BICYCLE ROUTE NETWORK PLANNING FOR ISLAMABAD USING ARCGIS

Final Year Project UG 2020

BY

NAEEM UL HASSAN (GL)	NUST-2016186679-SCEE
SHARJEEL AHMED MIRZA	NUST-2016182263-SCEE
ABDUL KHALIQ	NUST-2016174034-SCEE
AZLAN RAUF	NUST-2016141341-SCEE

NUST Institute of Civil Engineering

School of Civil and Environmental Engineering National University of Sciences and Technology, Islamabad, Pakistan

(2020)

This is to certify that the

Final Year Project Titled

BICYCLE ROUTE NETWORK PLANNING FOR ISLAMABAD USING ARCGIS

Submitted by

NAEEM UL HASSAN (GL)	NUST-2016186679-SCEE
SHARJEEL AHMED MIRZA	NUST-201612263-SCEE
ABDUL KHALIQ	NUST-2016174034-SCEE
AZLAN RAUF	NUST-2016141341-SCEE

has been accepted towards the requirements

for the undergraduate degree

in

CIVIL ENGINEERING

Assistant Professor.Malik Saqib

NUST Institute of Civil Engineering

School of Civil and Environmental Engineering

National University of Sciences and Technology, Islamabad, Pakistan

DEDICATION

We would like to dedicate our works to our parents, our teachers who hard with us and all of our friends. We executed our work with the considerable determination and applied best of ourselves to the task at hand.

DECLARATION

It is hereby solemnly and truthfully declared that all the work referred to this thesis is composed by us and it has not been submitted by any university, in whole or in part in any previous application for a degree. Any references to the work done by any other person or University have been duly cited.

ACKNOWLEDGEMENTS

"In the name of Almighty Allah, the Most Beneficent, the Most Merciful"

We are very thankful to Almighty Allah for granting us the strength, tenacity, diligence and endurance to complete our project successfully.

We are extremely obliged to our respected supervisor, Assistant professor Malik Saqib for providing his guidance, precious time, keen interest, confidence and great knowledge during the entire tenure of project. His displeasure on our work sometimes is none other than motivation for us. We contemplate ourselves lucky to have toiled under professional supervision.

We would also like to thank our co-supervisor Lec Kamran Shakir assisting us regarding this project unhesitant and tenaciously. ‘

At last we would like to beholden of our parents, other family members and all of our friend that inspire us through all troublesome and motivated us to keep us going.

ABSTRACT

Islamabad which was designed by Greek architect Constantinos Apostolou Doxiadis is considered as Pakistan best planned city. Day by day its population arises and now Islamabad is facing serious traffic problems which results in traffic delays, congestions and environmental issue. It has been observed and surveyed that people want to use bicycle, but city has no facility of bicycle tracks and cycling infrastructure. So, the main idea behind the project was to cope with these issues and to design master plan of the bicycle tracks in Islamabad as bicycle occupies less space, reduces traffic congestion and is environmentally friendly. The purpose is to promote cycling culture in Islamabad and switch more and more people to use bicycle as mode of transport. The project comprises on public, cyclist and reconnaissance surveys, Analysis, use of Google earth and routes designing on ArcGIS.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 01

INTRODUCTION

1.1 Location:

This Bicycling transportation project is basically designed to be in Islamabad. The major sectors which will cover this bicycling track will be G, F, I and H. These sectors and tracks direction are decided based on surveys results and analysis.

1.2 Background:

Pakistan is facing serious issues of environmental pollution and global warming and the major reason is carbon emission from industries and automobiles. The statistics shows that approximately 23 percent of greenhouse gas is emitted by transportation which causes serious health problem and other environmental issues. Islamabad is reaching a saturation level in terms of land availability because of the ever-increasing population. Due to this increasing population and limited public transport major trend shift has occurred towards use of cars for transport which causes more pollution and delays. Pakistan is a flourishing market for Automobiles Company with sales reaching ever high 185,781 units mark (figures source Express tribune) as shown in fig 1.1.

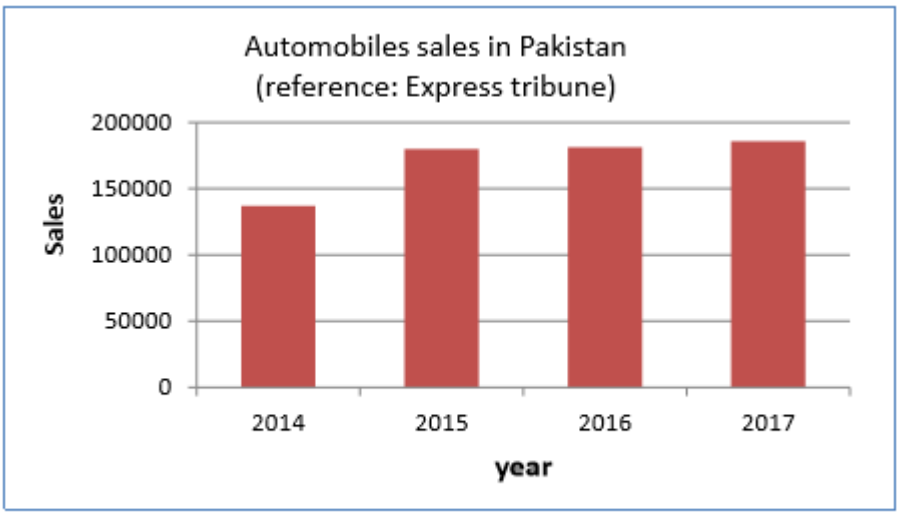


Figure 1: Automobile Sales in Pakistan

Figure 1. 1: Automobile sales in Pakistan

In order to reduce pollution, traffic delays for short distances and to promote health and entertainment, bicycling is one of the best alternate and for this bicycling track are the necessity at hand to design on the various routes and sectors of Islamabad.

Survey data from a selection of seven European countries show that 12-30% of all trips is made by bicycling (as main transport mode), the highest figure being for Great Britain. For short trips under 5 km, the bicycling with a maximum of 45% is in Great Britain. But unfortunately, in Pakistan this percentage is hardly 1 %.

1.3 Problem Statement:

Islamabad is one of the best planned cities of Pakistan which was designed by Greek firm Constantinos Apostolou Doxiadis for the population of 6 lac. But due to increasing number of housing societies in Islamabad and population shift from other cities with no restricted access the Islamabad is facing traffic problems now which results in delays, accidents, air and noise pollution. Various surveys were done from cyclists and public to know the reasons and their problems while riding bicycle as a transport. The reasons for which bicycle is not use as the transportation mode on a vast scale, in Islamabad are following:

- Unavailability of Bicycle tracks in Islamabad. Islamabad was designed by Greek firm without involvement of bicycle tracks in it and not any government focused to develop these tracks from last 40 years.
- Terrain of Islamabad is major issue. Islamabad is not the plain city like other cities of Pakistan for which ordinary bicycles give tough time on graded roads. So, bicycles with gears are required which results in price increment due to which employers, labors and students cannot afford easily.
- High speed traffic of Kashmir highway and other major roads arises the question of safety to use bicycling as a transportation.

This all results to discourage the use of bicycle for public and cyclist as a major transportation in Islamabad due to which we are lacking behind in bicycling transportation from European countries.

1.4 Objectives:

1. To promote the sense of awareness and global warming to the public and to shift them to use bicycle as a transport.
2. To designed master plan of bicycle transportation which will join all major sectors of Islamabad. Routes will be designed by the analysis of different surveys and population intensity of cyclists.

3 To reduce traffic load on roads which will ultimately reduce traffic delays and accidents and promote bicycling and public transport by providing bicycles tracks and safe bicycle parking's.

4 To promote bicycling culture as an entertainment and healthy activity.

5 Planning facilities and incentives to be provided to cyclists.

1.5 Scope:

Almost entire major sectors of Islamabad are included under this project. To achieve the above-mentioned research objectives a research plan was prepare and for the gratification of plan following tasks were outlined:

a) Literature review of European bicycling masterplan and to have analyses from this literature review.
b) Public, Cyclists and route reconnaissance Surveys from different sectors of Islamabad and to have analysis from this which will ultimately be useful to develop design and routes of tracks.
c) To provide shortest possible cycling routes and provision of facilities along these routes.
d) Use of software like Google earth and ArcGIS to design the route.
e) Preparation of Methodology and to perform accordingly then.

1.6 Limitations:

Not an exact representation of public and cyclist surveys in term of gender. As women in Pakistan are less prone to cycling and hesitate to give surveys due to cultural problems. Surveys are not done equally numbered in every sectors. For this concept of weighted percentage was used to deduce results for analysis.

1.7 Justification for Selection of Topic:

- Islamabad is facing serious problems in traffic congestion and delays day by day due to increase in population. It can be reduced by the introduction of Bicycling tracks.
- City like Islamabad which is best planned city and tourist attraction lacks this facility. So, this gap should need to be cover by initiative of this project.

- Lot of public mostly including students and employees and cyclist want to have this facility as according to survey results but feel lack of safety as there are no bicycling tracks and safe parking etc.
- To promote health and entertainment by allowing the tracks pass through F9 park and alongside other green belts, in the public. This will also enhance the overall traffic infrastructure and better image of Islamabad.

CHAPTER 02

LITERATURE REVIEW

2.1 Introduction:

Islamabad with better infrastructure, amenities and being well planned saw a tremendous increase in traffic congestion with each year but the cycling trend on the other hands went downward and almost vanished and it remained limited to some group of people (most of them using for entertainment/ exercise purposes or by hawkers who used to make their livelihoods by only using cycles).

Addressing the issues of citizen regarding cycling and providing the best possible facilities to attract citizen towards bicycling trend that was once major transportation mode in Pakistan is the major concern of our study.

To confront with the problems regarding cycling, surveys is conducted among the citizen of that particular region to acquire comprehensive knowledge about hurdles in cycling and how to mitigate those problems. Most of the studies with an objective of conducting surveys only are done and one of them is summarized below.

2.2 Survey related studies / Case studies:

1. In 2016 the bicycle association of Great Britain (BAGB) commissioned London school of economy(LSE) to conduct surveys to inspect the economic inspect of bicycling industry and cycling in the United Kingdom, SQW also scrutinized patterns and trend about bicycling and delivered to the World Health organization (WHO).

In the first part of the study the data regarding the number of cycles imported, imported e-cycle, the different types of user vs bicycle sales, gross value added by bicycle sales and labour cost and employment in the bicycle industry is acquired. It came out that passionate cyclist contributed to almost half (46%) of the total value of bicycle sales and then followed up by recreational users.

In the second part of this study the data regarding ownership or access to bicycle, average distance travel and frequency of bicycling by the age group is conducted. Beside it the actual and perceived risk of bicycling on roads is also conducted.

The main outcome of it was most the cyclist among different age group are children but are declining steadily and cycling among adults are increasing as shown in fig 2.1.

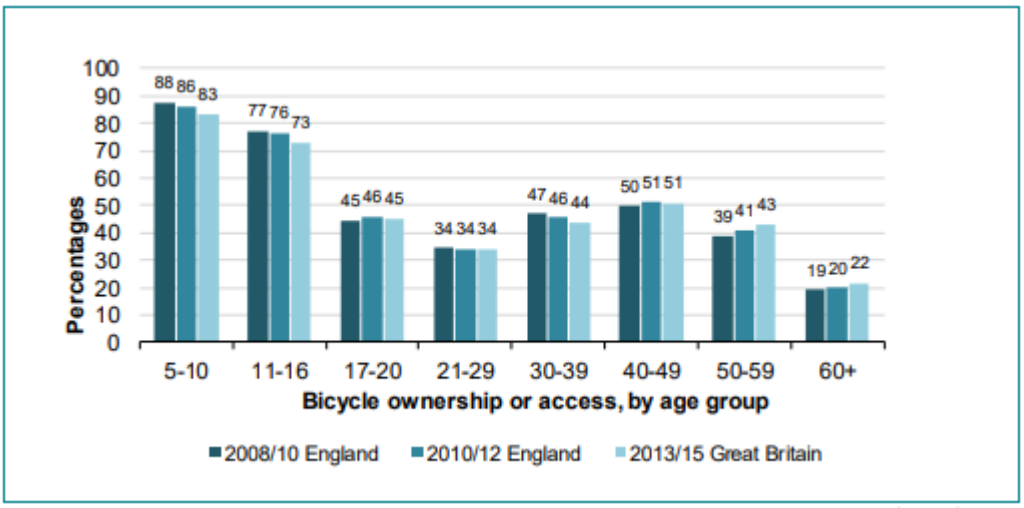


Figure 2. 1: Bicycle ownership or access, by age group

It was seen that passionate cyclist and those using cycle for commuting contributing in majority for proportion of miles cycled by different user groups, majority of them using cycle frequently as show in fig 2.2.

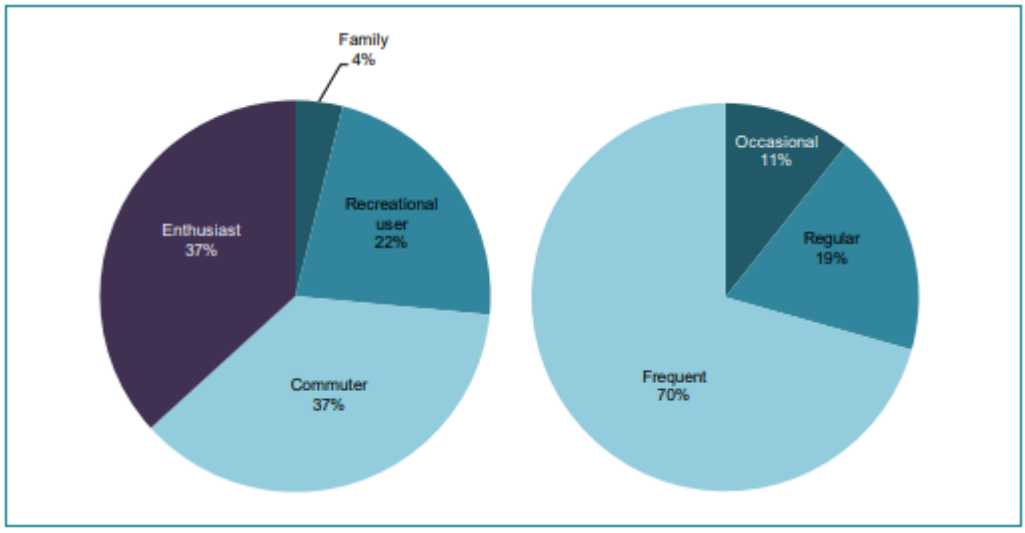


Figure 2. 2: Frequency of bicycling

On an average a cyclist can cycle for three miles in one trip and in whole year a person can bicycle for fifty-three (53) miles. Cyclist of age group 20-29 and 30-39 are majority in number and can be seen their proportion falling.

At last it was seen that fatalities rates are fewer among cyclist than motorists and pedestrians but still the decreasing trend towards bicycling is due to perception that roads too dangerous for cycling.

2. In 2012 survey regarding the use of and perception about bicycling is conducted by Bicycle Pedestrian Advisory Committee [BPAC] using Stand COG website. the crucial findings of this survey were that most of the people used cycle for health purpose and for enjoyment, majority of their cyclist use their cycle for recreational purposes, most of the respondents takes ride for 3-4 days per week and for longer distance, absence of bike lanes is the major issue among the cyclist and provided separate bicycle lane is an ultimate solution this problem.

2.3 Bicycling lane:

Bicycle lanes are the pathways that may be the portion of roadways are designated for the use of bicycles exclusively or preferentially it can be achieved by using roadway marking or using kerbs against roadside. It is most of the time is two-way travel but with the increased number of bicycles it can be one way. It is shown in fig 2.3.

Figure 2. 3: Bicycling lane

2.4 General background of bicycling lanes:

Land Transport Safety Authority (LTSA) was to first recognize that the separate pathways for the cyclist adjacent with country's roadway is the utmost desire with an escalating number of bicyclists across the country. So thus, put forward five general route requirements for all bicycling lanes:

"safety, comfort, directness, coherence and attractiveness" (LTSA 2004)

According to Van Houten and Seiderman the bicycling lanes adjacent to roadways has little effect on the positioning of moving vehicles but according to Hunter et al (1999)

the marked bicycling lanes in contrast to wide kerb lanes are vulnerable to unforeseen fatalities.

2.5 Bicycles Facilities:

It is a broad term that denotes upgradation and provisions to serve and to motivate bicyclist to carry out bicycling more often. These facilities may include separate bicycling lanes, separate parking, tuck shops, water coolers etc.

2.6 Bicycle lane around the world:

In the United Kingdom, the bicycle lane is restricted for bicycles only with the solid marked line and the entry of motor vehicles is prohibited or it can be advisory with broken white line that allow motor vehicles to enter into the bicycle lane when not in use.

In United Kingdom, there are different categories of bicycle lane in which *Class II bikeway* is used exclusively by cyclist with solid white stripe marked on roadway and *Class III bikeway* has a roadside sign which indicates shared use of lane. A *Class IV bikeway* is preferentially used by bicyclist but completely separate from the roadway.

In France, a bicycle lane exclusively for bicycles along with the roadway is known as *bande cyclable*, separate bicycle lane as *piste cyclable* and shared bicycle lane as *voie cyclable.*

In Belgium, two parallel broken white line are used for bicycle use only.

2.7 Bicycling around the world:

Cyclic trend in most of the northern European countries are much higher than North America and Australia. Thus, it is seen only 1 percent of cycling trend in Australia, Canada and the United states and only 2 percent in United Kingdom and Ireland. But cycling trend is much higher in the European countries that is Netherlands contributes by 26 percent of cyclist, Denmark by 18 percent, Germany, Belgium, Sweden and Finland contributes by 10 percent of bicyclist. Moreover, bicycling per capita ranges about 0.1 km in United states, 0.2 km in United Kingdom, 1 km in Germany, 1.6km in Denmark and 2.5 km in Netherlands (European Commission 2005-2007). Safest cycling is done in Netherlands, Denmark and Germany. It is found that the fatalities

rates dwindled sharply about 70 percent in Netherlands, Denmark United Kingdom, Australia and Germany.

2.8 ArcGIS Software

ArcGIS is a geoinformatics system software that is mainly used for working with maps and geoinformatics system that is maintained by Environmental Systems Research Institute (Esri). Main works of ArcGIS include creating different kinds of maps, inspecting and organizing the geographic data and mapped information and managing geographic data in the database. In constructing the map for cycling related purpose the ArcGIS provide best interface and simple working, different studies are carried out to propose best possible routes for the cyclist with an application of ArcGIS and one of the studies is discussed below.

2.9 ArcGIS for route network Planning / A case study:

A project under the supervision of Auckland Regional Transport Authority (ARTA) and VicRoads, Melbourne was conducted to analyse how the demographic data (Employment, population, and school rolls) and different bicycling routes network using a software ArcGIS. Using ArcGIS software, the zone of 2km, 5km and 10km is drawn across the Melbourne especially on the densely populated area and then in each of zone buffers of 400m, 800m and 1600m are created on the existing cycling routes which is the part of principal bicycle network (PBN) to calculate the effectiveness of the bicycle routes. Then using demographic data like population, employment and school rolls are converted into raw points and then it is divided buy route length to get the final score. In this way the score formed by higher demographic and lower bicycle route length would give the higher score thus will indicates the presence higher number of cyclists on that route. In conclusion the PBN will maximize the number of trips in Melbourne and will also maximize directness, separation and priority for cyclist using cycle as a mean of transportation. This method is simple and can be used to add proposed routes in the exiting PBN that is just demographic per KM.

CHAPTER 03

RESEARCH AND METHODOLOGY

3.1 Introduction

Project is to design the bicycle tracks along the various location of Islamabad. It includes sectors of F, G, I and H excluding the areas of Islamabad along the Islamabad express highway and south of Islamabad which is mostly undeveloped and less populated. Different thesis was read, and model and techniques were studied which have been applied in various parts of the world. Some techniques and methods were extracted from those models. But final methodology and techniques which we used to design the project were extracted from the analysis of different surveys which we did form our proposed project area. The purpose of this project is to let the people to use bicycle as a mode of transport as it will reduce traffic load and traffic congestion on the road. This is also health benefit and reduce Carbon dioxide emission.

3.2 Surveys

In most of the projects Survey is the first step before the designing and construction phase. The projects like running tracks and bicycling tracks are highly depended upon surveys after which the design and construction phase can be started.

The survey was developed by our team in which there are questions to be asked by the public regarding cycling. Moreover, the survey was designed and implemented to collect opinions from the general bicycling public regarding their uses of and feelings about such non-motorized transport.

When structuring survey questions, following points were considered.

- The main goal of the survey
- How we plan to apply the survey data on the project.
- The decisions we will make because of the survey data

In the first phase on field surveys were done form the Markaz of the sectors to all commercial markets, parks and nearby educational institutes. The surveys were done from various class of people including labor, employees, students, cyclist etc.

In the second phase online surveys were done. Google form surveys were sent to different social media pages, student groups and cycling club society members. Reasonable amount of responses was achieved from the surveys through these online platforms.

Surveys were divided into three parts:

1. Public interview Survey
2. Cyclists interview survey
3. Route reconnaissance

3.3 Public Survey

To figure out the problems and discouraging factors for the general public, surveys called as general public surveys were carried out from different sectors of Islamabad. Number of surveys were carried out with different timing in order to cover the public from all classes and professions to have a better result.

One of the most important aspect of any project is its cost. This is one of the major challenges for the Transportation engineer to design the project economical and cost effective. Surveys have great impact on the design as results and analysis form surveys tell us about actual work need to do thus make the project more budget friendly.

Every respondent was asked about the area and sector which they mostly travel as shown in fig 3.1. The purpose was to check their travel distance and their most frequent route pattern.

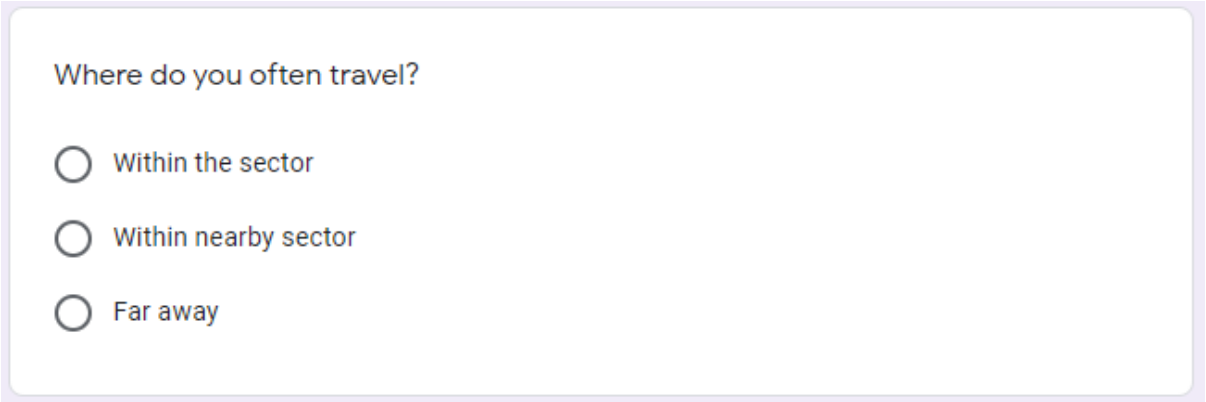


Figure 3. 1: Travelling area

Mode of transport were asked from the respondent and they are asked to rate their mode of transport on the scale from 1 to 5 as shown in fig 3.2.

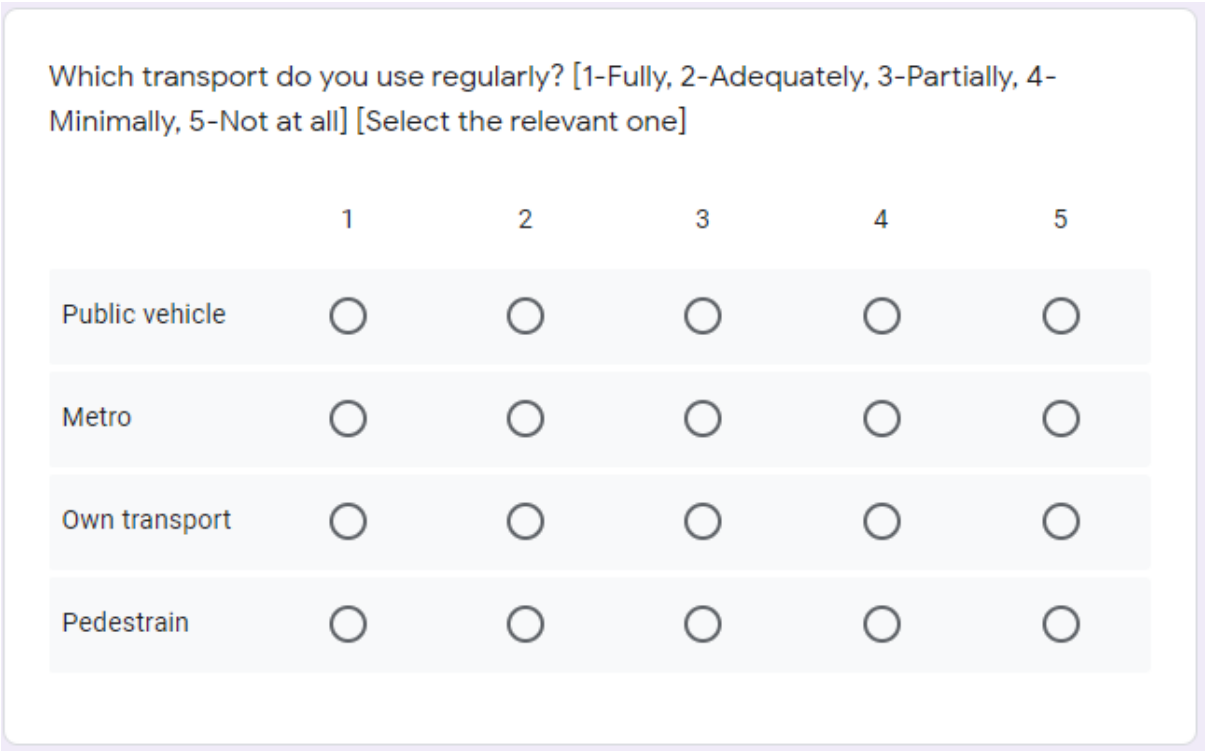
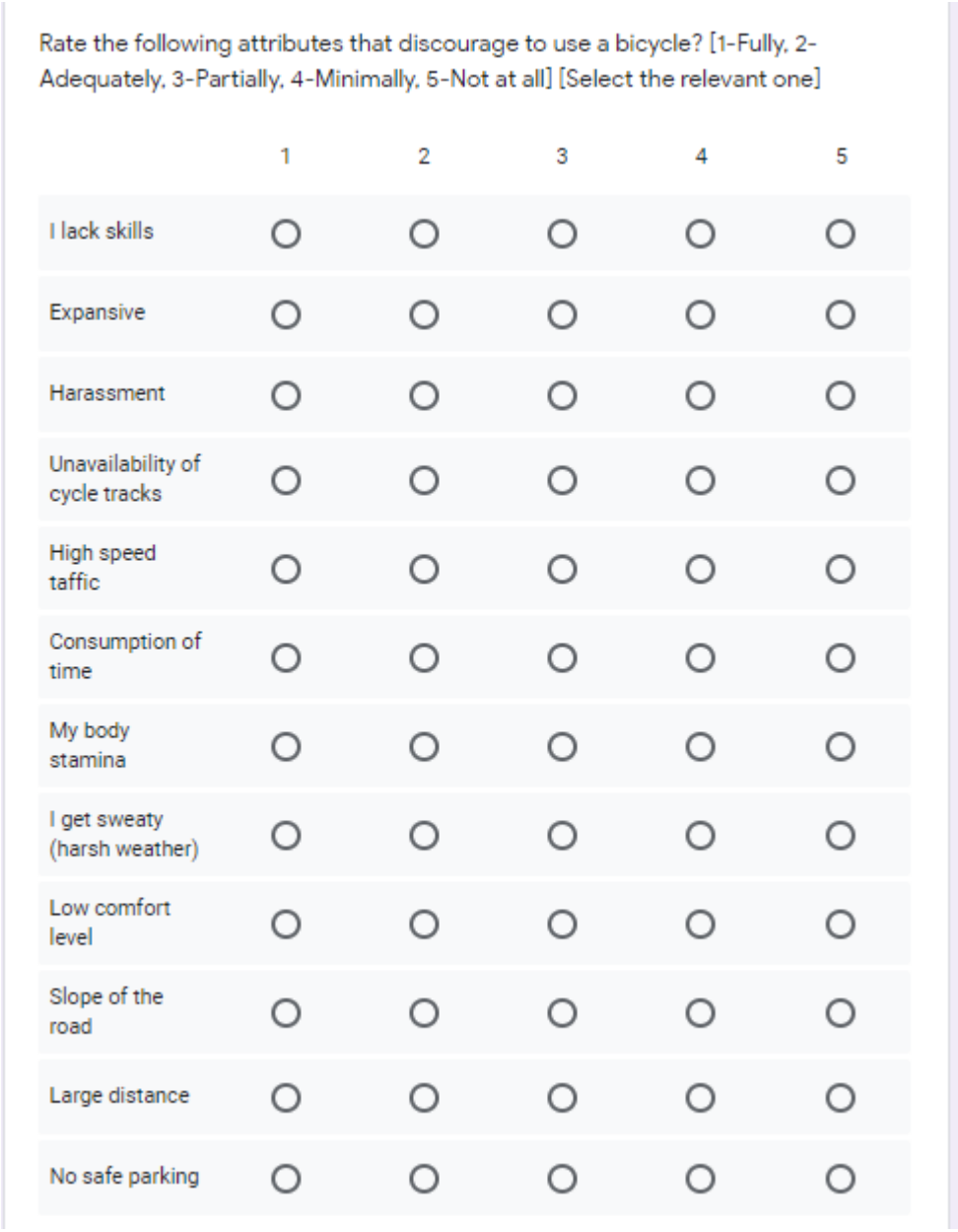


Figure 3. 2: Mean of transportation

Although mostly respondent rate higher for the public vehicle and own transport comparative to metro and pedestrian. Various reasons behind this rating is the luxurious lifestyle of Islamabad, cultural problems for females and comfortability factor which discourage them to use bicycle as a mode of transport. But when they were asked to use bicycle if bicycle tracks along with bicycling infrastructure will be provided on various major routes of Islamabad, results were quite surprising and mostly said they would like to do bicycling as a purpose of health benefit and recreational activity.

Then factors which discourage them to use bicycle were asked from respondents and to rate every factor from the scale 1 to 5 as shown in fig 3.3.



Rate the following attributes that discourage to use a bicycle? [1-Fully, 2-Adequately, 3-Partially, 4-Minimally, 5-Not at all] [Select the relevant one]

	1	2	3	4	5
I lack skills	○	○	○	○	○
Expansive	○	○	○	○	○
Harassment	○	○	○	○	○
Unavailability of cycle tracks	○	○	○	○	○
High speed taffic	○	○	○	○	○
Consumption of time	○	○	○	○	○
My body stamina	○	○	○	○	○
I get sweaty (harsh weather)	○	○	○	○	○
Low comfort level	○	○	○	○	○
Slope of the road	○	○	○	○	○
Large distance	○	○	○	○	○
No safe parking	○	○	○	○	○

Figure 3. 3: Discouraging attributes

The purpose was to figure out the reason which discourage them to use bicycle as the mode of transport. The detail analysis of this general public survey will be covered in the analysis portion.

3.4 Cyclist Survey

Just like the general public survey to figure out the problems and discouraging factors for the cyclist, surveys called as cyclist surveys were carried out from different sectors of Islamabad.

Some of the most important question asked from them are (fig 3.4):

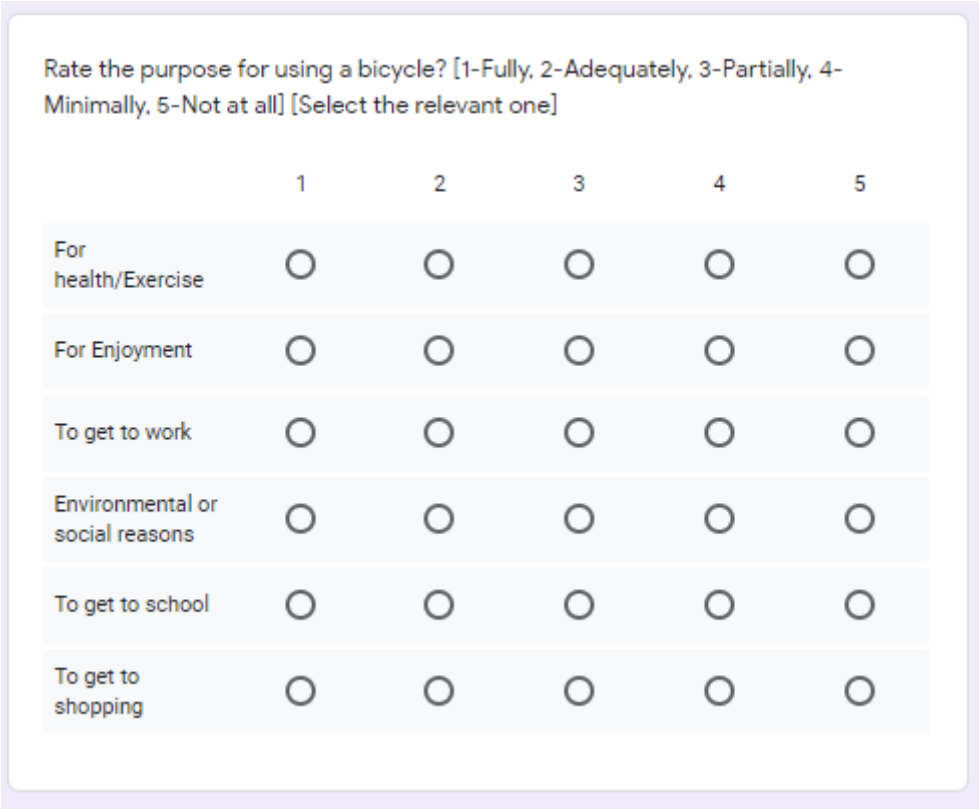


Figure 3. 4: Bicycling purpose

It was asked in order to figure out the purpose of the cycling and rating shows their intensity for this as shown in fig 3.5.

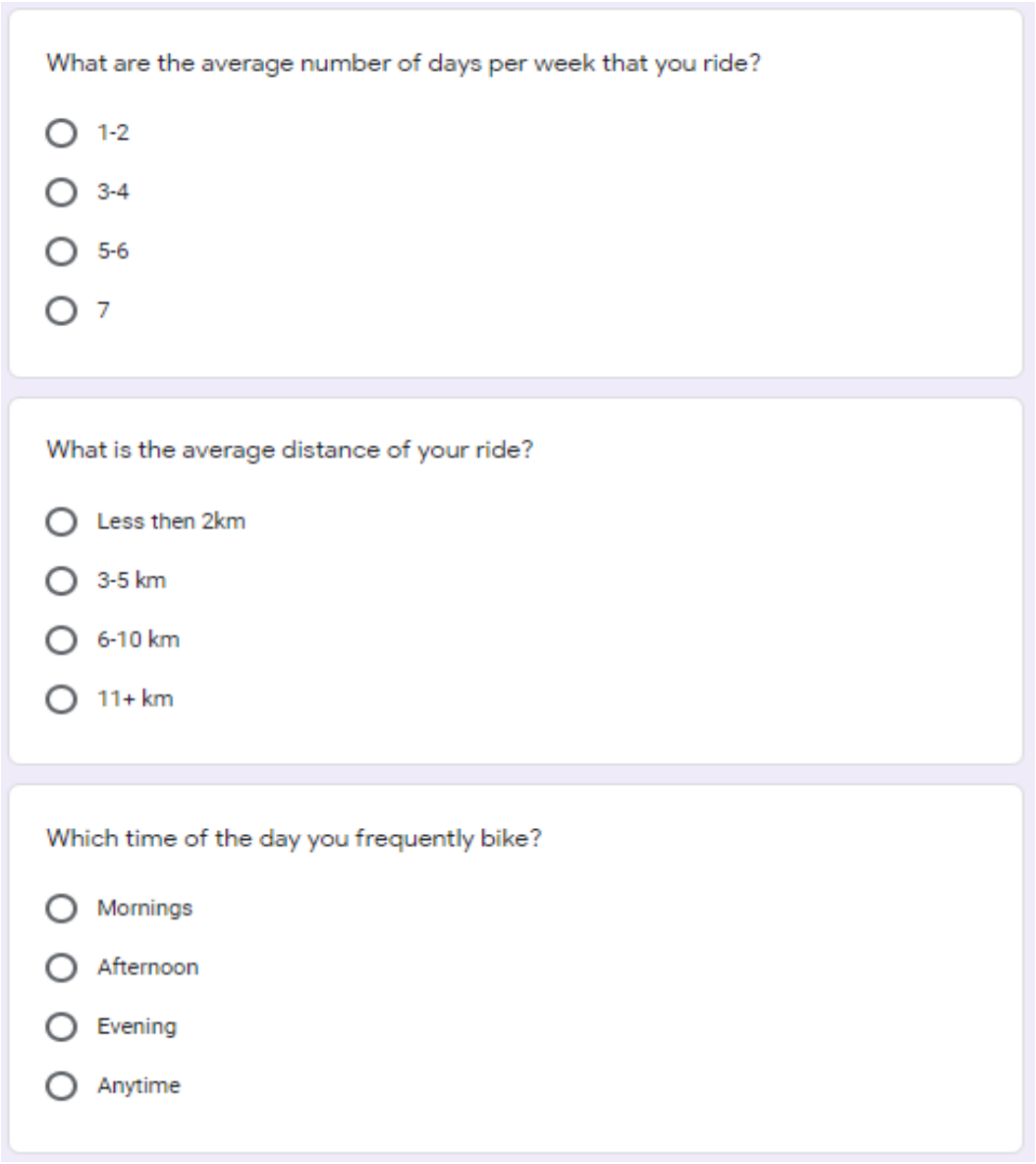


Figure 3. 5: Intensity of bicycle use

They were asked about the number of days they ride bicycle in a week and average distance they ride in a single ride. This has direct impact on the tracks to be designed as shown in fig 3.6 and 3.7.

Figure 3. 6: Discouraging factors

Figure 3. 7: Encouraging factors

Analysis from these questions and conclusion and results are discussed in the section of analysis of these surveys.

3.5 Route Reconnaissance Survey

A reconnaissance survey provides data that enables design engineers to study the advantages and disadvantages of a variety of routes and then to determine which routes are feasible. Different sectors were visited, and grades of road were observed. As Islamabad is not a plain city and have variation in grades in most of roads. When moved from sector I to F increment in slopes have been observed. So, purpose of reconnaissance survey is to choose roads and the tracks which will be more feasible and will have less variation in slopes.

Other purpose of this survey was to make design in such a way that maximize the use of green belts alongside road as a design part of bicycle tracks. This will help to remain the road portion undisturbed and also will be cost effective. This also improves the aesthetics of city.

Initially F-9 Park was not included in the design but later on it was added in the design due to the reason that parks must have bicycling tracks as from the surveys it was analyzed that there are lot cyclist and public who wants to have cycling as a recreational and entertainment purpose for which f9 park is most suitable sector because of healthy environment and lush greenery there.

Moreover, signals and chowks and intersections were visited to make the best possible design in order to reduce conflicts, any traffic congestion and to provide safety to cyclists.

3.6 Travel Trend Line Diagram

During surveys, each cyclist was asked about the path they usually take to reach their destination spot from their origin spot. Keeping these Origin to destination spots of cyclist in mind the travel trend diagram was prepared taking markazes of each sector as an origin point and their terminate points as destination spots. By doing this we got to know from which sector and from which part of the sector most of the trips were generated. This travel trend diagram was used as a basis for drawing routes on ArcGIS. After that, all the necessary facilities are provided along the route

3.7 Designing Routes Using Google Earth and ArcGIS Software

After all type of surveys their analysis, conclusions and Travel trend line diagram, next step was to design the route that will be in accordance with our survey results and travel trend diagram. The purpose was to design the best possible bicycling tracks that will facilitate people in every possible way. Now for designing a route, basic digitization was done on ArcGIS in which using editor tool the best possible track is traced on an open street map using polygon feature. Thus, the track had no connections with roads. After completion of tracks a proper map was prepared in the layout view tab of ArcGIS where this map was put into the proper shape with title and legends etc.

3.8 Routes Prioritization and Segmentation

There were some areas of sectors which we were not able to do survey. But there was need to cover that area in order to complete the tracks and to join them with other tracks. This will also allow cyclist and public of those area to have access to all tracks.

We made the tracks and prioritize them in the design. Top priority is given to the tracks in the areas where there are large number of cyclists and public who want to do cycling as deducted from the travel trend line diagram. After it the second and third priority was assigned which were showing little or no bicycling traffic. After combining all the priority of tracks, we came up with the entire cycle route network for Islamabad.

Due to reduced scope of this project we assumed the time period which these priorities will take to complete.

3.9 Facilities to be Provided Along Routes

One of the discouraging factors to not use bicycle as a mode of transport is the unavailability of cycling infrastructure and other related facilities. Also, secure and convenient bicycle parking is a key factor in influencing a person's decision to use cycle. In reconnaissance survey we observed about different facilities which were must to be provided with cycling tracks for the benefit of public.

These facilities are following; however, all of these facilities are discussed completely in detail in Chapter 5 (development of master plan):

1. Secure bicycle parking which will provide safe bicycle parking facilities such as:

1. Guarded bicycle parking with surveillance cameras
2. Bicycle lockers and bicycle stands
3. Weather-proof infrastructure to save bicycle from sun exposure and rain.
4. Bike parking facilities within workplace and also near metrobus stations.

2. Various tuck shops and water cooler points will be provided along these bicycling tracks.

3. Cycle repairing shop will be provided so that cyclist can deal mechanical and other related problems form these shops.

3.10 Initiatives for Promotion of Bicycling as Transport Mode

After all this there is need to promote cycling as a mode of transport by shifting more and more public towards the bicycling that was the main objective of this project but due to reduced scope of this project these initiatives are not implemented. This is actually the main objective of this project that should be achieved because without any promotion the developed track will be of no use. For this following task will be done:

- Developing bicycle education programs:

Bicycling education programs and presentation will me made which demonstrates the cost, health and environmental benefits of bicycling. Seminars will be given at various schools and institutes to raise importance of cycling as a mode of transport among kids and youth.

- Social media awareness:

Different social media platform will be used to spread awareness about environmental issues of Pakistan and how Pakistan is affected badly by global warming. The purpose was to let the people understand how bicycling as a mode of transport reduces the overall carbon dioxide emission and is more ecofriendly. Different videos will be made where some renowned cyclist of Islamabad will use the bicycle track. Then the videos will spread on various social media platform.

- By arranging group Cycling tournament in initial phase:

Various cycling tournament will be arranged with the help of members of bicycling clubs which already arranges tournament on weekly basis. This will develop the desire of participation in group cycling tournament.

- To aware people about Cycling Infrastructure:

Most people as per survey results are reluctant to do cycling because of unavailability cycling infrastructure. So, purpose is to let the people know about the presence cycling infrastructure. This will be done by seminars at schools and cycling education programs.

CHAPTER 04

RESULTS AND ANALYSIS

4.1 General:

Surveys were conducted among the general public and the among the cyclists all around the Islamabad and then with the assistance of these surveys, analysis on the Microsoft Excel was conducted, then analysis are used to get graphical representation of all the questions that were requested in the surveys. Those graphical representation are converted into the statements to get the precise objectives of all the questions.

With the assistance of these surveys and using ArcGIS Origin to destination Line diagrams are drawn to acquire broad vision of cycling trend across the entire Islamabad and keeping this information in mind, a map is drawn to facilitates the riders with the best possible route for cyclists. Which are discussed under new chapter named “Development of master Plan”.

4.2 Results of Surveys:

Answers from the different types of questions are inserted into the Microsoft excel sheets are then converted into the graphical form to get the result of each question.

4.2.1 General Public Surveys:

Some of the results obtained from the general public surveys are as following:

1. 200 Surveys almost conducted from all the sectors of Islamabad. Responders’ gender ratio was 91% male to 9% female as shown in fig 4.1.

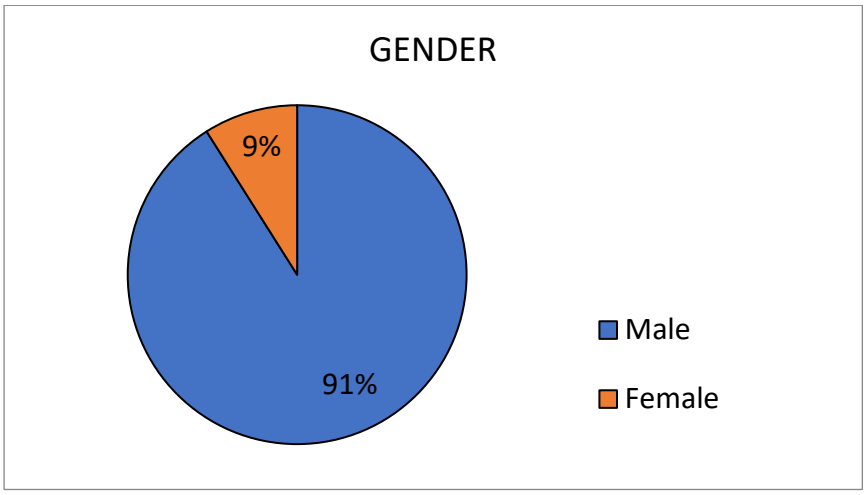


Figure 4. 1: Gender

2. It was initiated to ask the residents of Islamabad about their mean of transportation for their daily use. A lot of respondents chose own transport as a mode of their transportation as shown in fig 4.2.

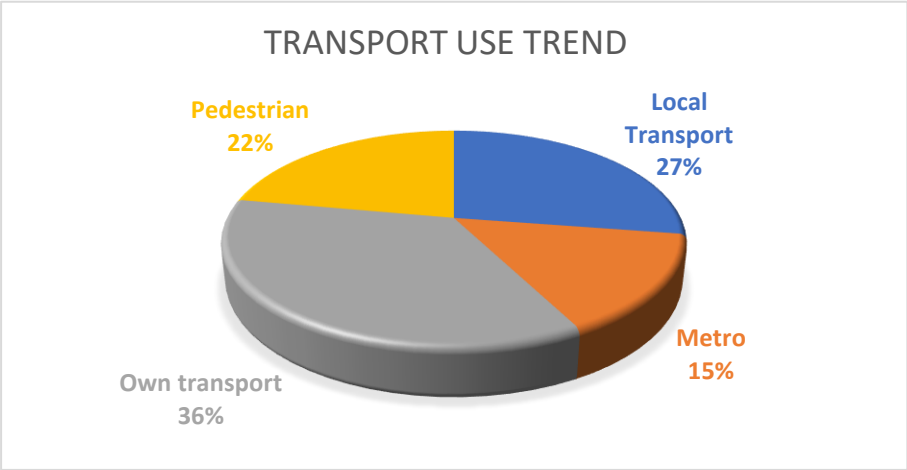


Figure 4. 2: Mean of transport

3. The culture of using bicycle has almost vanished but still residents think it as a healthy transport as shown in fig 4.3.

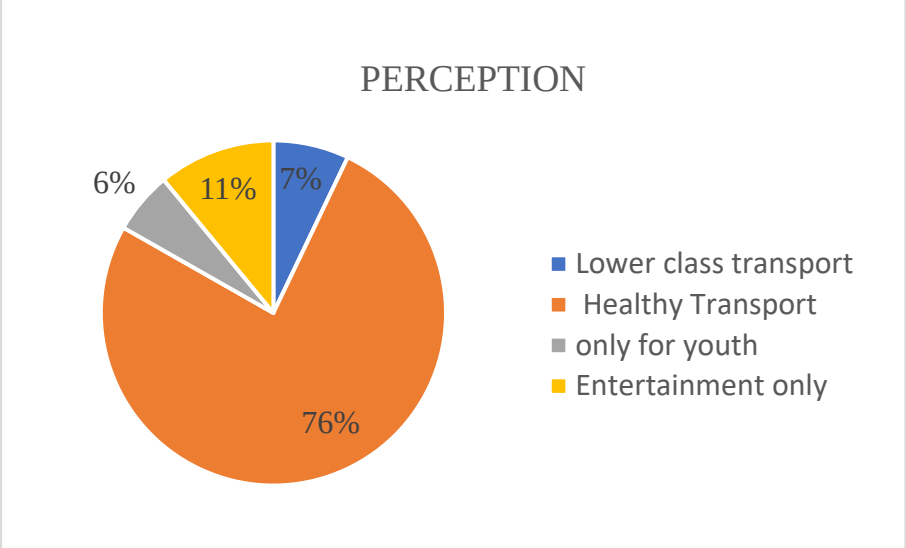


Figure 4. 3: Perception

4. A question was asked from the residents of Islamabad that to perceive if we provide separate route and secure parking with metro stations, will they travel to and from the stations via cycle?

   Their answers are Yes: 62%, No: 13%, People who say route matters: 15%, People who say weather matters: 10%. It is shown in fig 4.4.

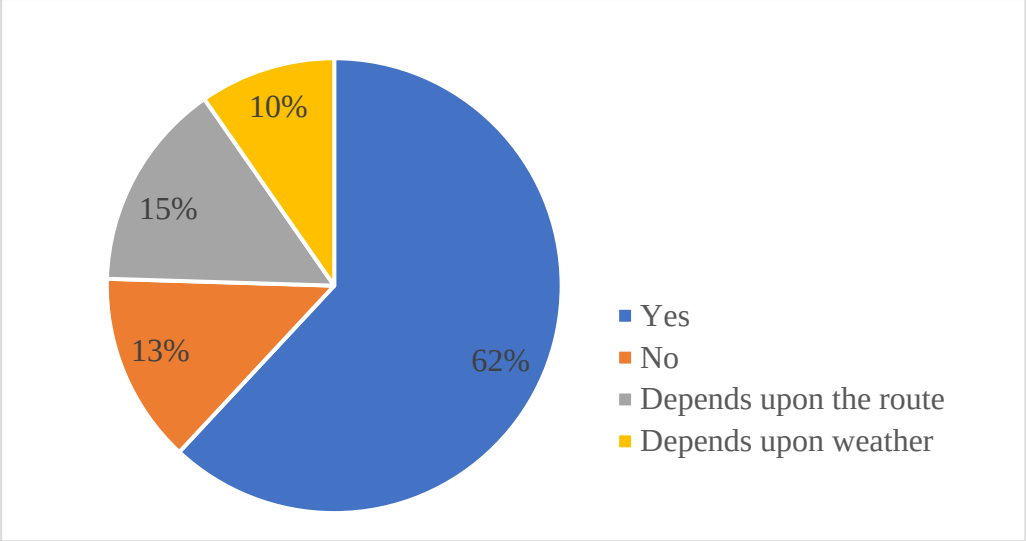


Figure 4. 4: Respondents views

5. We asked the respondents that why do not they use bicycle for their daily means and majority of them said unavailability of cycling tracks and high-speed traffic are the major problem that they face while using bicycle. On the other hand, harassment was the major problem faced by women. As shown in fig 4.5.

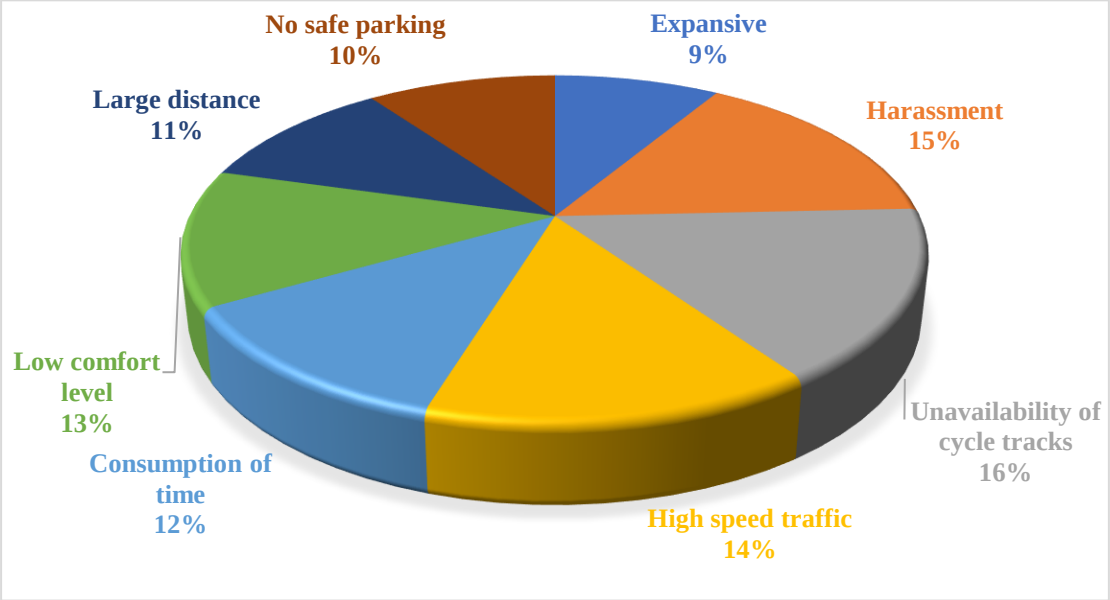


Figure 4. 5: Discouraging factors

4.2.2 Cycling commuter Surveys:

Some the results obtained from cycling commuter surveys are as following:

1. Total 120 surveys are conducted among the cycling commuters throughout the Islamabad. It includes all type of commuters from Professional cyclists to those

using for work and gender ration of cyclist comes out: Male cyclists as 94% and Female cyclists as 6%. As shown in fig 4.6.

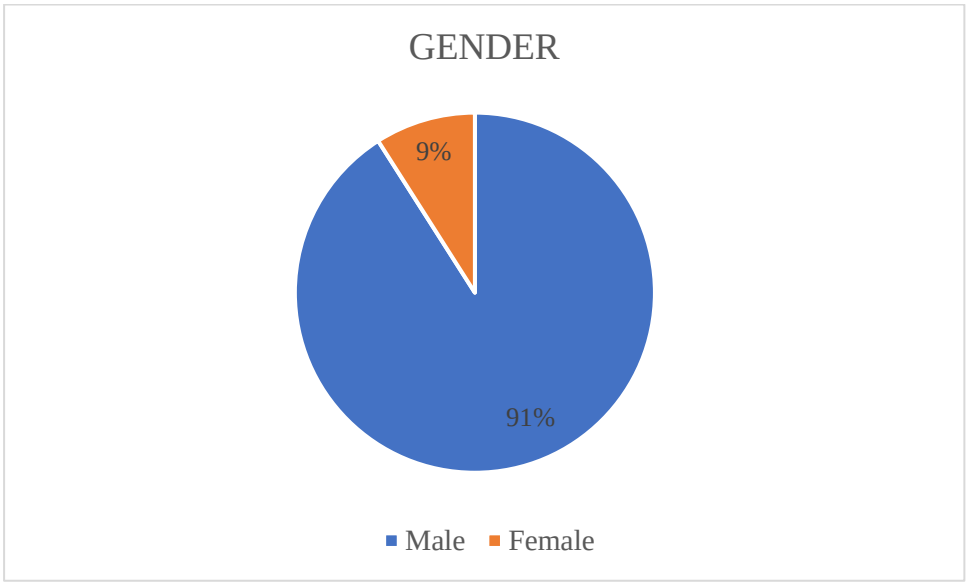


Figure 4. 6: Gender

2. We are interested in knowing the age of our cyclists as most of them falls in the age group of 20-30 and 30-40 that shows that a lot of our cyclist are young as shown in fig 4.7.

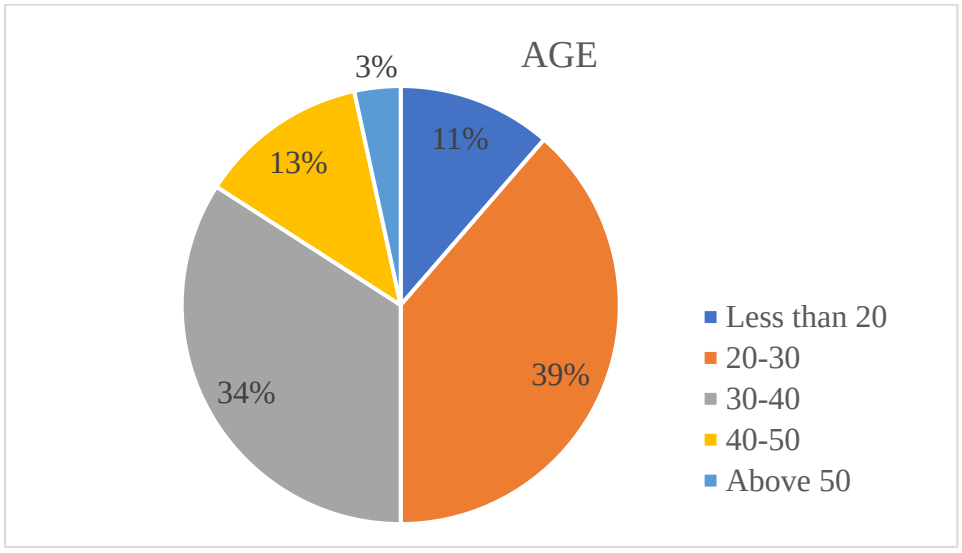


Figure 4. 7: Age of cyclists

3. Those using cycle for their daily means are using it mainly for health and exercise purposes then comes workers most of them are chandler are using cycling for their livelihood. As shown in fig 4.8.

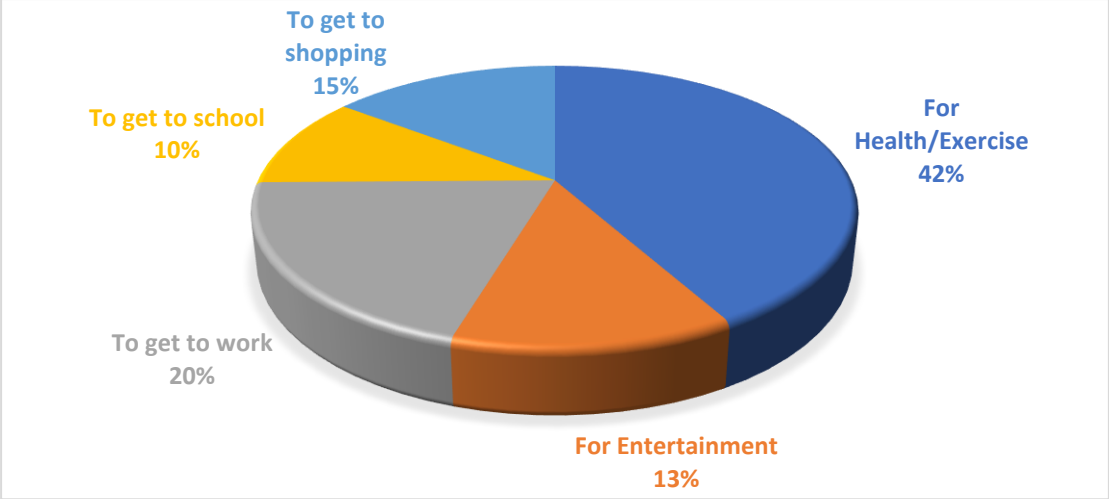


Figure 4. 8: Purpose of bicycling

4. Now it is turn, to consider the number of days and amount of distance cyclist usually takes to commute. It was found out most of them are daily cycling commuters with 51 percent and 1 to 2 days with 30 percent almost as shown in fig 4.9. Large distances are usually considered by the cyclists as 6 to 10 km are 33 percent and above 10 km are 28 percent as shown in fig 4.10.

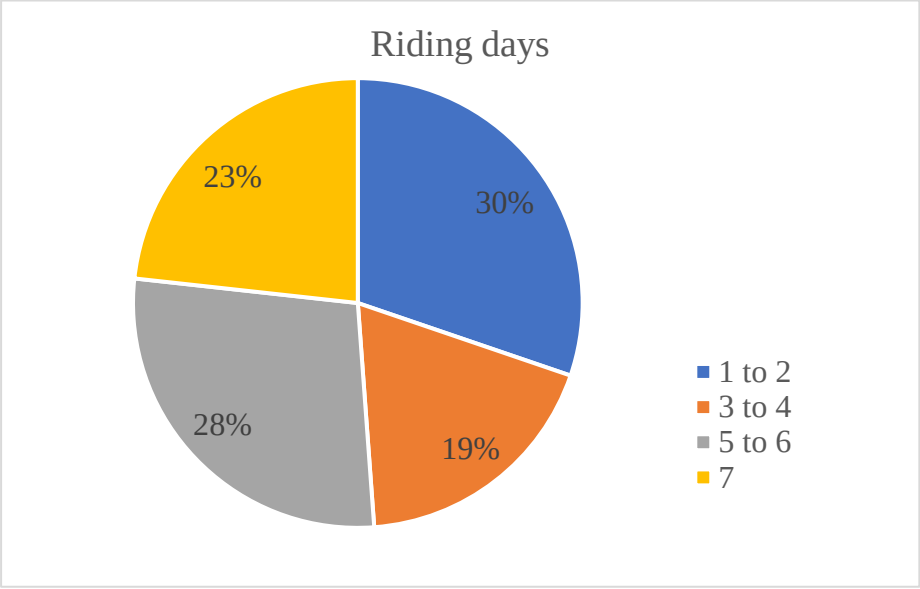


Figure 4. 9: Riding days

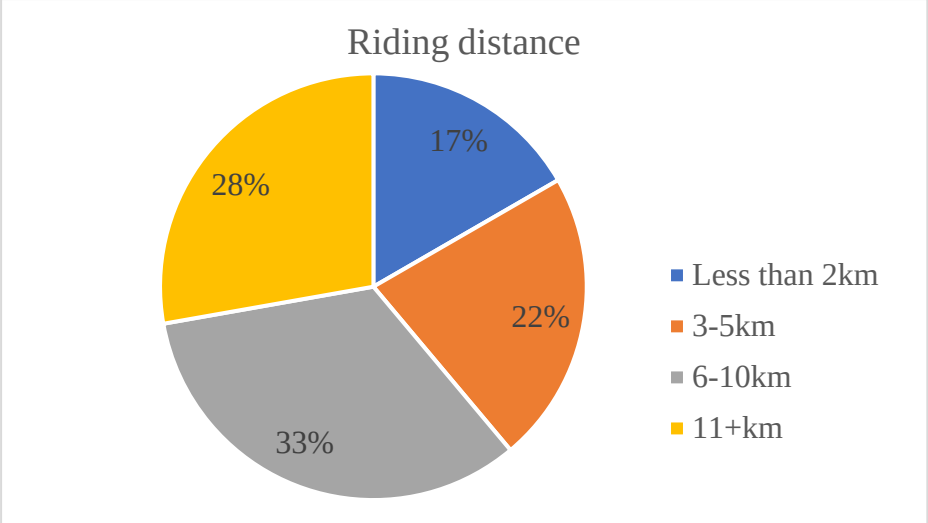


Figure 4. 10: Riding distance

5. Unavailability of cycling tracks, consumption of time, high speed traffic and no safe parking are some major problems that are encountered by the bicyclists as shown in fig 4.11 and to solve these problems cyclists think exclusively used bicycling lanes and bicycle priority on roadside should be provided as shown in fig 4.12.

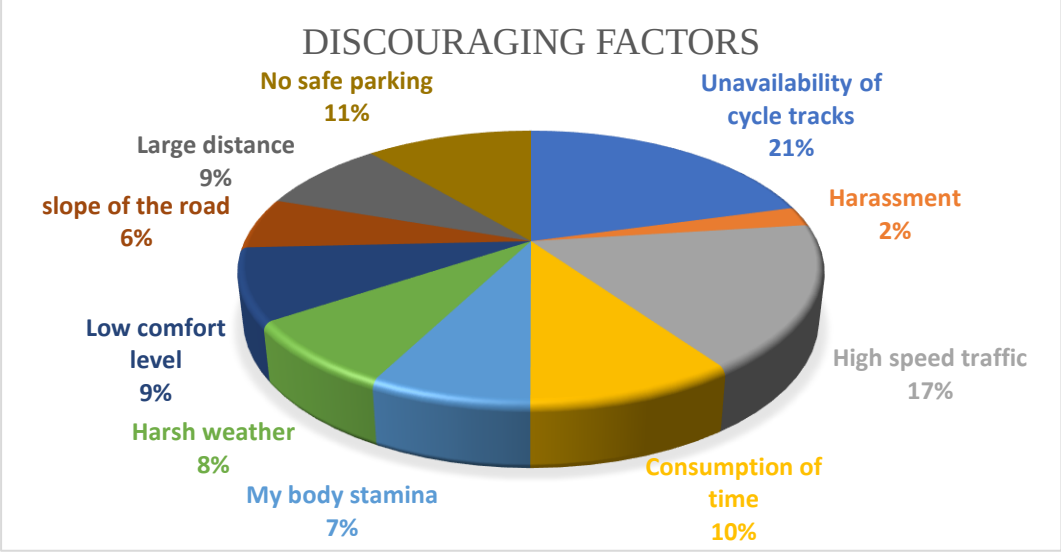


Figure 4. 11: Discouraging factors

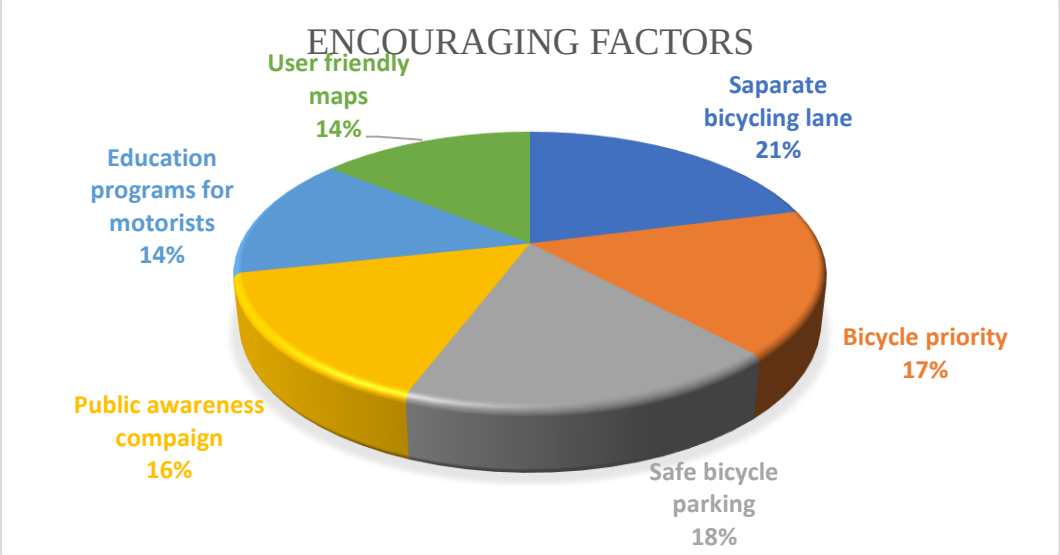


Figure 4. 12: Encouraging factors

4.3 Analysis of Surveys:

4.3.1 General Public Surveys:

The analysis is done by collating different questions of surveys conducted. By collating different questions, it is easy to acquire the right idea of our survey.

Some major findings from the surveys conducted by local people who were not on the cycle at the time of surveys.

1. Data from some of the major sectors of Islamabad shows that a lot of residents of Islamabad are not using bicycle for their daily use and data from G sector show some people use it sometimes as shown in fig 4.13.

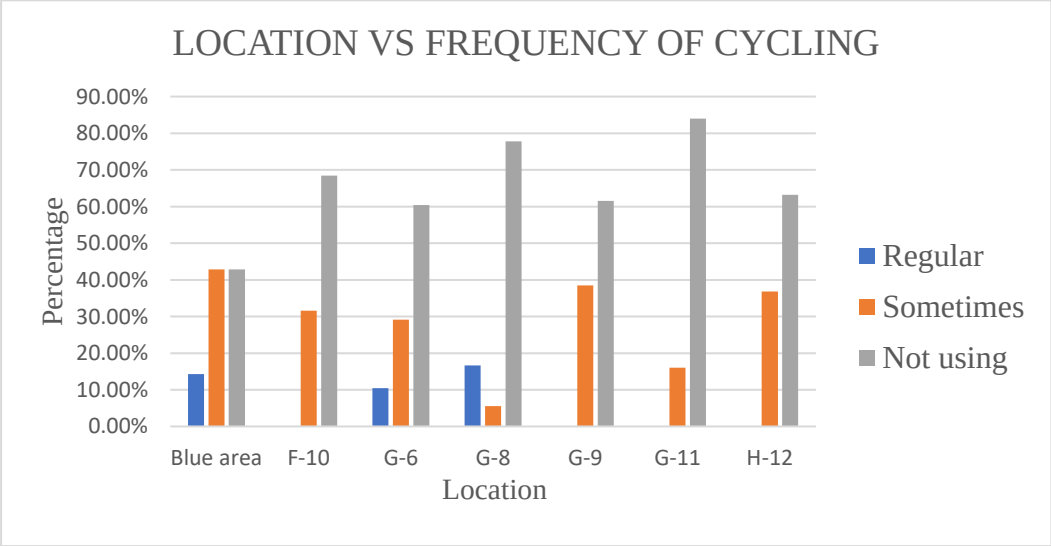


Figure 4. 13: Location vs frequency of cycling

2. Beside lot of respondents are not using bicycle there are only the student that are using cycle for sometime or for regular use as shown in fig 4.14.

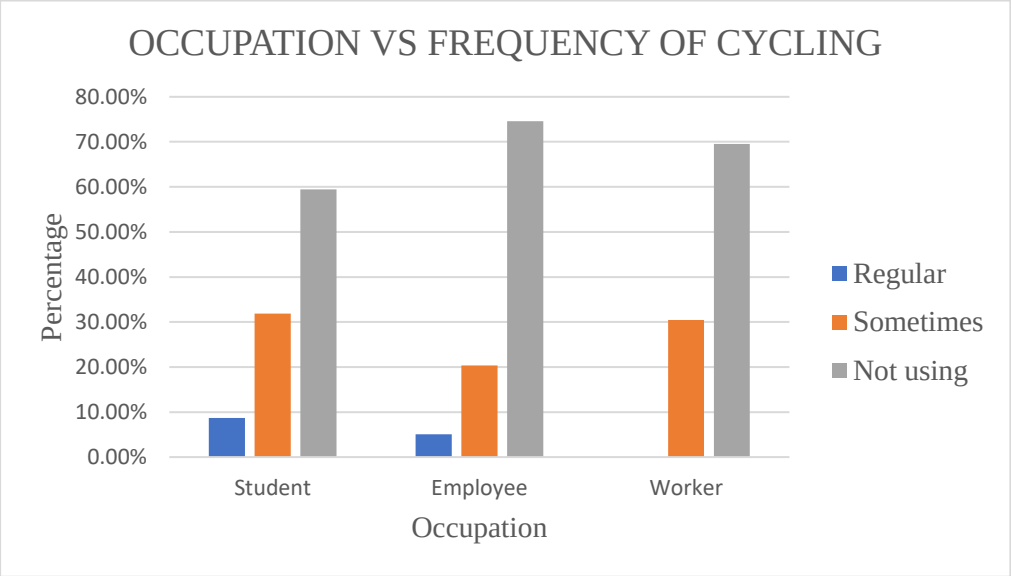


Figure 4. 14: Occupation vs frequency of cycling

3. It can seen that the among different age group respondents only students are using cycle regularly for most of the times as shown in fig 4.15.

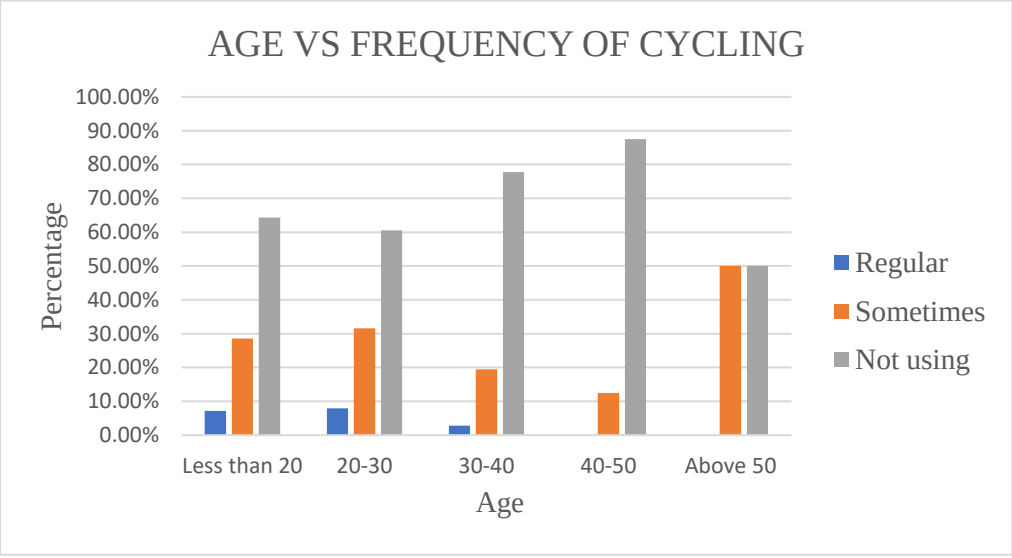


Figure 4. 15: Age vs frequency of cycling

4.3.2 Cyclist Surveys:

For the analysis of the surveys conducted in the entire sectors of Islamabad, the entire sectors of Islamabad are integrated into different zones which are as follow:

Zone 1: E-11

Zone 2: F-6 to F-8

Zone 3: F-9 to F-11

Zone 4: G-6 to G-9

Zone 5: G-10 to G-13

Zone 6: H-12 to H-13

Zone 7: I-8 to I-10

A lot of analysis is conducted using the acquired data of surveys. Some major findings of our analysis are as following:

1. The daily commuters are in majority in all zones except in zone 4 where the 1 to 2 days cycling is in excess. Zone 5 has highest percentage of daily commuters (82%) as shown in fig 4.16.

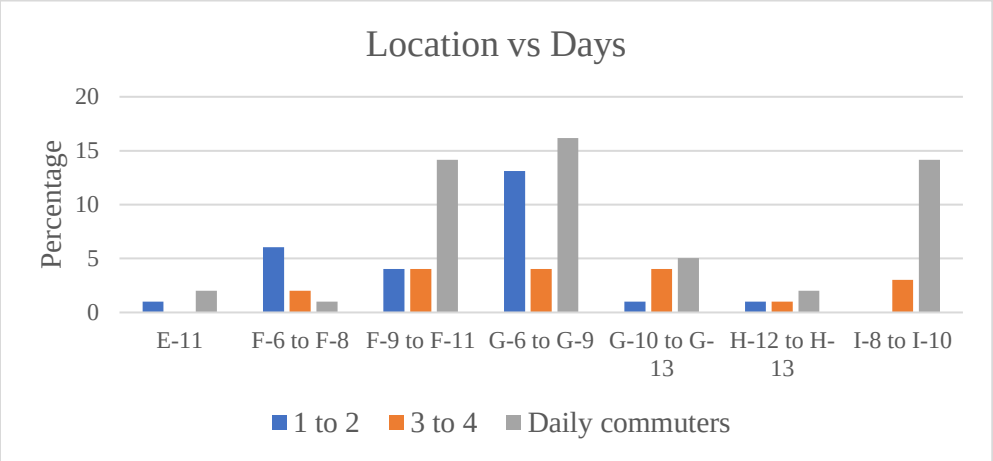


Figure 4. 16: Location vs days

2. The frequency of 11+km cycling is in abundance in all zones except in zone 5 where the frequency of 3-5km cycling is same as the frequency of 11+km of cycling as shown in fig 4.17.

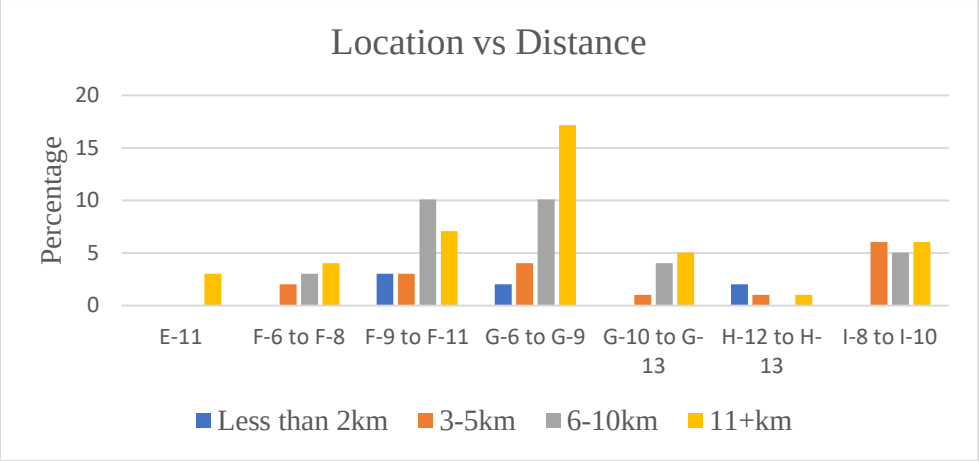


Figure 4. 17: Location vs distance

3. Among students and workers, daily commuters have highest percentage but for employees, 1 to 2 days per week cycling is common as shown in fig 4.18.

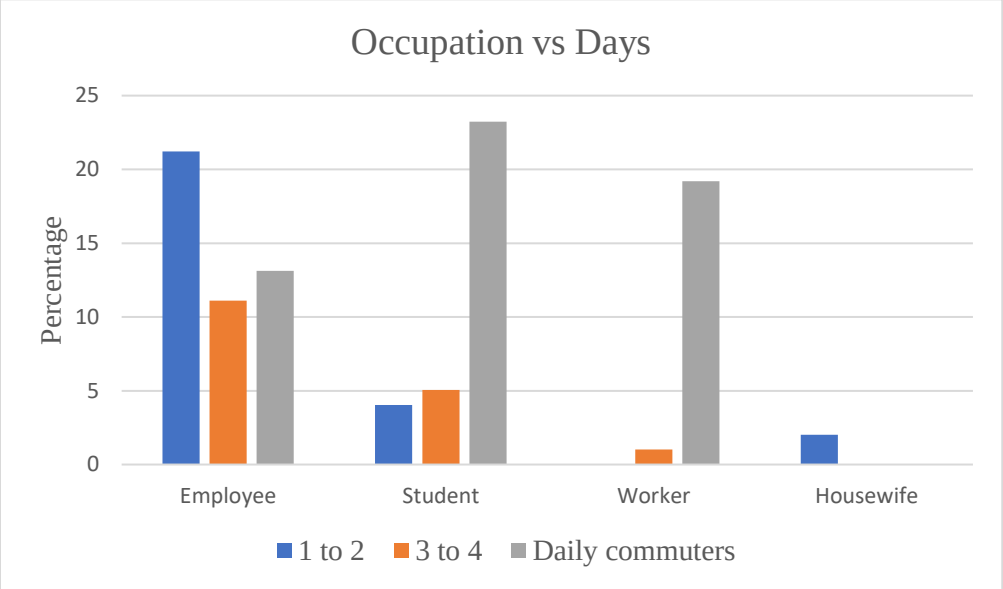


Figure 4. 18: Occupation vs days

4. The Average distance per ride of majority of the employees is 11+km while that of workers is 6+km as shown in fig 4.19.

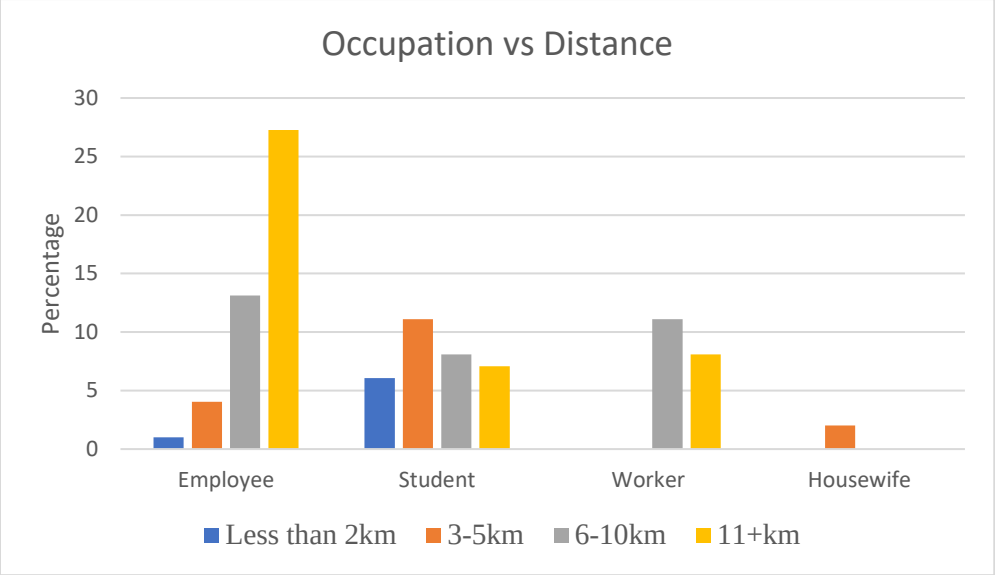


Figure 4. 19: Occupation vs distance

5. The cyclists using cycle for few days a week is mainly for health and enjoyment purposes while among daily commuters, those who get to work on bicycle are in excess as shown in fig 4.20, 4.21 and 4.22.

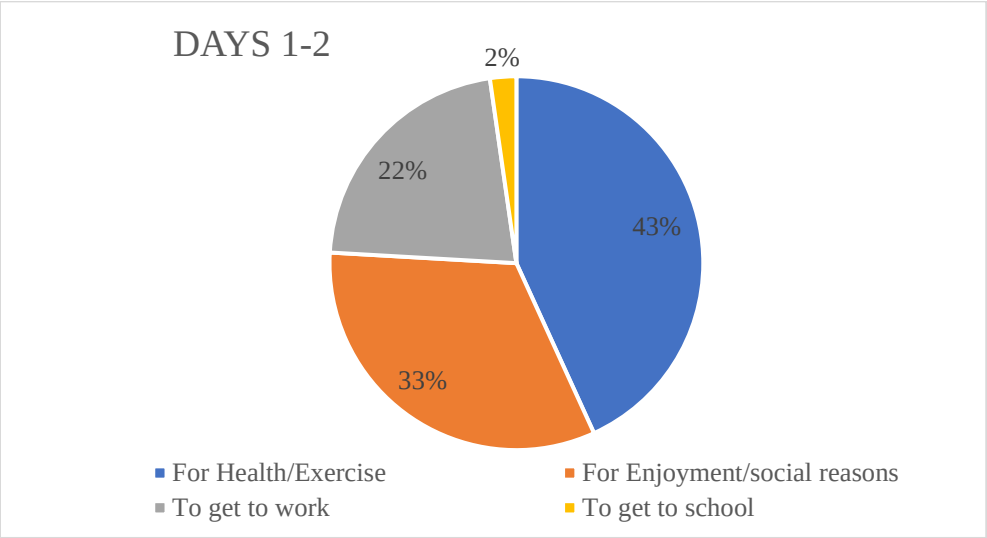


Figure 4. 20: Purpose vs 1-2 days of cycling

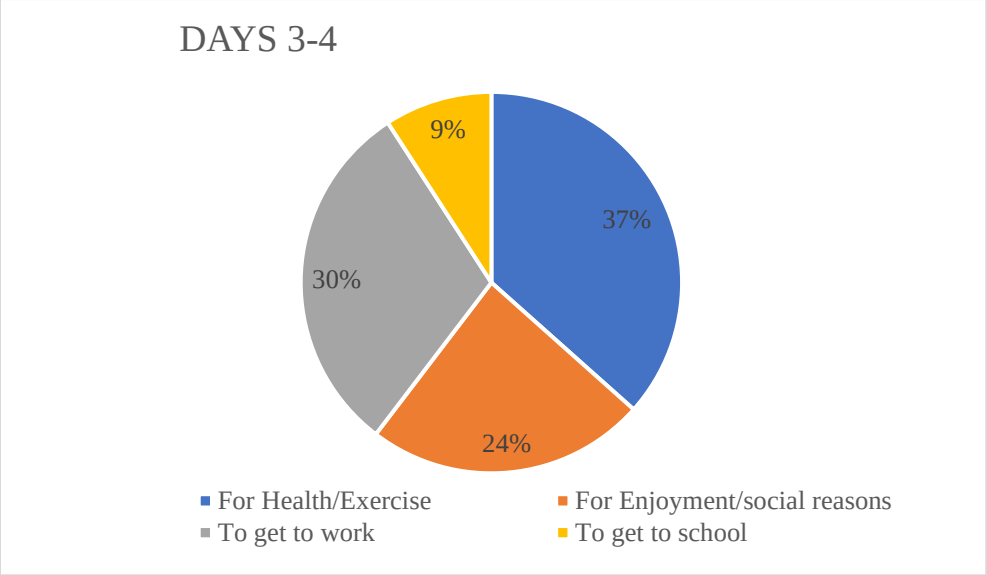


Figure 4. 21: Purpose vs 3-4 days of cycling

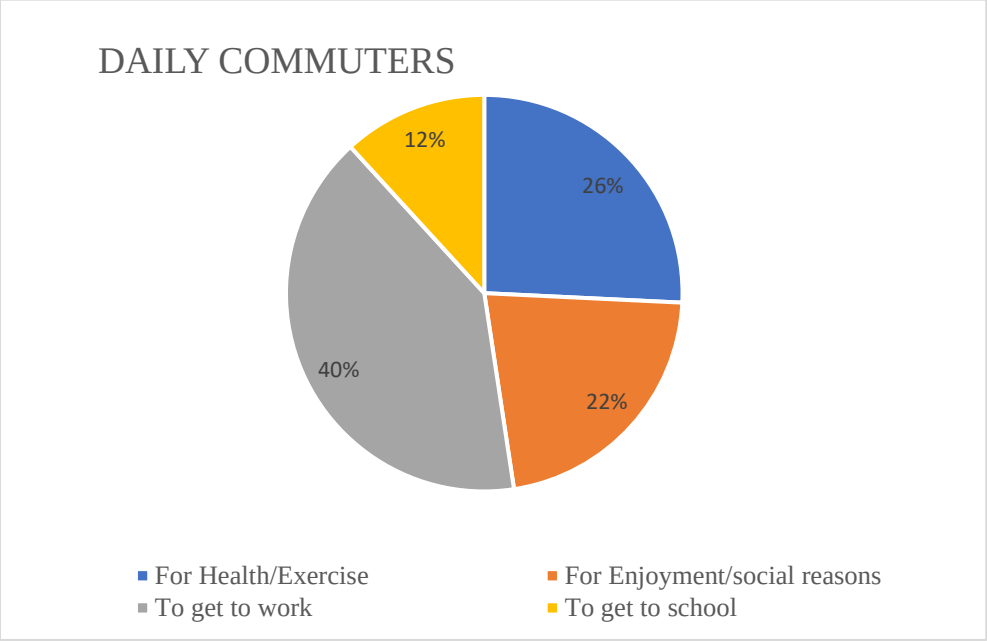


Figure 4. 22: Purpose vs cycling daily commuters

6. For every age group daily commuter have higher percentage except for old age (50+ years) people who mainly use cycle for 1-2 days a week as shown in fig 4.23.

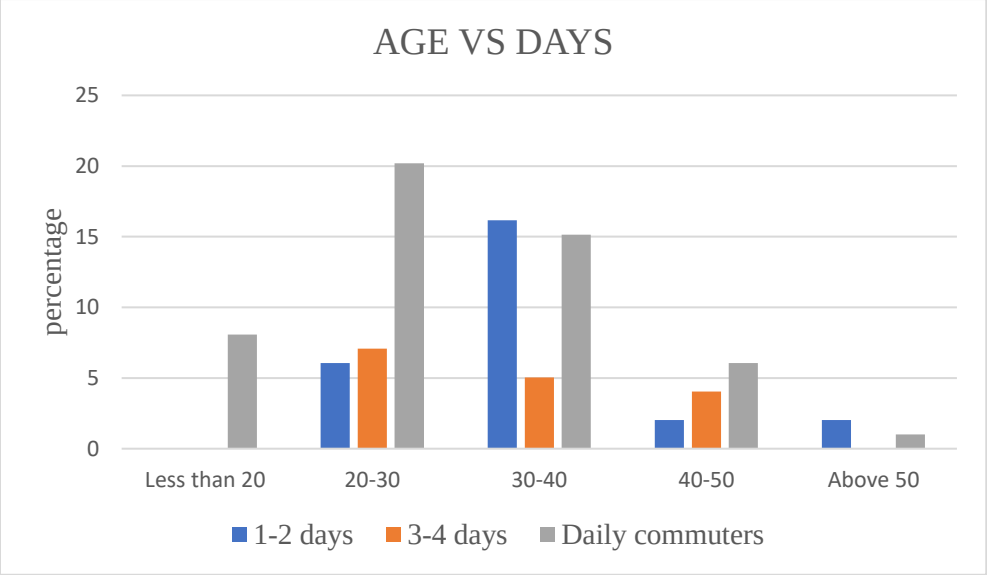


Figure 4. 23: Age vs days

7. Every age group of cyclists use cycle for larger distances (11+km) except for those having age less than 20 years who use cycle for 3-5 km as shown in fig 4.24.

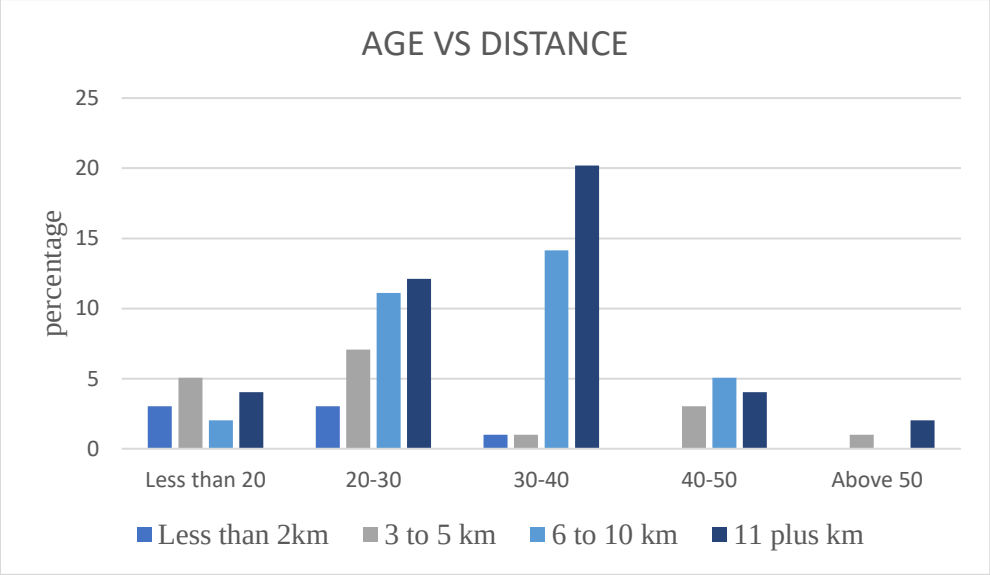


Figure 4. 24: Age vs distance

8. Those using cycle for health purpose are using cycle for 1-2 days in excess while those using cycle to get work are mostly daily commuters as shown in fig 4.25, 4.26 and 4.27.

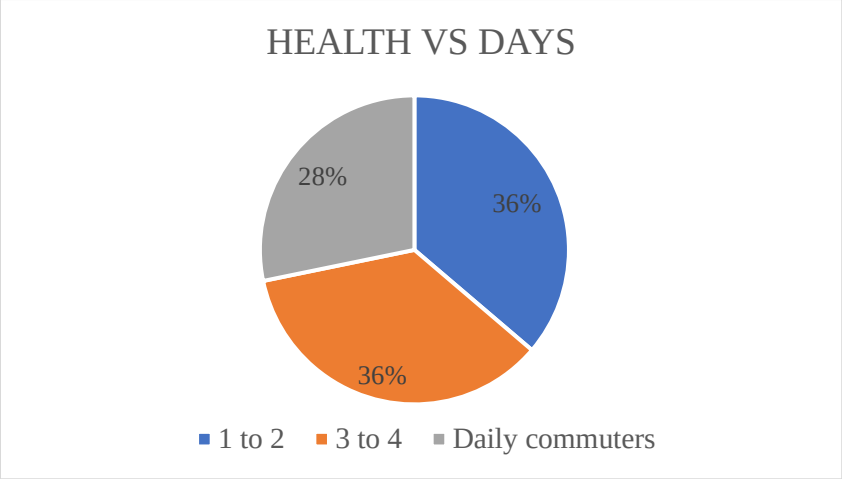


Figure 4. 25: Health vs days

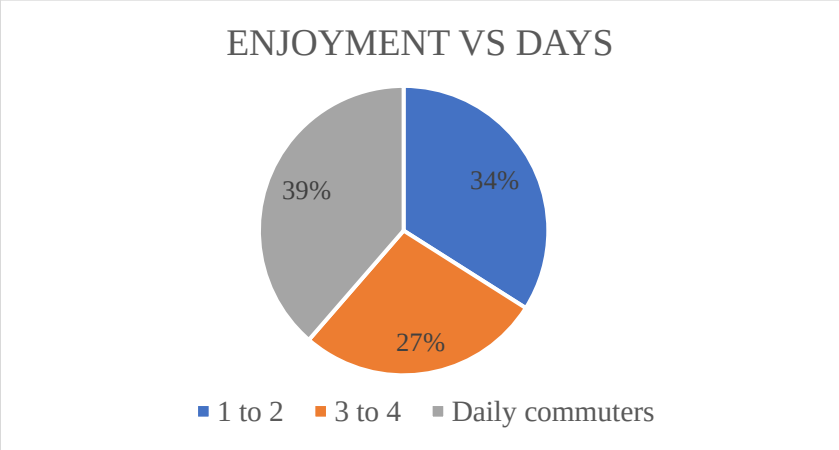


Figure 4. 26: Enjoyment vs days

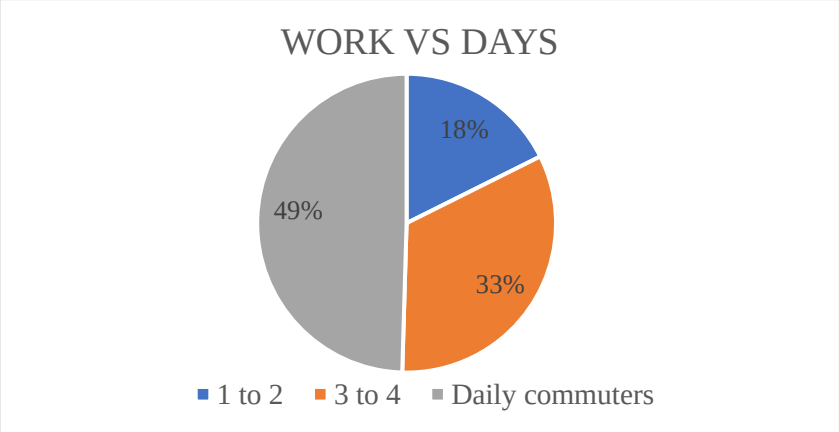


Figure 4. 27: Work vs days

9. It is seen that the cyclist is using cycles mostly for daily commuting as shown in fig 4.28.

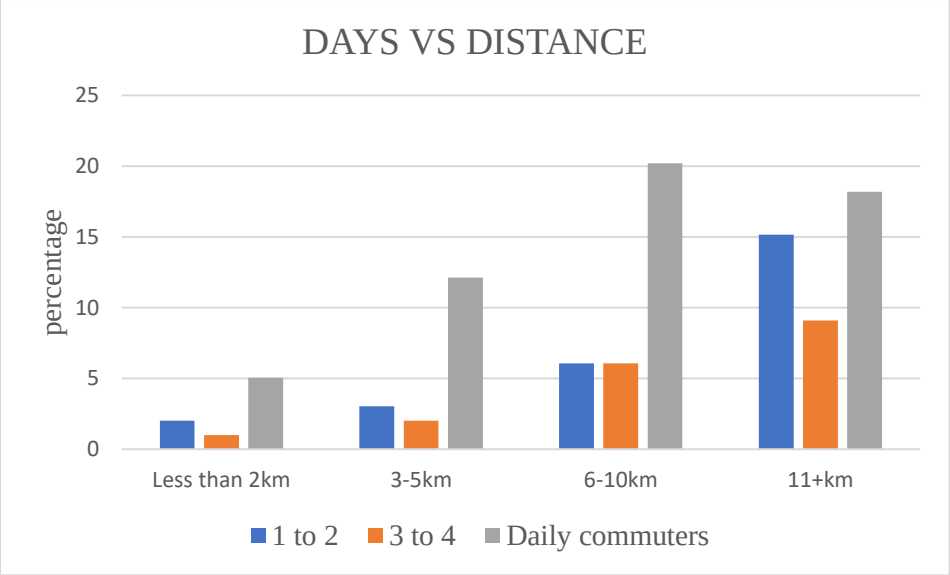


Figure 4. 28: Days vs distance

10. The major discouraging factors for the cyclists using cycle for 1-2 days a week and for less than 2km are the "Unavailability of cycling track" and "high speed traffic" as shown in 4.29 and 4.30.

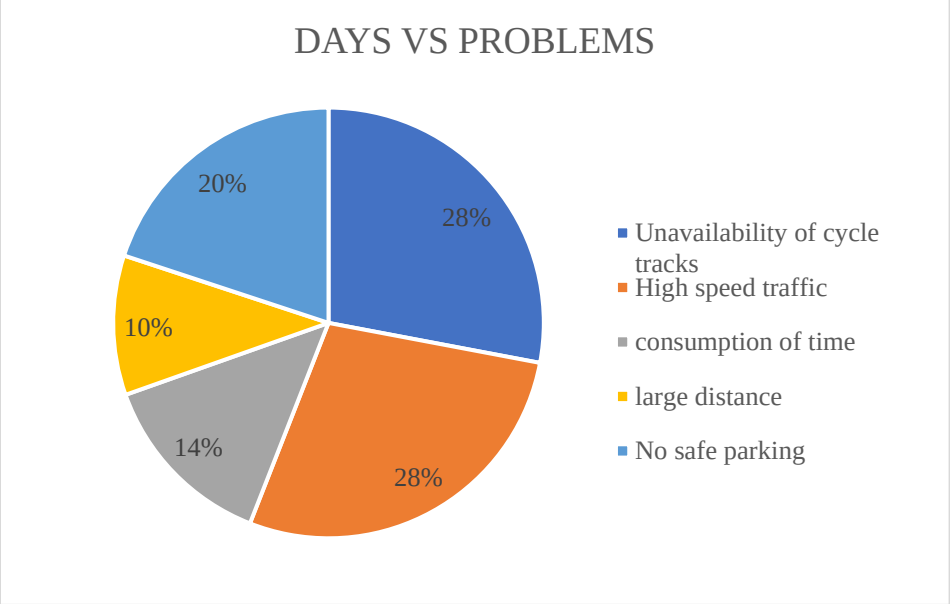


Figure 4. 29: Days vs problems

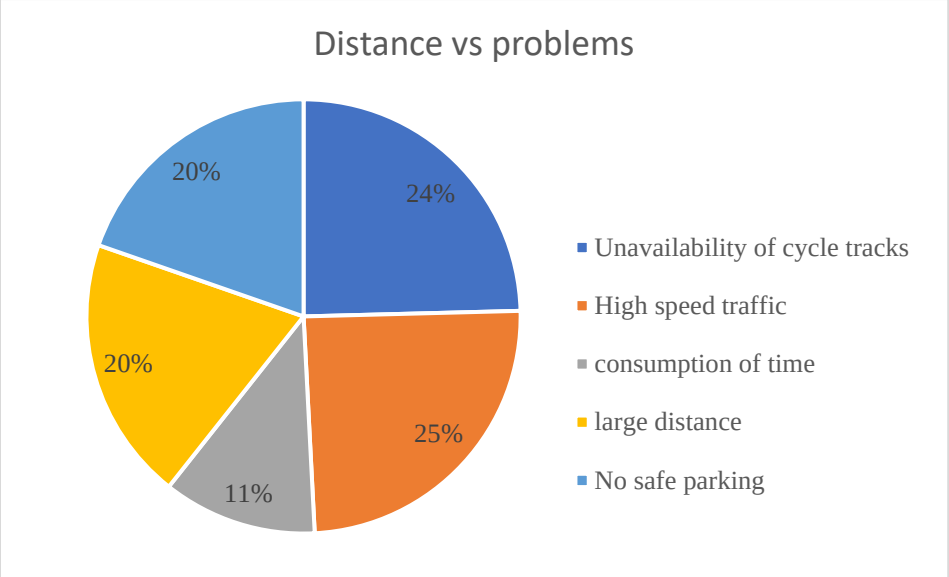


Figure 4. 30: Distance vs problems

11. Major Routes: Zone 1 has major route from Sachal Sarmast to Khurram Road, Zone 2 has major route from Saddar Road to Hanna Road, Zone 3 has route from Sumabal Road to Major Road, Zone 4 has Margalla Road as major route and Zone 5 has major route from Korang road to Pothwar Road. Cyclist frequency on the major routes of all the zones is more than 50% of the total cyclists in the respective zones.
12. Cycling on the major routes of all the zones is mainly of Daily commuters except on Margalla road where instead of daily commuters, the 1-2 days and 3-4 days per week cycling is of 50% each.
13. On the major routes of all the zones, 11+km distance of average ride is in majority except on Korang road to Pothwar road where 3-5km average ride distance is the most common.
14. Major facilities to be provided to promote cycling culture are cycling route, safe parking, cycle priority intersection, recreational centres and bicycle repairing shops.

Chapter 5

DEVELOPMENT OF MASTER PLAN

5.1 Introduction

Results and analysis from both kind of surveys depicts that the exclusively use bicycle lanes, bicycle given priority and safe parking is the solution to all kind of problems associated with the residents of Islamabad. Using these surveys first travel trend line diagram is prepared to use as basis for the construction of bicycle route network plan for an entire Islamabad.

5.2 Cycling Travel Trend Line Diagram

With an assistance of the location data in the surveys the Origin and destination of all respondents is plotted on the ArcGIS software. Thus, the Origin to destination Line diagram created indicates that majority of the respondents tends to ride horizontally across all the sectors of entire Islamabad with same name. It is observed that movement from one sector to another vertically (for example from sector F to G) is limited. It can also be seen majority of respondents tends to move towards the Margalla hills with their cycles as well.

Using the origin to destination data the Line diagram is drawn using ArcGIS is shown in fig 5.1:

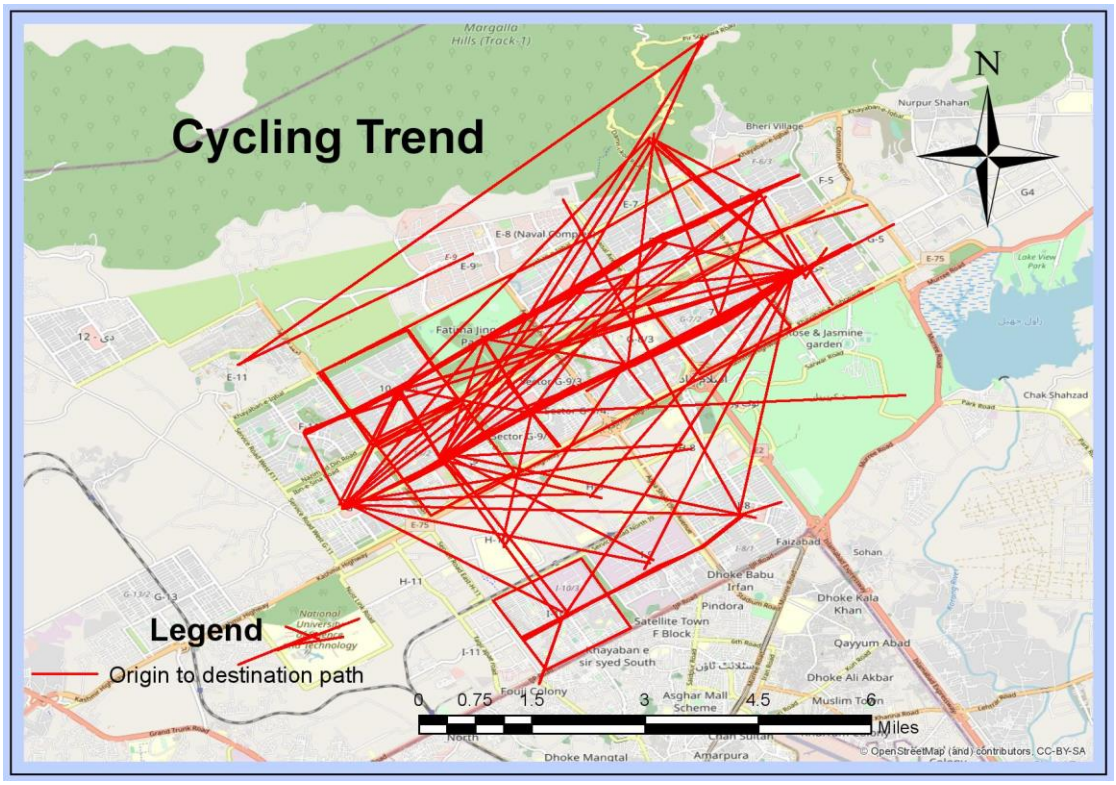


Figure 5. 1: Travel trend line diagram

5.3 Proposed Route

Keeping the general cycling trend in mind obtained by plotting the origin to destination using ArcGIS the best possible route for the cyclist is finalized to facilitate the cyclists in best possible way.

We have to implement our master plan in following three phases:

- Phase one which attracts the maximum bicycle users towards it. This has to be implemented firstly because of its higher demand. It includes very good facilities to fulfill its demand. It connects F-11 to F-10; F-8, F-7 and F-6; G-11, G-10, G-9, G-8, G-7 and G-6; H-11, H-10, H-9; I-10, I-9 and I-8; in the East-West bound of Islamabad as shown in travel trend line diagram in fig 5.1. It includes only priority 1 route (shown in red lines), is established in the East-West bound of Islamabad, as our movement is majorly concentrated in these areas. The total length of priority 1 is 42 Km and is shown in fig 5.2.
- Phase two includes the tracks with a bit lesser demand. This is of somewhat lesser facilities and of secondary importance. It connects F-10, G-10, H-10 and I-10; G-9, H-9 and I-9; F-8 and G-8; G-8, H-8 and I-8; in the North-South bound of Islamabad. It includes priority 1 with priority 2 route (shown in green lines), It

is established to connect different priority 1 routes. The total length of priority 2 is 17 Km and is shown in fig 5.3.

- Phase three includes the tracks with a minimal demand. This is to be implemented in the last having lesser facilities. These routes are those which are not covered while conducting surveys or to be constructed in Future. This includes E-11 and F-11; G-11 and G-13; F-8 and E-8; F-7 and E-7; F-6 and Khayaban e Iqbal; G-5 and Rose and Jasmine garden; G-5 and Lake view park, It includes priority 1, priority 2 and priority 3 route (shown in blue lines). The total length of priority 3 is 18 Km and is shown in fig 5.4.

So, the total length of bicycle route is 77 Km.

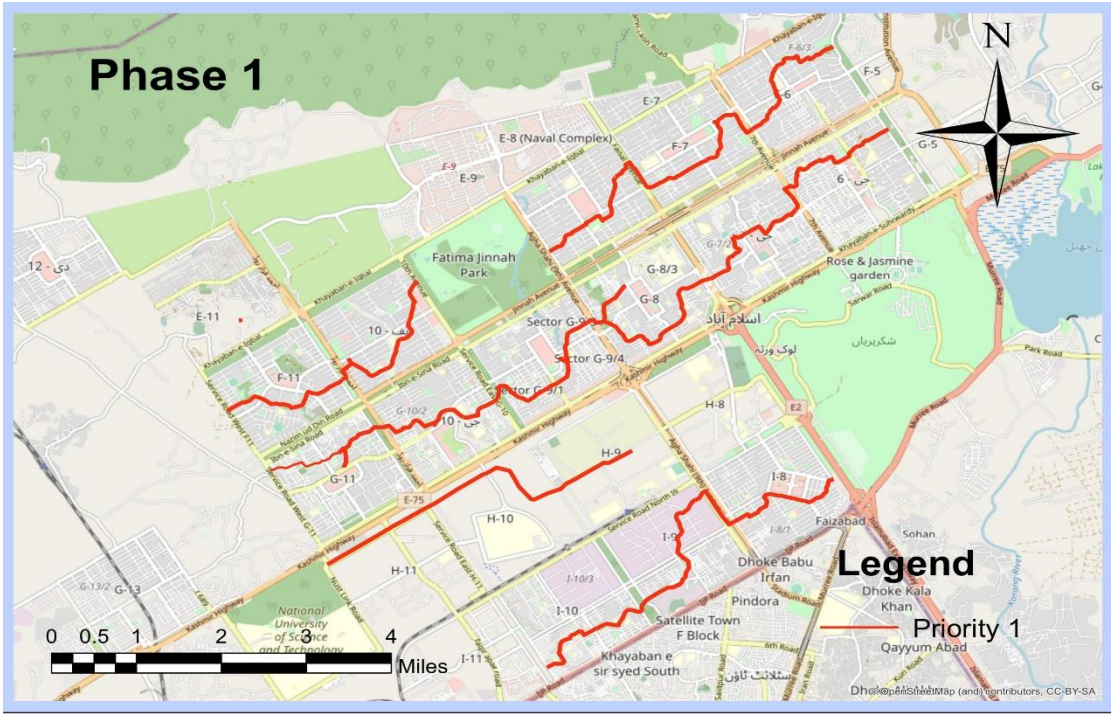


Figure 5. 2: Phase 1

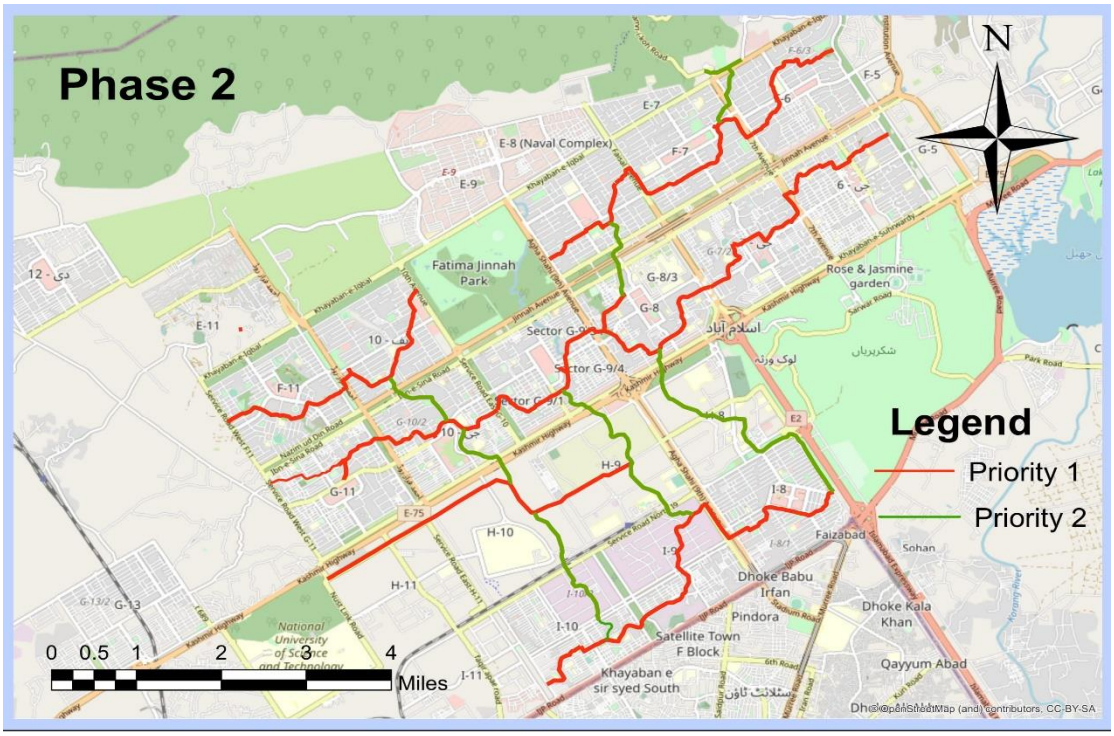


Figure 5. 3: Phase 2

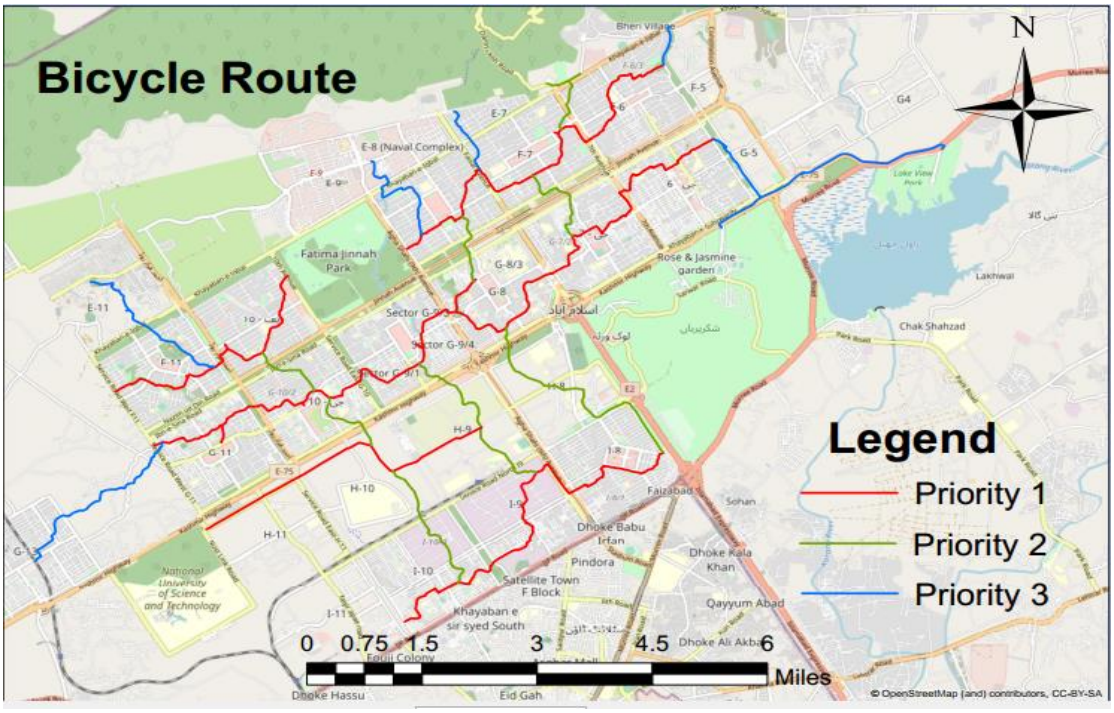


Figure 5. 4: Phase 3/ Bicycling route network

5.4 Bicycling Route facilities:

5.5.1 Bicycle lanes:

Bicycle lanes are the paths that are designed for the use of bicycles solely or preferentially. These can be created by using roadway marking or using kerbs against roadside.

In this project there are three different priority of routes for the cyclist.

For Priority 1 and priority 2 routes, the pavement should be made up of “Granular with Asphalt” type. One or more granular layers are placed and compacted before priming and surfacing the lanes with hot mixed asphalt layers.

For third priority route, the pavement type should be “Unsurfaced Granular”. An unsealed granular or gravel pathway may be adopted as the first stage of the development of a route.

Different plans of bicycling tracks are shown in fig 5.5 and 5.6:

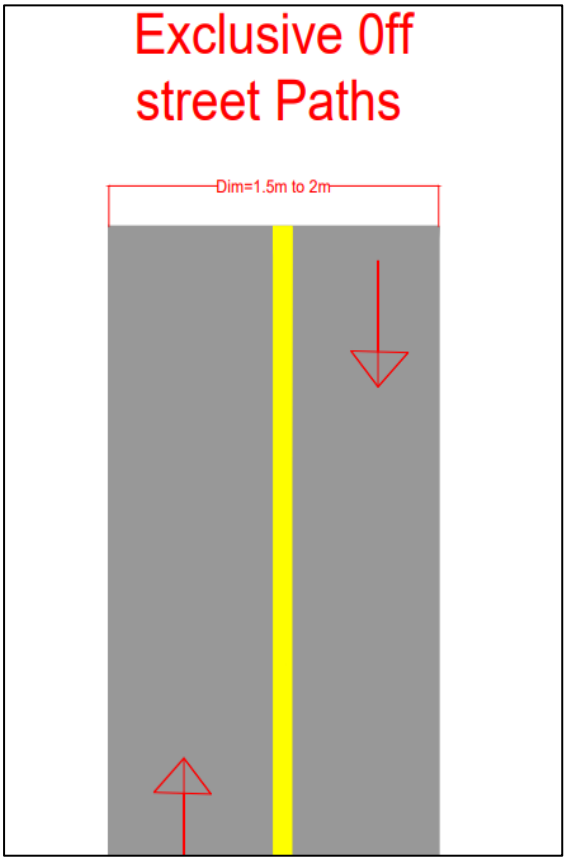


Figure 5. 6: Off street lane

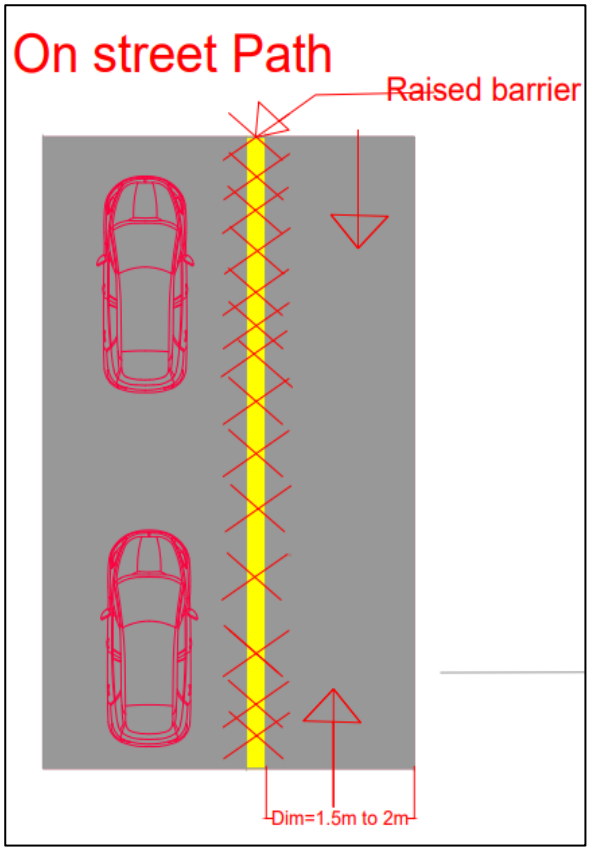


Figure 5. 5: On street lane

Recommended Lane Width by Department for Transportion (Annexe 3 Table A3.2) and by Institution of Highways and Transportation, CTC, DoT (Section: 11.3.2) is 2m while minimum width is 1.5m.

The typical cross sections of bicycle tracks prepared on AutoCAD. Priority 1 and 2 cross section is shown in fig 5.7 and priority 3 in fig 5.8.

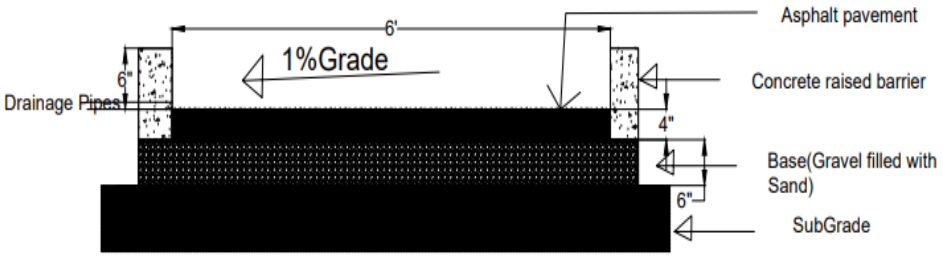


Figure 5. 7: Priority 1 and 2 cross section

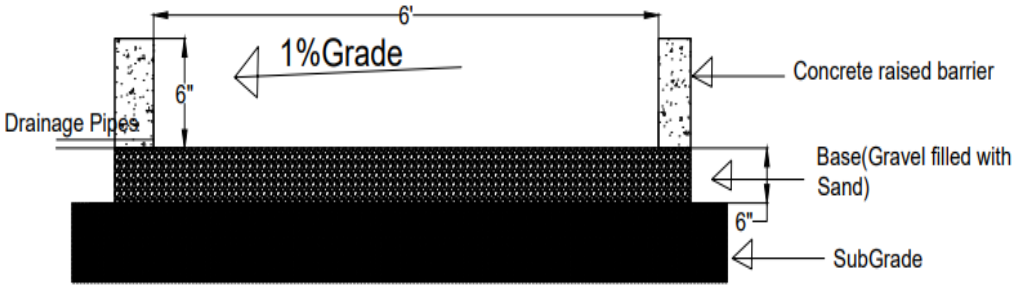


Figure 5. 8: Priority 3 cross section

5.5.2 Bike Boxes:

Bicycle boxes are the facility provided at signalized intersections to create a reserved space for cyclists while they wait for the signal's green light. These should be provided where bicycle tracks come in way of intersections.

Some of its important aims and functions are given below:

- aimed to provide the cyclist a "head start" and permit them to position themselves for different movements (i.e. left turns).
- They also help the cyclists to avoid conflicts with right-turning vehicles.

Bike boxes have been in use in various world cities including New York, Tucson (AZ), Portland, and Eugene and is shown in fig 5.9.

Figure 5. 9: Bike boxes

5.5.3 Bridges:

Bridges would be provided where the paths have to cross streams and drainages or comes in way major roads. Bridges may be prefabricated, made from self-weathering steel with wood decks. These are shown in fig 5.10 and 5.11.

Following are some important dimensions of cycle paths on bridges:

- Recommended width of cycle path on Bridge is 14 feet
- Openings between railings should me up to 4” maximum
- Railing height = 42” high minimum
- There are some locations where a 48” high railing should be considered. This includes bridges or bridge approaches where high-speed, steep-angle (25 degrees or greater) impacts between a bicyclist and the railing are more likely to occur, such as where the radius of a curve is below the minimum recommended curvature at the end of a long descending grade.

Figure 5. 11: Bridge above road

Figure 5. 10: Bridge above canal

5.5.4 Bicycle Parking:

The provision of safe and secure bicycle parking is quite necessary for a bicycle network. The availability of short and long-term bicycle parking at important locations such as parks, schools, community facilities, transit stations, and Plazas etc. is prerequisite for a complete bicycle network. Thus, it will be provided at every 8 Km of interval.

5.5.5 Bicycle Racks:

Bicycle Racks are economically cheap facilities that would be provide an easy way to secure a cycle. Both the wheels and frames can be locked using this facility, it is appropriate to place the racks at a location where it is visible from the doorways and/or windows of buildings. Short-term bicycle parking like Bicycle racks is generally used for short trips when the cyclists are intending to the cycle there for few hours as shown in fig 5.12.

Figure 5. 12: Bicycle racks

5.5.6 Bicycle Lockers:

Bicycle Locker is another type of cycle parking which would be provided for secure parking to individual cycles. These are closed cages which is accessed only by their doors.

Following are some of the positive aspects of Bicycle lockers:

- Provide a sense of high-level security
- Can comfortably leave the bicycles for long time
- Suitable for employees of huge buildings, metro stations etc.

Material of Bicycle Lockers: Stainless steel or Powder coated steel. It is shown in fig 5.13.

Figure 5. 13: Bicycle lockers

5.5.7 Unstaffed Bicycle Stations:

Unstaffed bicycle stations are areas shared by public for locking their cycles after registering the cycles. These are accessed only after registering for the key or lock. Security to the parking is ensured with surveillance cameras, human monitoring, visual transparency (such as wrought iron fencing), and by selecting a location where there is frequent pedestrian movement.

These stations should be provided at metro stations and sector markazes. These are shown in fig 5.14.

Figure 5. 14: Unstaffed bicycle station

5.5.8 Staffed Bicycle stations and Recreational facilities:

Bicycle parking where security and surveillance is ensured by human monitoring of the facility are referred to as staffed bicycle stations. They provide a high sense of safety and contains the associated cycle facilities.

Some of the amenities that should be provided along the route network include:

- Bicycle Repairs: should be provided within an interval of 8km.
- Water cooler: with in an interval of 5km.
- Washroom: on an interval of 8km.
- Café and Marts: within an interval of 8km given the required space is available.
- Streetlights would be provided to ensure the visibility of cyclists during night time.

CHAPTER 06

CONCLUSION AND RECOMMENDATIONS

6.1 Summary

By different traffic analysis it is very clear that traffic is increasing day by day in Islamabad which results in traffic congestions, delays and accidents. Problems are not limited to traffic delays in fact increasing traffic is also affecting the environment of Islamabad. So, the basic aim of this project was to design the master plan of bicycling tracks in Islamabad in order to promote the bicycling as mode of transport with the provision of bicycling tracks and cycling infrastructure. From analysis of different surveys bicycling tracks were designed with the use of ArcGIS. Further it is recommended to do a cost analysis of this project.

6.2 Conclusion

Our final year project concludes to some important findings:

- From public and cyclist surveys it was analyzed that there are lot of residents of Islamabad who do not do bicycling because of lack of cycling infrastructure and fear of high-speed traffic. So, it was concluded that people want to do bicycling as a mean of transport, as an entertainment and for recreational activities especially youth if tracks will be provided.
- From the cyclist survey, we came to know that the daily commuters are in abundance rather than those who use bicycle one or two days per week. Most of the bicyclists travel very large distances i.e. above eleven kilometres. Almost all the people perceive bicycling as a healthy and enjoyable activity. The major discouraging factors to the people are unavailability of cycle tracks, high speed traffic, large distances.

6.3 Discussions

The overall cycling trend present in the city is very low and it will take a lot of time to develop and nurture the bicycling culture. So, our proposed master plan will be serviceable only if there exists a cycling culture among the people otherwise people will not use cycle as a means of transport even if the tracks network will get develop in the city. There is also need to spread awareness among the people of Islamabad

about global warming and climate of Pakistan which will make people to shift from cars to bicycling at least for shorter distances. This can be done by arranging seminars in schools and colleges, by promoting cycling activities of different cycling clubs and arranging competitions to get people attention.

6.4 Limitations

During our project, we faced some of the limitations as follows:

- Significant amount of the people were not willing to give their answers of the survey questions.
- The illiteracy of the people restrained them to understand the scope of our survey and purpose of our survey and they did not respond in a satisfactory manner.
- As there were very less number of bicycling users present, we had to put a lot of effort to complete surveys regarding the cycling commuters.
- The females were also hesitating to answer our survey questions due to cultural issues, so we could not collect sufficient data about their problems and perceptions about bicycling.
- Due to the above reasons, we were unable to reach our required survey counts and the analysis was also affected due to these limitations.
- As Islamabad is not a plain city so light weight cycle with proper gears are required for the ease of cycling which is expensive for the people to buy.

6.5 Future recommendations

Some major recommendations are as follow:

- Cost analysis of the whole project should be done further to have an idea about how costly it is and how cost can be reduced.
- Geometric and pavement design of the bicycle tracks.
- Awareness and motivation to use bicycle as a primary conveyance.
- Bicycle Master plan further can be extended towards the Rawalpindi as it has lot populated city and hence has a lot of potential.
- A more detailed plan of bicycling tracks, showing minor details of them.

- Bicycle tracks design can further be extended toward south east side i.e. areas along Islamabad highway.
- Technical feasibility work should be done in future to implement the project.

REFERENCES

"*Guide for the development of bicycle facilities*" by the American Association of State Highway and Transportation Officials. 2012 fourth edition

Cycling survey report lse 2015/2016

"*Cycle Route Network Planning Using GIS*" by Andrew G. Macbeth, Tricia Allen, Anthony Barton (NZ Cycling Conference)

"Cycle Infrastructure Design" (PDF). Department of Transport. Retrieved 9 July 2015.

"Bicycle Facilities and the Manual on Uniform Traffic Control Devices". Federal Highway Administration (FHWA). Retrieved 8 July 2015.

LTSA (Land Transport Safety Authority) (2004). *Cycle Network and Route Planning Guide*. Auckland.

"City cycling" edited by Jhon Pucher and Ralph Buehler.

"*Bicycle survey report*" Stancog bicycle and pedestrian advisory committee report – summary

"What is ArcGIS Pro? – ArcGIS Pro". arcgis.pro.

AASHTO. A Policy on Geometric Design of Highways and Streets. American Association of State Highway and Transportation Officials, Washington, DC, 2011.

National Highway Traffic Safety Administration, Bureau of Transportation Statistics. National Survey of Pedestrian and Bicyclist Attitudes and Behaviors. U.S. Department of Transportation, Washington, DC, 2002.

French bicycle association **FUBi**, Pistes et bandes cyclables

ARRB (2005a, b, c). *User guide to bicycle and shared path selection – using whole-of-life*
costing. ARRB Group, Vermont South, Victoria.

Construction, Maintenance & Rehabilitation of Pavements. ARRB Group.

Austroads/AAPA (2006). Asphalt Cooling Rates, pavement work tips – no.46.

Austroads (1991*). Road Maintenance Practice*. 2nd Edition, Austroads, Sydney, New South Wales.

Austroads (1993). *Guide to Traffic Engineering Practice: Part 14 - Bicycles.*

Austroads (2009a). *Guide to Road Design: Part 6A: Pedestrian and Cyclist Paths.*

Austroads (2009d). *Guide to Pavement Technology: Part 3 Pavement Surfacings.*

Austroads (2009e). *Guide to Pavement Technology: Part 8 Pavement Construction.*

Austroads (2014a). *Cycling Aspects of Austroads Guides.*

Austroads (2014b). *Guide to Pavement Technology: Part 4B Asphalt.*

BikeWest (1988). *Guidelines for the Design of Bicycle Facilities.* First Edition, Department
of Transport, Nedlands, Western Australia.

Caltrans (1995). Californian Department of Transportation, *Californian Highway Design*
Manual: Chapter 1000 —Bikeway Planning & Design. California, USA.

C&CAA (1999). *Road Note 56—Cycleways*.