Study of Traffic Flow Characteristics on the National Highway (NH1) Connecting Jalandhar- Phagwara

Peerzada Mosir Shah

Department of Civil Engineering
Lovely Professional University, Punjab, India

Niharika Gupta

Department of Civil Engineering
Lovely Professional University, Punjab, India

Abstract - The data gathered from the Traffic Flow theory is an important tool required for planning and operation of a road system. Now days, due to rapid increase in volume of traffic the designed speed on highways could not be maintained resulting a delay in reaching target point. In Traffic Flow we have to consider generally three parameters, Volume, Speed, and Capacity. The inter relation of these parameters have a great impact on the traffic simulation and regulation. Speed is an important transportation consideration because it is related to safety, comfort and economics. The data collected from the speed analysis is used to calculate the speed percentile which is useful in making speed related decisions. While as traffic volume may be defined as the number of vehicles passing a given section of roads per unit time. The data collected from the Traffic volume is used to calculate the capacity of a given road stretch and LOS (Level of Service) for the given road along with the composition of traffic at any hour of the day. The LOS was calculated for both the directions. Speed and Traffic Volume data is collected on the mid-block section of 6 lanes on Jalandhar – Phagwara Road. In this paper we have calculated the Space Mean and Time mean and have proven the relationship between the two i.e. Vs<Vt .This paper represents the traffic condition on the Jalandhar-Phagwara Road (NH1) and the analysis of capacity, spot speeds with their limits and volume counts during the peak and off peak hours. The study gives recommendations for improvement of LOS of the highway within appropriate limits for better operation of traffic on the roads.

Keywords- Traffic Volume, Capacity, Level of Service, Spot Speed, Time Mean and Space Mean Speed.

I. INTRODUCTION

Traffic flow Characteristics comprises of traffic volume, speed and composition of vehicles on roads. In recent times there has been a massive increase in population and economic behavior thus resulting in huge travel demand of the traffic. The data gathered from the traffic volume and speed studies is used to determine the capacity and the LOS (level of service) for the given road. The traffic volume data is very helpful in planning, designing of a road system, while as speed data is an essential measure in determining the safety of a road network. The data gathered in spot speed studies are used to determine vehicle speed percentile which is useful in making speed related decisions. Generally two types of speeds are there: The Time Mean speed and The Space Mean Speed. Time Mean Speed (spot speed) is measured by taking a reference area on a roadway over a fixed period of time $V_t = (1/M) \sum_{i=1}^{m}(Vi)$.Where m represents the number of vehicles passing the fixed point. Space mean speed is the speed measured by taking the whole roadway segment into account.

$V_s=n (\sum_{i=1}^{n}(\frac{1}{Vi})$^-1) where n represents the number of vehicles passing the roadway segment. The time mean

speed is never less than space mean speed. $V_t=Vs+\alpha^2/V$. Where α^2 is the variance of the space mean speed.

II. LITERATURE REVIEW

Leong [1] studied speed and capacity at 31 sites in New South Wales between the periods of 1963 to 1973. This data was examined using the multiple regressions and the main outcome of the study was that with increase in pavement width, shoulder width and sight distance there is increase in free speed. Van Aerde and Yagar [2] analyzed the effects of traffic volume on speeds of 2 lane highways in Ontario, Canada. The data was used to calculate the 10th, 50th, 90th percentile speeds. Al-Ghamdi [3] Collected the spot speed data on the roads of

Riyadh and found that 85th speed percentile from regression modeling gives much better estimates than those from the normal approximation model, while as on the other hand around 90% of motorists were exceeding the speed limits , indicating that much more speed limit enforcement is needed.

III.SCOPE AND OBJECTIVES

The specific objectives of the research work are as follow:

- To collect traffic data for different parameters like traffic volume, speed and capacity.
- To derive a relationship between the different traffic parameters.
- Determining the capacity and level of service for a given stretch of road.
- To evaluate the prevailing situation of traffic on the road.

IV. STUDY AREA

The present study was carried out on the midblock section between Jalandhar- Phagwara road. Jalandhar is an ancient city in the state of Punjab, India. Jalandhar is considered as the business, education and commercial hub. Jalandhar is very much popular for education so people are attracted towards this city many engineering colleges are there in the city. The population of almost a million and another million live in the rural areas outside the city and population of the city are increasing rapidly.
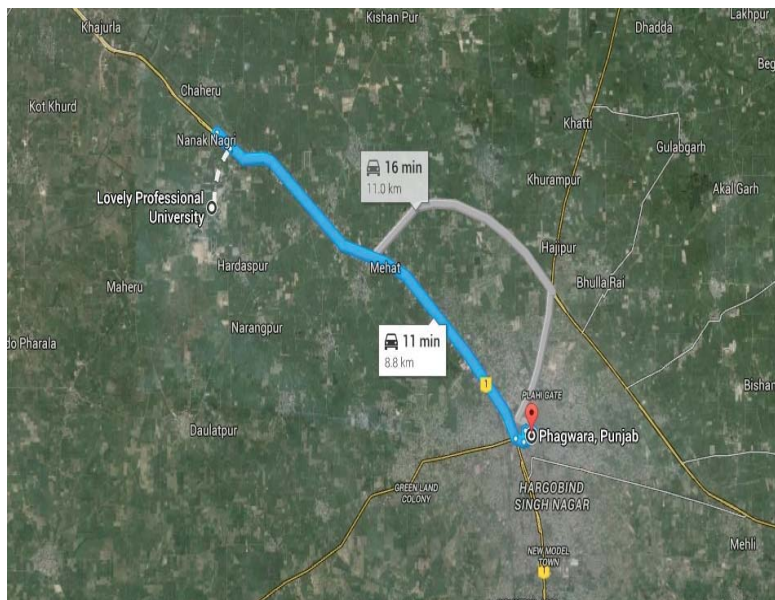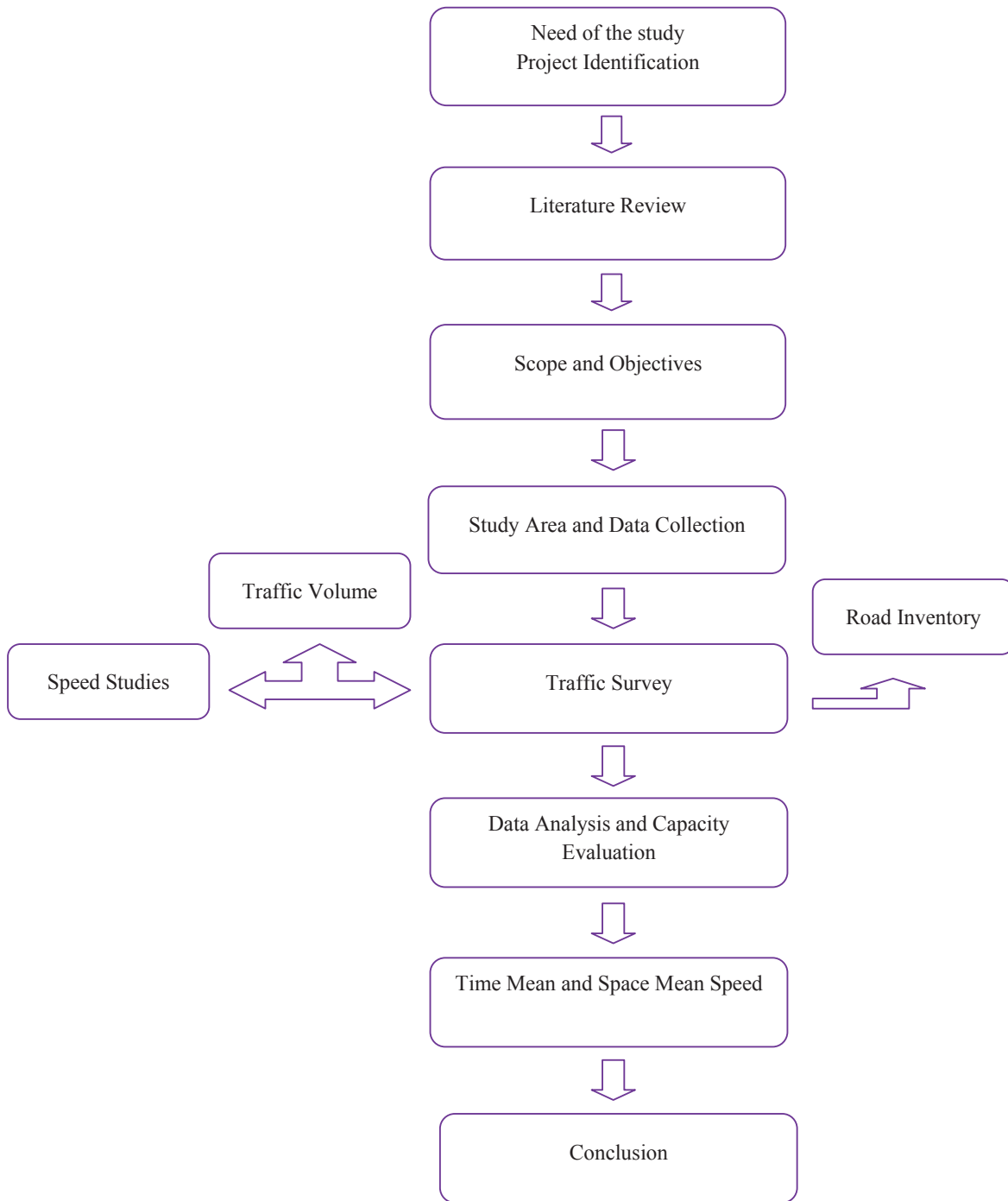

Figure 1: Locations of study points on Jalandhar Map

V. METHODOLOGY

```
┌─────────────────────────────┐
│      Need of the study      │
│    Project Identification   │
└─────────────────────────────┘
              ⇩
┌─────────────────────────────┐
│      Literature Review      │
└─────────────────────────────┘
              ⇩
┌─────────────────────────────┐
│     Scope and Objectives    │
└─────────────────────────────┘
              ⇩
┌─────────────────────────────┐
│  Study Area and Data Collection │
└─────────────────────────────┘
              ⇩
```

Traffic Volume

Speed Studies ⟷ Traffic Survey ⟸ Road Inventory

```
              ⇩
┌─────────────────────────────┐
│  Data Analysis and Capacity │
│          Evaluation         │
└─────────────────────────────┘
              ⇩
┌─────────────────────────────┐
│ Time Mean and Space Mean Speed │
└─────────────────────────────┘
              ⇩
┌─────────────────────────────┐
│          Conclusion         │
└─────────────────────────────┘
```

VI. DATA COLLECTION AND ANALYSIS

Traffic speed and traffic volume data were collected using various techniques such as stop-watch used for speed studies during off peak hours from 11:00 am-12:30 pm while as video photography method used to collect the traffic volume data. The data was collected for 12hrs hourly basis for week and weekend days.

VII. ROAD INVENTORY

The data was collected manually by using various techniques along the given road. The width of the road is 7m. It is provided with a divider of 80cm .There are some small shops along the road. One Hospital, Petrol Pump is also present along the road. The overall condition of the road is good, some potholes and unevenness is found along the road which slows down the speed of the vehicles.

VIII (A). TRAFFIC VOLUME STUDY

Jalandhar-Phagwara

The main purpose of Traffic volume study is used in planning, traffic operations and design of new facilities. The data was collected for 3 days (Monday Thursday and Saturday) at urban mid-block section of Jalandhar-Phagwara road. The data was collected for 12 hours and then it was analyzed with the help of pie charts and graphs.
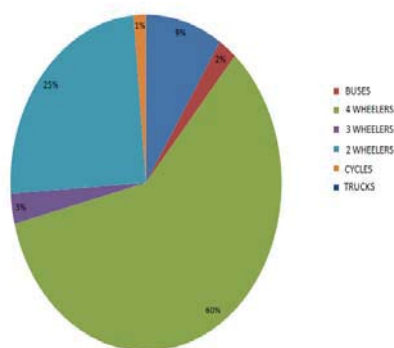

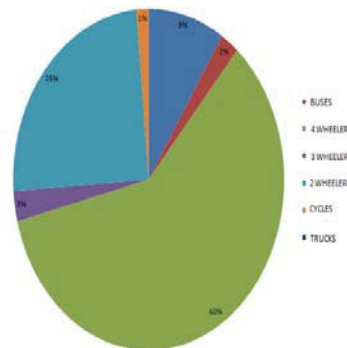Fig 2: Traffic Composition during entire day (Monday)   Fig 3: Traffic Composition during entire day (Thursday)
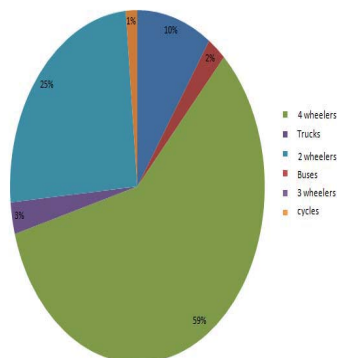

Fig 4: Traffic Composition during entire day (Saturday)

From the above pie chart the 4 wheelers shows 60% , 2 wheelers shows 25% which are much higher than other modes of transport as people usually travel from Jalandhar to Phagwara because of education purpose (Lovely Professional University) and Ludhiana is considered to be the Industrial hub , so people usually travel from Jalandhar.
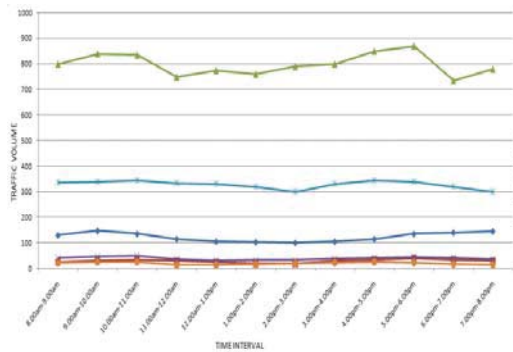
Fig 5: Hourly Variation of traffic volume with time (Monday)
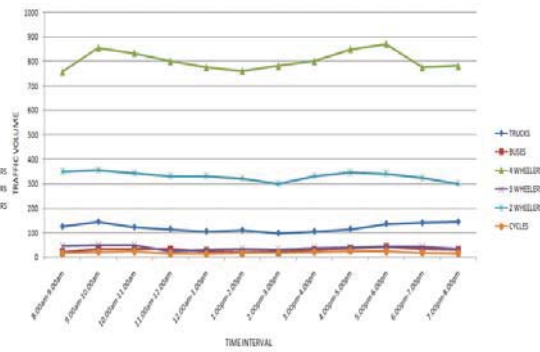

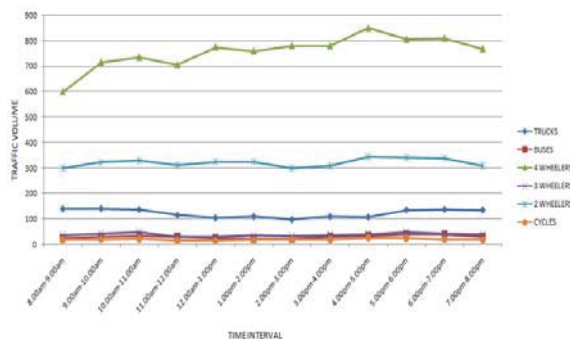Fig 6: Hourly Variation of traffic volume with time (Thursday)

Fig 7: Hourly Variation of traffic volume with time (Saturday)

From the above graphs the morning peak hour for Monday is 9:00-10:00am while as in the evening the peak hour is 5:00-6:00pm.Similarly the morning peak hour for Thursday is 9:00-10:00 am while as in the evening the peak hour is 5:00-6:00pm but in case of Saturday the morning peak hour is 10:00-11:00 am while as in the evening the peak hour is 6:00-7:00pm.

VIII (B). CAPACITY AND LEVEL OF SERVICE

Table 1: Calculation of V/C Ratio (Monday)

Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards Phagwara	Morning peak hour flow (PCU)	1947.1	3.50	3	2200	0.88	C
	Evening peak hour flow (PCU)	1978.5	3.50	3	2200	0..89	D
	During Off peak Hour	1639.9	3.50	3	2200	0.74	Intermediate of B and C

The above table clearly shows that the level of service during the peak morning and evening hours approaches C and D with V/C ratio. Drivers are restricted in freedom to select speed or change lane. While as during the off peak hours the road provides LOS B or C which is acceptable and free floe condition prevails.

Table 2: Calculation of V/C Ratio (Thursday)

Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards Phagwara	Morning peak hour flow (PCU)	1981.8	3.50	3	2200	0.9	E
	Evening peak hour flow (PCU)	1991.7	3.50	3	2200	0.9	E
	During Off peak Hour	1646.9	3.50	3	2200	0.74	Intermediate of B and C

The above table clearly shows that the level of service during peak morning and evening hours approaches E with V/C ratio. In this level of service there is unstable flow with tolerable operating speeds being maintained. Drivers have little freedom to manoeuvre. These conditions are tolerable for short period of time. Whereas during off peak hours the road provides LOS B or C which is acceptable and free flow conditions prevail.

Table 3: Calculation of V/C Ratio (Saturday)

Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards Phagwara	Morning peak hour flow (PCU)	1772.1	3.50	3	2200	0.8	C
	Evening peak hour flow (PCU)	1897.9	3.50	3	2200	0.86	D
	During Off peak Hour	1536	3.50	3	2200	0.69	B

The above table clearly shows that the level of service during the peak morning and evening hours approaches C and D respectively with V/C ratio. In this level of service there is unstable flow and tolerable operating speeds being maintained. Drivers have little freedom to manoeuvre. These conditions are tolerable for short period of time. While in case of off peak hours the road provides LOS B which is acceptable and free flow conditions prevails.

IX (A). TRAFFIC VOLUME STUDY

Phagwara-Jalandhar
The data was collected for 3 days (Monday Thursday and Saturday) at urban mid-block section of Phagwara-Jalandhar road. The data was collected for 12 hours and then it was analyzed with the help of pie chart and graphs.
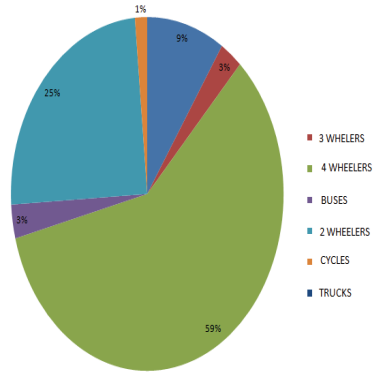
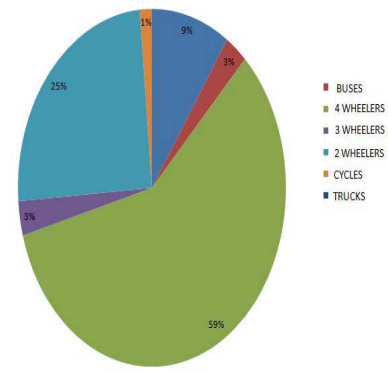Fig 8: Traffic Composition during entire day (Monday)

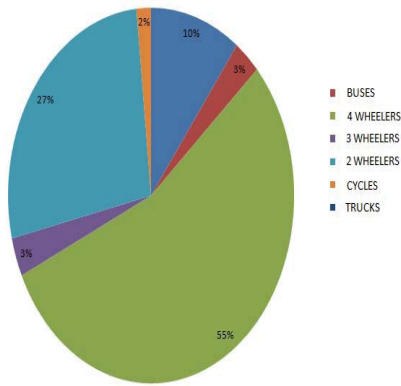Fig 9: Traffic Composition during entire day (Thursday)

Fig 10: Traffic Composition during entire day (Saturday)

From the above observation 4 wheelers shows 55-60%, 2 wheelers shows 25-27%. The people travel from the rural areas of Phagwara district towards Jalandhar city for education and employment purposes.
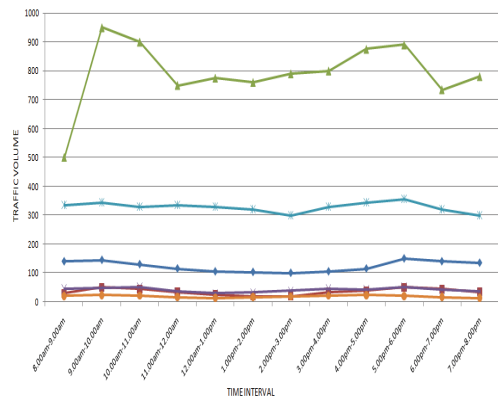

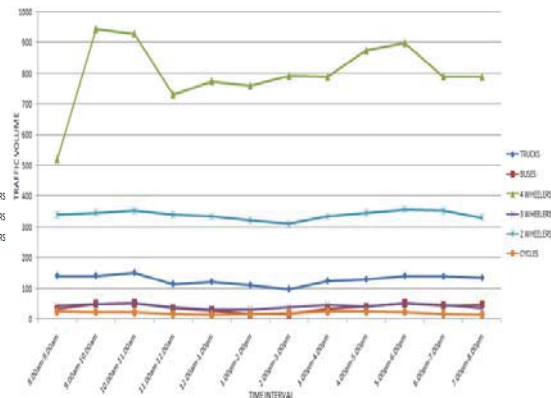Fig 11: Hourly Variation of Traffic Volume with Time (Monday)   Fig 12: Hourly Variation of Traffic Volume with Time (Thursday)
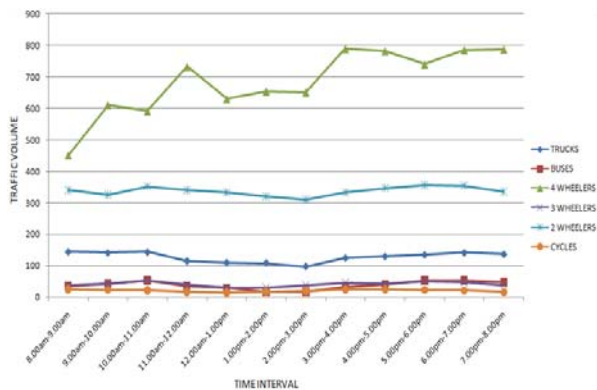
Fig 13: Hourly Variation of Traffic Volume with Time (Saturday)

From the above graphs the morning peak hour for Monday is 9:00-10:00 am while as in the evening the peak hours are 5:00-6:00pm. While as in case of Thursday the morning peak hour are 10:00-11:00 am and the evening peak hour are5:00-6:00pm. Similarly morning peak hour for Saturday is 11:00-12:00nooon and evening peak hour is 6:00-7:00pm

IX (B). CAPACITY AND LEVEL OF SERVICE

Table 4: Calculation of V/C ratio (Monday)

Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards PAP-Chowk	Morning peak hour flow (PCU)	2162	3.50	3	2200	0.98	E
	Evening peak hour flow (PCU)	2095.7	3.50	3	2200	0.95	E
	During Off peak Hour	1442.5	3.50	3	2200	0.65	B

The above table clearly shows the level of service during peak morning and evening hours approaches E with V/C ratio. In this level of service the road has a very unstable flow with intolerable delays and low running speeds. Whereas during off peak hours the road provides LOS B which is acceptable and free flow conditions prevail

Table 5: Calculation of V/C ratio (Thursday)

Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards PAP-Chowk	Morning peak hour flow (PCU)	2163.4	3.50	3	2200	0.98	E
	Evening peak hour flow (PCU)	2088.3	3.50	3	2200	0.94	E
	During Off peak Hour	1484.1	3.50	3	2200	0.67	B

The above table clearly shows the level of service during peak morning and evening hours approaches E with V/C ratio. In this level of service the road has a very unstable flow with intolerable delays and low running speeds. Whereas during off peak hours the road provides LOS B which is acceptable and free flow conditions prevails.

Table 6: Calculation of V/C ratio (Saturday)

| Location	Time	(V) (PCU/hr)	Width of road per lane (m)	No. Of lanes	DSV (Design Service Volume)	V/C ratio	LOS
National-Highway (NH-1) Towards PAP-Chowk	Morning peak hour flow (PCU)	1701.3	3.50	3	2200	0.77	C
	Evening peak hour flow (PCU)	1926.1	3.50	3	2200	0.87	D
	During Off peak Hour	1398.1	3.50	3	2200	0.63	B

The above table clearly shows that the level of service during peak morning and evening hours approaches C and D with V/C ratio. Drivers are restricted in freedom to select the speed and change lane. Whereas during off peak hour the LOS approaches B which is accepted and free flow conditions prevail.

X. SPOT SPEED STUDY

The traffic speed data was conducted on Jalandhar Phagwara road near. The data was collected during the off-peak hour's i.e 11:00am to 12:30 pm.
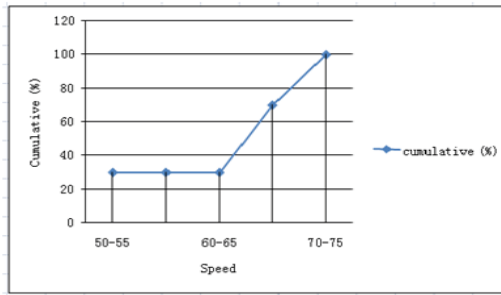
- A road stretch of 60 meters on the mid block section was taken and the spot speed study was conducted.
- Two observers were stationed at the two ends of the stretch each observer having a stop watch

- A sample of 10 (cars, 2 wheelers, 3 wheelers, Buses and trucks) were examined.
- The data collected was analyzed on an excel sheet and the speeds for each vehicle were calculated
- Then the Cumulative frequency curves were plotted to determine the percentile speed.
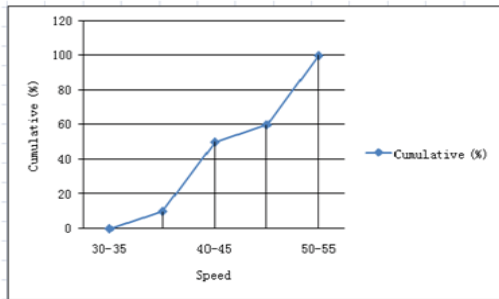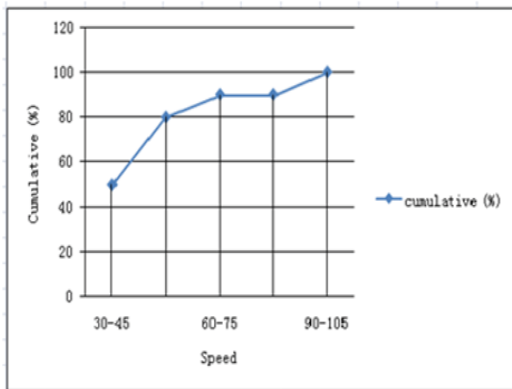

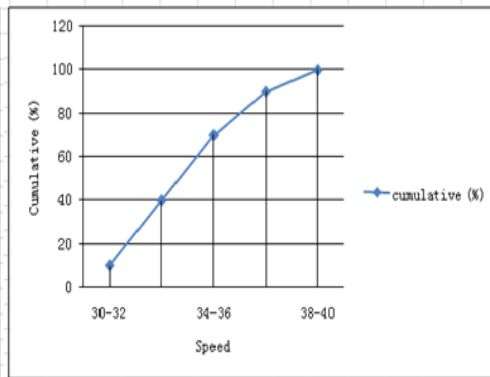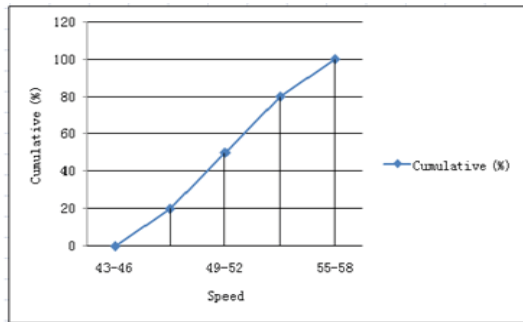Fig 14: Cumulative frequency graph for trucks   Fig 15: Cumulative frequency graph for buses

Fig 16: Cumulative frequency graph for 4 wheelers   Fig 17: Cumulative frequency graph for 3 wheelers

Fig 18: Cumulative frequency graph for 2 wheelers

Table 7: From the above figures, the percentile speeds for the vehicles can be interpreted as:

Percentile	Table 4.6: SPEEDS (kmph)				
	TRUCKS	BUSES	4 WHEELERS	3 WHEELERS	2 WHEELERS
98th	49.75	69.5	87	37.5	54.5
85th	48	67.5	52.5	35.5	52.75
50th	40	62.5	30	32.5	49

X1. TIME MEAN AND SPACE MEAN SPEED

Table 8: Time Mean Speed

speed mid value (v)	volume of trucks (qt)	volume of buses (qb)	volume of 4 wheeler (qs)	volume of 3 wheeler (qt)	volume of 2 wheeler (qc)	trucks (qt.v)	buses (qb.v)	4 wheeler (qs.v)	3 wheeler (qt.v)	2 wheeler (qc.v)
15	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
35	1	0	1	10	0	35	0	35	350	0
45	5	0	5	0	2	225	0	225	0	90
55	4	3	2	0	8	220	165	110	0	440
65	0	4	0	0	0	0	260	0	0	0
75	0	3	1	0	0	0	225	75	0	0
85	0	0	0	0	0	0	0	0	0	0
95	0	0	1	0	0	0	0	95	0	0
Total q	10	10	10	10	10					
Total q.v						480	650	540	350	530
Time mean speed vt= total (q.v)/ total (q)						48	65	54	35	53

Table 9: Space Mean Speed

speed mid value (v)	volume of trucks (qt)	volume of buses (qb)	volume of 4 wheeler (qs)	volume of 3 wheeler (qt)	volume of 2 wheeler (qc)	trucks (qt/v)	buses (qb/v)	4 wheeler (qs/v)	3 wheeler (qt/v)	2 wheeler (qc/v)
15	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
35	1	0	1	10	0	0.028571	0	0.028571	0.285714	0
45	5	0	5	0	2	0.111111	0	0.111111	0	0.044444
55	4	3	2	0	8	0.072727	0.054545	0.036364	0	0.145455
65	0	4	0	0	0	0	0.061538	0	0	0
75	0	3	1	0	0	0	0.04	0.013333	0	0
85	0	0	0	0	0	0	0	0	0	0
95	0	0	1	0	0	0	0	0.010526	0	0
Total q	10	10	10	10	10					
Total q/v						0.212	0.156083	0.1999	0.285714	0.189899
space mean speed vs= total (q)/ total (q/v)						47.16	64.068	50.0	34.999	52.659

Table 10: Time mean speeds and space mean speeds are tabulated as:

SPEED	Trucks	BUSES	4 WHEELER	3 WHEELER	2 WHEELER
Time Mean speeds	48	65	54	35	53
Space mean speeds	47.16	64.068	50.0	34.99	52.659

Hence, $v_s < v_t$ holds true.

XII. CONCLUSION

After analyzing all the parameters such as traffic volume, speed and Capacity it is concluded that the present situation of the traffic on the road is very high and does not match up with the capacity of the road. The Traffic during the morning and evening peak hour is very high and the speed is very low as it does not provide the required level of service. The various obstruct, Pot holes present on the road decreases the speed of the vehicle, which needs to be taken in consideration. Immediate attention needs to be given to the current condition of the road as it does not provide the required level of service.

XIII. RECOMMENDATION

- The main attention should be given to the junction points of the road such as PAP Chowk, Rama Mandi Chowk etc.
- The Rotaries such be provided at the Rama Mandi Junction to decrease the Congestion time.

- Proper Traffic Signaling system should be provided at the Rama Mandi Chowk and a proper check should be kept on the defaulters.
- Cycle lanes and foot paths need to be provided so that a certain portion of the composition of traffic can be channelized.
- Shoulder is not provided at many portions of the roads.
- Service lanes should be necessarily provided as it is a national highway and large amount of trucks and buses are using this road.
- Parking facilities are to be provided outside the viva mall and city hospital otherwise the people usually park their cars on the service lane, which is not meant for parking purpose.
- Parking should be restricted on the roads as it decreases the width of the carriage way.
- Public transport should be increased to reduce the congestion and accident rate on the roads

REFERENCES

[1] Leong (1978). "The distribution and trend of free speeds on two-lane-two-way rural highway in New South Wales", ARRB 4, part 1, pp.798-818.
[2] Van Aerde M. and Yagar S. (1983). "Volume effects on speeds of two lane highways in Ontario". Transportation Research Records, 17A (1), 301-313.
[3] Al-Ghamdi (1998). "Spot Speed Analysis on urban roads in Riyadh". Transportation Research Board, Washington, DC, 162-170.
[4] Niharika (2014). "Study of Traffic Characteristics on Chandigarh Roads, Dept of Civil Engineering, PEC, Chandigarh.
[5] Arash Maradkhani (2009) "Evaluation of Traffic Characteristics", International journal of Recent Trends in Engineering, Vol.1, No.6.