LEVEL OF SERVICE AND FEASIBILITY OF CYCLE TRACKS

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by

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DECLARATION

I, Abhishek Kohli (11207987), hereby declare that this thesis report entitled **"LEVEL OF SERVICE AND FEASIBILITY OF CYCLE TRACKS"** submitted in the partial fulfilment of the requirements for the award of degree of Master of Civil Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

Date: **ABHISHEK KOHLI**

Place:

CERTIFICATE

Certified that this project report entitled " LEVEL OF SERVICE AND FEASIBILITY OF CYCLE TRACKS" submitted individually by student of School of Civil Engineering, Lovely Professional University, Phagwara , carried out the work under my supervision for the Award of Degree. This report has not been submitted to any other university or institution for the award of any degree.

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Signature of Student

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ABSTRACT

As we are moving towards advancements in each and every field of science and technology, we also need to restrict our steps towards the damage we are causing to the nature, we are also moving very fast towards ending up our fossil fuels. This report aims at giving a plan for the construction of cycle tracks in Jalandhar city of Punjab. This report also aims at knowing the feasibility of the laying of such tracks in the selected area as well as in knowing the bicyclist's level of service. By the construction of such tracks it is expected that there will be an increase in the level of service of the bicyclists, there will be reduction in the number of cycle crashes/accidents, more number of people will be attracted towards the use of cycle of cycles for their day-to-day movement or as part of recreational activity etc. This will cause a reduction in the use of motorised vehicles and will contribute towards green movement.

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LIST OF ABBREVIATIONS

LOS	Level of service
mvph	Motor vehicles per hour
ADT	Annual daily traffic
AWT	Average weekly traffic
AADT	Average annual daily traffic
km	Kilometre
m	Metre
‘	Feet
%	Percentage
BLOS	Bicycle level of service

CHAPTER 1

INTRODUCTION

1.1 General

Over the years, there have been number of steps taken towards improvement of road user experience. Cycle Tracks are also a part of advancements and improvements in the field of traffic engineering. CYCLE TRACK (sometimes historically known as side paths) is a separated path meant for the movement of cycles. A cycle track can be located within a roadway or next to it, but it is separated from both the footpath and general roadway by elevation difference or through barriers. LEVEL OF SERVICE (LOS) is basically a qualitative measure used to relate the quality of traffic service. LOS is used to analyze the quality of traffic service by the measurement of parameters like speed, density etc. And FEASIBILTY means the state or degree of being conveniently or easily done. Hence, 'Level of service and feasibility of cycle tracks' refers to the quality of traffic service that can be achieved and maintained and how possible and practical to do conveniently and easily it will be for the cyclists by the construction of cycle tracks.

It has been recognised that the cycle tracks are a part of roadway system that need to be implemented keeping in view several points like fuel crisis, pollution problems, leading people to a healthier lifestyle, safety of cyclists etc. It also aims at reducing the common hindrances to the cyclists while using the same part of the road that is used by the motorised vehicles which move at comparative faster speeds. This has been estimated because there has been significant number of such problems faced by the cyclists, which in turn demotivate people from using cycles. Till date none of the methodologies have been developed to describe the bicyclist level of service or to offer priorities for bicycle facility construction has been widely accepted.

Cycle Tracks may be as per our requirements like One-way Cycle tracks or Two-way cycle tracks, or as per the availability of space like at road level, at sidewalk level or at an intermediate level. All of the above stated types have some separation from motor traffic. Cycle tracks are separated from common road by the means of barriers, which may include concrete beams, posts, curbs, median strips, plantings, trenches, walls, steel frames or fences

etc. At intersections they are accompanied by a curb extension or some other features to simplify the crossing for the cyclists.

Cycle tracks are constructed both in rigid as well as flexible pavement. Mostly rigid pavement is being adopted now a days for the construction of cycle tracks and are constructed in a different colour from the general roadway (Red or Green colour is commonly adopted for the cycle track construction), so as to distinguish it from the general roadway. Special markings are also adopted for cycle tracks like a directional arrow in case of a one-way cycle track, solid white lines on both sides of the cycle tracks, a cyclist is also drawn.

1.2 Statement of the problem

There are several different reasons which account towards the construction of cycle tracks. We are moving towards a greener lifestyle with the construction of green buildings, adaptation of less pollution emission mechanisms in every field, low power consumption mechanisms are being adapted etc, so one of the problem is pollution by motorised vehicles. Also the people who use cycles for daily manoeuvring face a lot of problem in using the same road which is used by motorised vehicles. Due to the use of same road, there are many accidents between the cycles and the faster moving vehicles, which also need to be reduced. People are less attracted towards cycling as an exercise as well as a sport. We also need to motivate more people for using cycles which can be done by the construction of cycle tracks.

1.3 Objective of the research

The major objectives of this research are as follows:

- Traffic study (ADT, AWT etc) of people using cycles for local movement in study area.
- Need of cycle tracks in cities of India (case study of Jalandhar region).
- Selection of site for the construction of cycle track in the study area based on different factors.
- Give a plan for the construction of the cycle tracks in the selected site.
- Type of cycle track that is to be constructed as well as the method of construction that is to be adapted for the construction in that area.
- Defining the specifications of the proposed construction.

- Lead to attraction of more people for using cycles for local movement, as well as adaptation of cycling as an exercise and as a sport.
- Increasing the safety of the cyclists.
- Decreasing the problems like pollution and fuel crisis with more number of people using cycles after the construction of cycle tracks.
- Increasing the value of level of service of the cyclists due to construction of cycle tracks.
- Improving the overall cycling experience of the cyclists.
- Reducing the common hindrances that were faced while using the same roadway that is used by motorised vehicles.

1.4 Scope of research

In this study, the area selected is Jalandhar, as the type of terrain of the study area is plain, hence there will be more number of people using cycles. We are selecting such locations in that part of the urban area which is well connected with the residential area as well as commercial area and where the future scope for the expansion is available. Selecting such type of location will ensure the maximum accessibility of the construction as well as maximum usage. Moreover, the plan laid will be such that it can be extended and joined to other areas in the future as per our need.

1.5 Expected Outcomes

The major outcomes of this research include the setting up of a plan of cycle tracks in Jalandhar city. It also aims at attracting more number of people towards use of cycles for local movement or as a recreational activity. Implementation of the plan will ensure an overall better cycling experience for the cyclists. It will also result in reducing the number of cycle accidents, hence increasing the safety of the cyclists. It will also contribute towards green movement, as there will be no pollution from cycles and if people will start using cycles for local movement then there will be reduction in use of other motorised vehicles, hence contributing toward less use of fossil fuels as well as less pollution.

CHAPTER 2

REVIEW OF LITERATURE

2.1 General

With the development in each and every field of transportation, cycle tracks also need to be developed. Cycle tracks have been of great importance in many foreign countries but in India its development has been rejected. But keeping in view certain problems like fuel crisis and green movement, these needs to be developed. In the past few years, a change has been seen and few initiatives have been taken towards the development of cycle tracks. Stretches of cycle tracks have been developed in cities like Chandigarh, Noida, Gurugram, Amritsar, and Bangalore etc. In countries like Denmark, they have huge percentage of local traffic movement by cycles and the one reason behind that is the presence of cycle tracks in most parts of Denmark. During the British rule in India, many stretches of cycle tracks were developed in many Indian cities but due to the ignorance those were put out of use and further initiatives could not be taken. Many private agencies and NGO's are working today towards a greener planet and a greener lifestyle, and such agencies are working towards the issue of development of cycle tracks in India. Also, as India is running toward developing its various cities as smart cities, there has been a plan of developing 100 cities of India as smart cities, so keeping in view the concept of smart cities cycles tracks should also be planned and developed in the cities of India. Talking about Punjab, Haryana, Delhi, NCR regions, all of these regions come under plain terrain regions and the movement through cycles is easy in these regions as compared to that of hilly terrain regions, a considerably larger amount of people use cycles in these regions and hence it also hints towards the development of cycle tracks in these regions.

In my study, I have done a research in Jalandhar region of Punjab. Till date, no work has been done on cycle tracks in the Jalandhar city. As Jalandhar city also comes under plain terrain region and many people use cycles for their daily movement or for recreational activities, keeping in view these points Jalandhar city was selected and further we expect a growth in the number of cyclists in this region with the development of cycle tracks as well as the previous cyclists experience will be better.

Also, some advancements in bicycle facilities have been studied, bicycle track markings, side furniture etc. At intersections and crossing several new techniques have been adapted to improve the bicyclist's experience and result in increased level of service, it also results in reduced chances of accidents while crossings at intersections. Different colours are being used for the construction of cycle tracks for differentiating it from other traffic path.

2.2 Variables affecting bicyclist's satisfaction and level of service

(*By Soren Underlien Jensen*)

In this model, the researcher studied about the different variables that bicyclist's satisfaction and level of service on roadway segments. By his study, he observed that the most important variables that affect the bicyclist's satisfaction and level of service are the presence of cycle tracks and the width of cycle tracks (depending upon whether it is a one way cycle track or a two way cycle track).

He also observed some other less important variables (that have less impact on bicyclist's satisfaction and level of service) which include traffic volumes, motor vehicles speed and number of parked motor vehicles and hence we can use reasonable rounded figure values for these variables.

Dummy variables like presence of trees, bus stops and medians can also affect level of service, but as these are variables of very less importance, so their value is almost negligible.

2.3 Comparison of Danish and American models

We have done a comparison of Danish Bicycle Model and three American Bicycle Models. These models basically give ratings to the bicycle facilities based on surveys done with the involvement of common people. In both the models, the system was tested under different conditions and differences in the results were noticed and their ratings were given. Also the reason for the different observations is stated.

- **Condition 1**: Baseline Conditions

  The baseline conditions used under these models are:

  1. A road with two 5.1m wide lanes.
  2. No bicycle track facility.
  3. Sidewalks – 1.8m (width)

4. Motor vehicles per hour – 500 (with 5% heavy vehicles)
5. Average motor vehicle speed – 60kmph.
6. 85th percentile speed – 65kmph.
7. No parking.
8. No pedestrian or bicycle traffic.
9. A good and even asphalt road.
10. No bus stops.
11. Rural fields in this area.

Ratings under baseline conditions are-

Danish Model: 4.03
American Model: 2.72 to 4.29

- **Condition 2:** Marking of cycle lanes.

  If 1.5m wide cycle lanes are marked and the width of drives lanes are reduced to 3.6m

  Under this condition, there was an improvement in the ratings in both the models. The bicyclists are more satisfied in this condition.

  Ratings under condition 2 are -

  Danish Model: + (1.28)
  American Model: + (0.66 to 0.98)

- **Condition 3:** If there is an increase in number of motor vehicles per hour.

  Previous motor vehicle count: 500mvph
  Current motor vehicle count: 1000mvph

  Under this condition the bicyclists were less satisfied and there was seen a decrease in the ratings in both the models.

  Ratings under condition 3 are -

  Danish Model: - (0.20)
  American Model: - (0.20 to 0.50)

- **Condition 4:** If there is an increase in average speed.

Previous average speed: 60kmph
Current average speed: 70kmph

Under this condition also the bicyclists were less satisfied and similarly there was a decrease in the ratings in both the models.

Ratings under condition 4 are –

Danish Model: - (0.32)
American Model: - (0.00 to 0.22)

Overall, both the approaches evaluated Bicyclist's level of service similarly.
However, presence of cycle tracks id of greater importance in Danish Model than in American Models.

Reasons:

- Bicycle facilities are more common in Denmark than in America.
- Danish people ride bicycle more than American people.
- In Danish study, randomly persons were selected whereas the American studies were based on respondents who signed up for participation.

2.4 Bicycle level of service: Where are the gaps in bicycle flow measures?

(*By Pamela Christine Johnson, 2014*)

As per studies, in Portland current bicycle mode share is 6.1 % of all trips. There is a plan of increasing this share from 6.1 % to 25 % by 2030. In this study, BLOS (Bicycle level of service) for capacity methods were summarised and it was tested that how much those methods are applicable on bicycle facilities where the bicycle traffic flow is high. It was observed that most of the models that measure BLOS (bicycle level of service) were not applicable to most of the bicycle facilities where the bicycle traffic flow is high such as on intersections and on-street bike lanes. It was recommended that there is need of initial research in the areas of bicycle flow and capacity. Also, new guidelines need to be developed that set a global standard for measuring the BLOS (as an A level of capacity in China is F level of service for Germany). One more thing of greater importance that was recommended was the variables that are statistically significant for a BLOS capacity measure for the urban context be investigated including speed of bicycle, geometric variables of

facility and standard deviation for different facilities. The other variables that need to be tested for significance in bicycle capacity are transit, motor vehicle and pedestrian variables. It also stressed on a development of a method which is more flexible and can handle data with varying facility differentials as well as different level of data available. There is also need for the research and establishment of new default values.

2.5 Development of cycle tracks in Chandigarh

Modern India's first planned city Chandigarh also includes cycle tracks in its plan. Convenience of cyclists was also kept in mind while it's planning. The city has got a cycle track spread of over 70km across all sectors but due to poor maintenance because of negligence and laxities of administration a larger number of tracks are not in use. Cycle tracks end at roundabouts which makes it risky for the cyclists to merge with heavy moving traffic.

There have been several failed proposals regarding the maintenance, improvement and construction of cycle tracks. In 2013 and 2014 there were plans being made by the authorities to introduce a facility to rent bicycles which was to be named "Park and Ride" and it was planned to be done by 2015, but the proposal failed.

A great stress has been laid on promoting cycling in master plan. The Chandigarh city master plan 2031 has laid a great stress on making the city a cycle-friendly city and several recommendations have been made for the same cause. There is also a proposal of reviving the V-7 roads as intended for bicycles in the same master plan 2031 of Chandigarh. Le Corbusier (the designer of Chandigarh city) had given the concept of 7 V's of traffic circulation which is yet to be completed. Along V-2 (major boulevards) and V-3 (sector definers) roads, there is a proposal of about 60km cycle track network. There is also a plan of improvement and proper integration along zebra crossing of existing cycle tracks along V-3 (sector definers) roads. Green corridors for both cyclists and pedestrians are to be developed and a total of 11 longitudinal green belts have been earmarked.

Recent development, in sector 26 the city got its first cycle-friendly roundabout, which is ready for public use. This project was conceptualised by Finance Secretary Sarvjit Singh. This cycle track stretch is developed from Sector 26 grain market to transport light point in Sector 26. The length of this facility is 1.5kms and is made red in colour to differentiate it

from regular pavement. This cycle track has been laid at road level and there is a separate pedestrian path.

With this development of cycle tracks at roundabouts, there will be reduce in the collision of cycles with other vehicles at roundabouts, there will be decrease in pollution, it will also improve efficiency of bus transport vehicles and will also help in enhancing the efficiency of the corridors, as the cyclists will not have to cross the light along the other commuters it will help in managing travel time. Proposals for similar cycle tracks on other major roundabouts on Jan Marg, Dakshin Marg, Udyog Path, Vigyan Path and Madhya Marg have already been made.

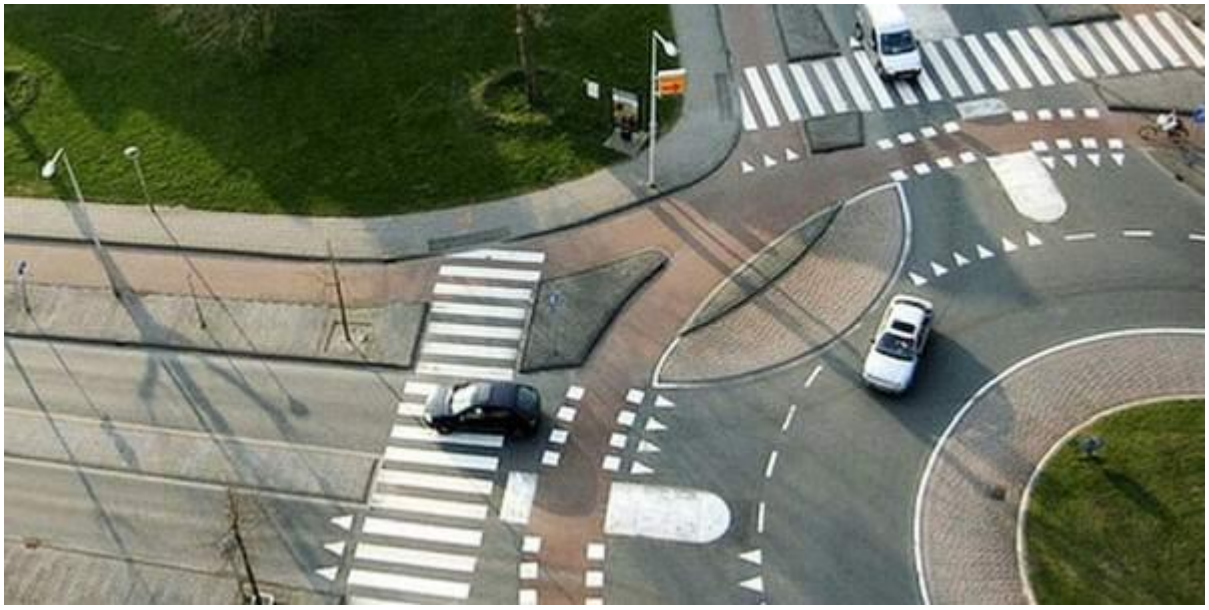


Figure 2.1: A cycle friendly roundabout

(Source: Google Images)

The above picture shows a cycle friendly roundabout, it is similar to the one constructed at Sector 26, Chandigarh. In this picture, the red coloured pavement is the cycle track. This type of track makes it easier for the cyclists to cross the roundabout without any problem from the regular traffic.

2.6 Development of cycle tracks in Amritsar

A 2km long stretch of cycle track near Trillium Mall, Old Jail road, Amritsar has been constructed in the recent past. This track has been developed by Amritsar Improvement Trust. Similar pattern has been followed as that of Chandigarh and cycle track crossing at

roundabout has also been provided. Alongside a green belt has been developed for the purpose of taking a walk. The cycle tracks have been put to public use and are getting great response and appraisal. There are plans being made of developing such tracks in the other parts of the city too. There are surveys being done near the Tara Wara Bridge for the same. It is 3km stretch which can be a good stretch for cyclists. Plans are also being made to construct a 7-9 km cycle track in Hudiara, which can span the entire bypass stretch and can become a healthier option for skirting the city.

Figure 2.2: Recently developed cycle track at Amritsar.

2.7 Danish Bicycle Track

(*By Soren Underlien Jensen, 7th of Nov, 2007*)

In this study, a before and after study of constructing cycle tracks is shown. Factors like crash studies, injury and traffic studies were observed before and after the construction of cycle tracks in Copenhagen, Denmark and the changes were noticed. It is a type of observational study. First cycle track introduced in Copenhagen in 1910 and since then 8000 km of cycle tracks have been constructed. So, about every 9th km of road in Denmark have these bicycle facilities.

This study shows that with the construction of cycle tracks, there had been 20 % increase in the bicycle traffic mileage and also 10% decrease in motor vehicle traffic mileage. Whereas with the cycle track markings there had been 5% increase in bicycle traffic mileage and a decrease of 1% was noticed in motor vehicle traffic mileage. Also, there had been a crash reduction of 4%. Rear end crashes (where the bicycles were hit by motor vehicles from behind) had fallen by 63% and the reason was traffic separation. Crashes during the left turning of the bicycles had fallen by 41% and the cases where the crashes were with the parked vehicles had decreased by 38%. Crashes with right turning vehicles were seen to be increased by 120%. There had been an increase in all types of right turning crashes. Crashes with bicycles and pedestrians or people entering or exiting the bus were also increased to a significant level. Results varied significantly from road to road.

2.8 Cycle tracks cross section recommendations

2.8.1 Determining the width

The design width of a cycle track comprises of the effective width. The effective width includes the space useable by the cyclist as well as certain clearances that will be required under different circumstances.

The width of an individual cyclist on a conventional cycle is 750mm approximately. A further extension of 250mm is accounted for accessories like side baskets, child trailers, carriers etc. While cycling there is wobbling and wandering at lower speeds in order to keep balance, so space needs to be provided for that too, so we keep a provision of 250 mm wobble room, which is considered to be sufficient. Some additional width needs to be considered in cases where the cyclists will be slower and wobbling more, like in bends, uphill sections etc.

2.8.2 Kerb Heights

Reduced Kerb Height (it is the height of the kerb between the cycle lane and footpath or between the cycle lane and verge) 50mm or lower, will not catch the lower side of the pedal and it enables the cyclists to cycle closer to the kerb. These values are taken as per the guidelines of IRC:11-2015 .

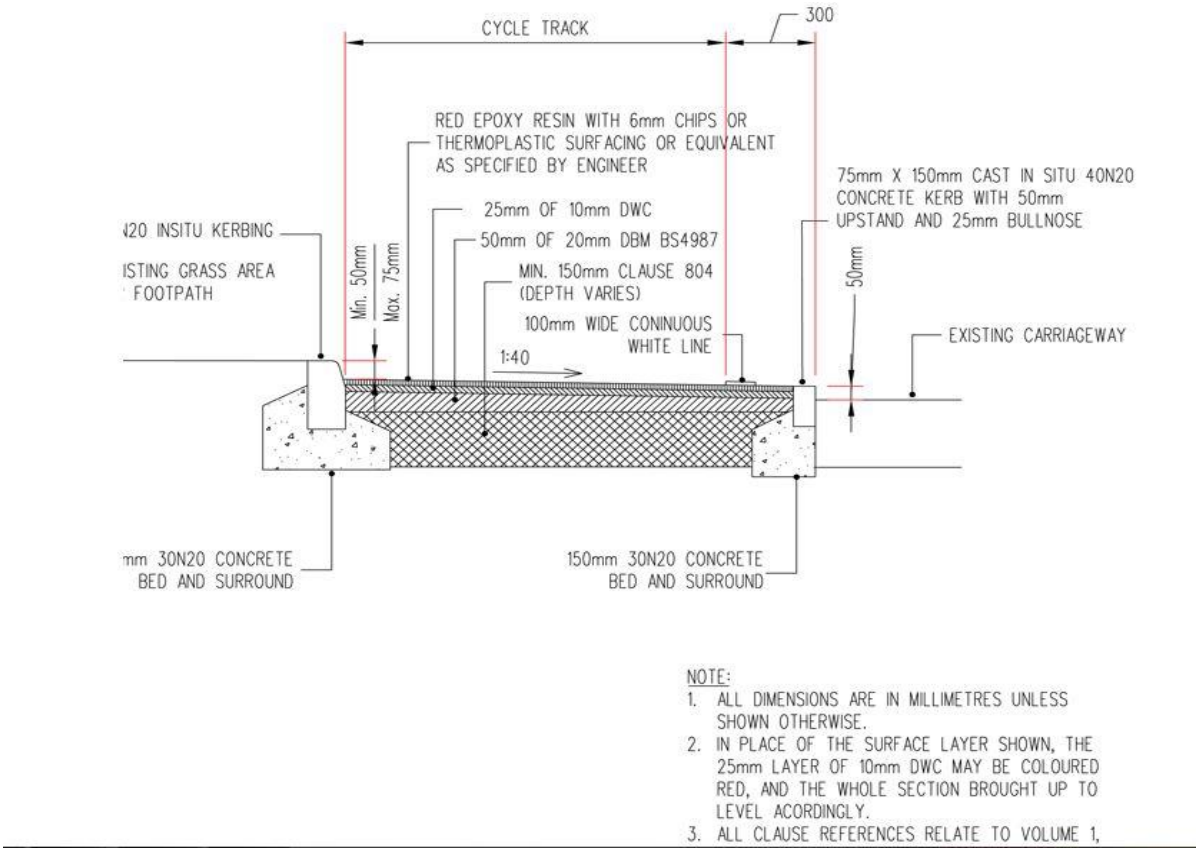


Figure 2.3: The above figure shows the cross-section with dimensions of a typical cycle track.

The Table below show us both the minimum as well as preferred dimensions of both One-Way Cycle Track and Two-Way Cycle Track, the type of construction can be raised or at the street level.

Table 2.1: Dimensions of Cycle Tracks.

Dimensions of facility	**One-Way Cycle Track**		**Two-Way Cycle Track**	
	Minimum	**Preferred**	**Minimum**	**Preferred**
Width Of Cycle Track	5’	7’	8’	12’
Separation	1’ to 3’	3’ +	1’ to 3’	3’ +

2.9 Separation methods

There are different methods available for the separation of cycle tracks. The need for the separation is to safeguard it from regular pavement where the faster traffic flows and to provide a physical barrier to separate it from regular traffic, parking, pedestrian area etc. Depending on the type constraints of the project site and the type of construction (raised or at street level), separation can be achieved through any of the following methods:

- Parking with pavement markings or with flexible bollards.
- With the help of plantings.
- Steel furniture (Barriers, grills etc)
- Curbs.
- Concrete Barriers.
- Railings etc.

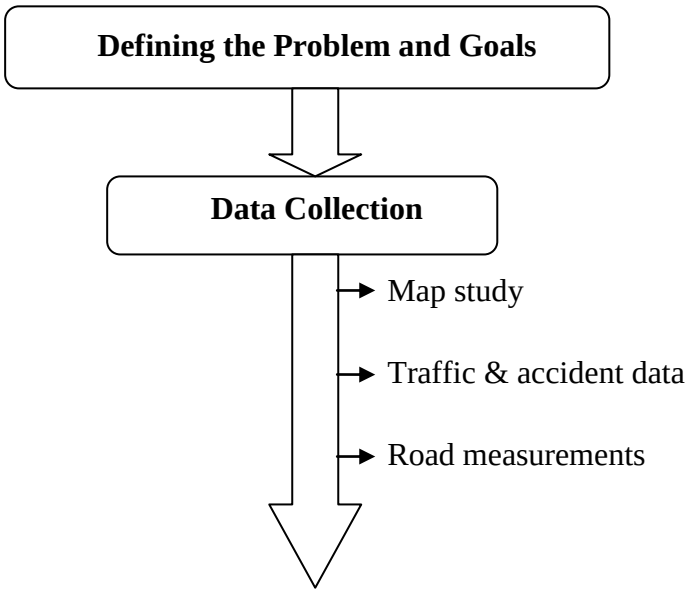
CHAPTER 3

APPROACH AND METHODOLOGY

3.1 General

The approach that we have followed is a four step approach. In first step we define the problem and the goals that we need to achieve through our research work. It explains the reason behind our research work. After this step we need to collect all the data necessary for our research. In this we do the map study of Jalandhar region, traffic data and accident data collection, road measurements etc. We also get a questionnaire filled and the type of questionnaire is public. After we collect all the data, we analyse the data. From the map study, we select the best suitable location for the construction of the track. During traffic data and accident analysis we try to minimize the risk to the cyclist and maximize the level of service goals. Through analysis of public questionnaire we try to concentrate on the areas where the people are facing problem and we need to look for their expectations. After all the data is analysed, we prepare a plan of the tracks in the selected area; we determine the full length of the facility that is to be developed as well as we design all the factors for the construction of the facility. We give a cross sectional plan of the track. We also state the type of cycle track that is to be constructed as well as the construction mechanism that is to be followed. Finally we give the result and conclusions.

3.2 Flowchart representing the methodology



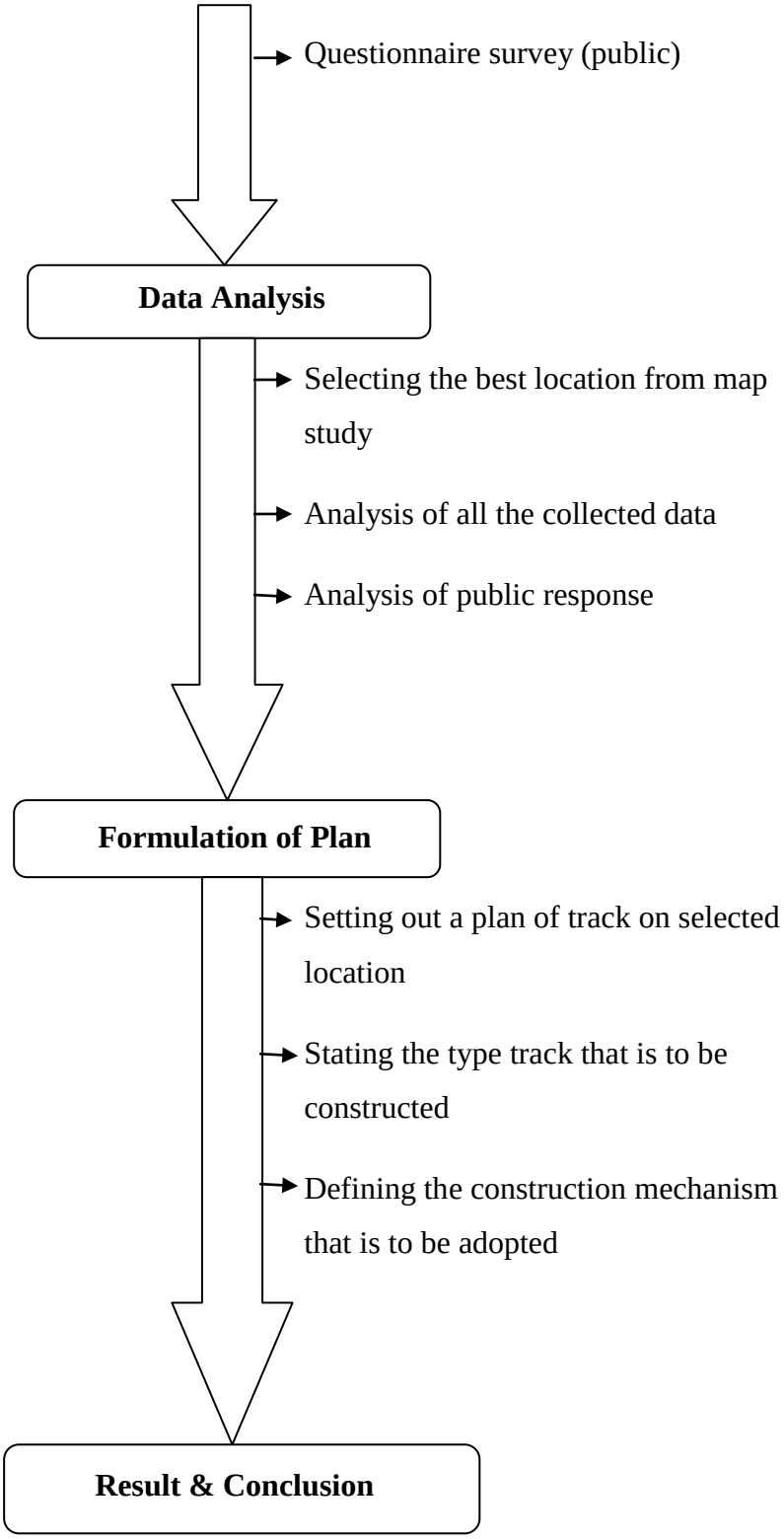


Figure 3.1: Flowchart representing methodology.

CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 MAP STUDY & SITE SELECTION

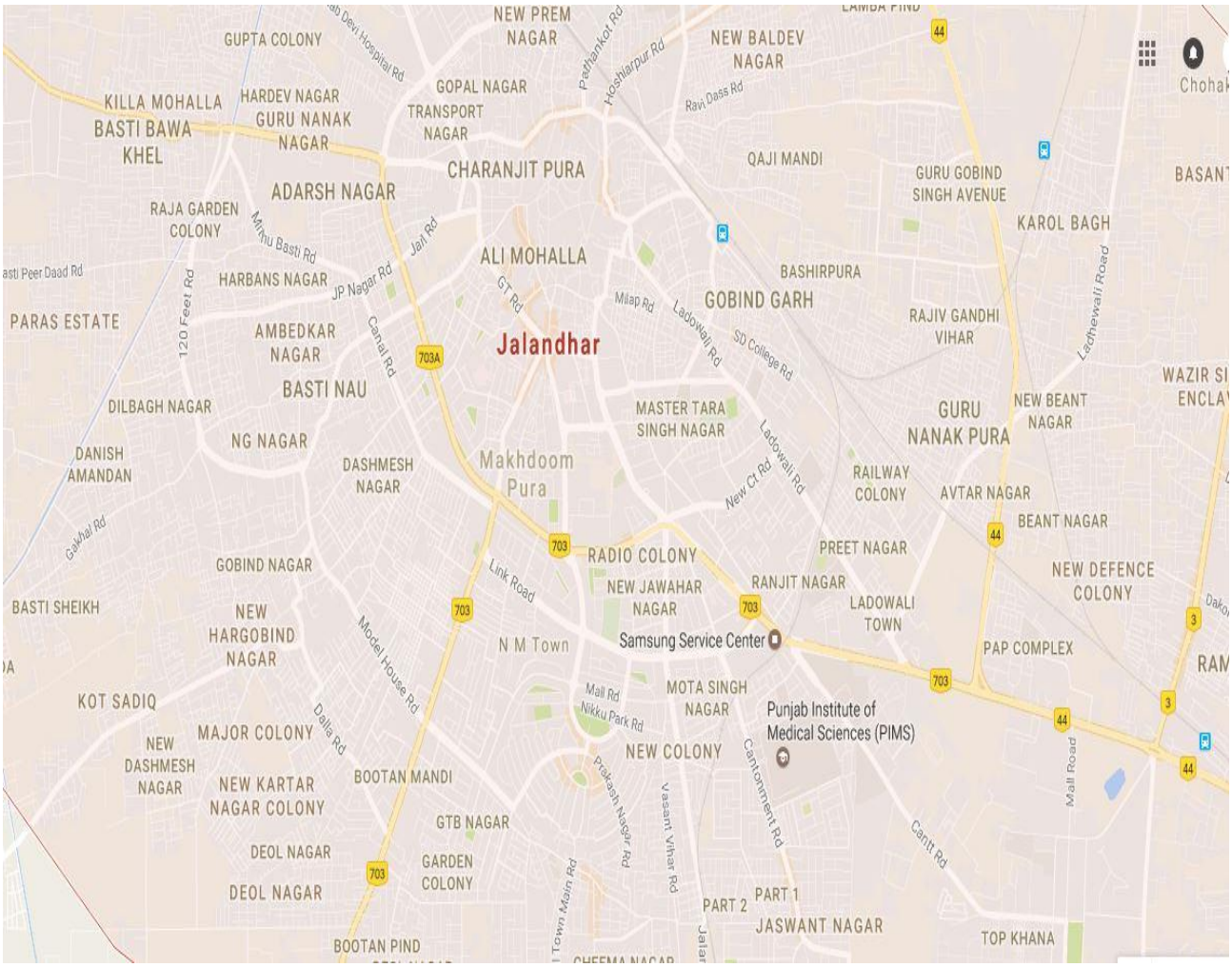


Figure 4.1: Map of Jalandhar city.

(Source: Google maps)

In this research, the study area selected is Jalandhar city and the map of Jalandhar city is shown in figure 4.1. We selected Jalandhar city as it comes under plain terrain region. Also many people use cycles for their day to day manoeuvring, and some use it as a part of

recreational activity. We did a study of different regions of Jalandhar city and selected the best suitable region for the construction of cycle tracks.

Figure 4.2: Map of selected area (GTB Nagar, Jalandhar).

(Source: Google maps)

After doing a study of different regions of Jalandhar city (shown in figure 4.1), we selected GTB Nagar region (shown in figure 4.2). The different reasons for the selection of this region as the best suitable region for the construction of Cycle Tracks are stated below:

- Presence of residential area in the selected site.
- There are adjoining commercial areas with the selected site.
- The selected site is a planned colony; hence the lanes division is proper.
- There are provisions available for the construction of construction of tracks (space is available).
- The selected site lies in the heart of the city, hence it is easily approachable.
- Keeping future planning goals in view, the track can be connected and further extended to other regions too.

4.2 Accident Data

Accident Data of Jalandhar city has been listed below in tables ranging from 4.1 to 4.5. The accidents have been classified as fatal and non-fatal accidents. Deaths and injuries in the accidents have also been listed in the tables below. We took the accident data of five years (i.e. from 2012 to 2016) for our research purpose. This data has been collected from the office of Assistant Commissioner of Police, Traffic Police, and Jalandhar.

Table 4.1: Accident Data of Jalandhar city of year 2012

MONTH	**Year 2012**			
	Fatal	**Non- Fatal**	**Death**	**Injured**
January	07	02	07	02
February	09	06	09	05
March	05	04	05	05
April	11	01	11	01
May	10	04	10	07
June	02	03	02	05
July	12	05	13	09
August	06	07	06	09
September	02	03	02	03

October	08	03	08	03
Total	72	38	73	49

Table 4.2: Accident Data of Jalandhar city of year 2013

MONTH	**Year 2013**			
	Fatal	**Non- Fatal**	**Death**	**Injured**
January	07	07	07	04
February	05	05	05	05
March	11	08	11	09
April	03	05	03	06
May	06	08	06	11
June	04	03	04	03
July	03	05	03	04
August	05	06	05	04
September	06	04	06	04
October	04	04	06	04
Total	54	55	56	54

Table 4.3: Accident Data of Jalandhar city of year 2014

MONTH	**Year 2014**			
	Fatal	**Non- Fatal**	**Death**	**Injured**

January	07	04	07	04
February	06	01	06	02
March	06	05	06	03
April	13	02	14	05
May	11	07	11	11
June	06	06	06	14
July	11	04	12	07
August	12	11	14	19
September	06	03	06	02
October	11	05	11	09
Total	89	48	93	76

Table 4.4: Accident Data of Jalandhar city of year 2015

MONTH	**Year 2015**			
	Fatal	**Non- Fatal**	**Death**	**Injured**
January	09	01	09	01
February	08	06	08	11
March	03	04	03	05
April	06	02	06	03
May	09	04	09	05
June	07	06	07	09
July	04	05	04	07
August	06	03	06	05

September	06	07	06	07
October	11	08	11	14
Total	69	46	69	67

Table 4.5: Accident Data of Jalandhar city of year 2016

MONTH	**Year 2016**			
	Fatal	**Non- Fatal**	**Death**	**Injured**
January	08	04	08	05
February	08	05	08	07
March	12	04	12	04
April	15	03	15	07
May	11	05	11	10
June	16	05	17	08
July	03	05	03	05
August	03	03	03	05
September	16	07	17	14
October	12	06	13	09
November	05	07	05	09
December	16	03	17	11
Total	125	57	129	94

Table 4.6: Cumulative Accident Data of Jalandhar city of year 2012-2016

Year	Fatal	Non Fatal	Death	Injured
2012	72	38	73	49
2013	54	55	56	54
2014	89	48	93	76
2015	69	46	69	67
2016	104	47	107	74

Graphical Representation of Accident Data

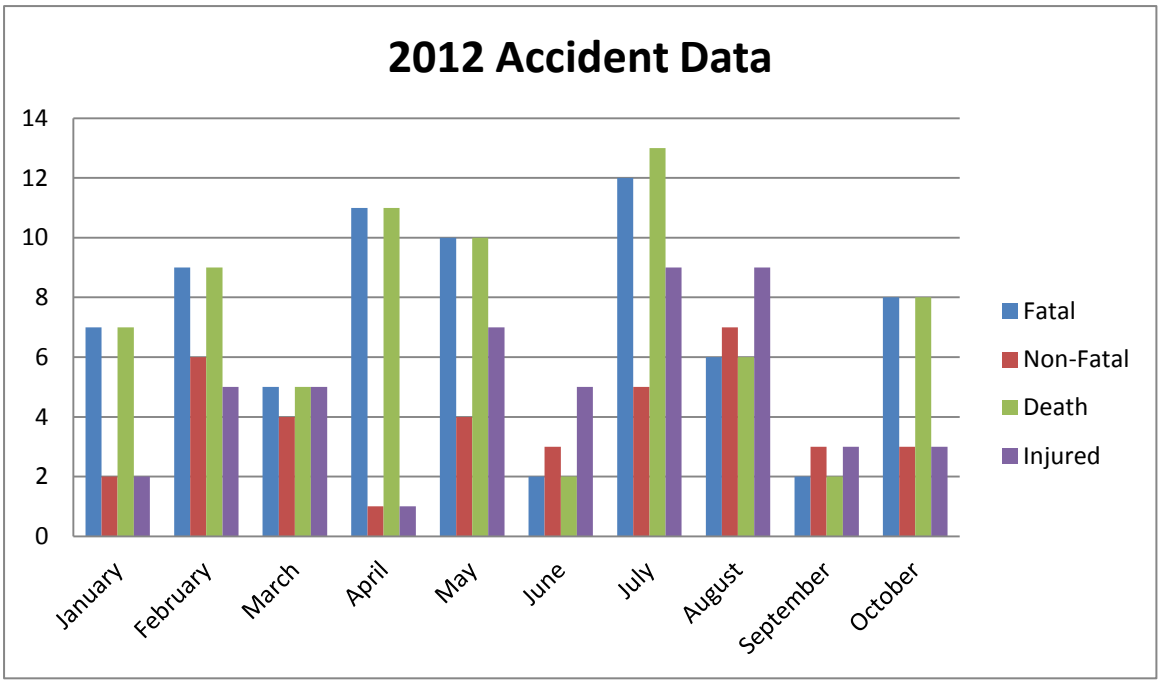


Fig 4.3: Accident Data graph of year 2012

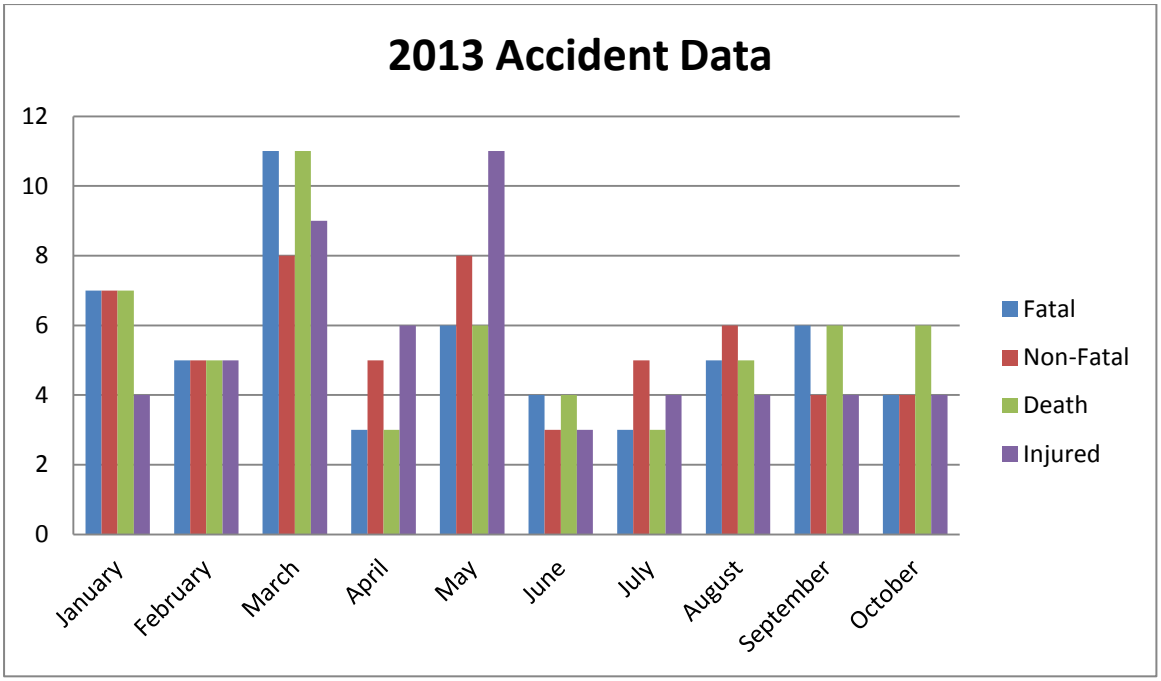


Fig 4.4: Accident data graph of year 2013

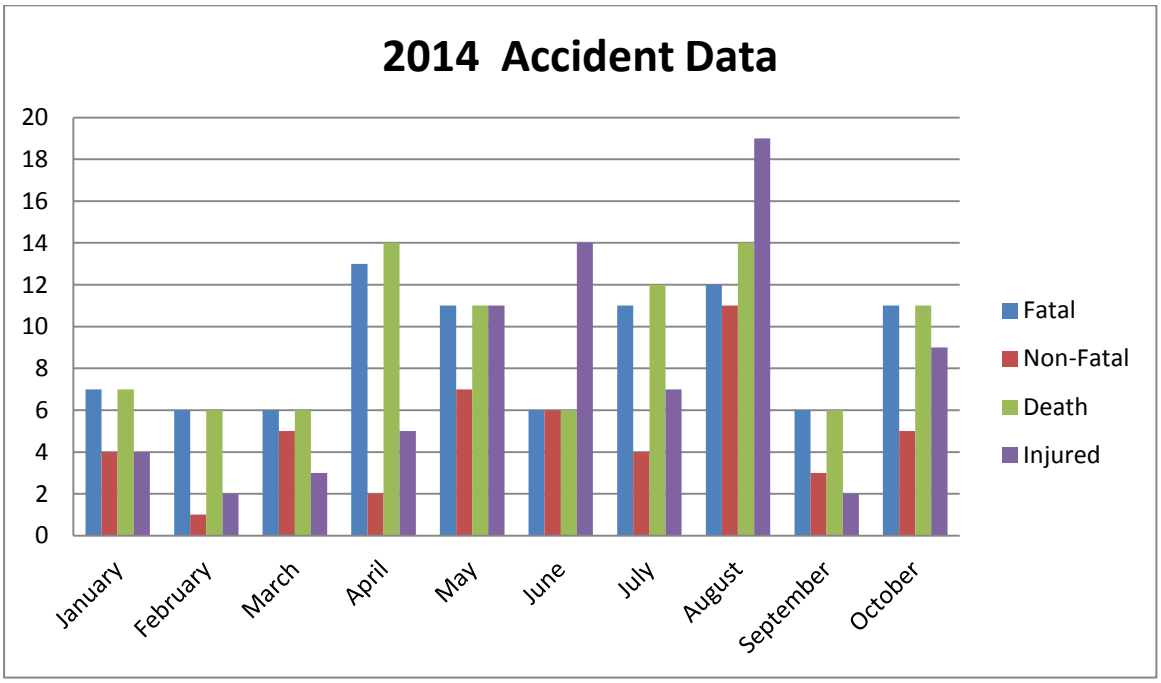


Fig 4.5: Accident data graph of year 2014

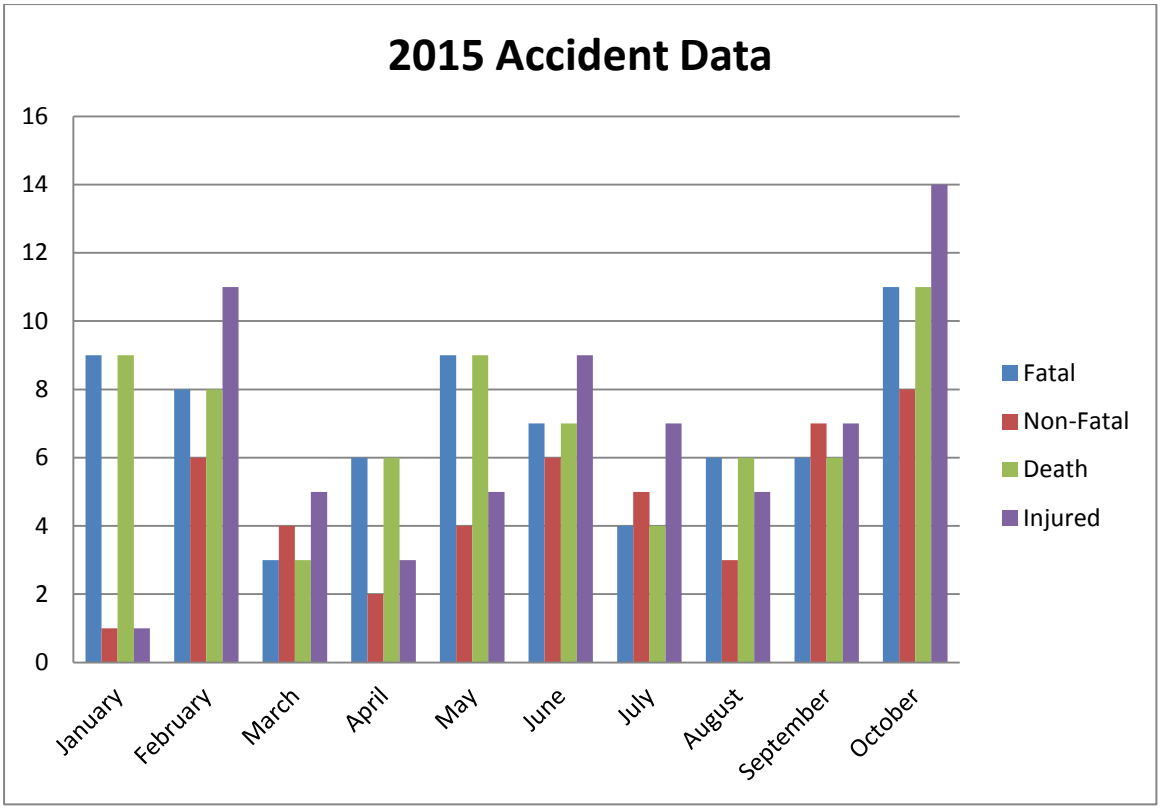


Fig 4.6: Accident Data Graph of year 2015

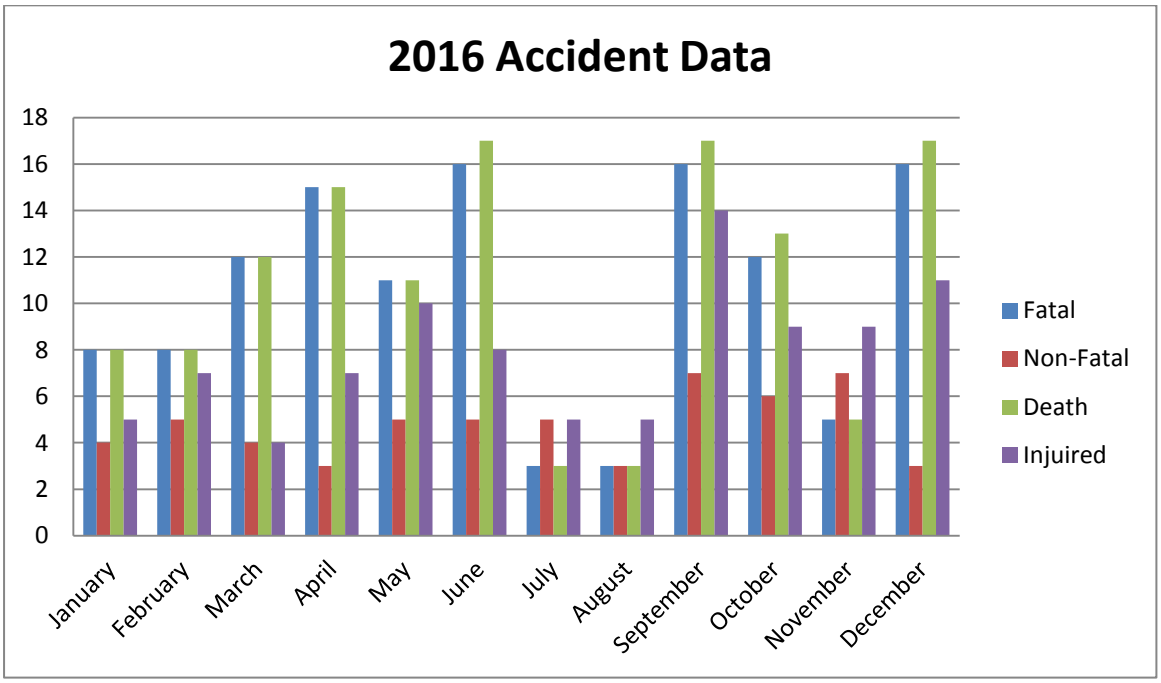


Fig 4.7: Accident Data of year 2016

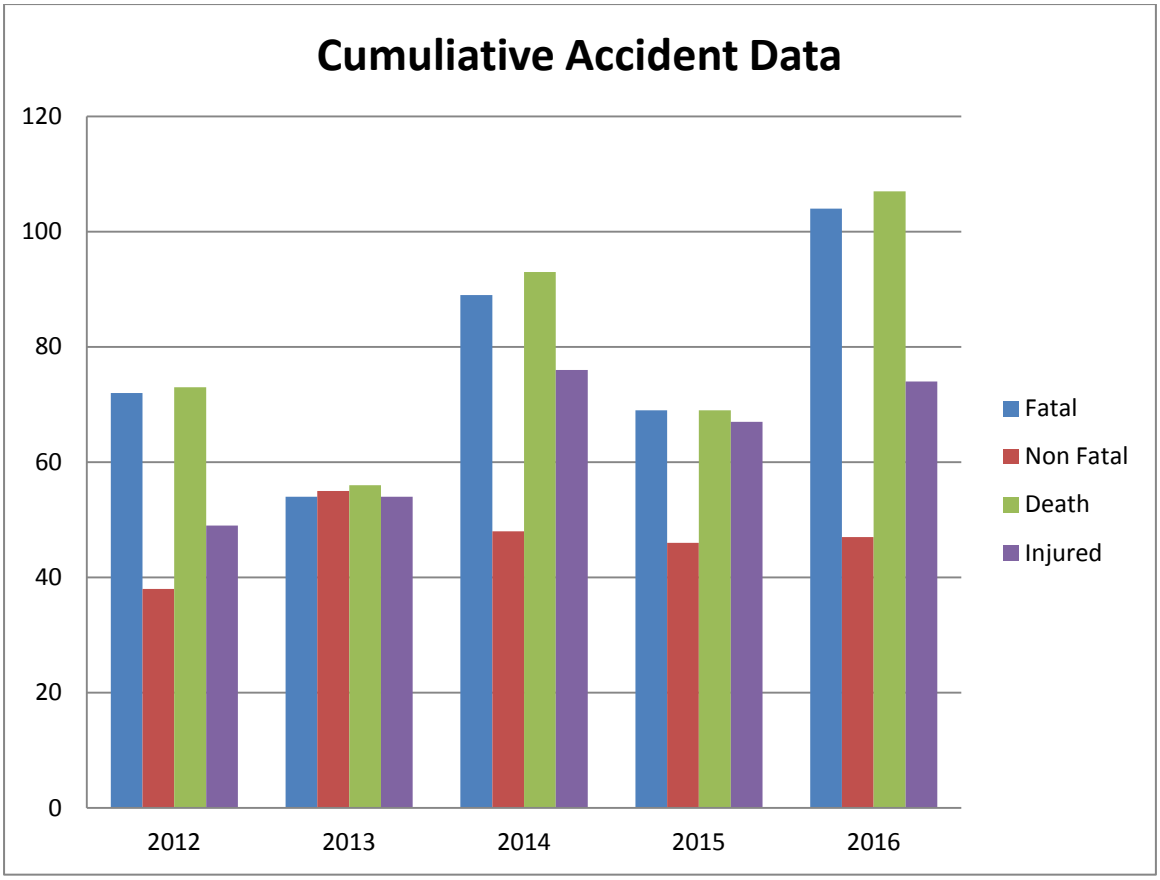


Fig 4.8: Cumulative Accident data graph of five years.

4.3 Traffic Volume Data

A traffic volume survey has been done on Moga-Jalandhar Road near GTB Nagar, Jalandhar and ADT (Average Daily Traffic) has been calculated and is listed below in the tables below and the map of the area is also attached. In traffic volume study, the primary step is counting the number of vehicles flowing on the road and secondary step is to arrange the count of vehicles and the route of vehicles.

Method: Manual count method has been used for traffic volume count.

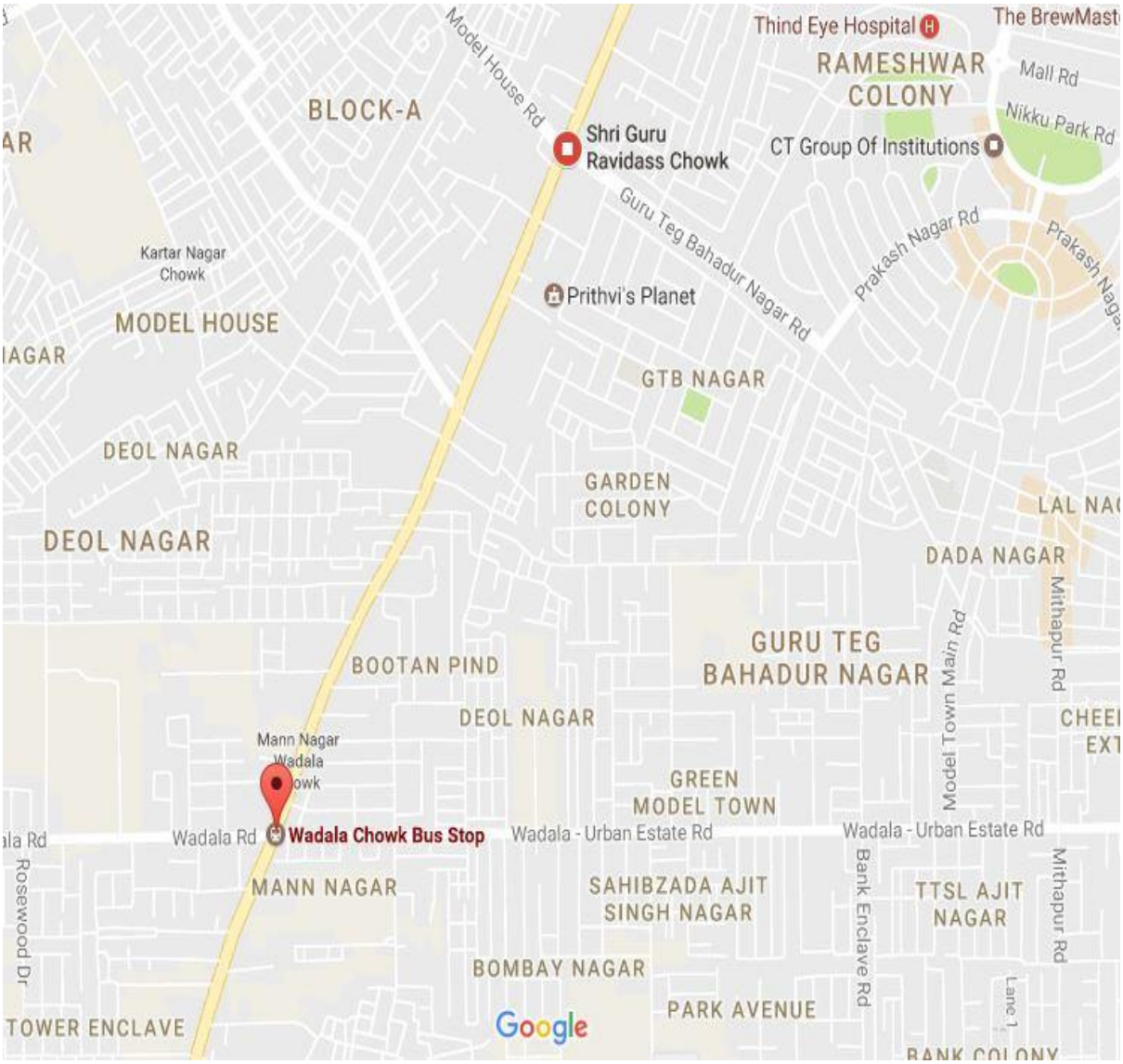


Fig 4.9: Map of Jalandhar-Moga Road on which ADT survey has been done.

Table 4.7: ADT (Average Daily Traffic) on way 1 of Jalandhar-Moga Road (Way 1- Towards Jalandhar)

Time	Two Wheelers	Three Wheelers	Cars	Vans	Buses	L.C.V.	Bicycles	Rickshaws	Trucks
8:00-9:00	425	149	343	39	44	31	124	42	31
9:00-10:00	655	204	468	36	56	32	161	54	25
10:00-11:00	620	219	454	48	54	36	156	60	24
11:00-12:00	596	194	422	44	49	30	104	63	21
12:00-13:00	555	177	396	38	42	30	117	58	19
13:00-14:00	602	172	402	41	39	28	121	57	19
14:00-15:00	549	167	372	42	44	33	135	58	22
15:00-16:00	566	181	411	34	47	29	139	66	18
16:00-17:00	616	186	423	39	58	28	147	61	17
17:00-18:00	659	191	451	49	51	31	163	63	19
18:00-19:00	599	144	449	41	49	36	164	59	24

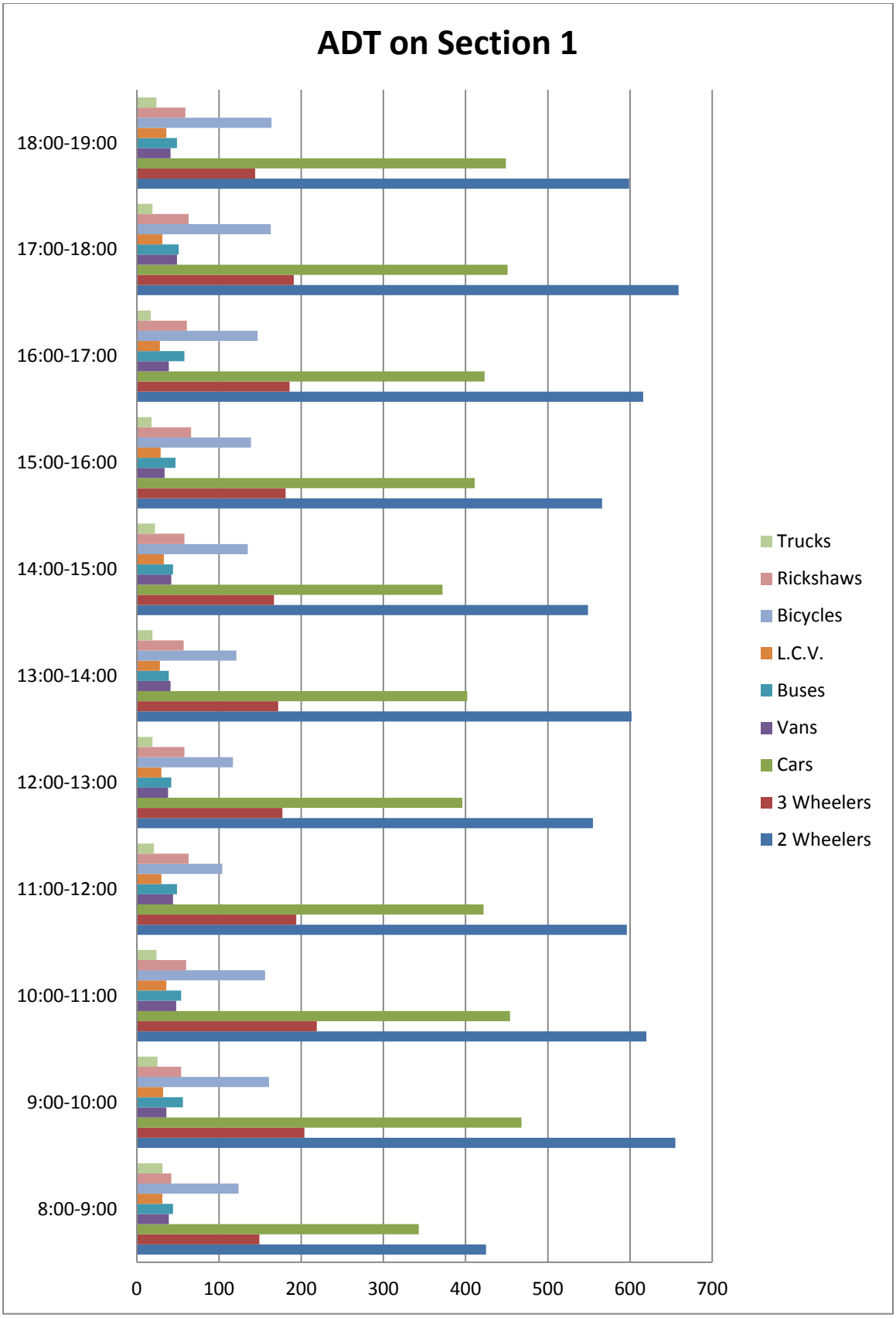


Fig 4.10: ADT (Average Daily Traffic) on way 1 of Jalandhar-Moga Road (Way 1- Towards Jalandhar)

Table 4.8: ADT (Average Daily Traffic) on way 2 of Jalandhar-Moga Road (Way 2- Towards Moga)

Time	Two Wheelers	Three Wheelers	Cars	Vans	Buses	L.C.V.	Bicycles	Rickshaws	Trucks
8:00-9:00	388	121	307	36	49	29	111	49	33
9:00-10:00	536	173	419	32	51	31	143	63	27
10:00-11:00	515	200	411	41	57	33	163	59	22
11:00-12:00	522	144	401	40	48	32	114	62	23
12:00-13:00	486	121	371	33	43	34	140	55	18
13:00-14:00	550	152	413	35	39	29	106	58	20
14:00-15:00	531	139	366	37	43	35	121	57	21
15:00-16:00	592	163	404	38	45	30	149	64	19
16:00-17:00	643	191	444	41	59	28	164	60	16
17:00-18:00	694	203	474	49	54	35	171	59	21
18:00-19:00	616	176	462	39	48	37	177	61	23

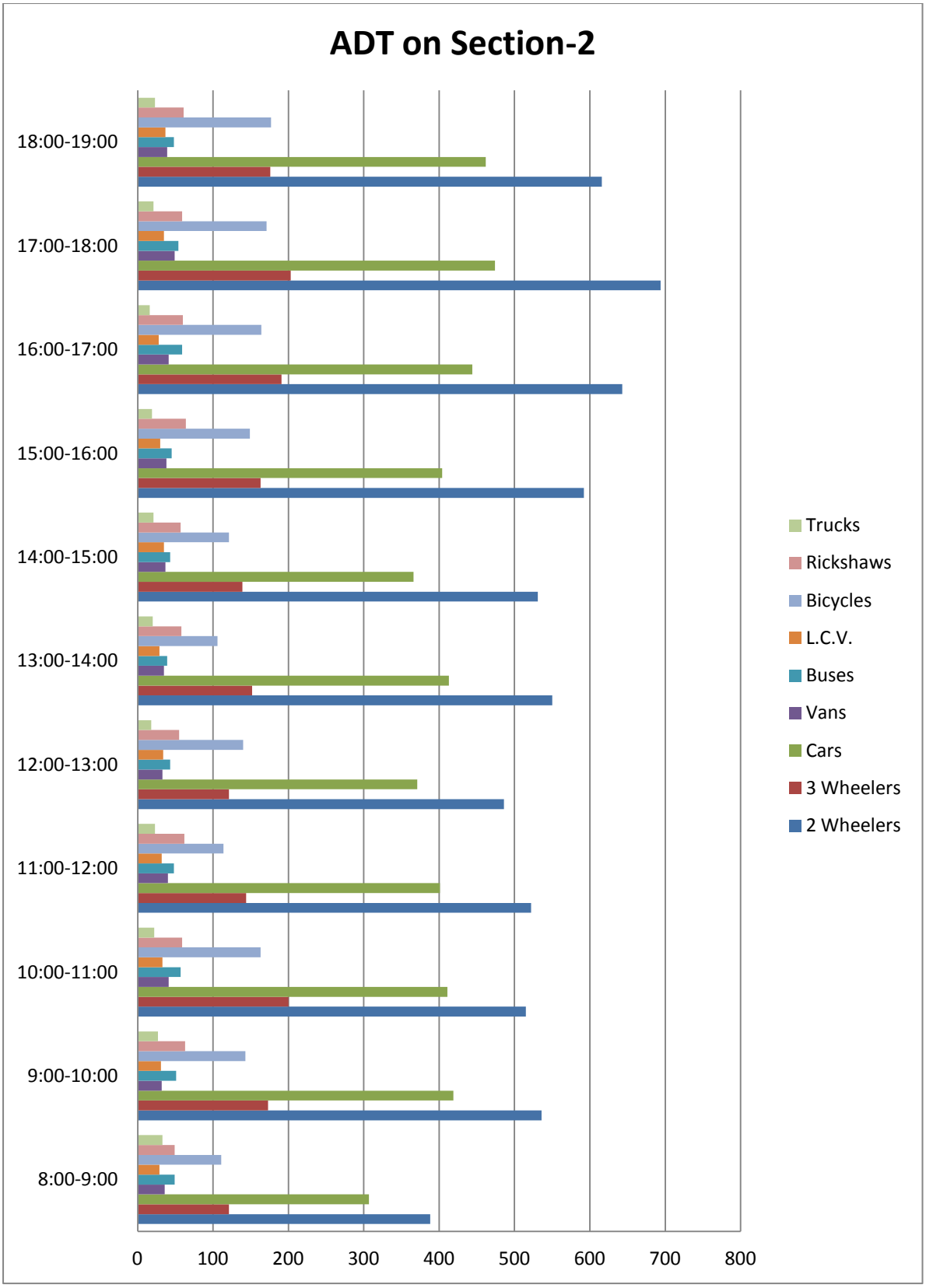


Fig 4.11: ADT (Average Daily Traffic) on way 2 of Jalandhar-Moga Road (Way 2- Towards Moga)

Table 4.9: Traffic volume for way 1 of Jalandhar-Moga Road (Way 1- Towards Jalandhar)

Time	Total Vehicle Count	P.C.U.
8:00-9:00	1228	1319.75
9:00-10:00	1691	1771.65
10:00-11:00	1671	1779.4
11:00-12:00	1523	1633.1
12:00-13:00	1432	1514.25
13:00-14:00	1481	1539.2
14:00-15:00	1422	1492.15
15:00-16:00	1491	1569.7
16:00-17:00	1575	1650.5
17:00-18:00	1677	1733.35
18:00-19:00	1565	1592.35
Total	16756	17595.4

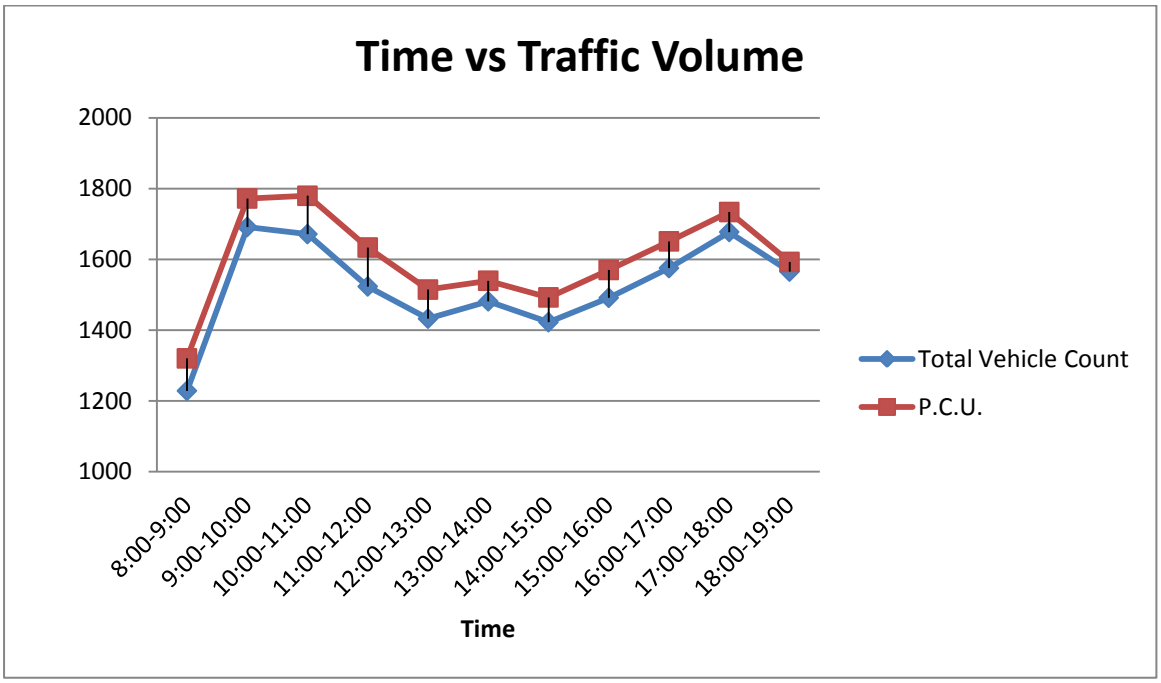


Fig 4.12: Time Vs Traffic Volume on way 1of Jalandhar-Moga Road (Way 1- Towards Jalandhar)

Table 4.10: Traffic volume for way 2 of Jalandhar-Moga Road (Way 2- Towards Moga)

Time	Total Vehicle Count	P.C.U.
8:00-9:00	1123	1214.9
9:00-10:00	1475	1565.7
10:00-11:00	1501	1611.95
11:00-12:00	1386	1460.1
12:00-13:00	1301	1330.8
13:00-14:00	1402	1464.3
14:00-15:00	1350	1402.95
15:00-16:00	1504	1550.4
16:00-17:00	1646	1709.05
17:00-18:00	1760	1820.4
18:00-19:00	1639	1685.3
Total	16087	16815.85

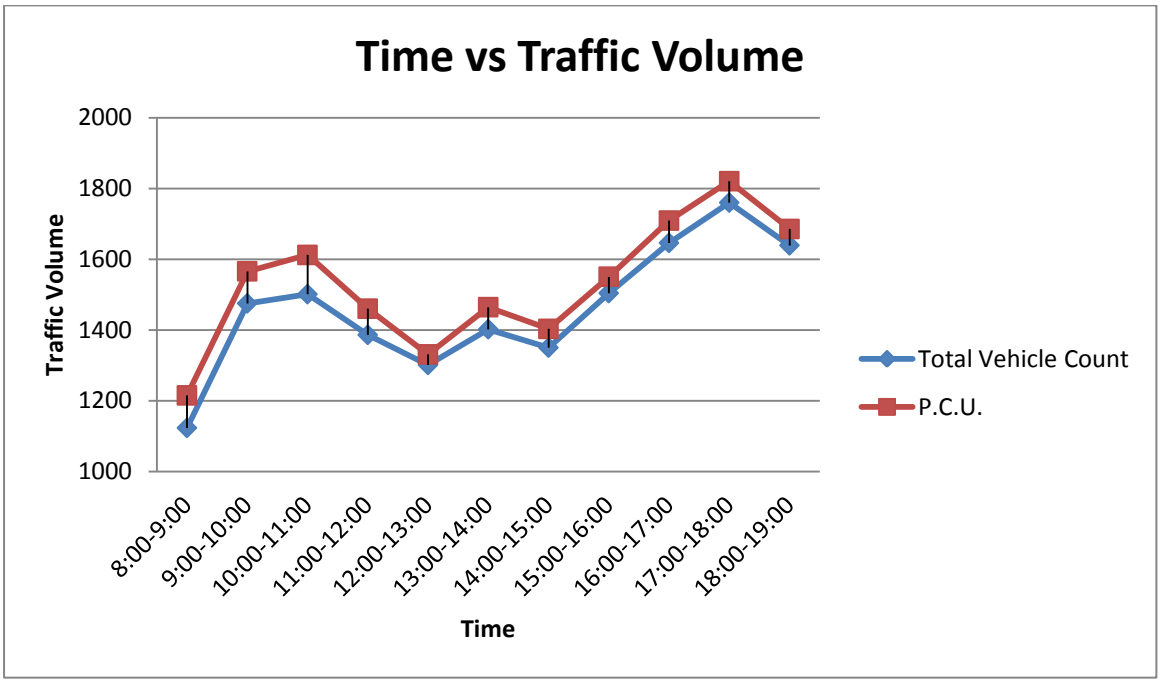


Fig 4.13: Time Vs Traffic Volume on way 2 of Jalandhar-Moga Road (Way 2- Towards Moga)

Table 4.11: Peak Hour Volumes for Way-1 of Jalandhar-Moga Road

Location	Period	Total Vehicles	Total PCU's
Jalandhar-Moga Road, GTB Nagar. (Way 1 – Towards Jalandhar)	Entire Day (12 Hours)	16756	17595.4
	Morning Peak Hour (9:00am – 10:00am)	1691	1771.65
	Evening Peak Hour (5:00pm – 6:00pm)	1677	1733.35

Table 4.12: Peak Hour Volumes for Way-2 of Jalandhar-Moga Road

Location	Period	Total Vehicles	Total PCU's
Jalandhar-Moga Road, GTB Nagar. (Way 2 – Towards Moga)	Entire Day (12 Hours)	16087	16815.85
	Morning Peak Hour (10:00am – 11:00am)	1501	1611.95
	Evening Peak Hour (5:00pm – 6:00pm)	1760	1820.4

4.4 Level of service (LOS) of general traffic

LEVEL OF SERVICE (LOS) is basically a qualitative measure used to relate the quality of traffic service. LOS is used to analyze the quality of traffic service by the measurement of parameters like speed, density etc.

Table 4.13: Level of service of Jalandhar-Moga Road (Way 1- Towards Jalandhar)

Location	Time	Volume (PCU/hr)	Width of road per lane	No. of lanes	DSV (Design service volume)	V/C Ratio	L.O.S.
Jalandhar-Moga Road, GTB Nagar. (Way 1 – Towards Jalandhar)	Morning peak hour flow	1771.65	3.5	2	2900	0.610	C
	Evening peak hour flow	1733.35	3.5	2	2900	0.597	C
	Off-peak hour flow	1409.4	3.5	2	2900	0.486	C

(Source: LOS values have been determined from the LOS graph in HCM2010)

Table 4.14: Level of service of Jalandhar-Moga Road (Way 2- Towards Moga)

Location	Time	Volume (PCU/hr)	Width of road per lane	No. of lanes	DSV (Design service volume)	V/C Ratio	L.O.S.
Jalandhar-Moga Road, GTB Nagar. (Way 2 – Towards Moga)	Morning peak hour flow	1611.95	3.5	2	2900	0.555	C
	Evening peak hour flow	1820.4	3.5	2	2900	0.627	C
	Off-peak hour flow	1338.35	3.5	2	2900	0.461	C

(Source: LOS values have been determined from the LOS graph in HCM2010)

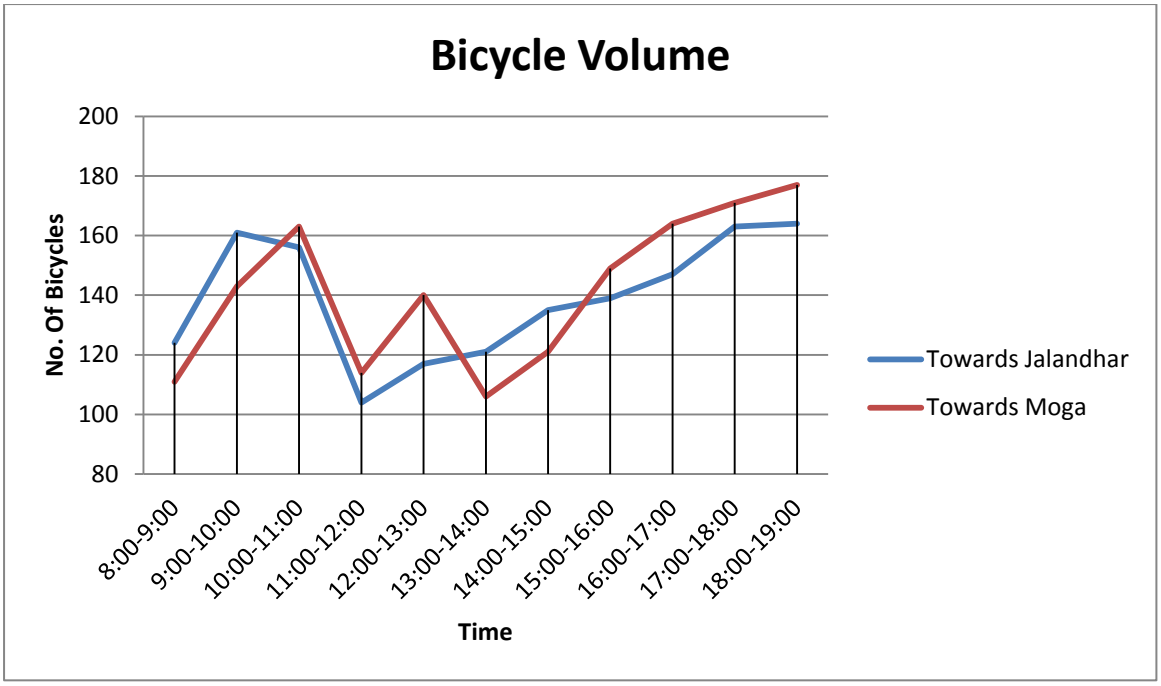


Fig 4.14: Graph showing cycle traffic volumes on way-1 & way-2 of Jalandhar-Moga road

Table 4.15: Hourly variation of average daily cycle traffic on Jalandhar-Moga road

Time	Towards Jalandhar	Towards Moga
8:00-9:00	124	111
9:00-10:00	161	143
10:00-11:00	156	163
11:00-12:00	104	114
12:00-13:00	117	140
13:00-14:00	121	106
14:00-15:00	135	121
15:00-16:00	139	149
16:00-17:00	147	164
17:00-18:00	163	171
18:00-19:00	164	177
Total	1531	1559

4.5 Questionnaire:

Public Questionnaire

1. **When did you last ride a bicycle?**

Today	Within the past week	Within the past month	Within the past six months	Within the past year

2. **How often do you ride a bicycle?**

Daily	Four to Five days a week	Two to Three days a week	Once a week	Several times a week	Several Times a month

3. **On an estimate, how many kilometres have you ridden the bicycle in the past week?**

None	1-9 km	10-19 km	20-29 km`	30-39 km	40-49 km	50-99 km	100-149 km	150+ km

4. **How many years of continuous bicycle riding experience do you have?**

Less than one year	1-5 years	5-10 years	10-20 years	20+ years

5. **What is the type of bicycle you ride?**
   a) Gear b) Non-Gear

6. **What is your type of ride?**
   a) Alone b) With a passenger c) With heavy luggage

7. **For what purpose mainly do you ride a bicycle?**

Training / Fitness	Ride to or from work	Ride around local area for shopping etc	As a main mode of transversing	Ride to or from place of study

8. On an average, how many delays do you face between Shri Guru Ravidass Chowk and Wadala Chowk?

None	1 or 2	2-5	5+

9. Have you ever had a cycle accident on this route?

a) Yes b) No

If yes then please answer these questions:-

9.1 What was the type of accident?

With no injuries	With minor injuries	With major injuries

9.2 What was the reason behind the accident?

Pedestrians	Parked vehicles	Faster moving traffic	Other Cyclists	Animals/ Trees/ Other obstacles

10. What according to you is the main reason for delay on this route?

Pedestrians	Parked vehicles	Faster moving traffic	Problem to cross intersections	Animals/ Trees/ Other obstacles

11. Have you ever used a cycle track?

a) Yes b) No

12. Do you think there is a need of Cycle Track on this route?

a) Yes b) No

13. On a scale of A to F, What rating would you give to your cycling experience on this route?

(A is for most satisfied and F is for least satisfied)

A	B	C	D	E	F

Filled By:

Responses to public questionnaire:

The above given Public questionnaire was rolled out in two languages (English and Punjabi {local language of Punjab}) and approximately 150 responses were collected from the people who use cycles for different purposes in GTB Nagar area of Jalandhar city. The responses were as follows:

Fig 4.15: Photograph of a cyclist on the Jalandhar-Moga Road.

1. **When did you last ride a bicycle?**

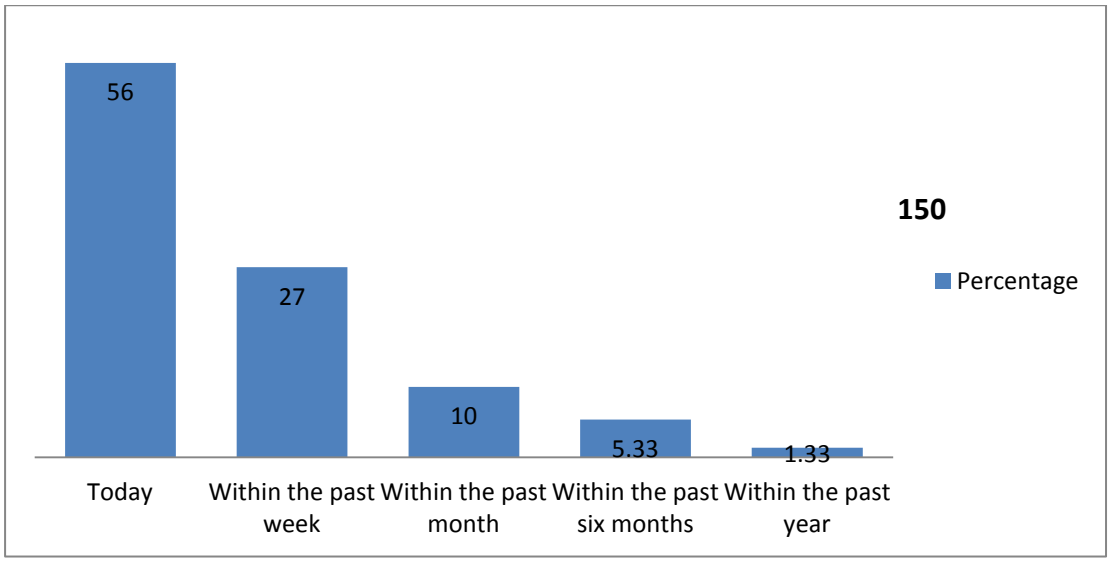


Fig 4.16: Bar Chart showing public responses to Q1 of the questionnaire.

The responses of the above question indicate that most of the respondents have recently ridden a bicycle and hence more active riders will respond better than the inactive riders.

2. How often do you ride a bicycle?

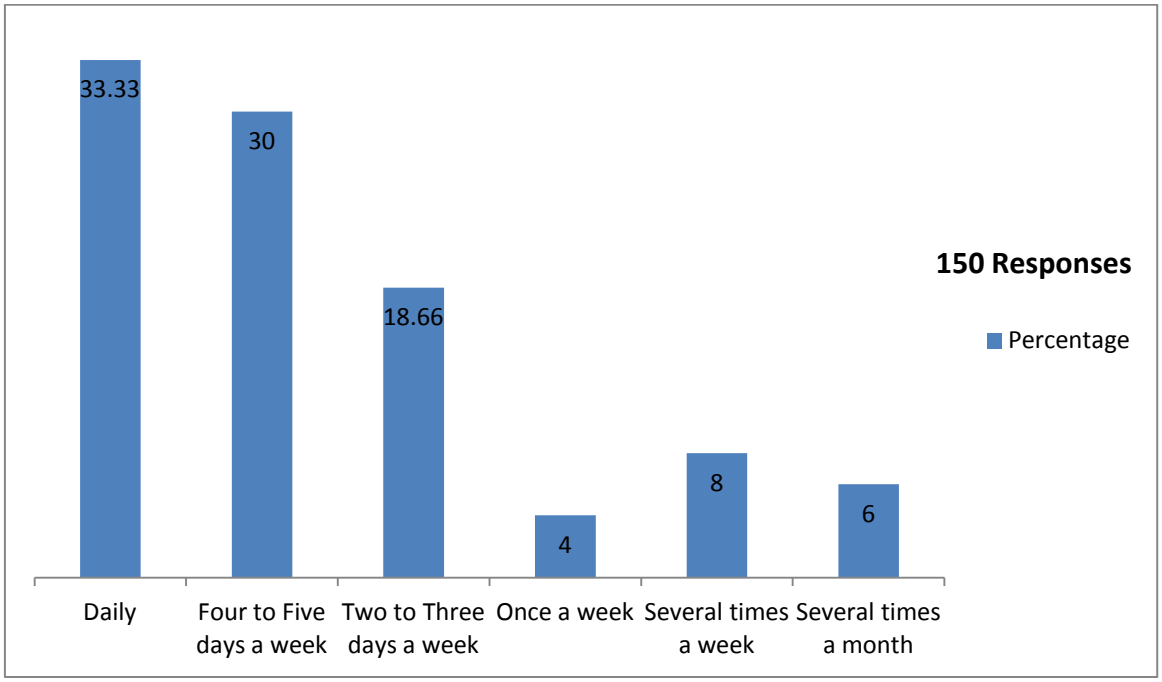


Fig 4.17: Bar Chart showing public responses to Q2 of the questionnaire.

The above responses tell about the regular and non-regular riders. Approximately 33.33% of the respondents ride the bicycle daily and 30% of them ride 4-5 days a week and 18.66% ride 2-3 days a week, these three groups constitute approximately 82% of the total respondents, hence 82% of the total respondents are regular riders.

3. On an estimate, how many kilometres have you ridden the bicycle in the past week?

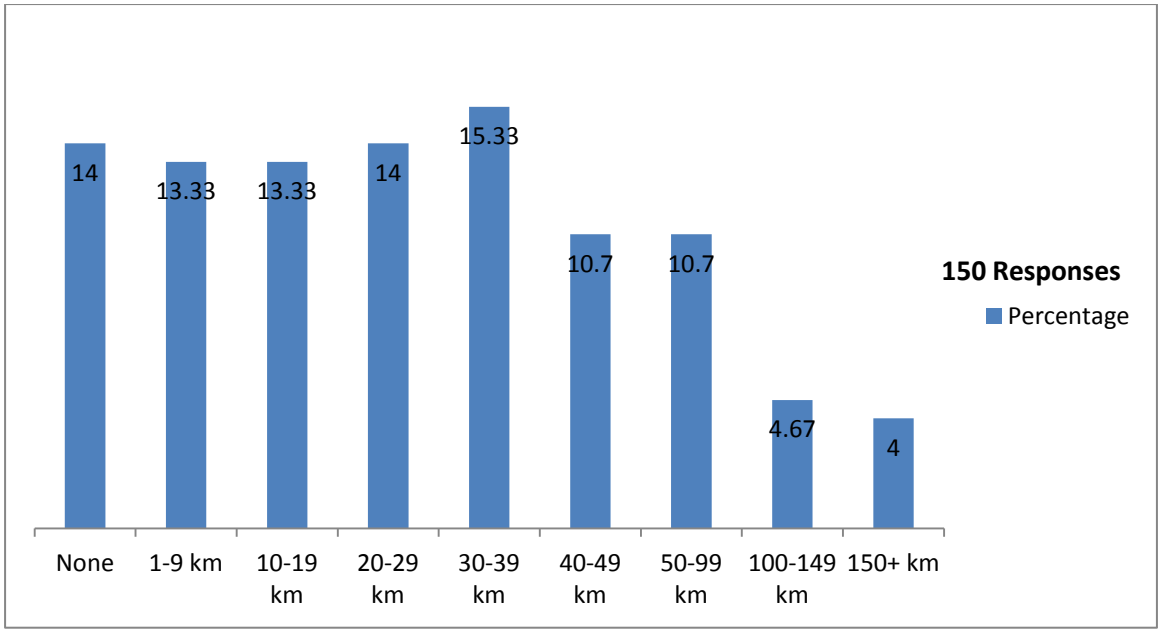


Fig 4.18: Bar Chart showing public responses to Q3 of the questionnaire.

Since, there are mixed type of riders in the respondents, so as per their need they cycle to different distances, but approximately 80% of them have cycled to a distance less than 50kms in the past week. And only 8-9% of them have cycled more than 100kms in the past week.

4. How many years of continuous bicycle riding experience do you have?

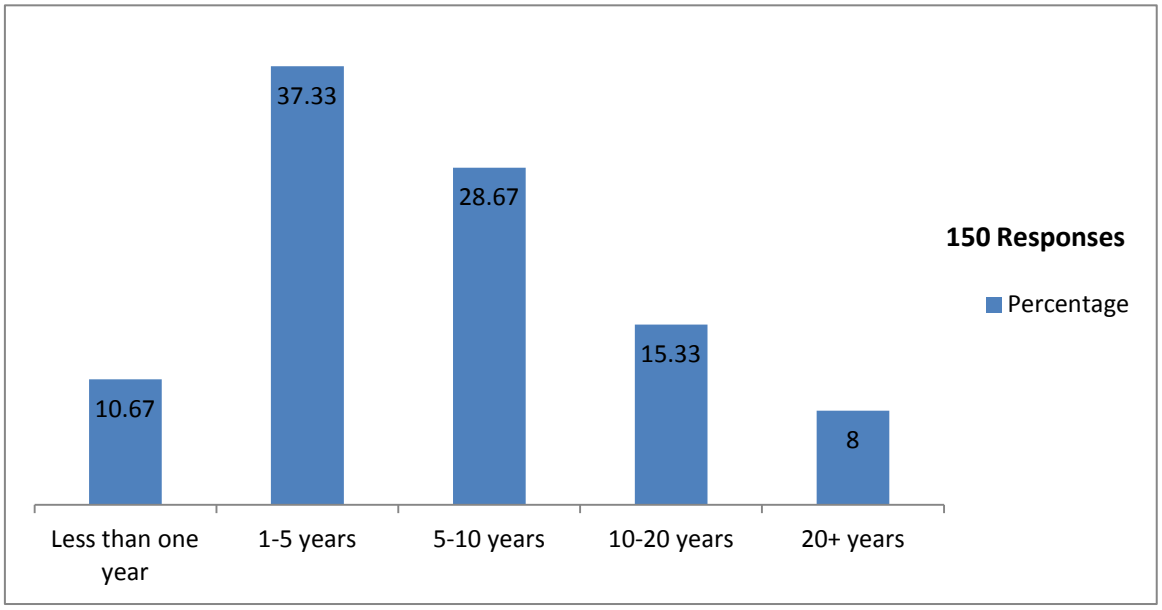


Fig 4.19: Bar Chart showing public responses to Q4 of the questionnaire.

Most of the riders have a continuous cycling experience of less than 10 years. Only 23.33 % people have a continuous cycling experience of more than 10 years.

5. **What is the type of bicycle you ride?**

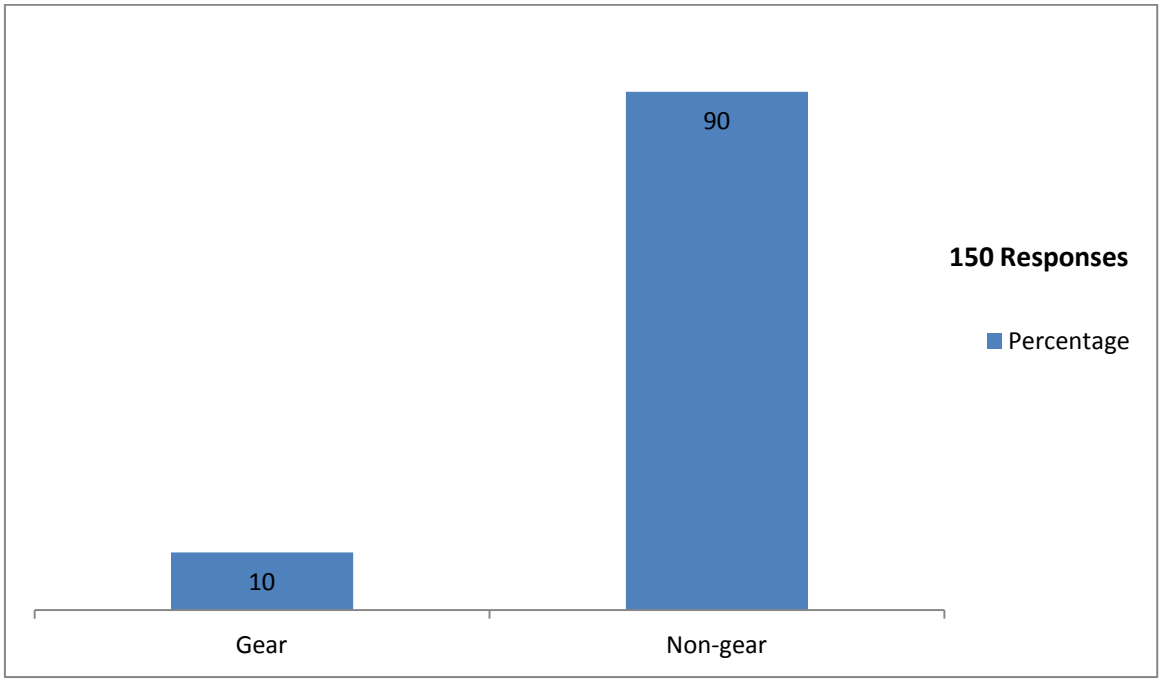


Fig 4.20: Bar Chart showing public responses to Q5 of the questionnaire.

90% of the respondents use a simple non-gear bicycle, and only 10% use a bicycle with gear. Bicycles with gears are lighter to pedal and can be cycled at greater speed as compare to that of non-gear models. But since more number of respondents use a non-gear model we will follow the average speed of bicycle according to that.

6. **What is your type of ride?**

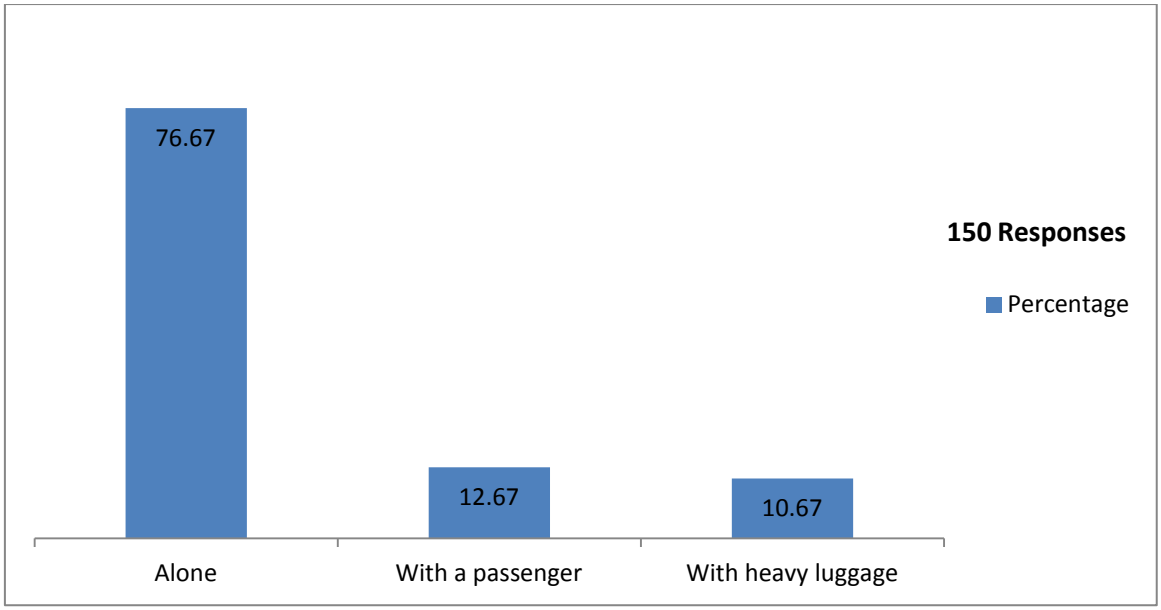


Fig 4.21: Bar Chart showing public responses to Q6 of the questionnaire.

Most of the respondents ride the bicycle alone and hence the general wobbling conditions can be considered for a single rider. Wobbling increases on lower speeds and as the weight on the bicycle increases.

7. **For what purpose mainly do you ride a bicycle?**

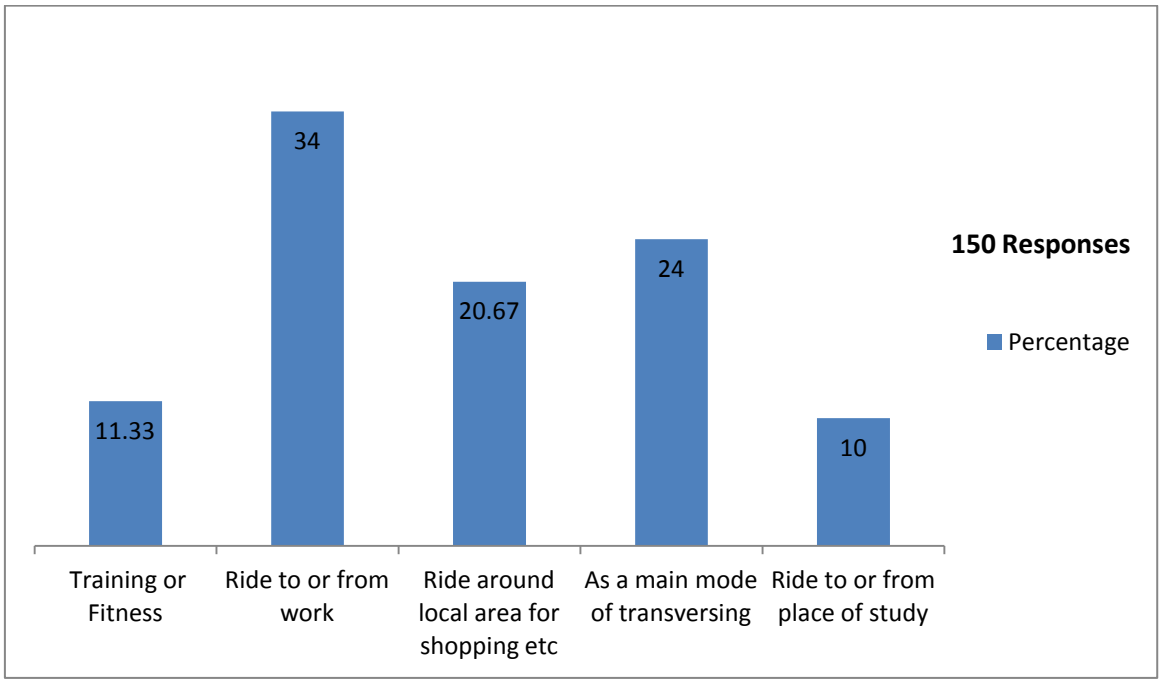


Fig 4.22: Bar Chart showing public responses to Q7 of the questionnaire.

In order to classify the respondents with respect to their purpose of using bicycle, we got the responses to the above question and got mixed responses to each type, which means the respondents belong to a group of mixed users who use bicycle for different purposes like going to work, going to school, market, for exercise etc. Also there were approximately 24% riders who use it as a main mode of transversing.

8. **On an average, how many delays do you face between Shri Guru Ravidass Chowk and Wadala Chowk?**

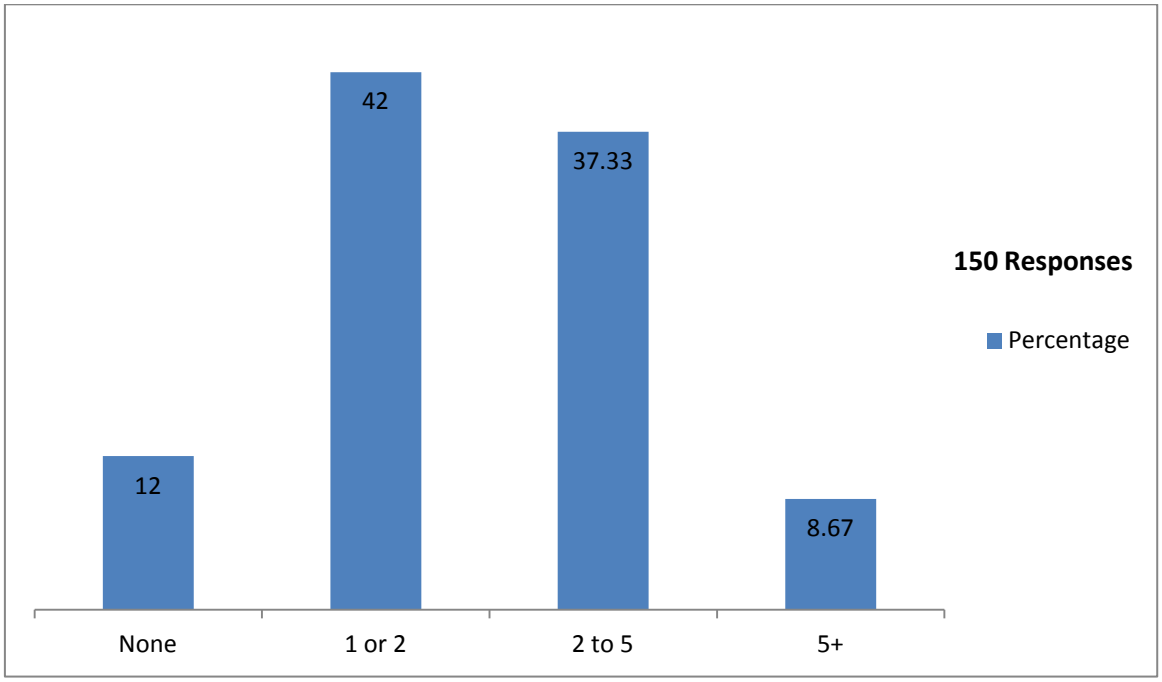


Fig 4.23: Bar Chart showing public responses to Q8 of the questionnaire.

This shows the uncomforted riding experience. Only 12% of the respondents do not face any delay between Shri Guru Ravi Dass Chowk and Wadala Chowk, rest 82% of the respondents face 1-5 and more delays. This shows the problem experienced by riders due to absence of cycle track. These delays are due to different reasons which are explained in question 10.

9. **Have you ever had a cycle accident on this route?**

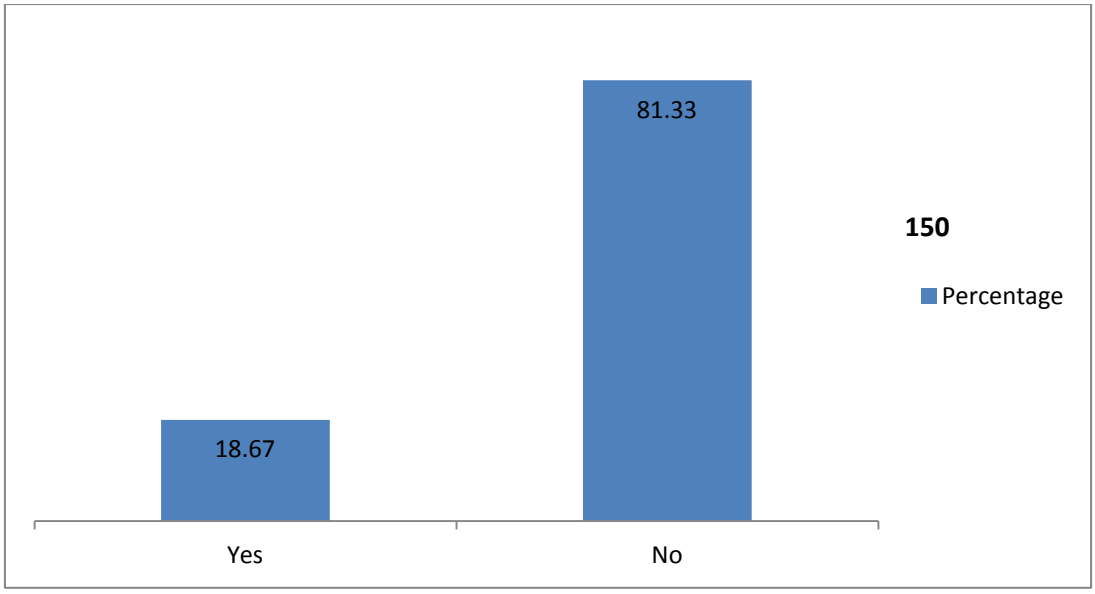


Fig 4.24: Bar Chart showing public responses to Q9 of the questionnaire.

Approximately 19% of the respondents have faced a cycle accident. The type of accident may be with no injuries, with minor injuries or with major injuries, which is explained in the next question and the reason behind the accident has also been stated in the question below. We can take some steps to decrease the number of such accidents in the future.

9.1 What was the type of accident?

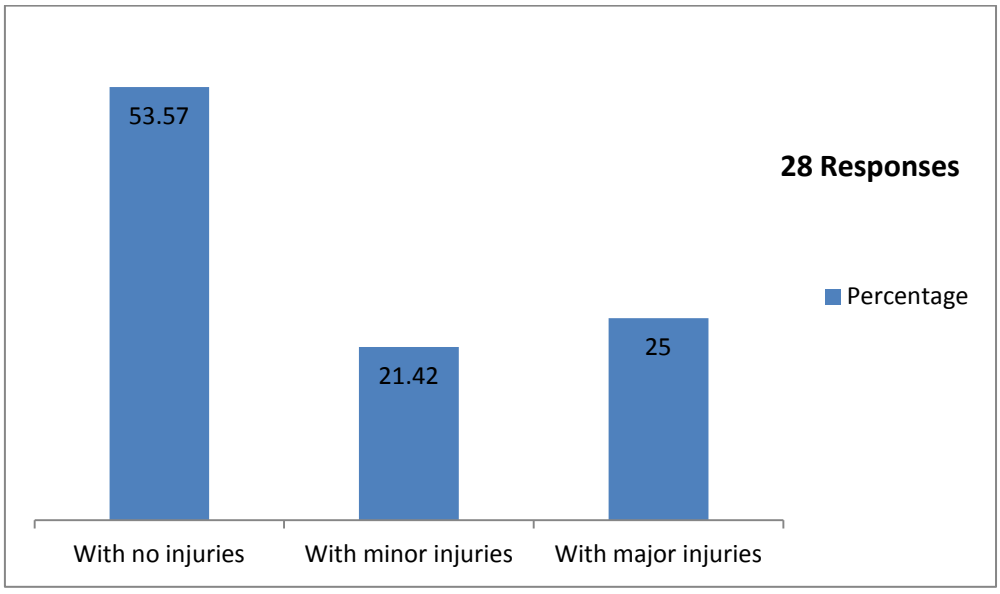


Fig 4.25: Bar Chart showing public responses to Q9.1 of the questionnaire.

Most of the respondents (54% approx) who have faced an accident have listed it as an accident with no injuries, it might be only a slipping or skidding or a fall due to some reason. 21.42% of the people have faced an accident with minor injuries, whereas 25% of the respondents got major injuries.

9.2 What was the reason behind the accident?

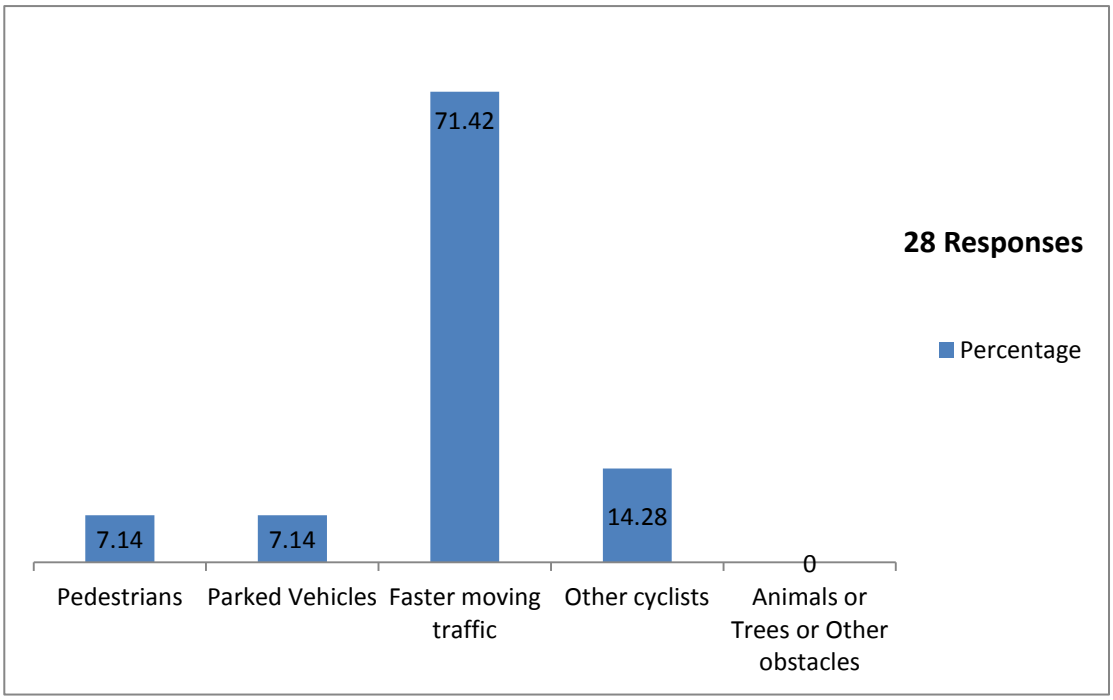


Fig 4.26: Bar Chart showing public responses to Q9.2 of the questionnaire.

Most of the times (approx 72%) the reason behind the accident was faster moving traffic. Though there were accidents due to other reasons like Pedestrians, Parked vehicles, other cyclists etc too. These problems can be reduced by the construction of cycle track, as there will be no interference of faster moving vehicles etc.

10. What according to you is the main reason for delay on this route?

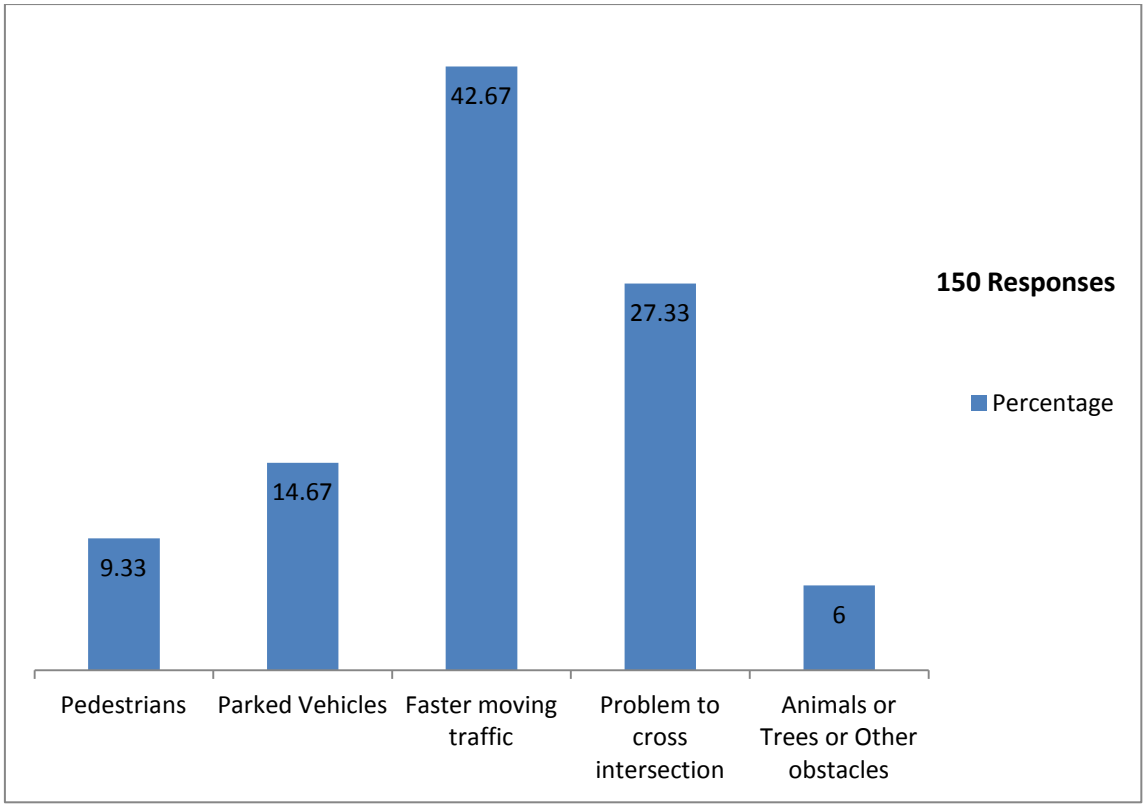


Fig 4.27: Bar Chart showing public responses to Q10 of the questionnaire.

Delays account to fall in the level of service. Faster moving traffic is the reason behind most of the delays on this route; this problem can be removed by the construction of cycle track, hence level of service can be increased too. Pedestrians will not be allowed to walk on the cycle track hence delays due to that can also be reduced. People will not be allowed to park vehicles on the cycle track and hence delays due to this can also be reduced.

11. Have you ever used a cycle track?

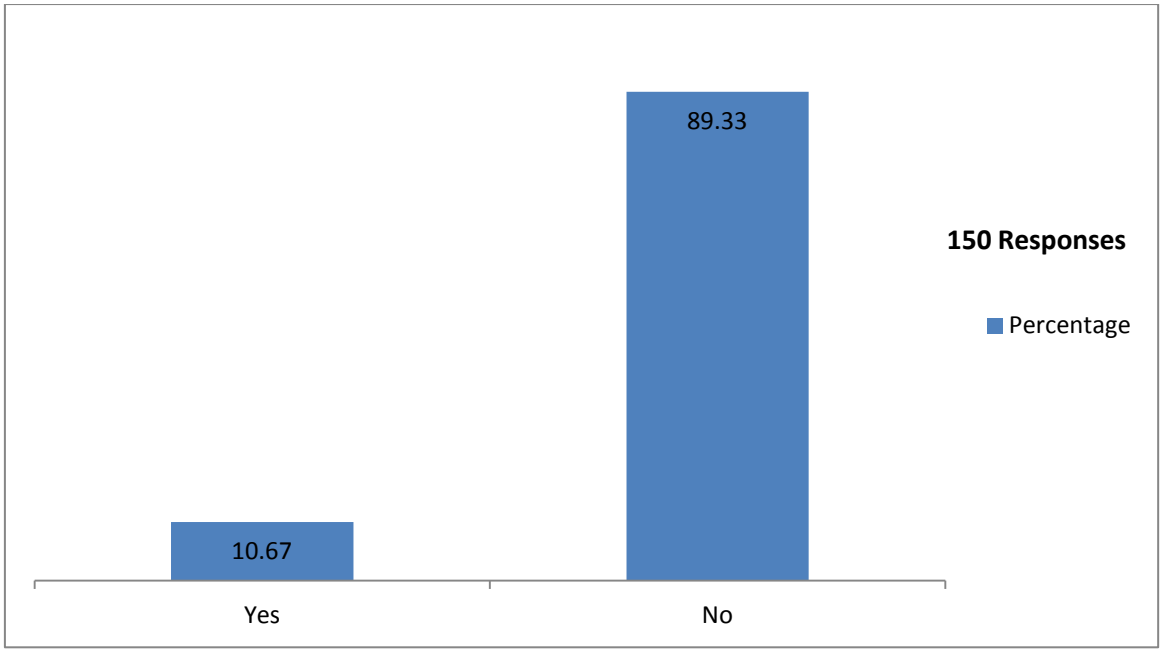


Fig 4.28: Bar Chart showing public responses to Q11 of the questionnaire.

Due to absence of cycle tracks in most Indian cities very less people have used a cycle track. Most of the respondents (89.33%) have never used a cycle track. Only 10.67% of the respondents were there who had used a cycle track.

12. Do you think there is a need of Cycle Track on this route?

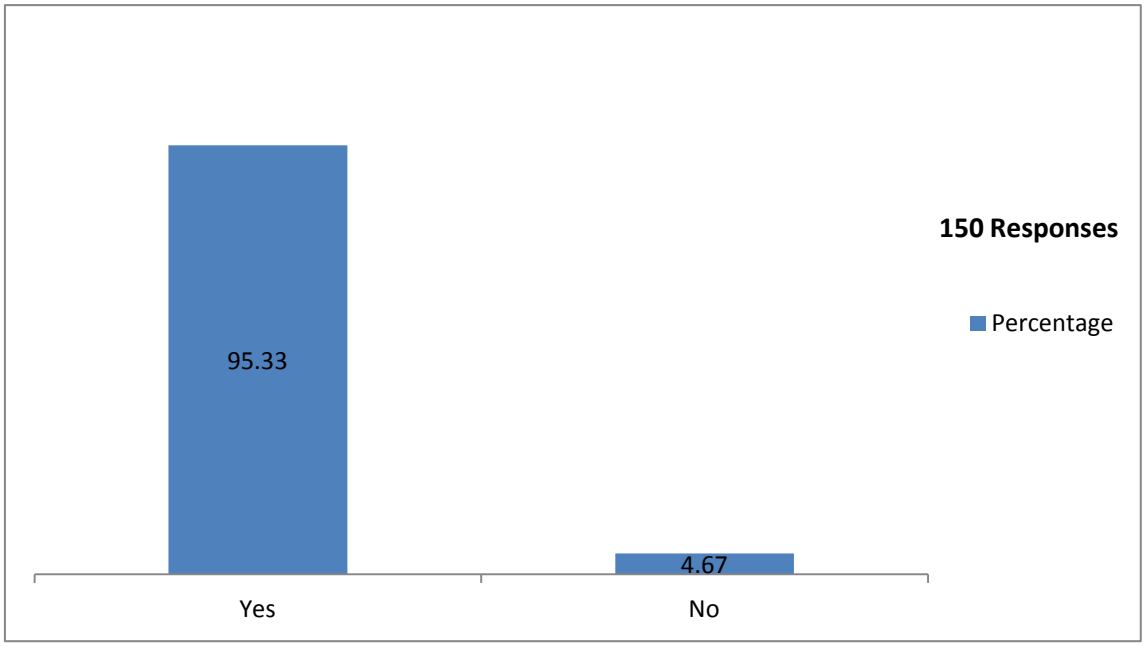


Fig 4.29: Bar Chart showing public responses to Q12 of the questionnaire.

Most of the respondents have voted in the favour of construction of cycle track. 95.33% of the respondents feel that there should be a cycle track on this route. Only 4.67% of the people voted against it.

13. On a scale of A to F, What rating would you give to your cycling experience on this route?

(A is for most satisfied and F is for least satisfied)

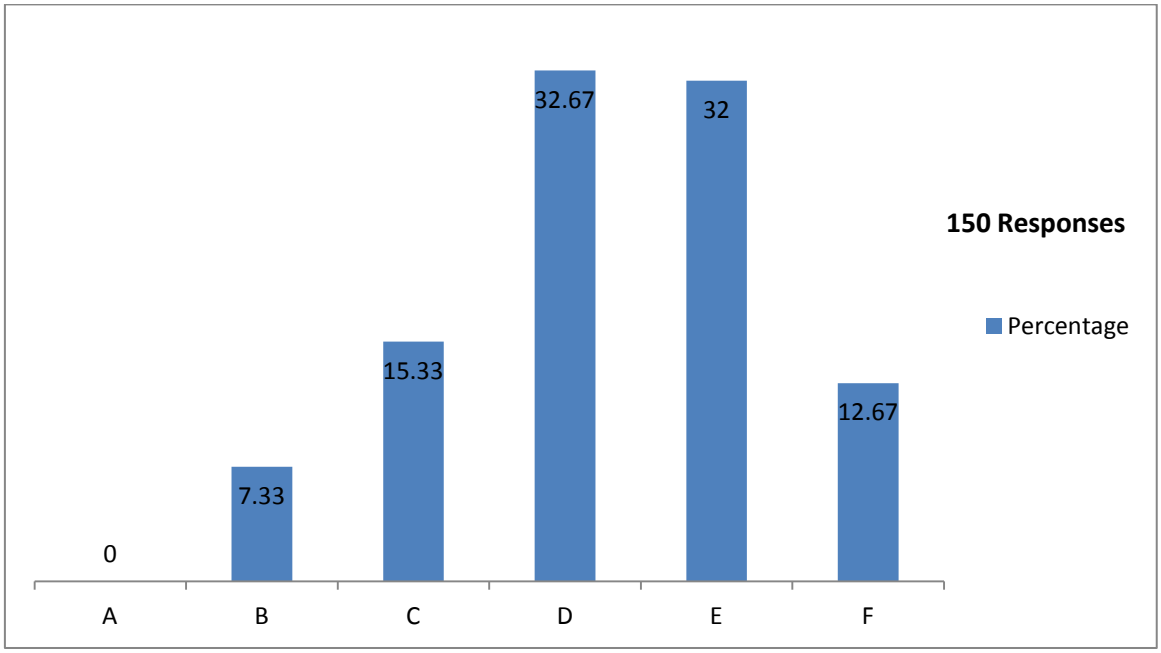


Fig 4.30: Bar Chart showing public responses to Q13 of the questionnaire.

The LOS criteria are based on the split of the response levels of satisfaction. To remain consistent with the *Highway Capacity Manual* (*10*), six LOS designations (LOSs A through F) were defined as follows:

A "democratic" definition of LOS is used. This means that LOS is designated A if 50% or more of the respondents are very satisfied. LOS is designated B if 50% or more are very or moderately satisfied and less than 50% are very satisfied, and so forth, ending up with an LOS of F if 50% or more are very dissatisfied.

Looking at the responses to the above question, we can see that most of the responses lie in the range of 'D' (32.67%) and 'E' (32%).0% of the respondents gave rating A to their cycling experience. 7.33% gave rating B and 15.33% gave rating C.

So, based on the ratings and referring to the LOS criteria based on split of responses level of satisfaction, as per HCM2010, **BLOS D** can be determined.

4.6: Calculation of BLOS (Bicycle Level of service):

Tableo 4.16: LOS criteria for exclusive bicycle paths.

(Source: Highway Capacity Manual 2010)

LOS	Frequency of events 2 way, 2 lane (events/hour)
A	=<40
B	>40-60
C	>60-100
D	>100-150
E	>150-195
F	>195

Number of events = $\frac{\text{2*Bicycle flow rate*Standard Deviation}}{\text{Mean Bicycle Speed*Square Root of pie}}$

(Source: Highway Capacity Manual 2010)

Standard Deviation of 3km/h is used when the facility is assessed by various user types.
In case of selected site, there are different types of users (source: questionnaire survey)

Mean Bicycle Speed of 18kmph is taken as per IRC 11:2015.

On Way 1 (i.e. towards MOGA)

Average Daily Cycle Traffic =1559
(source: Traffic volume survey)

Therefore, Bicycle Flow Rate = 1559/11
(ADT was calculated for 11 hours per day)

Bicycle flow rate = 141bicycles/hour

Number of events = $\frac{\text{2*Bicycle flow rate*Standard Deviation}}{\text{Mean Bicycle Speed*Square Root of pie}}$

$= \frac{2*141*3}{181*1.772}$

Number of events = 26.51

On Way 2 (i.e. towards JALANDHAR)

Average Daily Cycle Traffic =1531
(source: Traffic volume survey)

Therefore, Bicycle Flow Rate = 1531/11
(ADT was calculated for 11 hours per day)

Bicycle flow rate = 139 bicycles/hour

$$\text{Number of events} = \frac{2*\text{Bicycle flow rate}*\text{Standard Deviation}}{\text{Mean Bicycle Speed}*\text{Square Root of pie}}$$

$$= \frac{2*139*3}{181*1.772}$$

Number of events = 26.14

Referring the above table, we can get the values of LOS for cycle tracks on both the lanes.

Therefore, Level of service for Cycle track facility on way1 (i.e. towards MOGA) is **LOS A.**

Level of service for Cycle track facility on way2 (i.e. towards JALANDHAR) is **LOS A.**

CHAPTER 5

RESULTS AND DISCUSSION

Planning of cycle track:

Selected site for construction of cycle track is **GTB Nagar, Jalandhar-Moga Road**, Jalandhar city, Punjab. (Reason for selection of the site have been explained in section 4.1)

Bicycle Traffic selected site is approximately **10.62%** of the total traffic on the Jalandhar-Moga Road. (From section 4.3)

Fig 5.1: Actual photograph of the selected site.

The above photograph shows the actual site photograph of Lane-2 of Jalandhar-Moga Road. We have planned a cycle track facility for Jalandhar-Moga Road from **Shri Guru Ravi Dass Chowk to Wadala Chowk**. We can see the vacant space available for the construction of cycle track facility in the photograph.

Since it is a four lane two way road, there will be a cycle track facility on the outer sides of the pavements of each way.

The type of the cycle track facility that is planned is an exclusive bicycle track, raised from general pavement level. And only one way movement of cycles will be allowed. Over takings in the same direction will be allowed. Cycle Track markings and signboards can be used to implement these things.

Method of construction to be used is Rigid Pavement construction. The surface of the facility will be made Red in colour to distinguish it from the general pavement and there will be cycle track markings with white colour on the facility.

The length of Cycle Track Facility that is planned (i.e. from Shri Guru Ravi Dass Chowk to Wadala Chowk) will be 1750m* on each side. Therefore a total of 3500m cycle track facility will be constructed.

{*the distance 1750 m was measured using a metre tape}

The width of the Cycle Track Facility is planned to be 2.2m. (Width is planned as per the recommendations of IRC: 11-2015)

Also at the selected site, there is vacant space available on both sides of the pavement (widths of available vacant space ranging from 3.75m to 5.2m**) {**these distances were also measured using metre tape}

Improvement of Level of Service:

Bicycle Level of service (BLOS) for has been calculated for both the conditions i.e.

1. LOS at present conditions, i.e. without cycle track (calculated in section 4.5), we got **BLOS D**.
2. LOS after planning of cycle track facility (calculated in section 4.6), we got **BLOS A**.

Thus, we can see an improvement in the BLOS (bicycle level of service) from **BLOS D** to **BLOS A** in conditions of absence and presence of cycle tracks respectively.

CHAPTER 6

CONCLUSION

A bicycle track facility on each both sides of the road between Shri Guru Ravi Dass Chowk and Wadala Chowk, GTB Nagar has been planned. The type of the facility is an exclusive bicycle track, raised from the general pavement surface and the method of construction is rigid pavement construction, with red colour surface of the cycle track and white cycle track markings over it.

BLOS (bicycle level of service) will be improved from BLOS D to BLOS A by the construction of cycle track.

Increase in BLOS indicates increase in comfort of the rider, reduction in delays etc. There will be reduction in bicycle accidents as the bicycle traffic will completely be separated from general traffic (faster moving traffic is one of the major reasons of the bicycle accidents).

Hindrances from pedestrians, parked vehicles, faster moving traffic, and other obstacles will be reduced.

Due to all these improvements, more number of people will be attracted towards use of bicycles which will result in a healthier lifestyle, less pollution as well as less use of fossil fuels.

As this a place which connects both commercial and residential areas, hence more number of people will be able to assess the cycle track.

Future extension plans can be made to connect this cycle track to surrounding areas or extension in the same line can be provided too.

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