other environment problems being faced by residents of those cities daily. The main factor behind is abrupt increase of congestion of vehicles on roads as number of vehicles are increasing promptly as compared to facilities need to accommodate them, either because of limitation of resources or scarce utilisation of new advanced resources/techniques although being used by the various developed nations. So, this study reflects upon the new methodologies and techniques being adopted for conducting volume studies and speed studies in order to augment/abate congestion from the well-planned city of India i.e. Chandigarh situated at the foothills of Shivalik. Despite being the most planned city, Chandigarh is now facing acute problem of congestion which is mainly due to increase in flow of traffic within and from tricity i.e. Chandigarh, Panchkula and Mohali. So, there is dire need of carrying out the traffic studies with the help of advanced instruments being available at our disposal for more accurate analysis and more precise implementation of the results.

II LITERATURE REVIEW

The literature is available on traffic studies like volume and speed studies for heterogeneous traffic but it is quite difficult to analyse heterogeneous traffic [20], which arises the need of converting heterogeneous traffic into equivalent passenger cars known as PCU. Various authors have analysed the problem of measuring large heterogeneous traffic volumes and converting different types of vehicles into equivalent passenger cars known as PCUs [14]. The PCU estimates have been done through simulation techniques for different types of vehicles of heterogeneous traffic in a wide range of traffic

volume and roadway conditions [18,20].An empirical study has found that for a given road width, an increase in volume level of heterogeneous traffic causes more density on the road resulting in reduced uniform speed of vehicles [19]. The lower speed difference between cars and subject vehicles yield smaller PCU value for the vehicle type and authors have also developed a mathematical equation and a computer program relating PCU [2]. Mathematical models have been developed to derive PCU values for vehicles on urban roads based on different aspects of road geometrics, traffic and environmental conditions. These values may be tentatively adopted on urban roads in India until more rational and variable design vehicle unit's dependent on roadway and traffic factors are developed [6]. Once PCU values being determined, next step is to calculate speed of road segments which affects the capacity and LOS of roads. The speed distributions of vehicles have been observed to follow the normal distribution with co-efficient of variation for car, buses and two wheelers being 0.11, 0.13, and 0.16 respectively obtained from modeling which helps in deciding speed limits of any road [1,7]. The authors have adopted advance instruments such as traffic counter-cum-classifier and Radar Gun to collect traffic and speed data as analysis of data is much easier [3].For finding the capacity, the authors have emphasized on the need of developing highway capacity norms [11].In this context, an insight has been provided into a new technical approach, the 'enveloping curve technique', for developing suitable capacity norms by adopting an appropriate level of service concept for Indian conditions [9,10]. Using the capacity of the road depending upon the nature of road, Level of Service (LOS) is being found out which is a qualitative measure used to relate the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measure like speed, density etc. [16].Level of service (LOS) is found to be the key index in analysing congestion on roads. The level of service and congestion indices for different segments between destination points facing heaviest traffic problems have been determined by various researchers using different approaches and techniques [15,12].LOS cannot provide a continuous range of values of congestion and these methods provide no distinction between different levels of congestion once congested conditions are reached[8]. It has been observed that the reason behind the congestion could be increase in trips by personal mode of transportation by using heterogeneous traffic, decrease in width of road by BRTS, improper management of traffic along the intersection, illegal parking along the carriage way, merging of traffic from different directions and lack of public awareness after performing analysis of congestion [21,22]. This leads to potential improvement of traffic in the form of either expansion of width of roads, construction of fly over or by-pass, improvement of signal design. Thus, an attempt has been made to analyse congestion in Chandigarh, one of the planned city of India and thereby to recommend certain congestion mitigation measures.

III SCOPE AND OBJECTIVES

The scope of the present study is to understand the existing traffic situation on various major roads of Chandigarh city i.e. V-2 roads using advanced equipment's and to study the traffic flow pattern for determining various traffic flow characteristics. It also includes collection of traffic data which includes collection of volume data and speed study data using various techniques as per IRC: 9 and further comparing those to techniques in order to find the better one. Data collected is further to be analyzed to find Level of Service (LOS) at various points on study area as per IRC: 106. After studying various traffic characteristics, recommendations are to be provided for the improvement of geometrics and removal of congestion problems of the roads and the futuristic levels of service are to be determined.

Thus, the objectives of this study are:

(a) To collect Traffic data of all V-2 roads for different parameters like Traffic Volume, Speed on hourly /weekly / seasonal basis.
(b) To perform comparative analysis of various equipment's used in the study to find the more accurate one.

IV STUDY AREA

The present study is carried out on the midblock sections of all V-2 roads (which includes Madhya Marg, Himalaya Marg, Dakshin Marg, Jan Marg, Purv Marg, Udyog Path etc.) of Chandigarh whichare the major arterial roads. Each sector is surrounded by V-2 roads with number of buildings opening on to them. These V-2 roads are the major avenues of Chandigarh, with important institutional and commercial functions running alongside. One mid-block section is to be considered for study from each road.

The various study points on the roads are as follows: -

(a) Madhya Marg - Section is in between GHSC (Sector 10) and GMSH (Sector 16).
(b) Dakshin Marg - Section is in between Sector 21 and Sector 34. It is in front of JW Marriot.

(c) Jan Marg - Section is in between Sector 16 and Sector 17. It is in front of Zakir Rose Garden.

(d) Himalaya Marg - Section is between Sector 22 & Sector 21. It is in front of Aroma.

(e) Purv Marg - Section is in between Sector 29 and Industrial Area. It is in front of Centra Mall.

(f) Udyog Path - Section is in between Sector 15 and Sector 24. It is in front of ParkView Hotel.

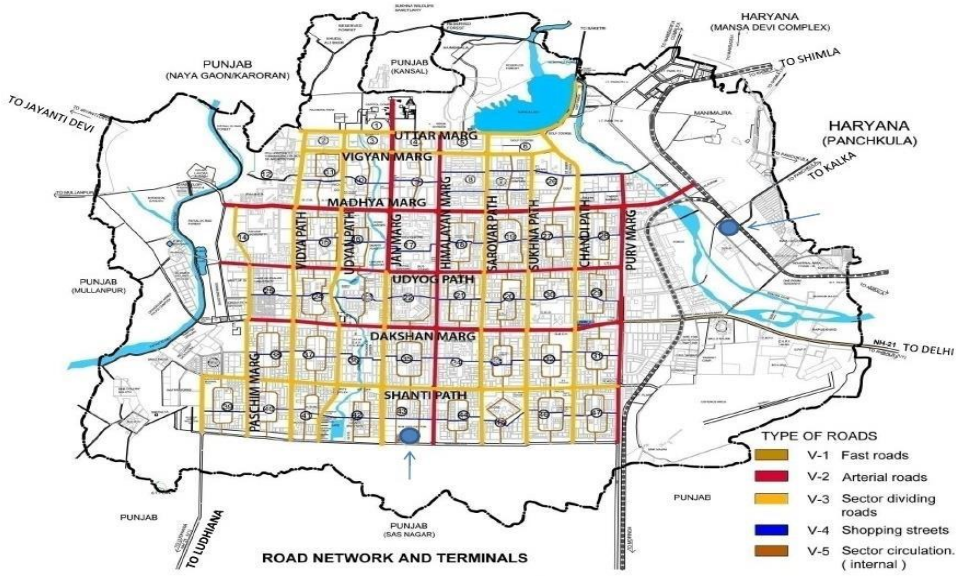


Fig. 1. Map of Chandigarh showing Study Area
(Source: www.chandigarh.gov.in)

V METHODOLOGY

The methodology includes in this study mainly focuses on the use of advanced instruments i.e. Metro Count or Radar Gun for carrying out traffic characteristics and then analysis of data using bar charts and histograms. The steps followed in sequential order to study the area are described in figure given below.

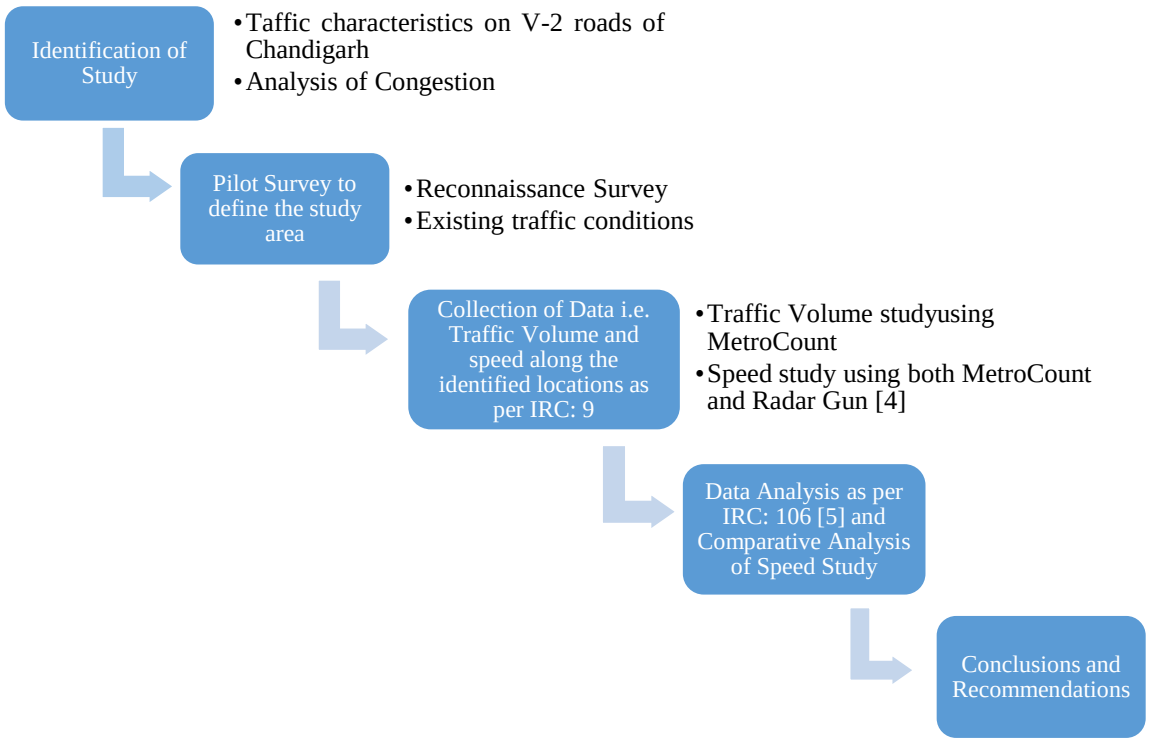


Fig. 2 Flow Chart with Study Methodology

VI TRAFFIC DATA COLLECTION AND ANALYSIS

The data collection is done on mid-block sections of all the major V-2 roads of Chandigarh which are the arterial roads of Chandigarh with important institutional and commercial functions running alongside. The roads identifiable as V-2 are Madhya Marg, Dakshin Marg, Purv Marg, Himalaya Marg, Jan Marg and Udyog Path. All the roads are divided carriageways; thus, the volume data and speed data is collected on a mid- block section of these roads for both directions of traffic using Metro Count aka Automatic-Traffic Counter-Cum-Classifier.

(a) Volume Data Collection and Analysis-For collection of traffic volume data, in spite of manual counting, advanced traffic instrument traffic-counter-cum-classifier (Metro Count) is used. Two Metro Counts are installed simultaneously on the road section for both direction of traffic and data is collected for approximately 12 hours. Data automatically gets stored in the Metro Count. Metro Count Software generates a report after extraction of data into computer using an external source. This Metro Count report is further analysed to find peak hour and LOS of each road section taken in study which is presented in tabular form as shown in table 1.

Table 1:
Capacity and LOS of each road section

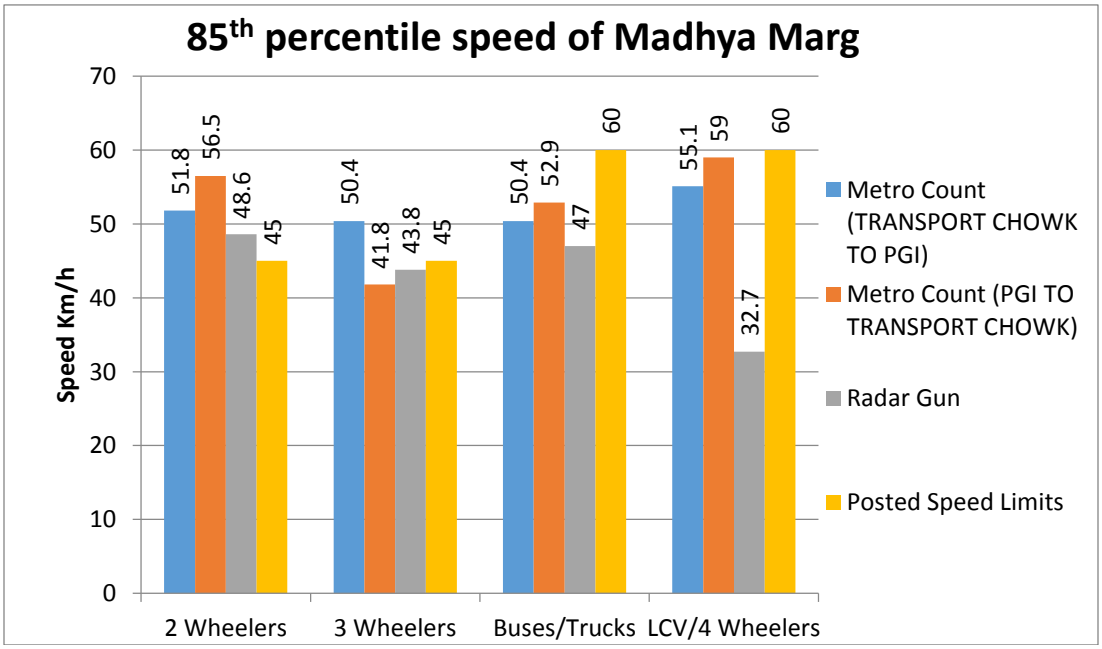
Location	Direction	Time	(V) PCU/h	Width of road per lane (m)	No. Of lanes	Design Service Volume (C) in PCU/h as per IRC:106	V/C	LOS
MADHYA MARG	TOWARDS PGI	Morning peak hour (9.00am - 10.00am)	2224	3.5	3	3600	0.6	C

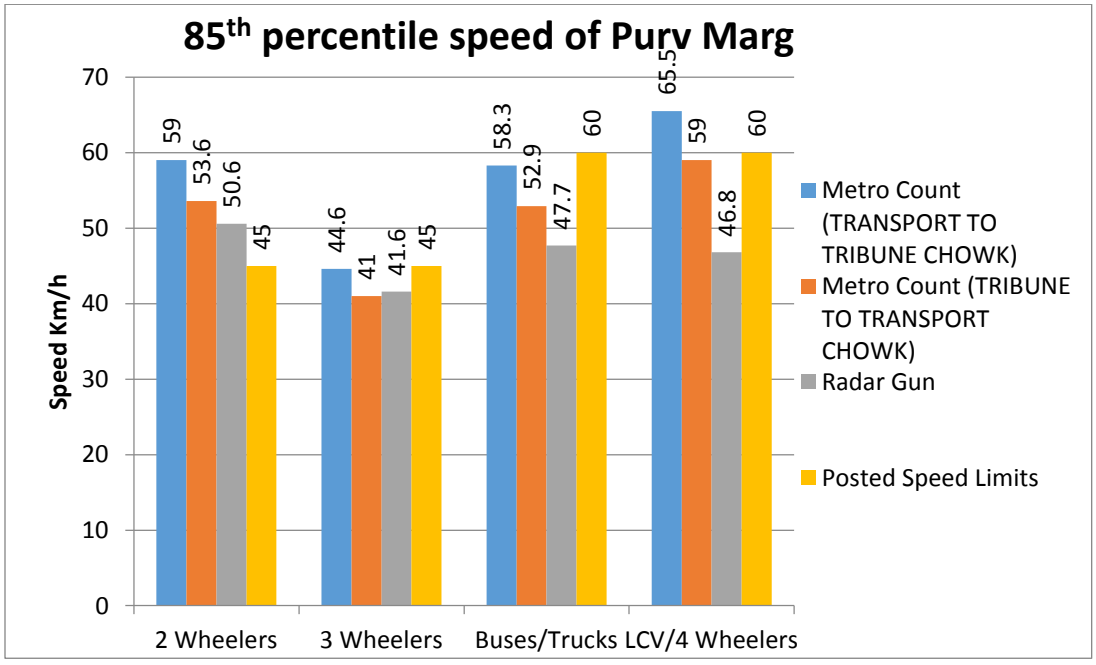
		Evening peak hour (6.00pm - 7.00pm)	2578	3.5	3	3600	0.7	D
	TOWARDS TRANSPORT CHOWK	Morning peak hour (9.00am - 10.00pm)	2344	3.5	3	3600	0.7	D
		Evening peak hour (12.00pm - 1.00pm)	2006	3.5	3	3600	0.6	C
PURV MARG	TOWARDS TRIBUNE CHOWK	Morning peak hour (9.00am - 10.00am)	2957	3.5	4	4800	0.6	C
		Evening peak hour (1.00pm - 2.00pm)	2109	3.5	4	4800	0.4	B
	TOWARDS TRANSPORT CHOWK	Morning peak hour (9.00am - 10.00pm)	2423	3.5	4	4800	0.5	C
		Evening peak hour (5.00pm - 6.00pm)	2210	3.5	4	4800	0.5	C
DAKSHIN MARG	TOWARDS KISAN BHAVAN	Morning peak hour (9.00am - 10.00am)	2371	3.5	3	3600	0.7	D
		Evening peak hour (5.00pm - 6.00pm)	1685	3.5	3	3600	0.5	C
	TOWARDS PICCADILY	Morning peak hour (11.00am - 12.00pm)	1821	3.5	3	3600	0.5	C
		Evening peak hour (6.00pm - 7.00pm)	2046	3.5	3	3600	0.6	C
HIMALAYA MARG	TOWARDS 21 (AROMA)	Morning peak hour (9.00am - 10.00am)	1982	3.5	2	3000	0.7	D
		Evening peak hour (12.00pm - 1.00pm)	1884	3.5	2	3000	0.6	C
	TOWARDS 34 (PICCADILY)	Morning peak hour (11.00am - 12.00pm)	1800	3.5	2	3000	0.6	C
		Evening peak hour (5.00pm - 6.00pm)	2263	3.5	2	3000	0.8	D

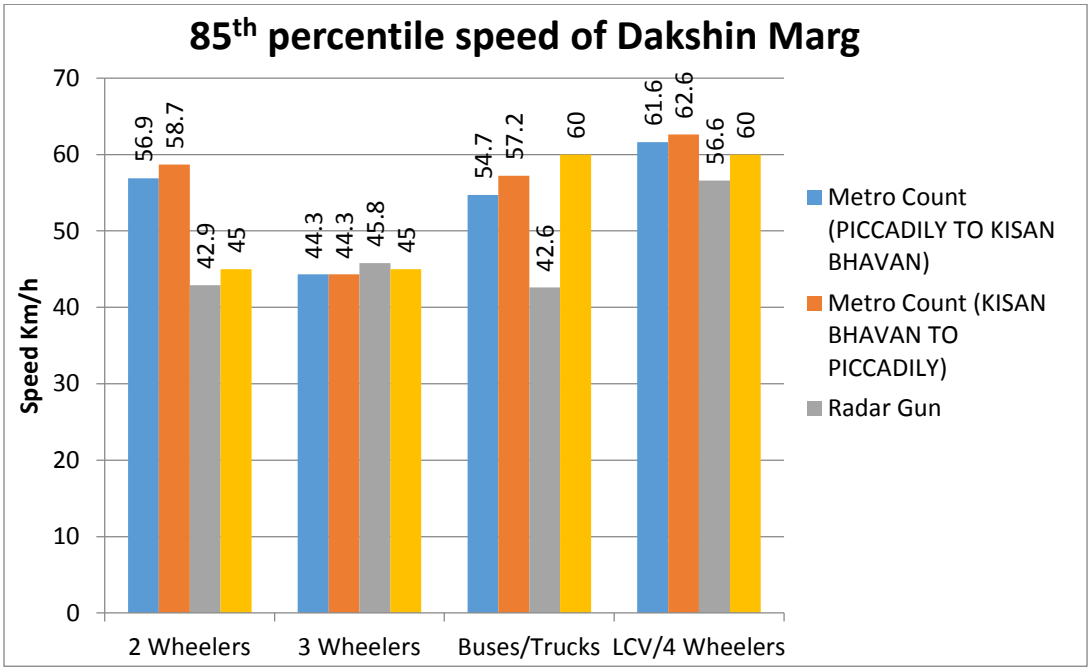
JAN MARG	TOWARDS 9 (MATKA CHOWK)	Morning peak hour (9.00am - 10.00am)	2651	3.5	3	3600	0.7	D
		Evening peak hour (12.00pm - 1.00pm)	2057	3.5	3	3600	0.6	C
	TOWARDS 17 (ISBT)	Morning peak hour (11.00am - 12.00pm)	1405	3.5	3	3600	0.4	B
		Evening peak hour (5.00pm - 6.00pm)	1968	3.5	3	3600	0.5	C
UDYOG PATH	TOWARDS ISBT	Morning peak hour(9.00am - 10.00am)	2792	3.8	2	3000	0.9	E
		Evening peak hour (12.00pm - 1.00pm)	1621	3.8	2	3000	0.5	C
	TOWARDS UIET	Morning peak hour(9.00am - 10.00am)	1417	3.8	2	3000	0.5	C
		Evening peak hour (5.00pm - 6.00pm)	2046	3.8	2	3000	0.7	D

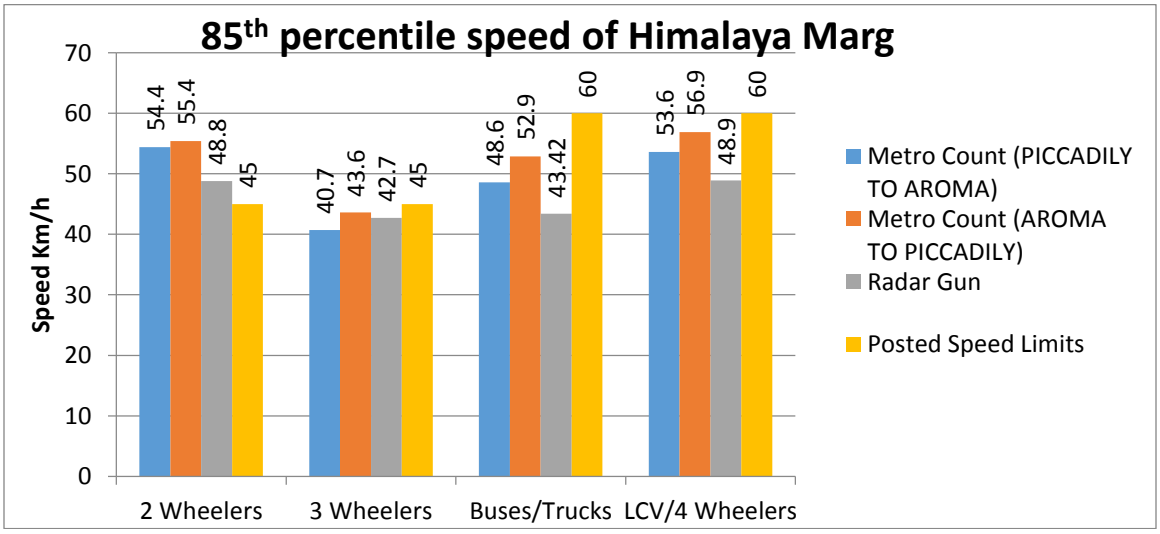
In Table 1,volume count has been presented for the morning and evening peak hours for all the roads and Level of Service (LOS) for Purv Marg, Dakshin Marg and Udyog Path is found to be 'C' which shows stable conditions with volume of traffic less than the practical capacity of roads whereas for Madhya Marg, Himalaya Marg and Jan Marg, LOS comes out to be 'intermediary of C or D' which indicates that flows are at a level where small increase may cause a considerable reduction in the performance or 'service'.

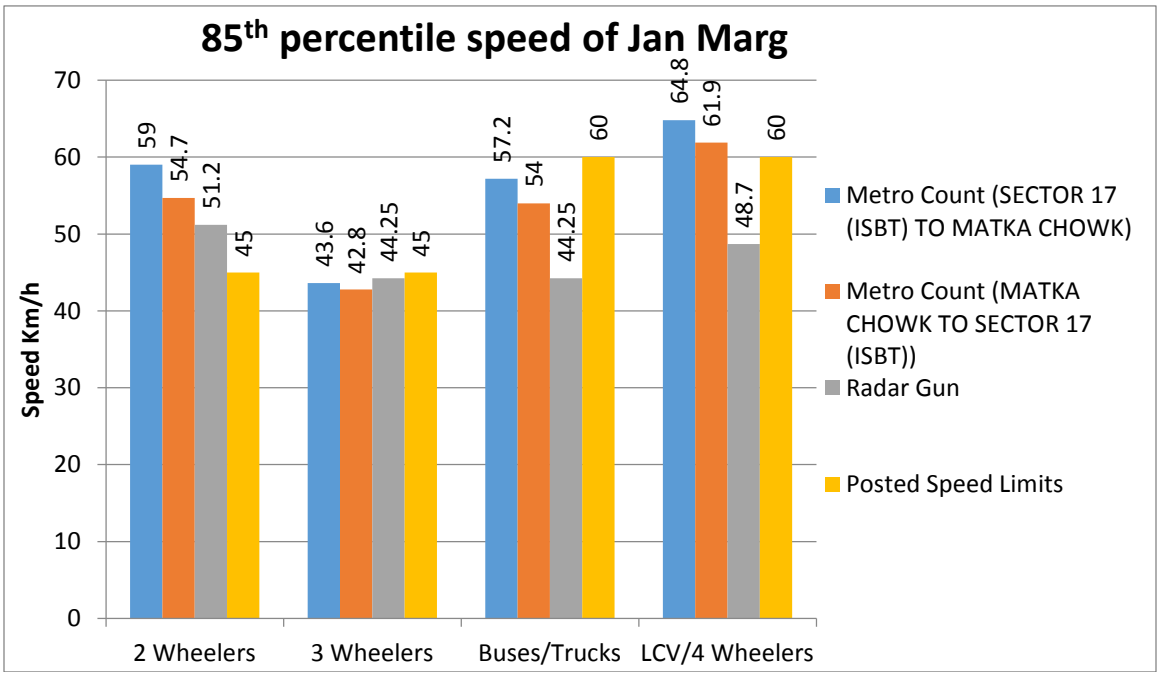
(b) Collection of Speed Data and Its Comparative Analysis-The speeds on the various mid-block sections are observed using both Metro Count as well as Radar Gun aka Speeder. With Metro Count, 12-hours data has been observed whereas with Radar Gun, limited numbers of vehicles have been observed. The analyzed speed percentile (85^{th} percentile) found from data collected using both the instruments are compared with prescribed speed limits for heterogeneous traffic on each road section undertaken in study and shown in form of bar charts in figure 3.


85th percentile speed of Madhya Marg
Speed Km/h
70
60
50
40
30
20
10
0
51.8
56.5
48.6
45
50.4
41.8
43.8
45
50.4
52.9
47
60
55.1
59
32.7
60
2 Wheelers
3 Wheelers
Buses/Trucks
LCV/4 Wheelers
Metro Count (TRANSPORT CHOWK TO PGI)
Metro Count (PGI TO TRANSPORT CHOWK)
Radar Gun
Posted Speed Limits


85th percentile speed of Purv Marg
Speed Km/h
70
60
50
40
30
20
10
0
59
53.6
50.6
45
44.6
41
41.6
45
58.3
52.9
47.7
60
65.5
59
46.8
60
2 Wheelers
3 Wheelers
Buses/Trucks
LCV/4 Wheelers
Metro Count (TRANSPORT TO TRIBUNE CHOWK)
Metro Count (TRIBUNE TO TRANSPORT CHOWK)
Radar Gun
Posted Speed Limits


85th percentile speed of Dakshin Marg
Speed Km/h
70
60
50
40
30
20
10
0
56.9
58.7
42.9
45
44.3
44.3
45.8
45
54.7
57.2
42.6
60
61.6
62.6
56.6
60
2 Wheelers
3 Wheelers
Buses/Trucks
LCV/4 Wheelers
Metro Count (PICCADILY TO KISAN BHAVAN)
Metro Count (KISAN BHAVAN TO PICCADILY)
Radar Gun


85th percentile speed of Himalaya Marg
Speed Km/h
70
60
50
40
30
20
10
0
54.4
55.4
48.8
45
40.7
43.6
42.7
45
48.6
52.9
43.42
60
53.6
56.9
48.9
60
2 Wheelers
3 Wheelers
Buses/Trucks
LCV/4 Wheelers
Metro Count (PICCADILY TO AROMA)
Metro Count (AROMA TO PICCADILY)
Radar Gun
Posted Speed Limits



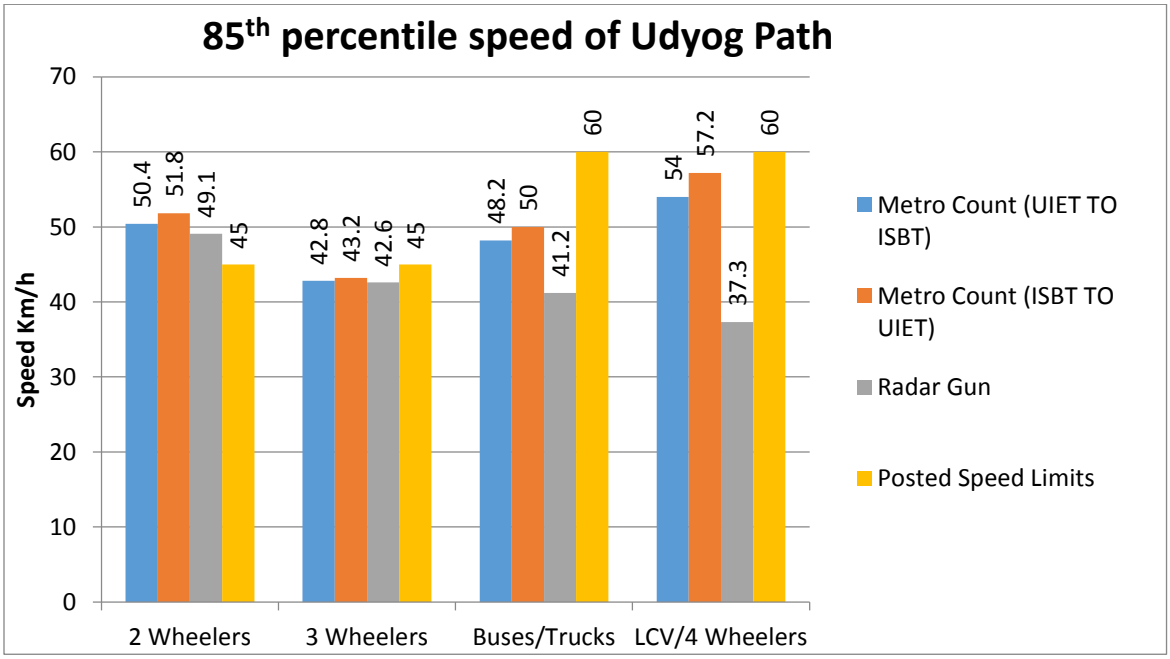


Fig. 3 Comparison of Speed Limits of All V-2 Roads

In Figure 1, it is observed that the speeds found using Radar Gun is relatively low as compared to Metro Count and these are further compared with that of the posted speed limits on the various roads for bi-directional traffic flow. The average speed percentiles as observed in the figure falls within range of posted

speed limit i.e. 60 km/h in case of 4 wheelers/LCVs and Buses/Trucks whereas for 2-wheelers and 3-wheelers, the speed percentiles are observed to be higher than posted speed limit i.ee 45 km/h. This is occurring because percentage of 4-wheelers and buses/trucks are more in number as compared to 2-wheelers and 3-wheelers due to which there is lot of interaction to be faced by the 2-wheelers and 3-wheelers.

VII RESULTS AND CONCLUSIONS

The present study has been conducted to analyse the traffic characteristics of V-2 roads i.e. Madhya Marg, Purv Marg, Dakshin Marg, Himalaya Marg, Jan Marg and Udyog Path of Chandigarh using automated and advanced instruments such as Metro Count for traffic volume study and Radar Gun for traffic speed study. The following conclusions have been drawn from the study:

(a) Mid-block counts indicate that V-2 roads usually have very high PCU and at present Volume/ Capacity (V/C) ratio are less than one for all V-2 roads but as traffic is increasing, they may approach their saturation point soon.

(b) Level of Service (LOS)is computed using Volume/ Capacity (V/C) ratio for all the roads during peak hours of the day which comes out to be 'C' for Purv Marg, Dakshin Marg and Udyog Path which delivers stable flow conditions and for Madhya Marg, Himalaya Marg and Jan Marg; LOS comes out to be 'intermediary of C or D' which indicates that flows are at a level where small increase may cause a considerable reduction in the performance or 'service' of the highway and drivers are restricted in freedom to select speed or change lane.

(c) Speed study data is observed with both Metro Count and Radar Gun and after its comparative analysis it has been deduced that results of Metro Count are more reliable as compared to Radar Gun. Metro Count range (10-200 km/h) is also higher than Radar Gun (19-150 km/h).

(d) Analysis of data in Metro Count is very easy as it directly gives speed distribution graphs but the installation of instrument on road section/site is difficult task whereas Radar Gun although easily operated, its analysis has to be done manually which is somewhat tedious task.

(e) Various speed percentiles for different composition of vehicles are observed and the average 85th percentile speed (speed limit) has been found out to be 55.5 km/h for Madhya Marg, 59.8 km/h for Purv Marg, 61.4 km/h for Dakshin Marg, 53.5 km/h for Himalaya Marg, 60.7 km/h for Jan Marg and 53.5 km/h for Udyog Path for all classes of vehicles which indicates that there is appreciable difference between the percentiles speed found in the study and the already prescribed speed limits on the respective road sections for different classes of vehicles.

Taking into account the study, authors recommended certain suitable measures like road pricing, odd-even system (as adopted in developed countries) [17], to be adopted to check congestion on V-2 roads of Chandigarh and as far as speed study is concerned, authors proposed either to adopt strict traffic control measures like challenging for over speeding or installation of speed breakers on Dakshin Marg, Jan Marg and Udyog Path so that people can follow the prescribed speed limits or revising speed limits of these road sections.

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