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Study of Traffic Characteristics of Major Roads of Chandigarh Using GIS–A Case Study

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Abstract—*Nowadays, the urbanization trends in India have given an impetus to the growth of the cities. Many cities have seen a large increase in road traffic and transport demand, which has consequently lead to deterioration in capacity and inefficient performance of traffic systems. Traffic in Chandigarh has also been increasing at much higher pace in tune with the vastly increasing commercial, industrial and manufacturing needs. Madhya Marg and Dakshin Marg, major arterial roads of Chandigarh are under intense pressure today due to increase in population and explosive growth in the number of private vehicles. Transportation professionals all over the world have discovered and embraced GIS as an important tool in managing, planning, evaluating, and maintaining transportation systems. GIS data and tools are revolutionizing transportation research and decision making, allowing transportation professionals to understand and solve complex transportation problems that were previously impossible. In this paper, traffic data (volume and speed) collected using automatic traffic counter - cum classifier is analyzed and its results are presented which further gives the capacity and level of service (LOS). The instrument used for study can work from minimum one hour duration to one year duration continuously whereas in manual method lot of manpower and time is required for collecting data for long period and it is available with software in which the site map can be incorporated to do repetitive traffic studies. In the end, digital map of Chandigarh is created using GIS highlighting various attributes of roads which help in the detailed analysis of various characteristics and its relationship to causative factors and ultimately leading to the solution for the traffic planners.*

1. INTRODUCTION

Cities are the powerhouses of economic growth for any country. For the purpose of economic activities, it is imperative to facilitate movements as the backbone of urban activities is the urban transportation network. Transportation system provides the way for movements and medium for reaching destinations. Inadequate transportation system hampers economic activities and creates hindrances for development. In most of the developing countries like India, which are overburdened by huge population and extreme poverty, increasing economic activities and opportunities in the cities result in rapid increase in urban population and consequent need for transportation facilities which causes uncontrolled expansion of the cities, urban sprawl, traffic congestion and environmental degradation. The transportation network of an urban area is usually designed to accommodate the transportation activities of urban people. With growing population and diversified land- use activities, transportation system needs to be updated or readjusted. Any lag between growing transportation demand and network capacity results in traffic congestion, thereby economic loss and environmental degradation. Although the expansion of road infrastructure is not absolutely ruled out as the demand may be expected to continue to grow by time, the immediate, most relevant and acceptable strategy to mitigate capacity problems and increase efficiency of the road network is through traffic management applications. The most recent approach that has gained prominence in traffic management operations is the introduction of Intelligent Transportation Systems (ITS) and use of GIS to monitor and manage traffic flow, reduce congestion, provide alternate routes to travelers and increase safety.

2. LITERATURE REVIEW

Leong (1978) measured speeds and capacity at 31 sites on rural highways in New South Wales between the period 1963 and 1973. The sites had varying lane & shoulder width with gravel shoulders. The data were analyzed using multiple regression and it was suggested that speed increased with increasing shoulder width. The important findings were that the speed distributions of cars can be represented by a 'standardized' normal distribution with a standard deviation of 0.17 Times the mean [1]. **Kadiyali et al. (1981)** studied free speed behavior of vehicles on a four lane divided highway. The speed distributions of vehicles were 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 [2]. **Van Aerde and Yagar (1983)** analyzed the effects of traffic volume on speeds of 2-lane rural highways using a large data bank compiled in Ontario, Canada in 1980. The 10th, 50th and 90th percentile speeds were estimated using two models. The 90th percentile speed equation is found to be most sensitive to main directional volume and the 10th percentile equation is least sensitive [3]. **Taylor et al. (2000)**

presented review of issues, procedures, and examples of application of geographic information system (GIS) technology to the development of congestion management systems (CMSs). They examined transportation network performance measures and discussed the benefit of using travel time as a robust, easy to understand performance measure [4]. **Rijurekha Sen et al. (2013)** presented techniques to measure traffic density and speed in unlaned traffic prevalent in developing countries and applied those techniques to better understand the traffic patterns in Bangalore. Technique used was video processing of traffic resulting in about 11 % average error as compared to manual values [5]. **Ashish Padshala (2014)** carried out study of level of service (LOS) of different segments i.e. for stretch path of Pragatinagar to Akhbarnagar & Akhbarnagar to Ranip Cross Road between destination points facing heaviest traffic problems. Expected solution lead 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 [6].

3. OBJECTIVES OF STUDY

The study was carried out to understand the existing traffic situation on major roads of Chandigarh (Madhya Marg and Dakshin Marg) and to study the traffic flow pattern and determine the various traffic flow characteristics which includes collection of traffic data i.e. volume data and speed study data using automatic traffic counter-cum classifier (also known as metro count) and then this data is to be analyzed to find level of service and capacity. A digital map is also created in GIS software (ARC GIS) which consists of spatial as well as non-spatial information of the above roads. 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 main objectives of this project are:

1) To collect Traffic data for major roads for different parameters like Traffic Volume, Speed.
2) To collect different constituents of road inventory like geometric design, Road furniture such as Railings, Lights etc. for creation of digital map and geocoding.
3) To use GIS in understanding and visualizing different characteristics of traffic.

4. STUDY AREA

The study was carried out on the midblock sections of major V-2 roads (which includes Madhya Marg and Dakshin Marg) of Chandigarh as these are the major arterial roads and each sector is surrounded by V-2 or V-3 roads, with no buildings opening on to them. These are the major avenues of Chandigarh, with important institutional and commercial functions running alongside. One mid-block sections which was considered for study from each road are as follows:-

- MADHYA MARG - Section is in between GHSC (Sector 10) and GMSH (Sector 16).
- DAKSHIN MARG - Section is in between Sector 22 and Sector 35. It is in front of JW Marriot.

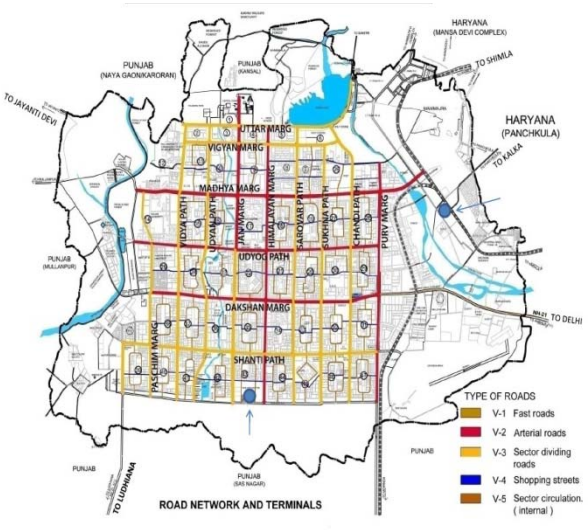
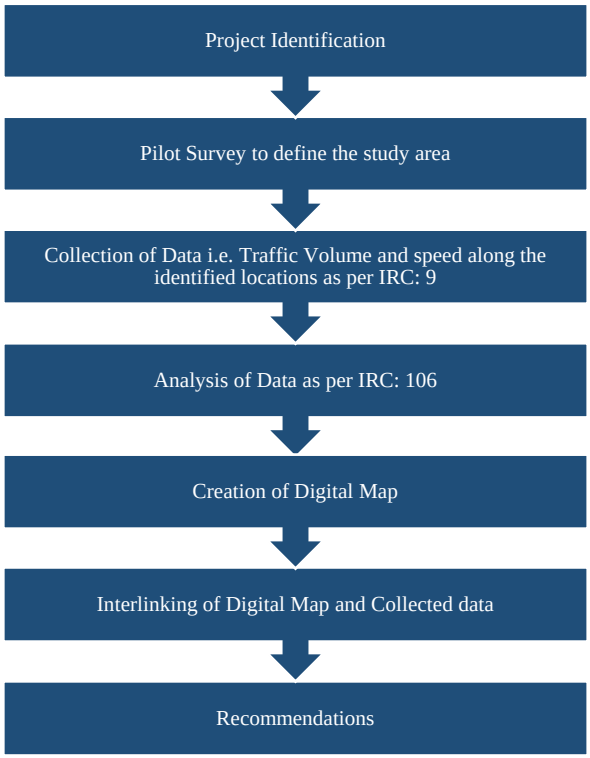


Fig. 1: Map of Chandigarh showing study area

5. METHODOLOGY

Methodology adopted includes various steps to be done in sequence. It is depicted below in tabular form.



6. DATA COLLECTION AND ANALYSIS

Traffic data collection is very tedious task. There are various methods of collecting traffic data. But data base of traffic is very limited in India. In this paper, the traffic data has been collected using automatic traffic counter cum classifier. The information provided by the Automatic Traffic Counter is the number of vehicles, classification of vehicles, direction in which the vehicle is moving, speed of the traffic.

Data is collected and graphically presented approximately for 12 hours on midblock sections for both roads - Madhya Marg and Dakshin Marg.

6.1. Madhya Marg

This is major arterial 3-lane 2 – way divided highway (each 3.5 m wide) with service lane on both sides.

6.1.1. Volume Study

The variation of traffic volume with time is shown in fig. below.

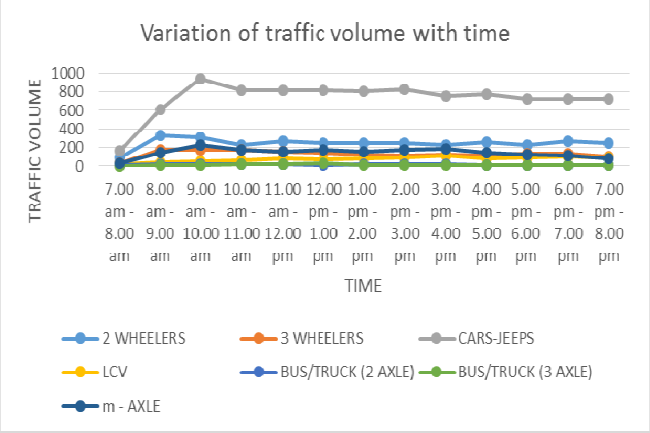


Fig. 2: Hourly Traffic Volume of different vehicles

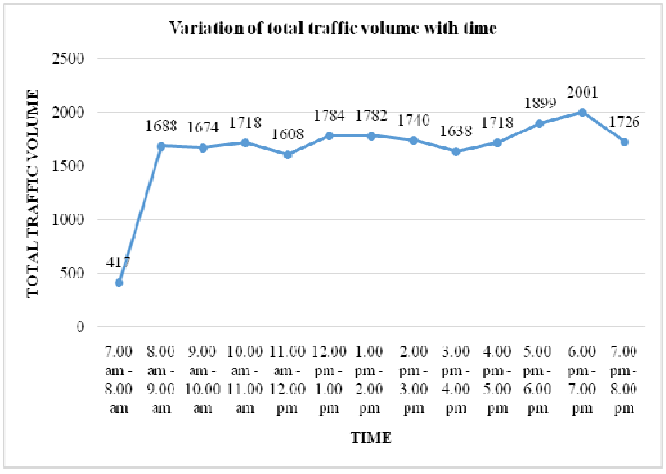


Fig. 3: Hourly Traffic Volume of total vehicles

After this the total volume was converted into PCU/hour. PCU conversion factors were taken acc. to IRC: 106.

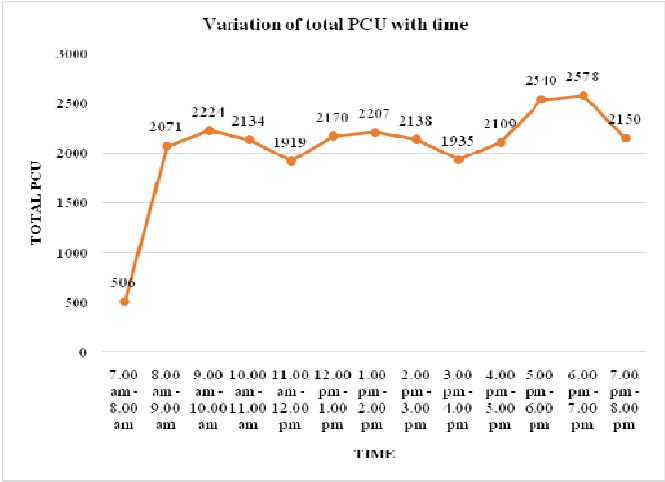


Fig. 4: Hourly PCU Volume

From above Fig. s, the morning peak hour came out to be 10.00 am – 11.00 am and the evening peak hour came out to be 6.00 pm – 7.00 pm. Further, using PCU/hour for these peak hours LOS was found out as per IRC: 106.

Table 1: Design Service Volume (DSV) and LOS

Time	(V) PCU/HOUR	DSV	V/C ratio	LOS
Morning peak hour (10.00am - 11.00am)	2134	3600	0.6	C
Evening peak hour (6.00pm - 7.00pm)	2578	3600	0.7	D

Level of Service (LOS) of Madhya Marg came out to be C.

6.1.2. Speed Study

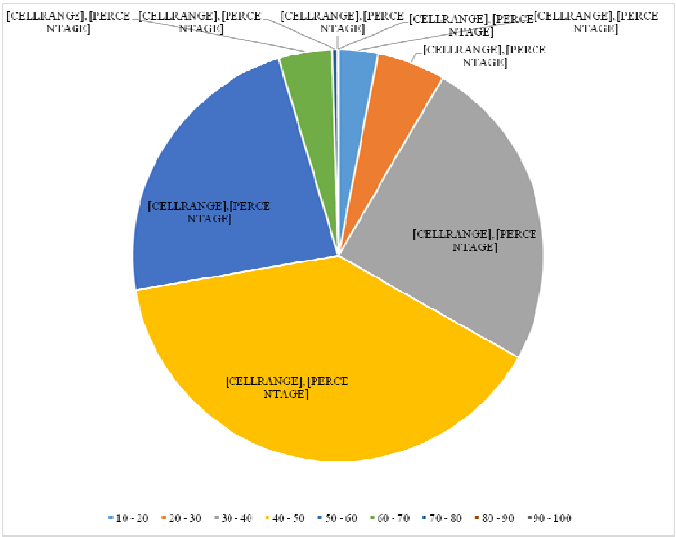


Fig. 5. Pie Chart showing frequency of vehicles in different speed ranges (km/hr)

Speed data was taken for 12 hours using metro count, with which speed percentiles were calculated and existing and revised speed limits were proposed.

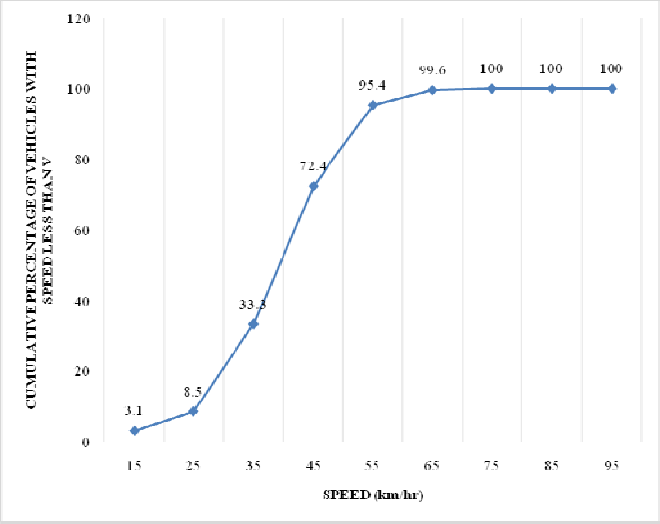


Fig. 6: Ogive Speed Distribution.

From the above Fig. , the various results were concluded:-

Vehicles = 21393
Posted speed limit = 60 km/h, Exceeding = 996 (4.66%), Mean Exceeding = 64.47 km/h
Maximum = 94.3 km/h, **Minimum** = 10.0 km/h, **Mean** = 43.9 km/h
85% Speed = 50.0 km/h, **95% Speed** = 54.4 km/h, **Median** = 44.3 km/h
20 km/h Pace = 34 - 54, **Number in Pace** = 14982 (70.03%)
Variance = 107.62, **Standard Deviation** = 10.37 km/h.

6.2. Dakshin Marg

This is also major arterial 3-lane 2 – way divided highway (each 3.5 m wide) with service lane on both sides.

6.2.1. Volume Study

Variation of traffic volume with time is shown in fig. below.

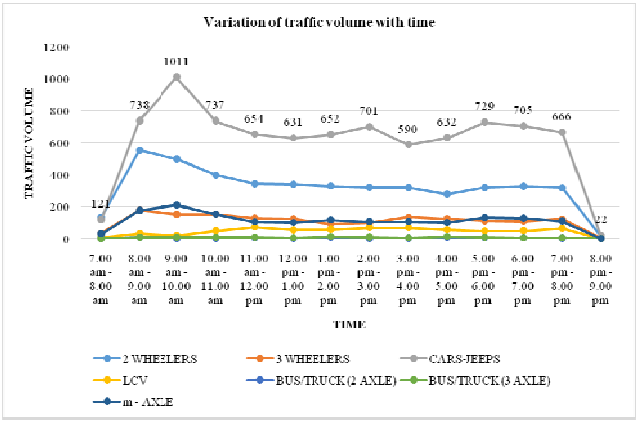


Fig. 7: Hourly Traffic Volume of different vehicles

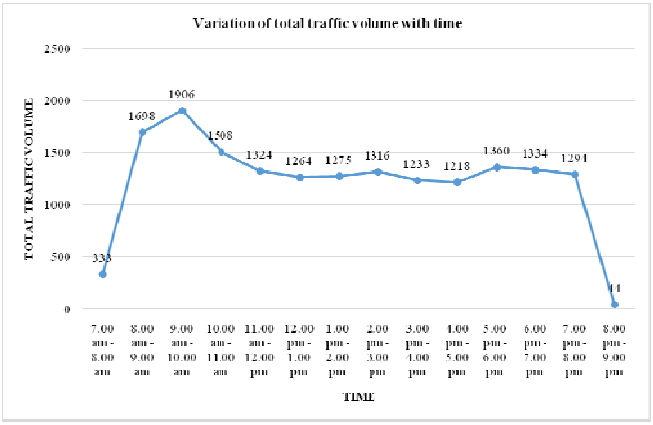


Fig. 8: Hourly Traffic Volume of total vehicles

After this the total volume was converted into PCU/hour. PCU conversion factors were taken acc. to IRC: 106 1990.

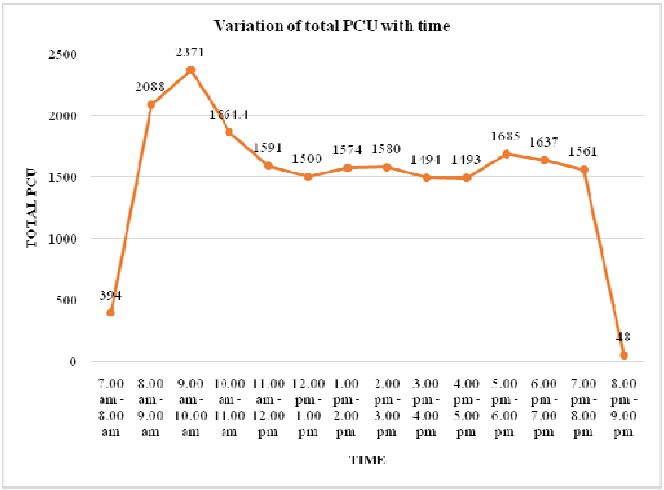


Fig. 9: Hourly PCU Volume

From above Fig. s, the morning peak hour came out to be 09.00 am – 10.00 am and the evening peak hour came out to be 5.00 pm – 6.00 pm. Further, using PCU/hour for these peak hours LOS was found out as per IRC: 106.

Table 2: Design Service Volume (DSV) and LOS

Time	(V) PCU/HOUR	DSV	V/C ratio	LOS
Morning peak hour (9.00am - 10.00am)	2371	3600	0.7	D
Evening peak hour (5.00pm - 6.00pm)	1685	3600	0.5	C

Level of service of Dakshin Marg comes out to be C.

6.2.2. Speed Study

Speed data was taken for 12 hours using metro count, with which speed percentiles were calculated and existing and revised speed limits were proposed.

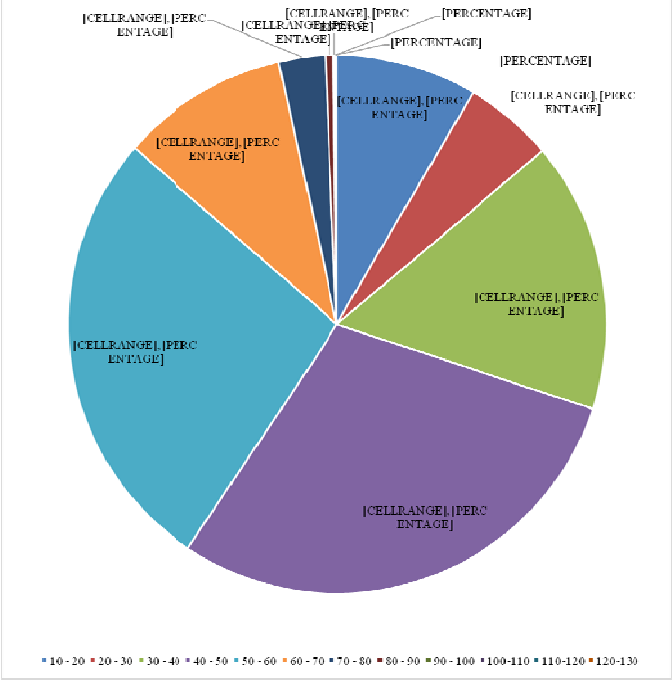


Fig. 10: Pie Chart showing frequency of vehicles in different speed ranges (km/hr)

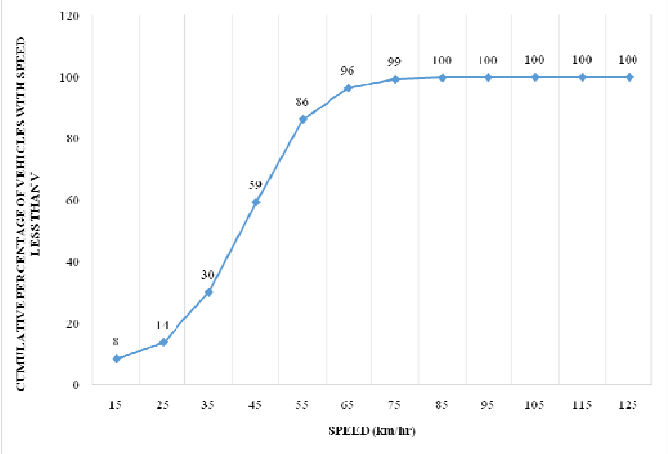


Fig. 11: Ogive Speed Distribution.

From the above Fig. , the various results were concluded:-

Vehicles = 17107

Posted speed limit = 60 km/h, Exceeding = 2330 (13.62%), Mean Exceeding = 67.30 km/h

Maximum = 144.4 km/h, **Minimum** = 10.2 km/h, **Mean** = 45.7 km/h

85% Speed = 54.0 km/h, **95% Speed** = 64.3 km/h, **Median** = 46.8 km/h

20 km/h Pace = 39 - 59, **Number in Pace** = 9819 (57.40%)

Variance = 210.94, **Standard Deviation** = 14.52 km/h

7. CREATION OF DIGITAL MAP

The digital map was created using GIS software ARC GIS which helps in better understanding of road inventory of Chandigarh roads. After creation of digital map, various attributes like name of road, width of road, LOS, peak hour etc. were given to the two roads which were undertaken in this study. These attributes gives us better understanding of existing road and traffic characteristics and provides a base for any further study to be done in this region.

and Dakshin Marg were 2578 PCU's and 2371 PCU's respectively.

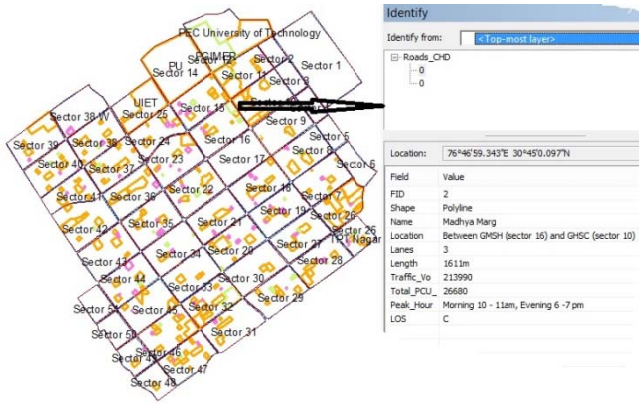


Fig. 12: Digital map of Chandigarh with attribute table

8. CONCLUSIONS AND RECOMMENDATIONS

The above study has revealed that the roads of Chandigarh which were designed and constructed many years ago need to be revolutionized and redesigned in order to accommodate the huge population of Chandigarh as well as nearby towns.

- The daily volumes on the major roads i.e. Madhya Marg and Dakshin Marg have very high PCU's as of the order of 26,680 PCU's and 20,832 PCU's respectively. But the design capacities of the roads don't match such large volumes.
- The peak hour volumes for two roads are too high so as to get accommodated in the roads. The peak hour volumes for Madhya Marg
- Mid-Block counts indicates that at present V/C ratio are less than one for both roads and level of service is computed using V/C ratio for both the roads during peak hours of the day and it is found out to be LOS: C These delivers stable flow conditions. Flows are at a level where small increases will cause a considerable reduction in the performance or 'service' of the highway. Drivers are restricted in freedom to select speed or change lane.

It is seen that during the peak hours of the day the traffic volumes are high and speeds are too low with very low level of service. Therefore certain measures recommended for the study points are as follows:

- The geometric designs of the roads need to be revised on all the roads and junction points.
- The width of the roads needs to be increased. Each lane should be about 3.5 m in width. The number of lanes needs to be worked out as the amount of traffic is quite large.
- The road islands, medians and dividers should be designed according to the volume on the roads.
- Use of Intelligent Transportation Systems (ITS) and GIS for traffic management operations. GIS managing both static urban data and dynamic traffic flows information could provide an integrated geographical reference to the management of a traffic system leading to the improvement of the quality of transport systems.

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