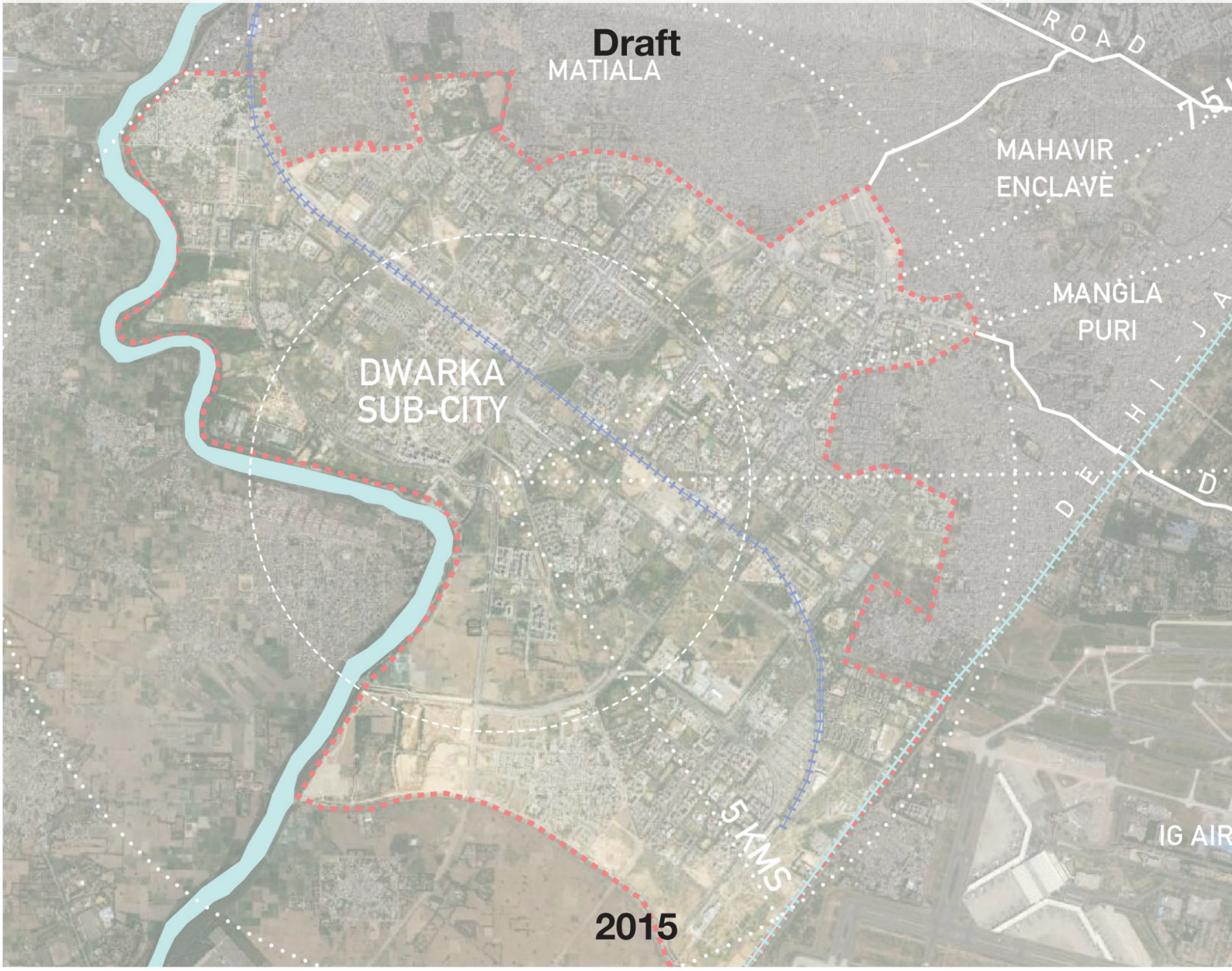
Bicycle Share System for Dwarka Sub-city

Detailed Project Report



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Apart from that we also would like to sincerely thank Delhi Metro Rail Corporation (DMRC), South Delhi Municipal Corporation (SDMC), Delhi Traffic Police (DTP) and Delhi Transport Corporation (DTC) who also helped us with the required data.

introduction

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List of Abbreviations

BRT:	Bus Rapid Transit
CGM:	Centre for Green Mobility
CoI:	Census of India
GPRS:	General Packet Radio Service
GPS:	Global Positioning System
INR:	Indian Rupee
IT:	Information Technology
ITS:	Intelligent Transport System
MPD:	Master Plan Delhi
NCT:	National Capital Territory
NH:	National Highway
OD:	Origin Destination
PBS:	Public Bicycle Sharing
PIN:	Personnel Identification Number
PIU:	Project Implementation Unit
PPP:	Public Private Partnership
PT:	Public Transport
RFID:	Radio Frequency Identification
RITES:	Rail India Technical and Economic Service
SDMC:	South Delhi Municipal Corporation
SMS:	Traffic Analysis Zone
TfL:	Transport for London
UDPFI:	Urban Development Plans Formulation and Implementation
UTTIPEC:	Unified Traffic & Transportation Infrastructure (Planning & Engineering) Centre
VAS:	Value Added Service

1. BACKGROUND

1.1 Introduction

"Public Bicycle Sharing (PBS) system is a form of a public transport, where bicycles are strategically placed in a closely spaced network of stations, and offered for public use. The location of the bicycles can be tracked and monitored through a control centre. The system, when integrated with the existing public transport network in a city, allows the use of bicycles for first and last mile commute. The dense network of stations encourages short bicycle trips, within a travel time of 5 to 15 minutes.

The system offers a convenient, affordable and environment friendly mode of public transportation. Users can check out a bicycle from a bicycle station closest to their origin point and return it to one near their destination point. Once subscribed into the system the users can access bicycles freely. Many bicycle share systems around the world offer the first 30-40 minutes of usage of their bicycles for free, encouraging the use of cycles for shorter trips.

Keeping in mind the current needs of public transport and with a view towards a better future, an integrated solution for public bicycle sharing system had been proposed by the Centre for Green Mobility (CGM) in the general body meeting held on the 21st November, 2014. The system having been approved by the Governor, Mr. Najeeb Jung, it was decided to take up Dwarka sub city as a pilot project study and implementation project.

CGM had entered into a non-financial Memorandum of Understanding (MoU) with Delhi development Authority (DDA) to provide technical support in carrying out tasks related to PBS, such as study and detailing out the proposal, assisting in procurement of services and infrastructure and monitoring the system, this is supported by Shakti Sustainable Energy Foundation (SSEF).

1.2 Vision for Delhi (MPD 2021)

Delhi vision 2021 is to make "Delhi a global and a world-class city", wherein people resources would have conducive atmosphere and infrastructure to conduct themselves in productive work with better quality of life, living in sustainable environment. (MPD, 2021)
The aim of MPD 2021 in terms of transportation is to ensure safe and economical commuting between place of origin and destination, convenient and quick access which should reduce pollution, congestion, and increase energy efficiency.
In order to meet these objectives, following are the proposed major strategies of MPD 2021:

- Preparation and operationalisation of an integrated multi modal transportation and traffic plan
- A multi modal system with safe facilities for pedestrians, bicyclists, disabled person and Information Technology System (ITS) enabled transport services.
- Smooth and safe flow of buses and NMT transport on all arterial roads
- Promotion of usage of public transport
- Developing an integrated relationship between the bus, rail and metro system to provide seamless transport
- All arterial roads and sub arterials roads in urban extension should have segregated bicycle tracks with safe parking

1.3 Aim and Objectives

The aim of the project is to propose and implement the Public Bicycle Sharing (PBS) System in Dwarka in line with Delhi government's vision to develop a sustainable and integrated transportation system for the city.
The various objectives of PBS System in Dwarka are stated below (refer Figure 1)

To provide economical mobility option to the citizens: To provide an economical and convenient mode of transport for short trips as an alternative to motorized forms of transit that cost more.

To serve last mile connectivity: To bridge the gap in public transportation for end to end journeys, this would attract high ridership.

To minimize adverse effect on environment: To reduce negative impact that motorized vehicles have on the environment by encouraging people to opt for cycling.

To reduce the congestion on roads: To reduce number of vehicles on road by catering to short trips through PBS which will help in reducing the number of active vehicles on the roads and hence serve as long term strategy to improve transport scenario.

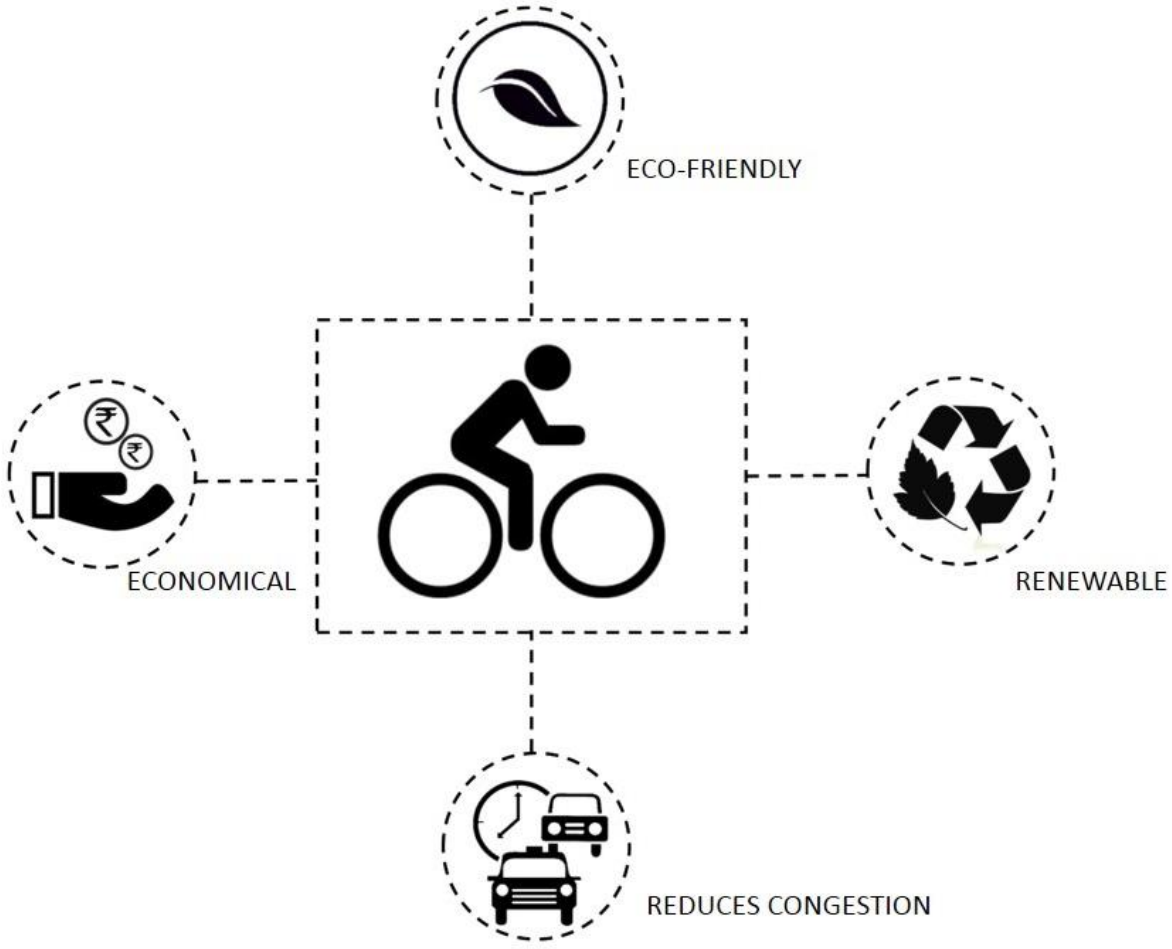

Figure 1: Objectives of PBS System

2. METHODOLOGY

2.1.1 Identification of the area

In Dwarka, the first step was to delineate the area where the project was to be implemented and proceeded, which enabled a clear understanding of the targeted area and its surroundings. (Refer Figure 2)

2.1.2 Secondary data collection

To understand the area, information from secondary data was collected from sources such as:

1. DDA (Delhi Development Authority) – the proposed plans for that area, the ongoing and upcoming projects and also the administrative maps of Dwarka.
2. SDMC (South Delhi Municipal Corporation) – the studies done on Dwarka and Delhi as a whole and various other municipal and administrative specifications, along with the current ward boundaries of Dwarka.
3. DMRC and DTC (Delhi Metro Rail Corporation & Delhi Transport Corporation) – available updated data on various transit nodes and other transport related data can be received from these offices.

2.1.3 Assessment of Secondary Data

Collection of secondary data was followed by preparation of base maps with all the administrative and transportation data.
Along with assessing the secondary data so gathered, a primary survey of Dwarka was planned and survey forms for the same were prepared along with formulation of Terms of References (TORs). To carry out the survey, a survey agency was hired and contracted.

2.1.4 Primary survey

Primary survey was then carried out by the survey company and the data was collected at a household level on the travel characteristics of the members of the household, the demographic details, the socio-economic details (income and pattern of work, etc.), bus stop foot-fall (number of people using public transport for medium distances), perception study, etc. Such parameters were taken into consideration for the primary survey to understand the travel pattern of the people of Dwarka and also to understand its existing demand and supply pattern of transport.

2.1.5 Data Analysis

After gathering all the secondary and the primary data from all sources, the existing situation of Dwarka was analyzed with respect to the travel characteristics of the people, their socio-economic factors, their perception of the proposed project, their willingness to shift to the proposed project etc. Data analysis forms the backbone of the proposed project as it provides an insight into the people's perception of their area and their demands. It also suggests if the proposed project would work and help the targeted group.

From the data, a demand assessment was carried out to estimate the potential users of proposed PBS which further helped in arriving few other conclusions such as the required fleet size of the bicycles, how the system needs to be phased, how and where the stations need to be distributed and how many bicycle would be there at each station.

2.1.6 Assessment of required infrastructure

Once the primary numbers related to PBS in Dwarka were realised, the supporting infrastructure was assessed and accounted for. For this, various case studies from across the globe were considered and were compared to the scale of proposed project in Dwarka. Taking

cues from the case studies, a proposal specific to Dwarka was designed, keeping in mind the existing situation of the sub-city and the demand of the people residing there.

2.1.7 Preparation of DPR

After all the research, data collection, data analysis and planning of the project, a Detailed Project Report (DPR) of the same were prepared. The report consisted of all the details of the surveys conducted, the analysis done and the consequent conclusions. The DPR has all the details pertaining to the proposed project in Dwarka as to what the project is, what its and the objectives to achieve it.

It also mentions the details of the project like the area the project is catering to, the number of bicycles proposed as per the proposal, the locations of the PBS stations, etc. along with a primary financial analysis required to get the project on ground.

2.1.8 Way Forward

Once all the ground level studies and the required numbers were in place, the project was ready to come under the implementation phase. For implementing the project, firstly an institutional structure was formed wherein, after few consultations and general body meetings with operators, government officials and technical consultants, it was concluded that an NMV cell shall be constituted for the efficient implementation and sustainability of the proposed PBS, which would be followed by hiring of technical consultants. The hiring of technical consultants would be based on pre-mentioned terms of references (TOR) and any other mentioned parameters. They would be responsible for the design of the project like the PBS stations, the bicycles etc., after which all the required equipment of the proposed PBS would be finalized. Once the equipment and all the elements are finalised, an operator for the system would be hired, again on the basis of consultation and terms of references (TORs). They will start with the project implementation on ground and the testing of the project would begin.

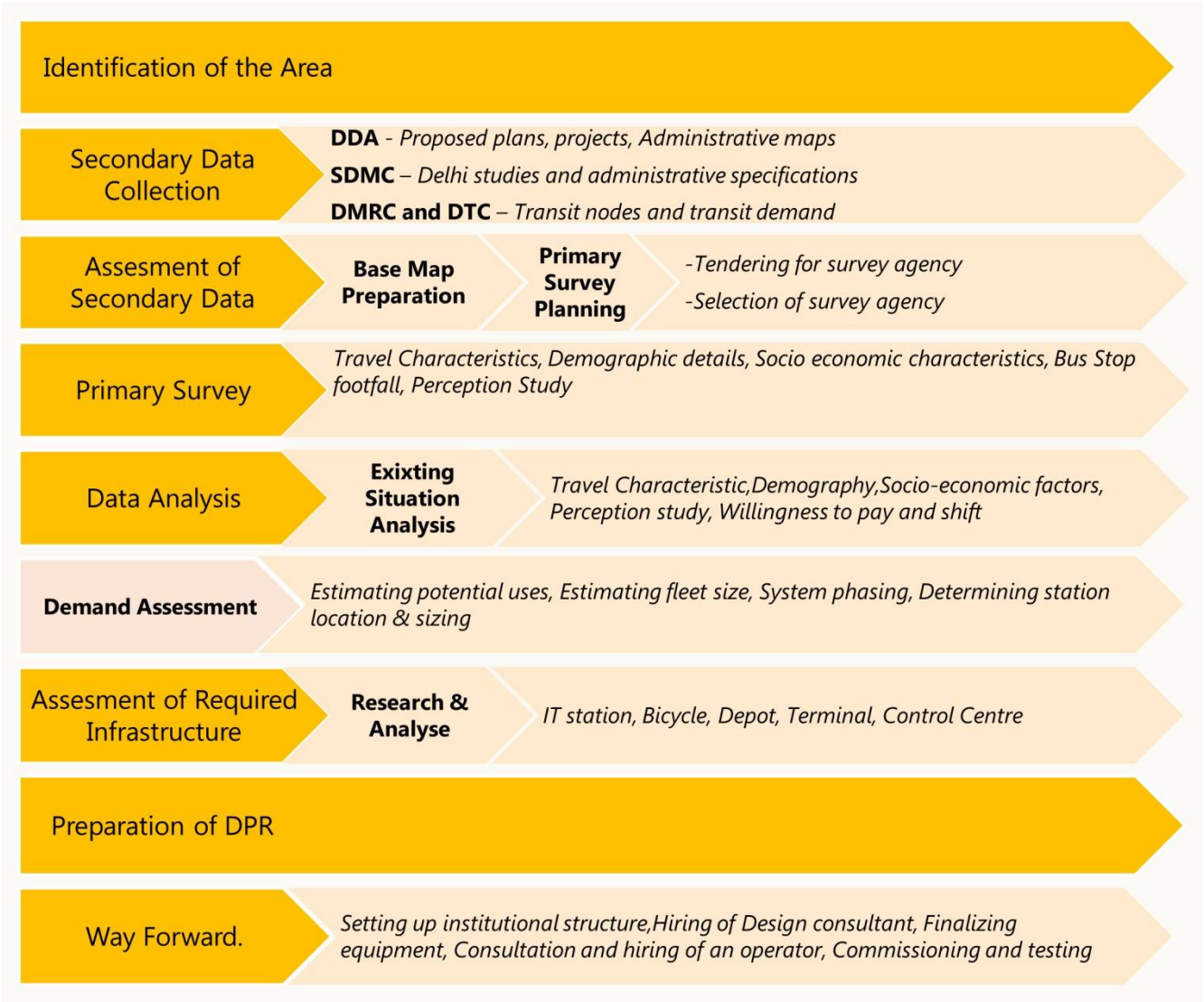

Figure 2: Methodology

2.2 Data base

Data plays an important role in identifying coverage areas and delineating zones. It also assists in determining potential subscriptions for the system. Termed as 'uptake rate'- data helps identify the proportion of the population that will utilise the bicycle share system. Data also helps to optimize, monitor and plan an efficient system before as well as after implementation.

For Dwarka sub-city data has been collected through secondary sources and primary surveys. Random sampling has been followed in primary surveys (Refer
Table 2). Information required for planning the PBS system and their sources have been listed below:

Table 1 Data Collection Details

Sr. no.	Information	Sources	Usage
Secondary Data			
1	Master plan and proposed projects	UTTIPEC	To understand the area and incorporate future developments in the proposed project.
2	Administrative boundaries and demographic information	UTTIPEC & DDA	To determine population densities and determine a sample size for the survey.
4	Metro stations and its ridership	Delhi Metro Rail Corporation (DMRC)	To understand the potential user group.
5	Metro station foot fall	DMRC	To decide a sample size for user perception surveys at metro stations.
6	Bus stops list and its ridership	Delhi Transport Corporation (DTC)	To understand the potential user group
Primary Surveys			
7	Socio economic information	Household Survey	To understand social and economic background; income, age.
8	Major attraction and production points	OD from House hold survey	To study the travel demand estimate transport supply
9	Origin destination of population	OD from House hold survey	To study the travel demand estimate and transport supply
10	Trip rate, trip length and Trip cost	Travel diary from House hold survey	To understand travel scenarios in the study area, short trip numbers.
11	Mode of travel	Travel diary from House hold survey	To understand travel scenario in the study area and target potential users.
12	Bus stop foot fall	Boarding and alighting survey	To have an idea of the potential user at particular place and To decide a sample size for user perception surveys.
13	Perception about Public bicycle sharing system	User perception survey	To understand - The willingness to shift to PBS - People's acceptance and perception about the system

Sr. no.	Information	Sources	Usage
14	Willingness to pay	User perception survey	To estimate fixed charges for membership subscription for the system.
15	Mode of payment	User perception survey	To estimate how the users will choose to pay for the services and subscription.
16	Physical infrastructure drawings	Total Station Survey	To collect information on existing land features and prepare execution drawings accordingly.

Table 2 Sampling Details of Primary Surveys

Sr. no	Type of surveys	Units	Sample size	Percentage of sample
1	Household survey	Households	2050	2
2	Boarding alighting surveys	Bus stops	230	100
3	User perception survey at Bus stops	Person	3000	1
4	User perception survey at metro stations	Person	5900	1

3. ABOUT DWARKA

Dwarka sub city is located in the south-west Delhi district of National Capital Territory of Delhi (refer Map 1) and is situated approximately 10kms away from the Indira Gandhi International Airport (refer Map 2). It is surrounded by NH-8, the Outer Ring Road, Najafgarh Road, Pankha Road and the Rewari railway line. It has been cited as Asia's largest residential enclave with a population of approximately 1.07 million. It is well connected to the rest of Delhi through road ways and metro service (Refer Map 1 and Map 2)

The city of Dwarka has a stark contrast in terms of its fabric. A part of Dwarka is well planned, with wide roads, sector-wise development, sparse population and good public transport connectivity referred as the planned authorized colony, while a part of it is still unplanned with narrow winding roads and high population density referred as the unplanned-unauthorized colony.

The Dwarka sub-city is divided into fifteen wards, with a combined area of 56.48sqkm or 5648 hectares (refer Map 3).The entire sub-city has been considered in study area. For ease of traffic analysis the wards have been divided into 47 Traffic Analysis Zones (TAZ) (Refer Map 4). The rational considered for delineating TAZ area as follows;

- Zones should have homogeneous land use
- Anticipated changes in land use considered when sub dividing the study area into zones.
- The subdivision of zones to be at par with other bodies, such as census department for data collection.
- The zones are not too large to cause considerable errors in data. Also, not be too small to cause difficulty in handing and analyzing data.
- The zones represent the catchment of trips generated on a primary route.
- Natural or physical barriers such as canals rivers etc can form convenient zone boundaries

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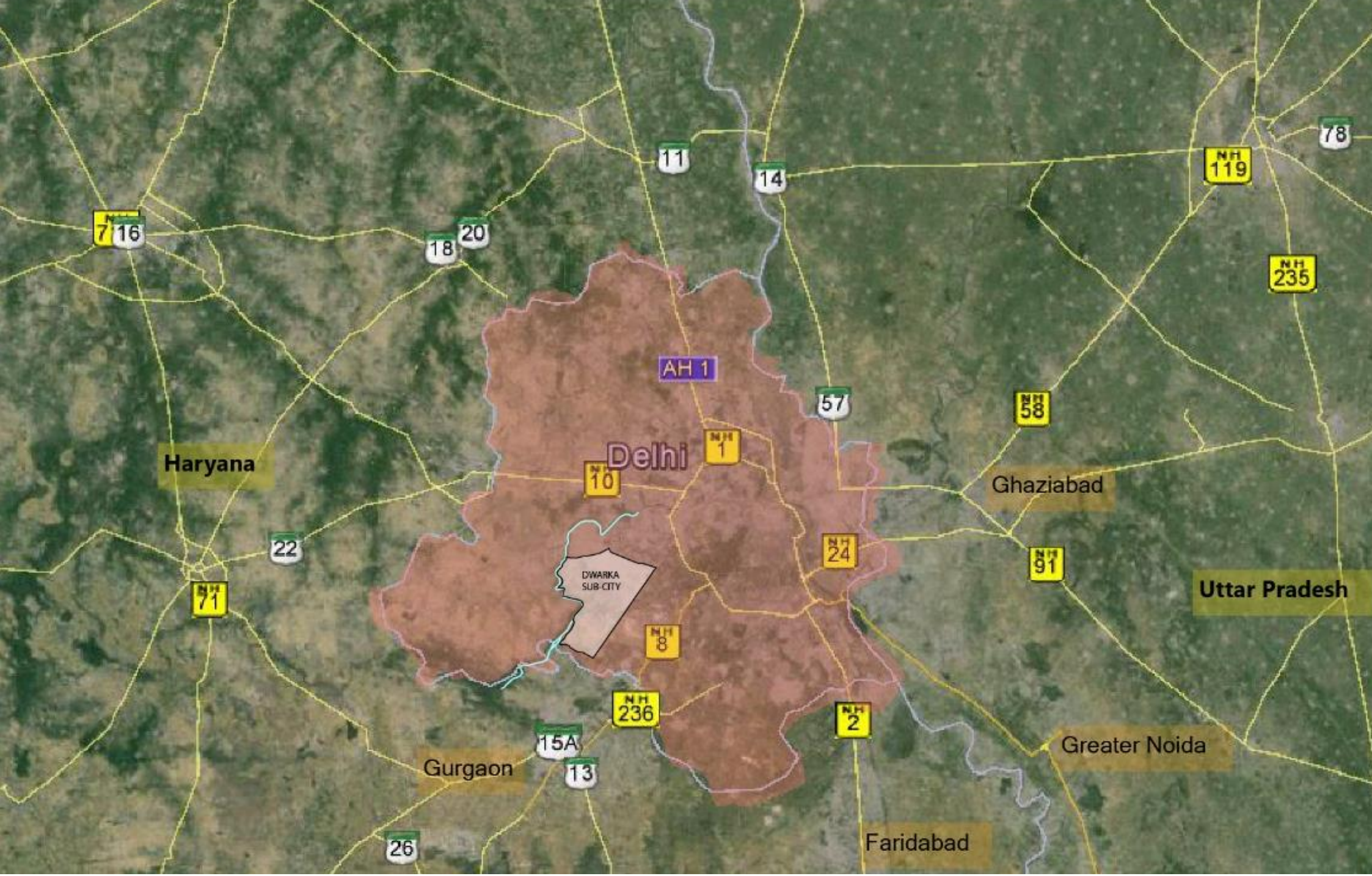
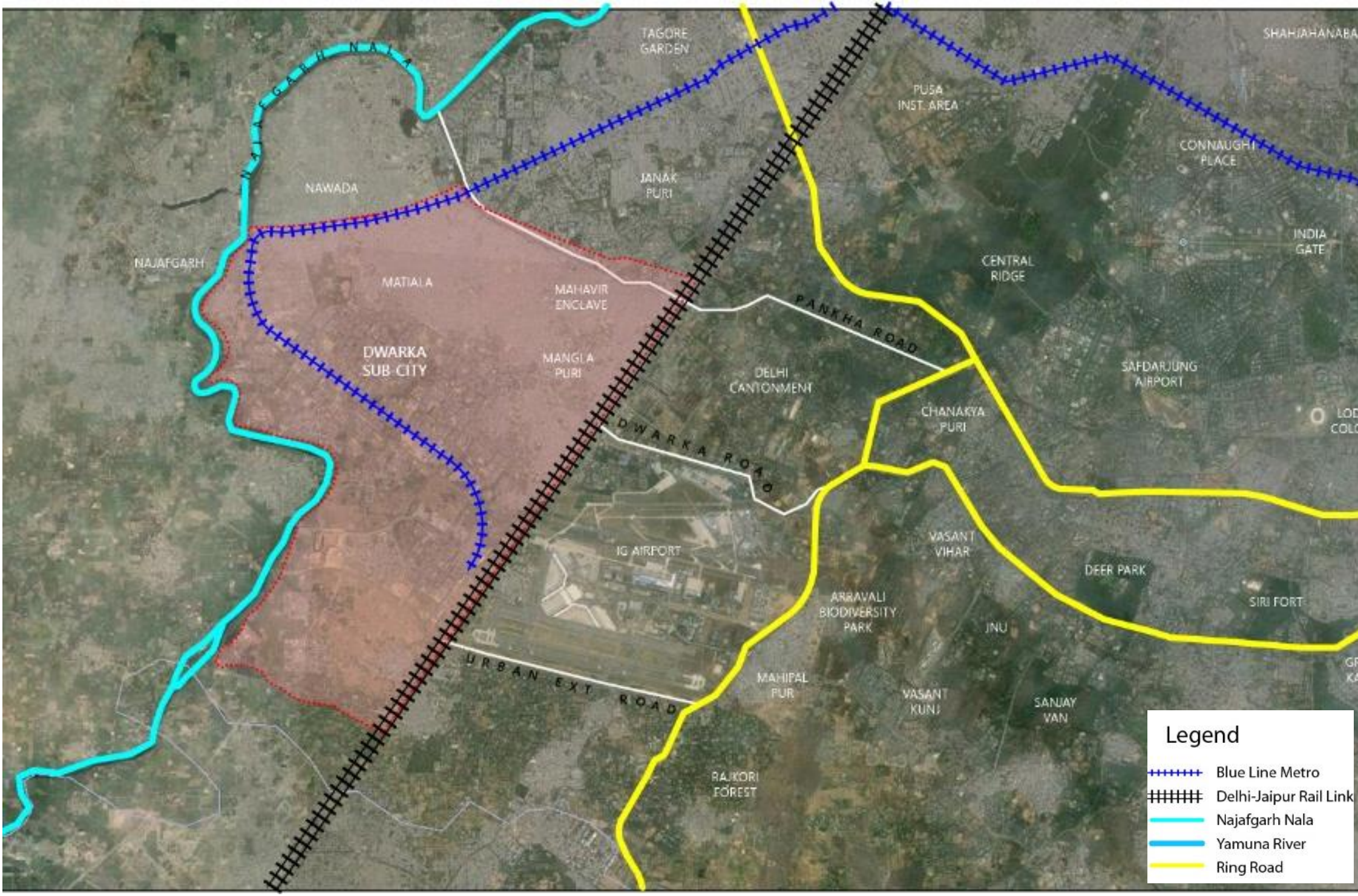
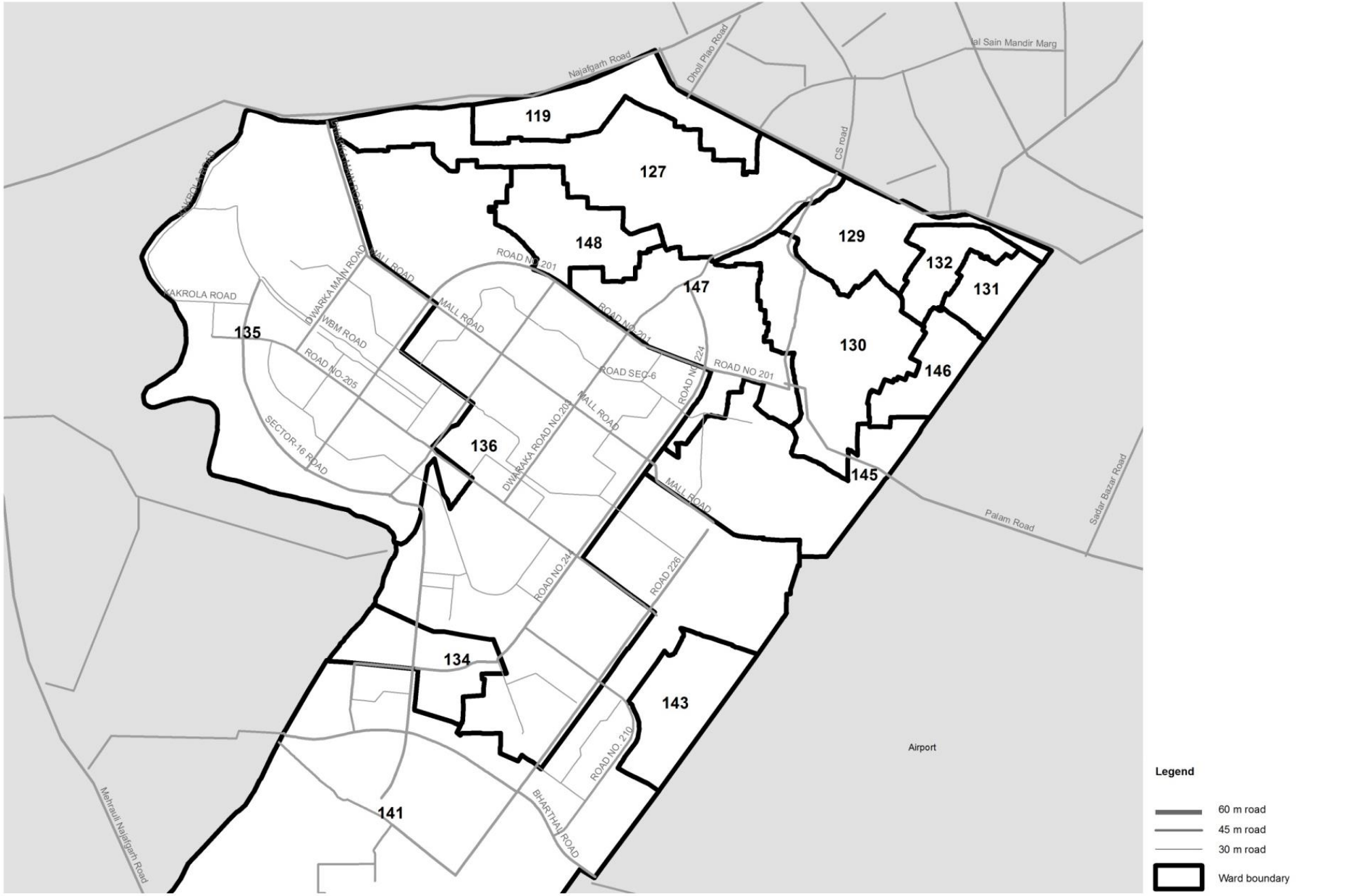
Figure 3 : Dwarka, Sector 11



Map 1: Location Map Delhi Dwarka

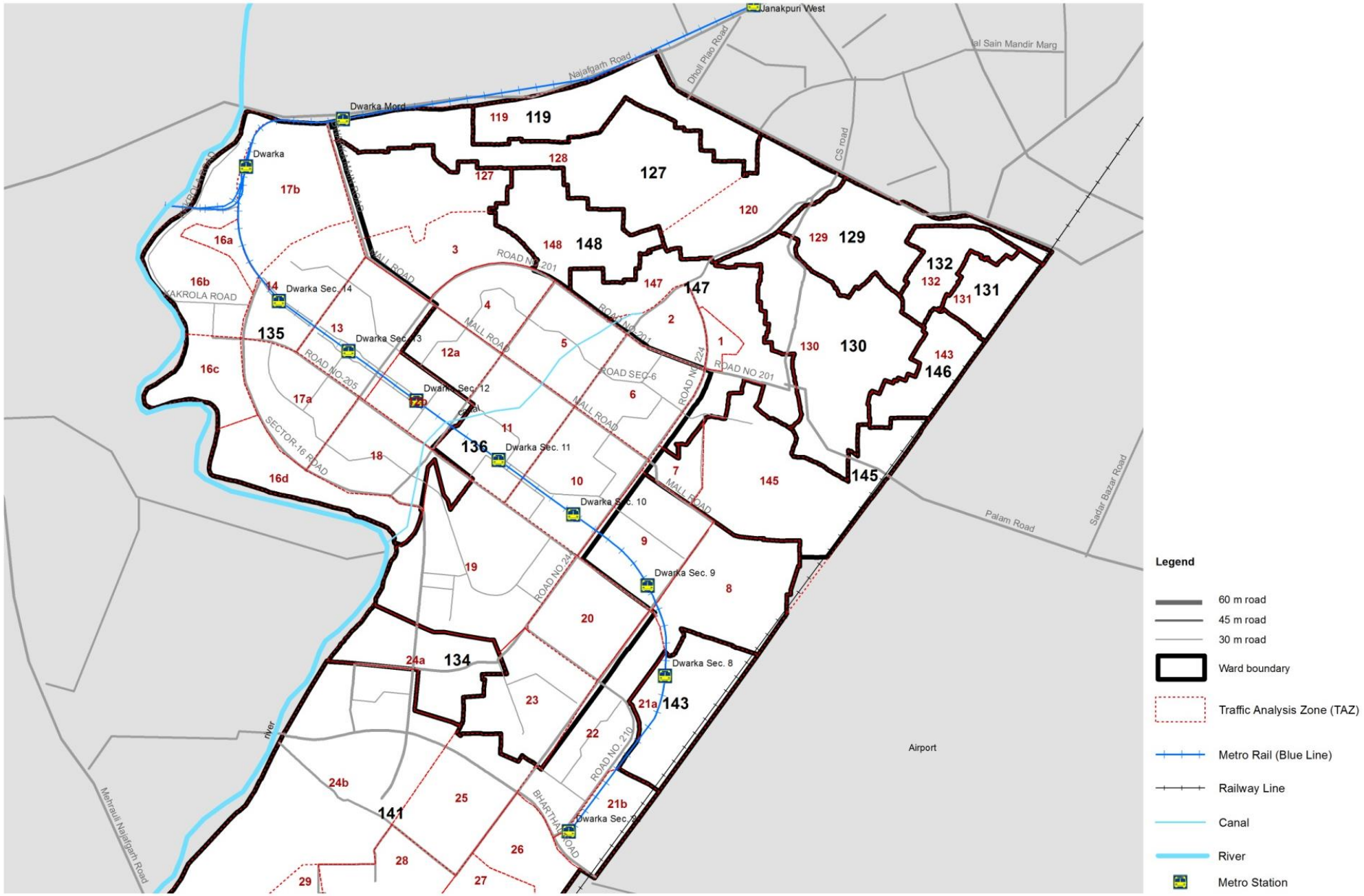


Map 2: Location Map - Dwarka



Map 3: Ward Map of Dwarka

Kilometers



Map 4: TAZ Map of Dwarka

3.1 Demography

Dwarka with 1.07 million population, has a high potential for development, as it accounts for a density of 150 people per hectare which is less as compared to the other zones in NCT of Delhi and also less as compared to proposed density of the master plan i.e. 225 people per hectare (CensusofIndia, 2011) (refer Figure 4).

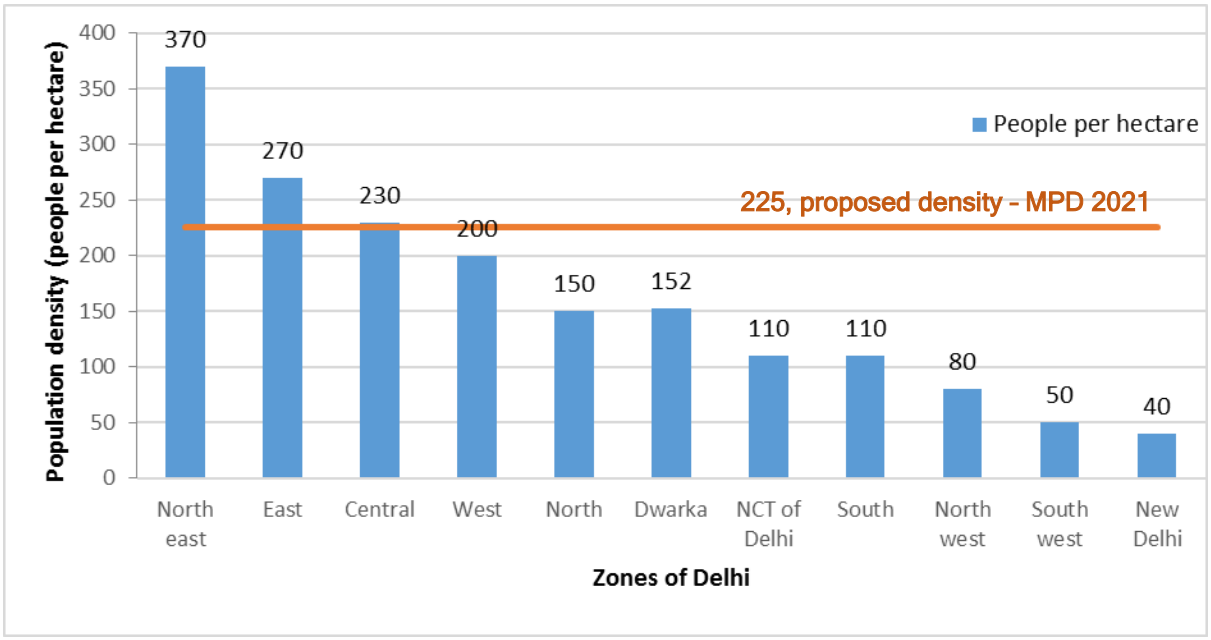


Figure 4: Population density per hectare in various zones of Delhi (Census of India, 2011)

Presently workforce participation ratio is 36.3 percent in Dwarka (CGM, 2014). 56 percent of the population falls in the age group of 17 - 44 (refer Figure 5), who might be the potential users for Public Bicycle Sharing System.

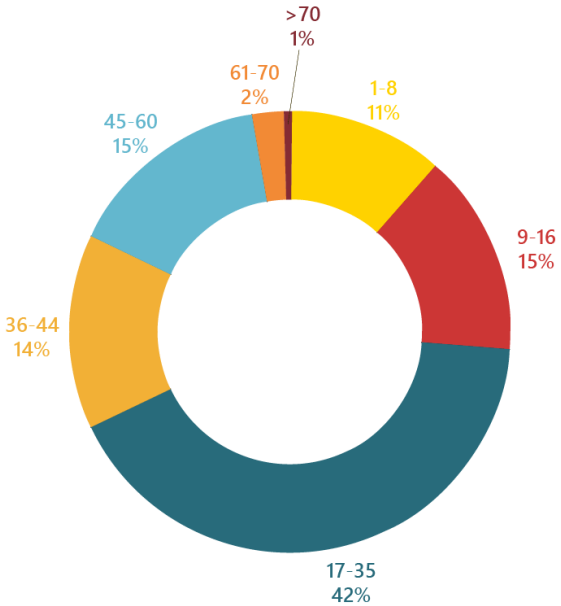


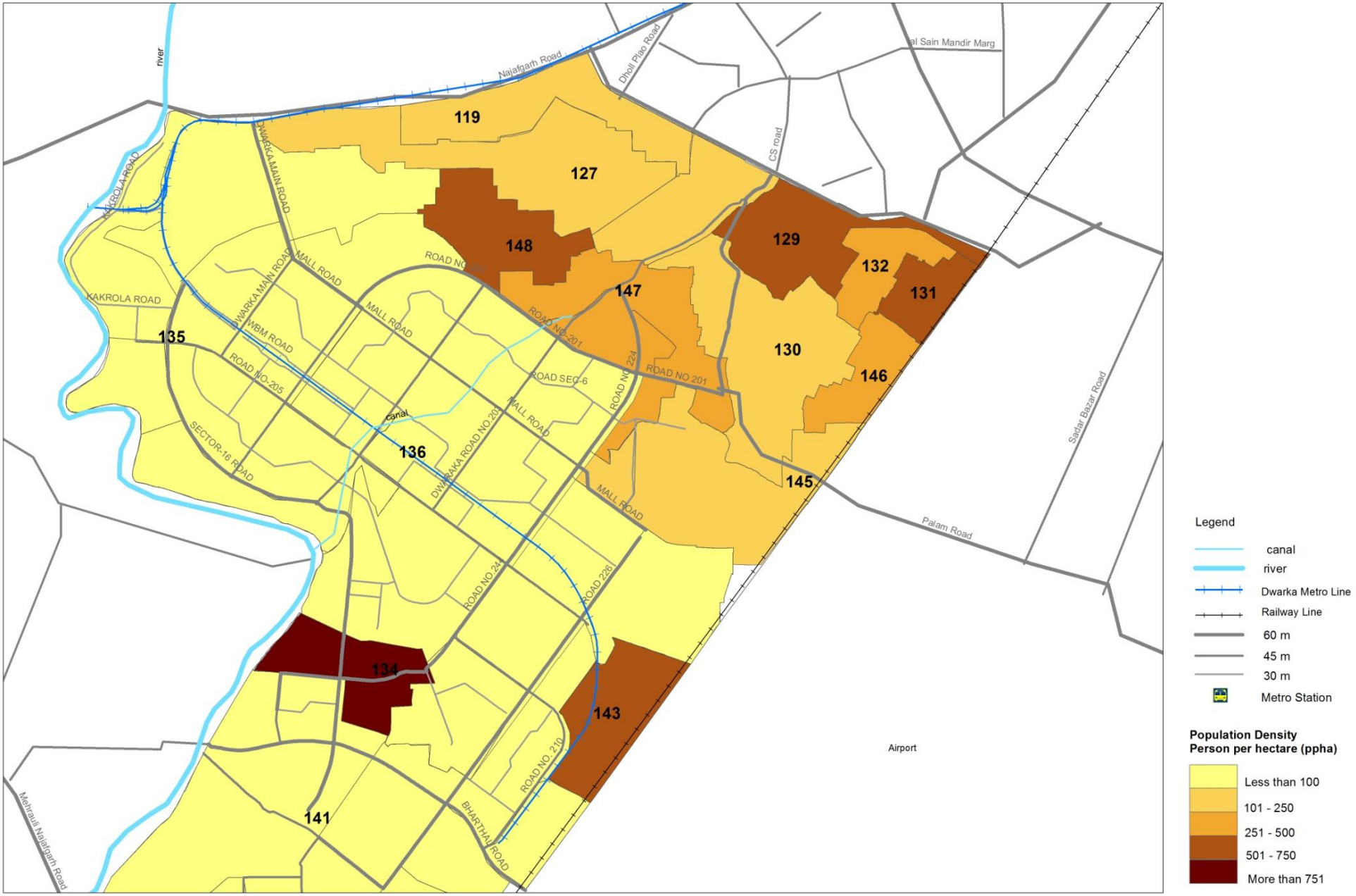
Figure 5: Age Classification (primary survey)

Dwarka has been imaginarily divided in terms of spatial spread into authorized colony and unauthorized areas. Authorized colony is the planned city with sector-wise development, wide roads, metro line and sparse population belonging to medium to high income group, while the other part is dense and compact with narrow winding streets and high population density belonging to the medium to low income group, usually referred to as the unauthorized colony.

Dwarka comprises of 15 wards, with total population of more than 8.6 lakhs, and population density of 384 person per hectare (ppha). Ward 134,143 in the south and ward 148, 129 and 131 in the north has the highest population density with more than 500 ppha. The northern part of the sub city has overall high population density compared to the rest of the sub-city. This area is the unplanned authorized area with narrow winding streets and unplanned settlement. The Central Dwarka falls under the planned colony and has population density varying from 100ppha to 500ppha. (Refer Map 5) The minimum population density in Dwarka accounts for 37 people per hectare in ward number 14, it has open land as per the land use , and has proposal to developing it to residential area in the proposed land use map. (refer Map 6)

Table 3: Population density ward-wise, Dwarka 2011 | Source: SDMC

Ward No.	Population 2011	Area in sq. km	Population density ppha
135	64301	9	71
146	47012	1	470
129	54351	1	544
136	108099	12	90
147	79403	2	397
131	51921	1	519
132	46697	1	467
143	63180	1	632
141	62928	11	37
148	56976	1	570
145	46251	3	154
130	46251	2	231
119	13950	1	140
127	51297	4	128
134	76562	1	766
Total	**8,69,179**	**51**	**Average density 384**



Map 5 Population Density of Dwarka, 2011, source SDMC

3.2 Land use

Dwarka city spreads over an area of 5,648 hectares with a population of approximately 10 lakh people. It is majorly a residential development, with significant commercial and open/green space pockets.

Dwarka has a sector wise development with each sector of about 81 ha and serving to a population of 30,000 people. It is proposed that each sector would have a mix of housing of various socio-economic groups and each sector would have four entries the arterial roads which would be 450m apart. The major commercial nodes connect different sectors of Dwarka via 60m and 45m roads and are majorly lined up along the Metro line.

About 20 percent of Dwarka sub city is planned for development as a green area, with the provision of a number of parks and other open spaces, which would be maintained by the Delhi Development Authority (DDA).

Dwarka also houses a number of noted institutions like the Netaji Subhas Institute of Technology (NSIT), National Law University, Delhi, All India Football Federation (AIFF) Headquarters etc.

The sector planning of Dwarka Sub-City specifies 49 percentage of the land to be residential, 7 percentage of commercial and 6 percentage of public and semi-public use in proposed land use (DDA, 2013) (refer
Table 2 and Map 6). Mix land use pockets have been placed at corners of sectors 4, 6, 10, 12 which attract a majority of the trips.

Table 4 Proposed Land use Details

Sr. no	Use	Area (in ha.)	Percentage
1	Residential	2910	49
2	Commercial	353	7
3	Govt. Use	66	1
4	Public & Semi public	368	6
5	Utility	139	3
6	Recreational	1041	20
7	Transportation	798	14

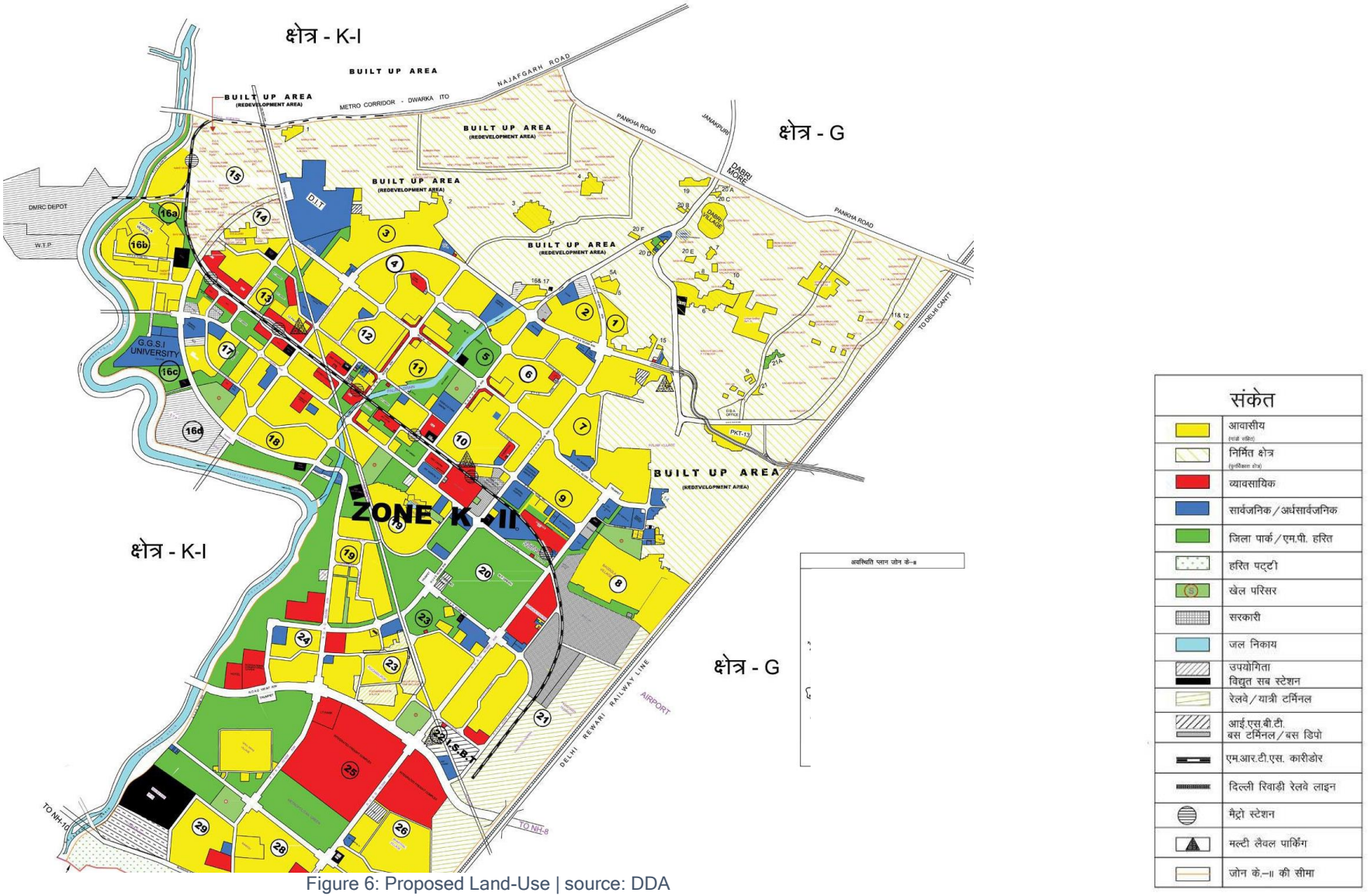
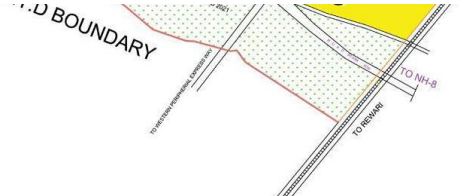


Figure 6: Proposed Land-Use | source: DDA



3.3 Road Network

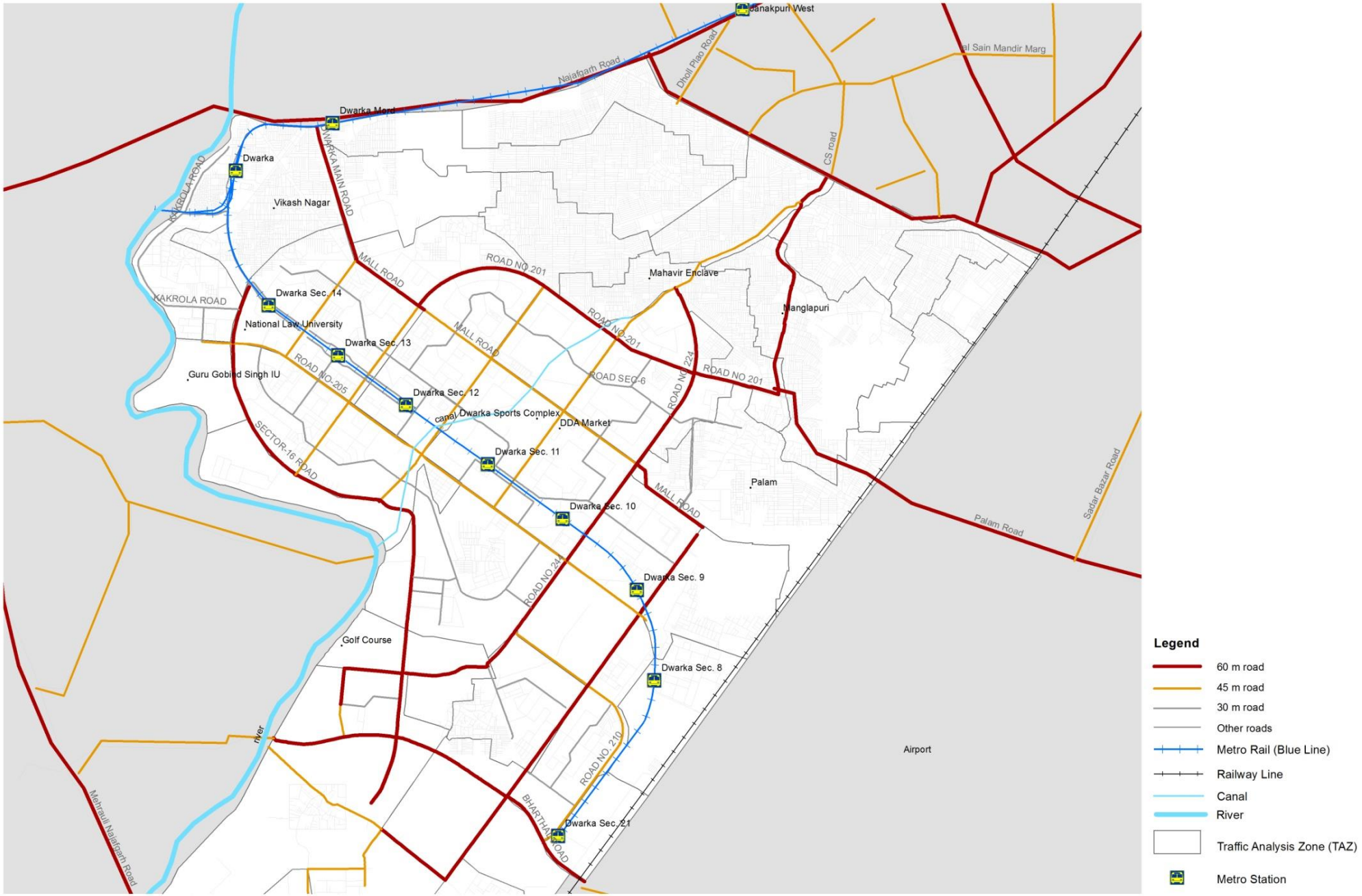
Dwarka's road network has broadly four types of roads, sixty meter, forty five meter, thirty meter and other roads. A distinct division of the sub-city of Dwarka can be seen in terms of the road network. The planned central Dwarka has grid iron pattern of road network with 60m road forming ring broadly. And 45m road & 30 m roads cut across at right angles joining east west and north south, forming a grid and surrounding the sector wise plan of the colonized part of the sub city. The northern part of the city or the unauthorized colony of Dwarka has dense road network of irregular pattern, forming more of an organic road network pattern, with narrow winding streets. (Refer Map 7)

Road network contributes to 14.1 percent of the total area of Dwarka. Lengths of various Right of Way (RoW) have been specified in the Table 5.

Table 5 Road Categories by Length and RoW

Sr. no	RoW (in meters)	Total length (in km)
1	30	30.18
2	45	20.46
3	60	37.5
4	Other roads (12m, 9m & 6m)	935
	TOTAL	1023

A distinct division of the sub-city of Dwarka can be seen in terms of the road network. The authorized colony of the city has planned road network with a sector wise development whereas an unplanned road network, being narrow in nature; can seen throughout the unauthorized colony.



Map 7: Road Network Map of Dwarka

3.4 Traffic generating activities

Dwarka is highly residential area with majority of its population working in service sector i.e. government jobs, institutional jobs etc. Traffic generating activities are referred to those nodes that contributes to trip generation and traffic movement (refer Map 8 and Map 9). In Dwarka, traffic generating nodes identified, such as

1. Commercial center/ Market places

Sectors 4, 5, 10, 11 and 12 are the prime commercial areas of Dwarka. Dwarka has two major markets, one at sector 10 and the other at sector 12; these areas attract lot of commotion and traffic every day.

2. Public/ Semi public institutions

Public and semi public buildings include post office near Dwarka sector 11 metro stations, DDA office near Dwarka sector 10 DDA sports complex and MCD building near Manglapuri.

3. School/ colleges/ institutions

In Dwarka there are four popular colleges, and more than 60 schools spread across 52 sq km. majority of the schools are located in the central part of the city.

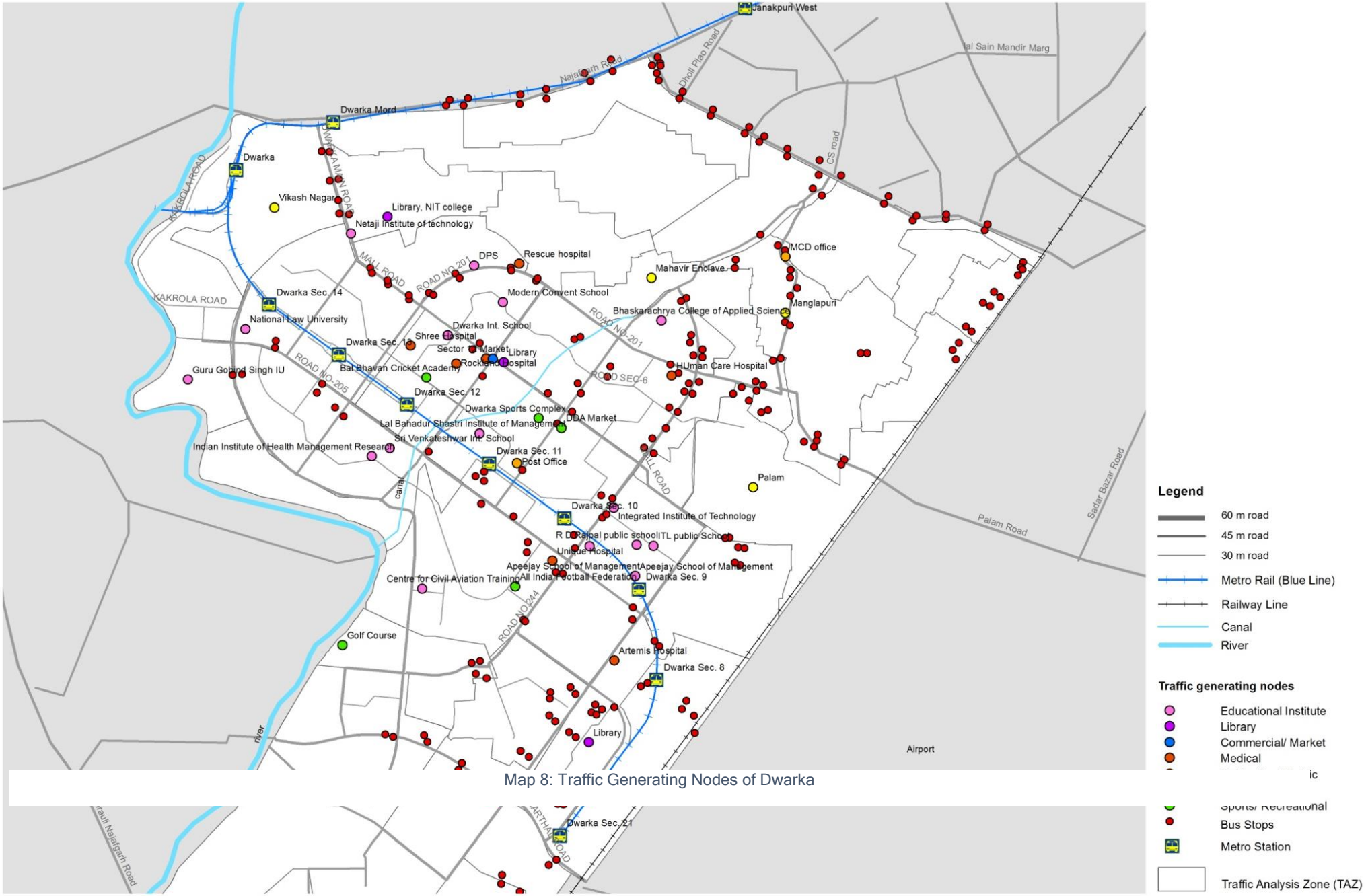
4. Sports and recreational

Dwarka has popular football clubs and sports academy. DDA Sports Complex, Sector 11, Bal Bhavan Cricket Academy, Sector-12,AIFF (All India Football Federation) Headquarter, Sector-19, Dwarka is home to Dwarka FC, a football club at Sector-25 and Shastri FC Football Academy at BGS International Public School.

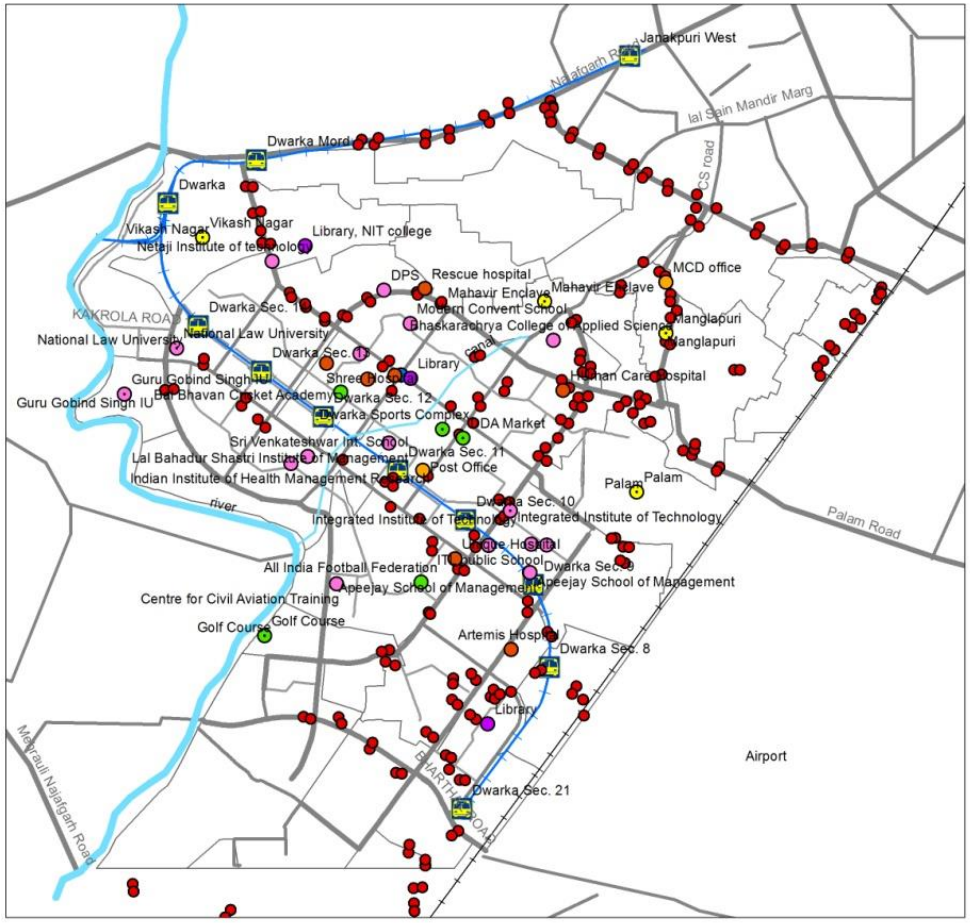
5. Public Transit stations

The city has 10 metro station linking Dwarka with central secretariat in New Delhi. And 232 bus stops. The bus stops are mostly along the 60 meter road and also some in 45m and 30m road inside the study area.

Figure 7 Left: Commercial/ Market Place at Sector 10, Right: School at Sector 12| source: Indian real estate market 2012,



Map 8: Traffic Generating Nodes of Dwarka



Traffic generating nodes

- Educational Institute
- Library
- Commercial/ Market
- Medical
- Public Semi Public
- Residential
- Sports/ Recreational
- Bus Stops
- Metro Station
- Metro Rail (Blue Line)
- Railway Line
- Canal
- River

Heat Map, from activity nodes and transit nodes

- Low density
- High Density
- 60 m road
- 45 m road
- 30 m road

Map 9: Heat Map of Dwarka

0 0.40.8 1.6
Kilometers

3.5 Transport in Dwarka

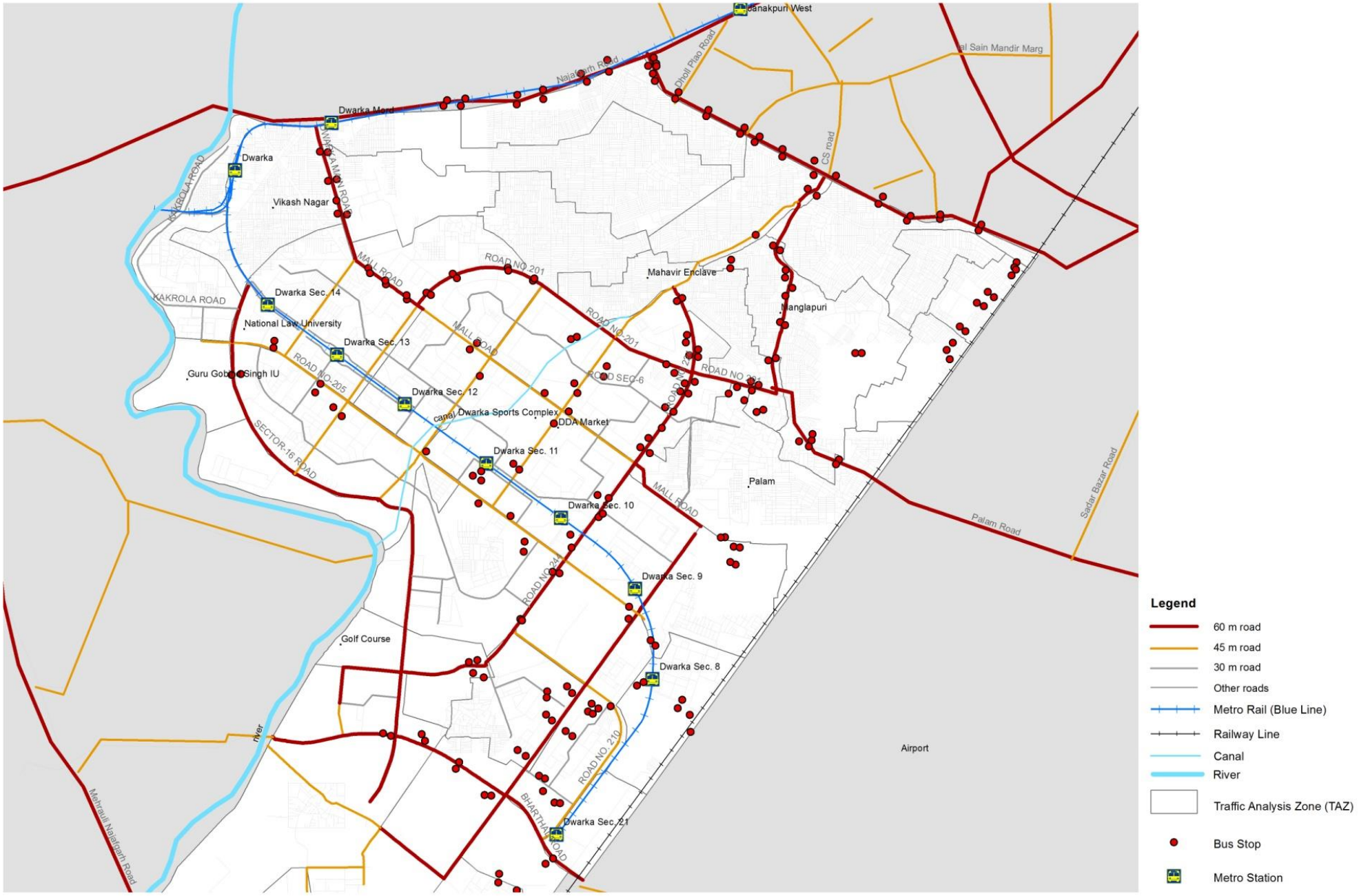
Dwarka is served with 232 bus stops and 10 metro stations. The bus service within Dwarka is provided by the Delhi Transport Corporation (DTC) and is spread across the city with a majority being aligned along the arterial and the sub-arterial roads. Whereas, the Metro rail is operated by the Delhi Metro Rail Corporation Limited (DMRC) and two metro lines connect Dwarka with rest of the city i.e. Blue line connecting Rajiv Chowk (center of the City) and Airport express line connecting New Delhi Railway station and the Indira Gandhi International Airport. (Refer Map 10).

For the intermediate commute of people from their place of origin to their place of destination, primarily three modes are available in Dwarka, namely; pedal rickshaws, auto rickshaws and electric rickshaws apart from walk.

Figure 8: Integrated Mode of Metro station and Pedal Rickshaw

Figure 9: Pedal rickshaws operating in Dwarka

Figure 10: Auto station near metro station aiding in last mile connectivity



Map 10: Road and Transit Map of Dwarka

4. TRAVEL AND SOCIO ECONOMIC CHARACTERISTICS

4.1 Introduction

Travel patterns described in terms of trip rate, mode choice, trip length, geographical distribution etc. are major factors in assessing the needs and system demand of the city. This chapter will briefly describe household travel needs, travel scenario and demand assessment procedure for PBS System based on primary surveys done in Dwarka.
To understand and analyze the socio economic condition and mobility demand of Dwarka, it has been divided into 47 traffic analysis zones, (TAZ) (Refer Map 4) considering ward boundaries, road network, transit nodes, water bodies, railway line etc.

Looking at the educational structure breakup of people of Dwarka, only 9 percent of the total population do not have formal education, while the rest of the population is quite educated with some people even opting for professional courses (refer

Figure 11a). While the occupational breakup of the people of Dwarka indicated that the population consists majorly of student population followed by house-wives and people working in the private sector in and around Dwarka (refer

Figure 11b).

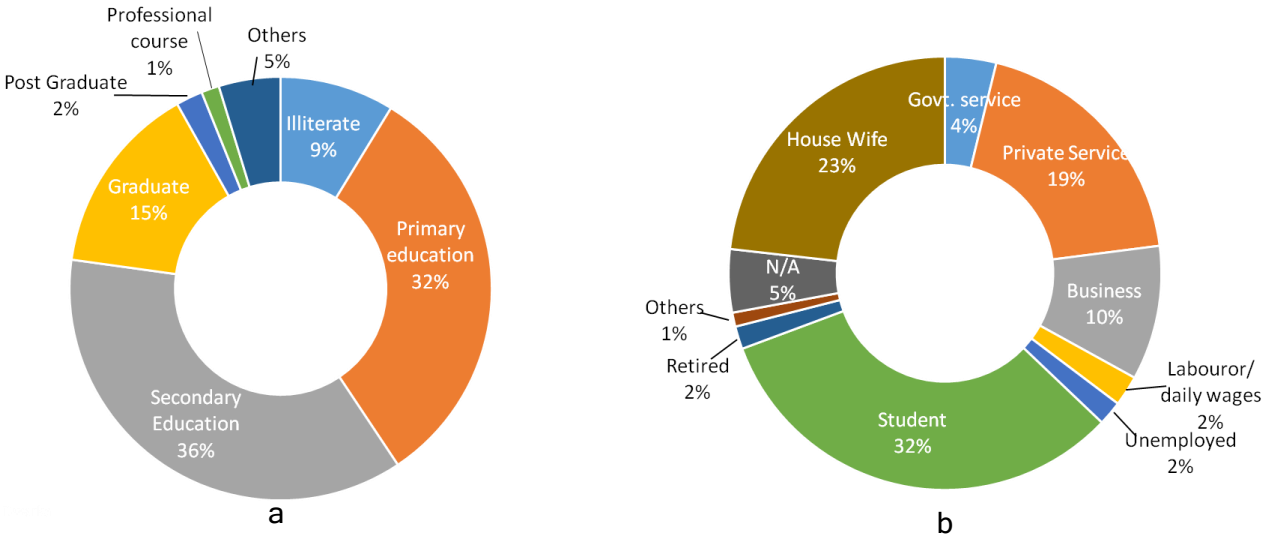


Figure 11 (a) Education Level of People of Dwarka (source: primary survey)
(b) Occupation Level of People of Dwarka (source: primary survey)

Also about 70 percent of the households have income under Rs.50,000 per month (refer Figure 12) (CGM, 2014)

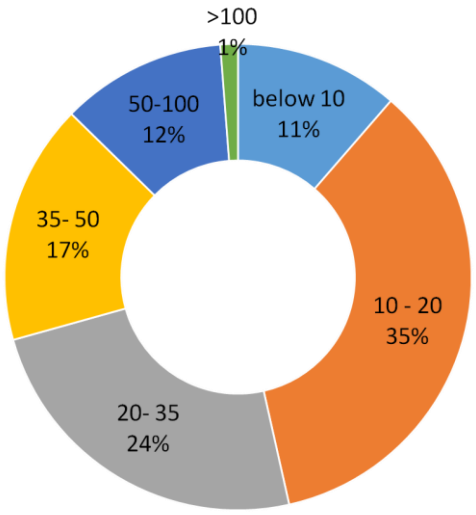


Figure 12: Monthly Household Income Classification (source: primary survey)
*all amounts are in thousands

4.2 Income group and Vehicle ownership

The household survey revealed that 95 to 100 percent of the households fall in high income group category i.e. households having a monthly income of more than Rs.50,000 while70 percent and 80 percent of the households fall under the category of monthly incomes of Rs.10000 – 20000 and Rs.20001- 50000 respectively. 70 percent of the households own at least one motor vehicle in Dwarka. As shown in Table 6, 21 percent of total households own a bicycle, 25 and 0.84 percent of total households own four wheelers and autos respectively, which is in line with the vehicle ownership data of rest of Delhi. 63.7 percent of the total households own a two wheeler, which is too high in terms of the average two wheeler ownership of Delhi which is 44.1 percent.

This along with the modal share of private vehicles shows an overall dependency of people on private vehicles. Perception surveys for public transport reveals that due to lack of reliable, direct and integrated public transport in Dwarka, people are left with no choice other than using private transportation. Also in line with other urban areas, the percentage of vehicle ownership is increasing with an increase in income (refer Table 7).

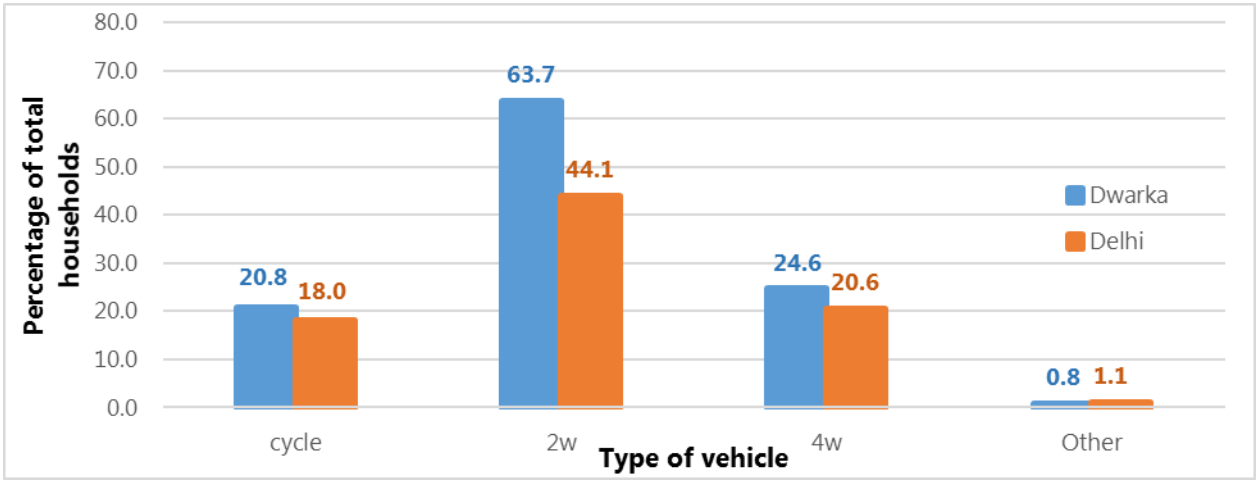


Figure 13: Ownership of Household in Delhi and Dwarka (source: primary survey)

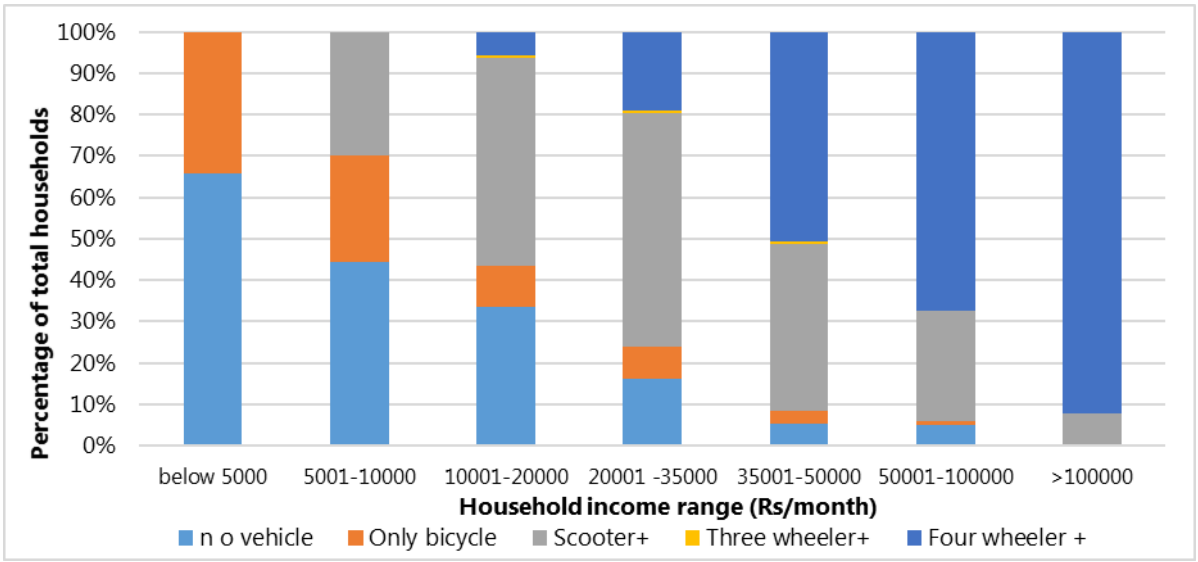


Figure 14: Household Vehicle Ownership and Income (source: primary survey)

4.3 Trip rate

The total number of trips in Dwarka is 19,63,378. The per capita trip rate including walk in Dwarka is 1.89 trips per day. Motorized trip rate is 0.9 and walk trip rate is 0.82. The highest trip rate is for work and education at 0.36 and 0.32 respectively.

Table 6 Trip Rate (trips per day) by Purpose (source: primary survey)

Trip purpose	Trip rate
Work	0.36
School/Edu	0.32
Shop/Market	0.11
Recreational/Social/Religion	0.09
Medical/Health	0.01
Pick & Drop passenger	0.03
Transfer/ Other mode of travel	0.00
Other	0.02
Return home	0.95
Total Daily PCTR	**1.89**

4.4 Trip purpose

Keeping aside the return home trips, which forms fifty percent of the total trips, work trips and educational trips constitute nearly 40 percent and 34 percent of the total trips respectively. Interestingly shop/market trips make up 10 percent of the total trips (refer Table 7) (other cities like Ahmedabad have only 2.7 percent share from shopping trips).

Table 7 Trip by Purpose (source: prmary survey)

Trip purpose	Total trips	Percentage of total trips
Work	4,16,707	42
School/ Education	3,40,939	35
Shopping	95,456	10
Recreation/social/Religion	76,326	8
Medical/Health	11,192	1
Pick & Drop passenger	18,900	2
Transfer/ Other mode of travel	1,076	0
Other	25,589	3
Total	**9,86,185**	**100**

4.5 Modal Split

The dominant transport mode in Dwarka is walk. It contributes to 47 percent of the total trips made (refer Figure 15), this is high as compared to whole of Delhi which has 34 percent walk trips. Also 63 percent and 16 percent of total females in Dwarka use walk and bus respectively, this indicates a need of a women sensitive PBS system (refer Figure 15).The total trips made by all non-motorized modes is 53 percent which is significant and justifies the requirement of better infrastructure to cater to it.

Nearly 22 percent of the population uses public transport which is less than the average share of Delhi at 35 percent. Use of car and auto is still limited and accounts only for 7 percent and 3 percent respectively.

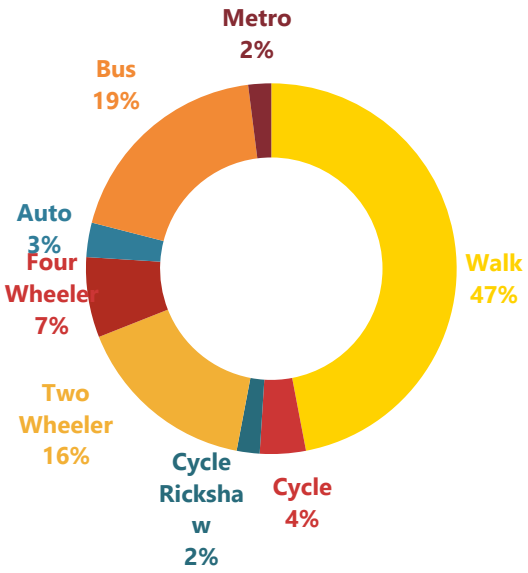


Figure 15: Modal Split in Dwarka (source: primary survey)

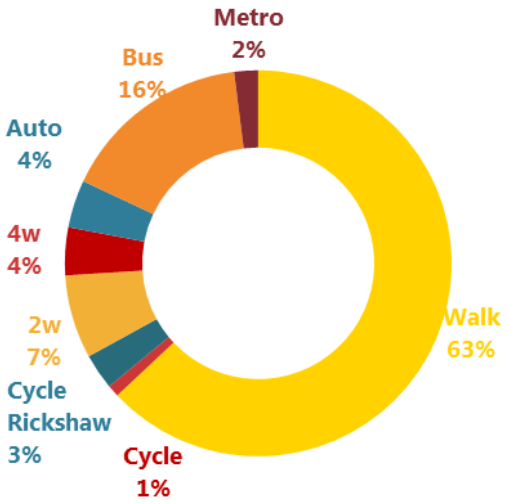


Figure 16: Mode Split: trips Made by Female (source: primary survey)

The purpose of walk trips is majorly for educational, recreational and shopping activities (refer Figure 17). Nearly 25 percent of the work trips use public transport to reach their work places. Also the choice of mode shifts from walk and bicycle to more personalized modes as we move upwards on the income group ladder (refer Figure 18).

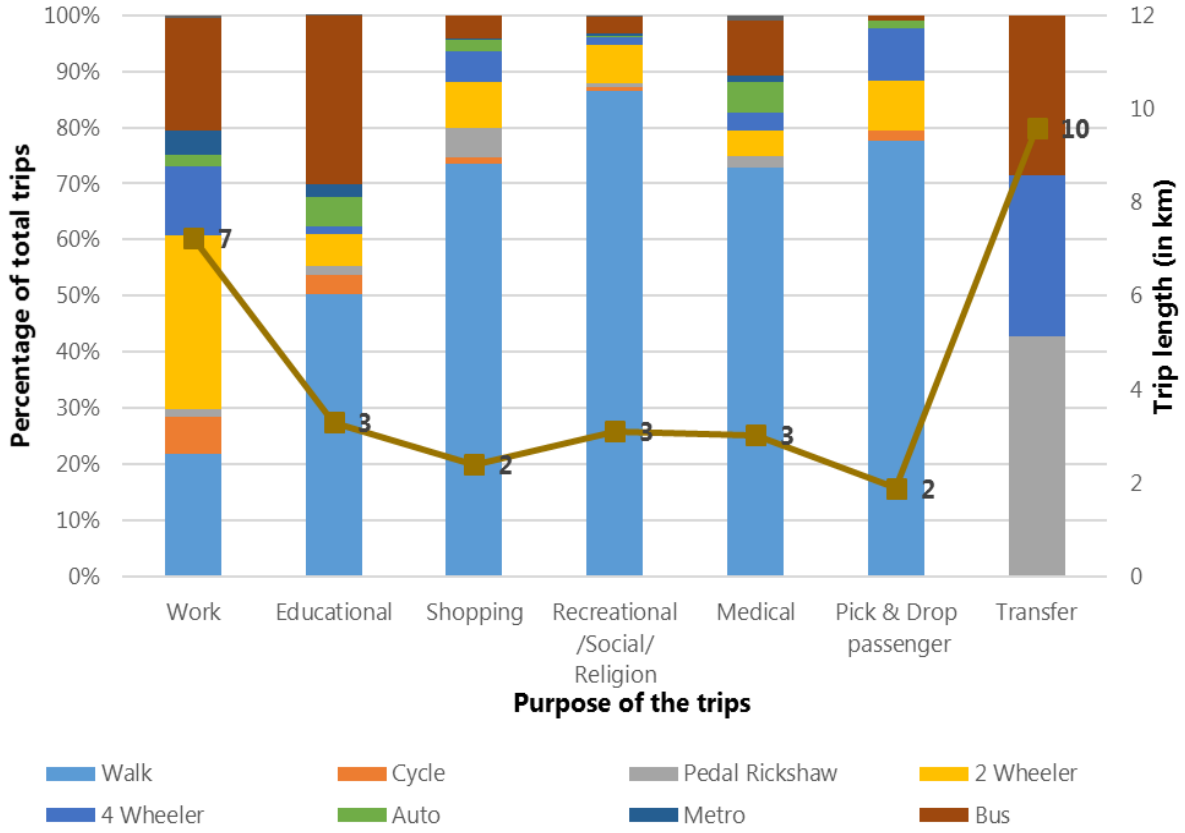


Figure 17: Trip Purpose by Mode and Average Trip Length by Purpose in Dwarka (source: primary survey)

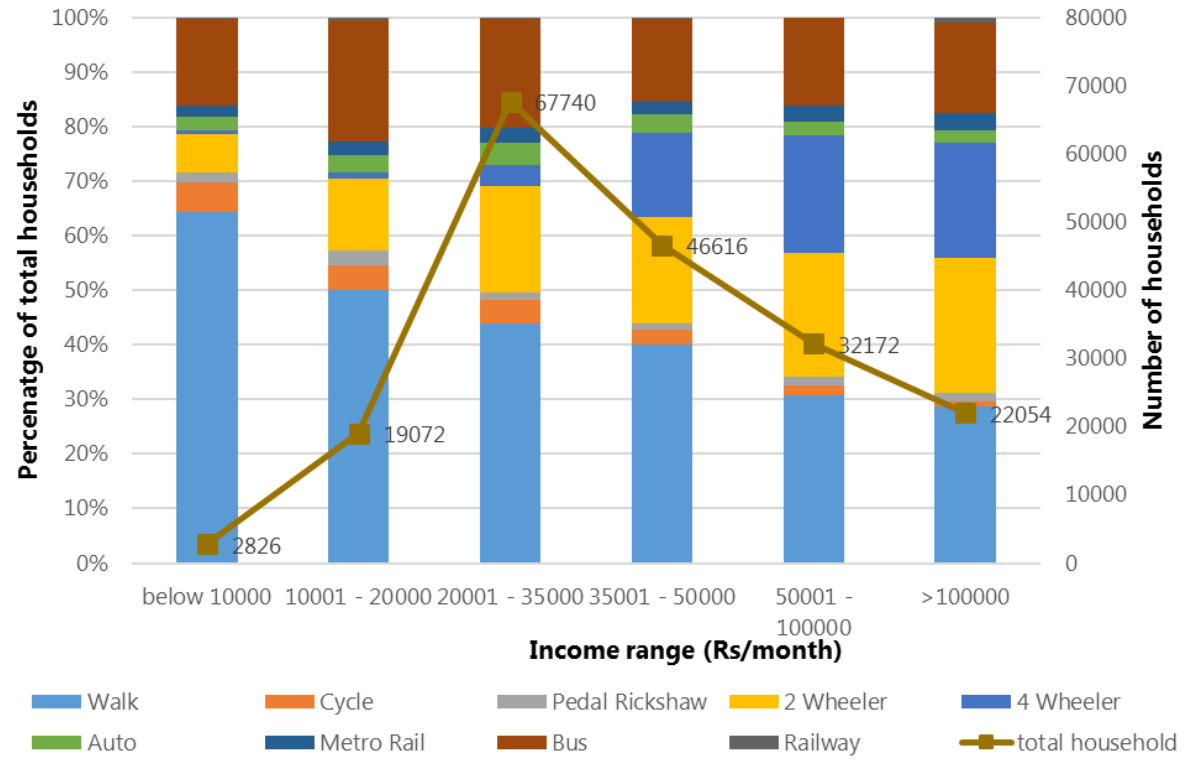


Figure 18: Mode choice and Household income (source: primary survey)

4.6 Trip length

Interestingly 70 percent of the trips in Dwarka have trip lengths less than 5km while 80 percent of the total trips made by females are under 5km of length (12 minute walking time), which increases the number of potential users of the PBS system (Refer Figure 19 and Figure 20). Average trip length including walk is 5.9km. Two wheeler, four wheeler and metro trips are longer with 13.5, 14 and 20.44 km respectively, along with high dependency on two wheelers. Population of Dwarka travels much longer on motorized modes as compared to trip lengths in Delhi (refer Figure 21). The main target of the PBS system should be short trips i.e. bicycle trips, pedal rickshaw trips and also last mile trips for metro and bus users. Work trips are longer i.e. 7.33km, all other purpose trips have average trip lengths within 6kms (refer Table 8). Number of trips made by females in different TAZ has been shown in map no 7.

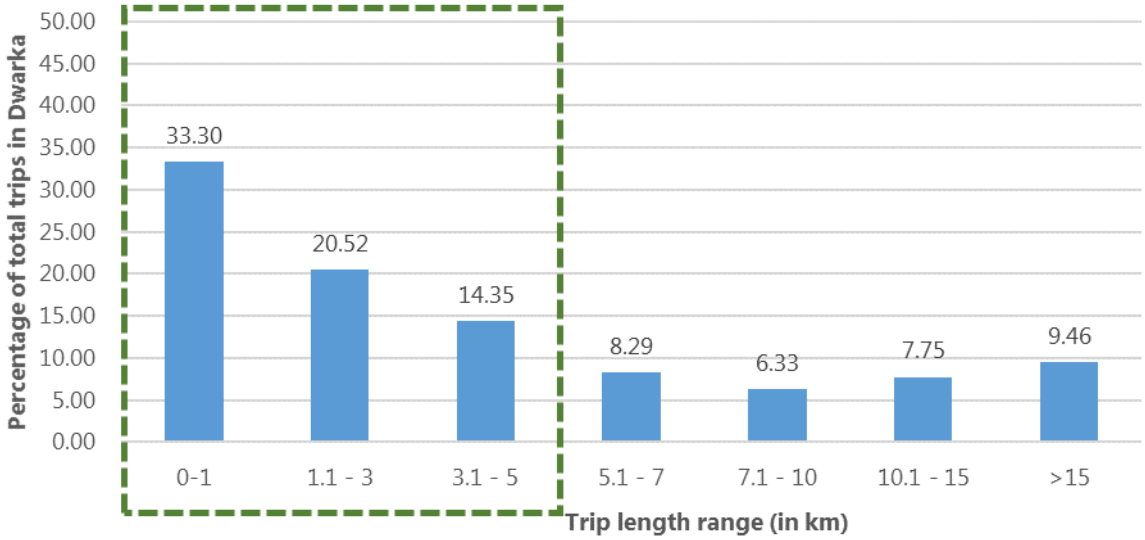


Figure 19: Trip length distribution for Dwarka (source: primary survey)

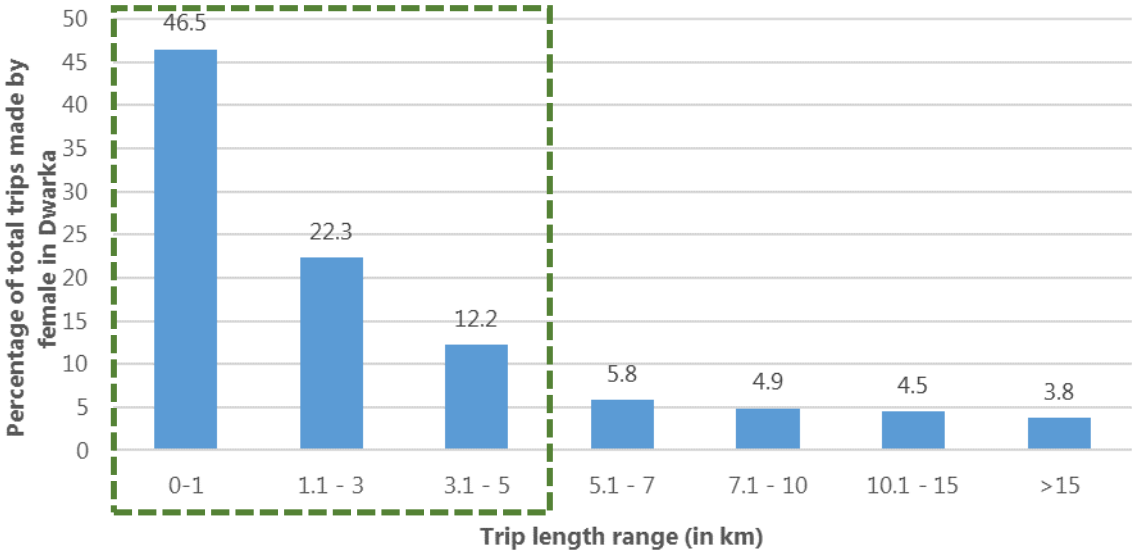


Figure 20: Trip length distribution: trips made by female (source: primary survey)

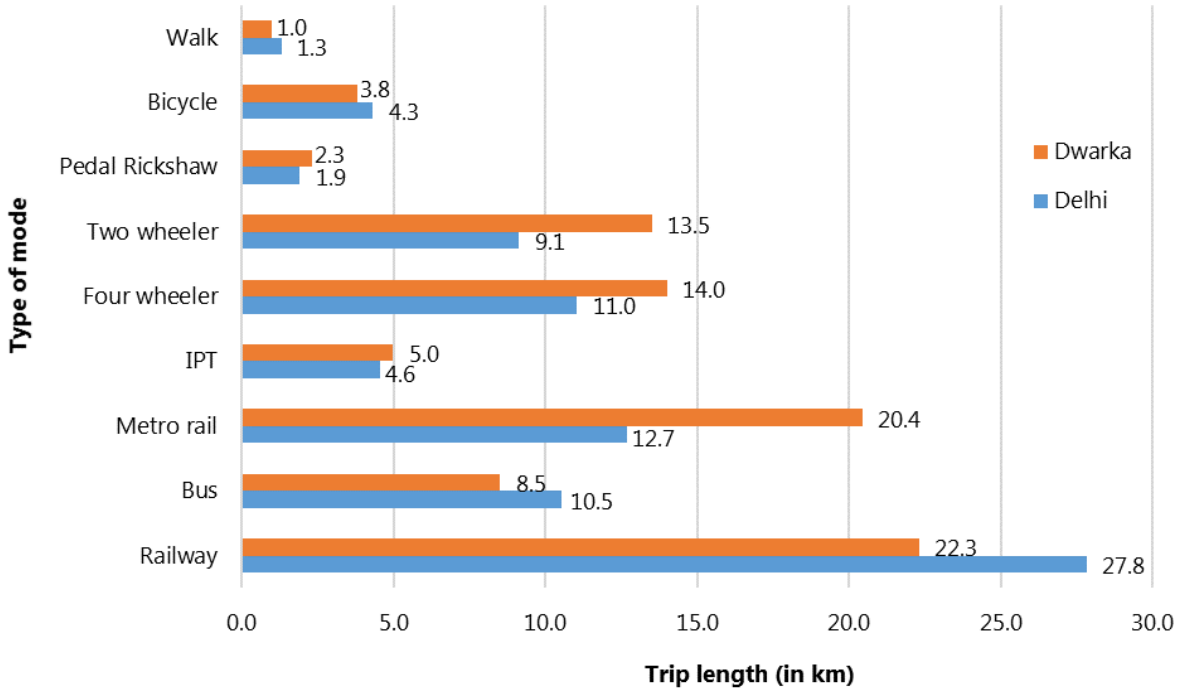


Figure 21: Average trip length mode wise for Delhi and Dwarka (source: primary survey) (RITES, 2007)

Table 8 Trip length by trip purpose (source: primary survey)

Trip purpose	Average trip length (in km)
Work	14.5
School/ Edu.	3.3
Shop/Market	2.4
Recreation/social/religion	9.34
Medical/Health	3.03
Pick & Drop passenger	1.9
Transfer/ Other mode of travel	9.6
Other	2.56

4.7 Last mile connectivity

Metro and DTC bus service are the life lines of Dwarka. But the last mile of the commute is still dependent on auto rickshaw, pedal rickshaw and electric rickshaw. For any of these modes, the charges are very high and provided the income group in Dwarka, it is more of affordability issue. Dependency on sharing of auto, pedal rickshaw and e-rickshaw service entails time wastage, compromising women safety and inconvenience in general.

4.7.1 Metro Rail

The dominant modes of metro access and egress trips are either walk, two wheelers or autos contributing 45, 22 and 13 percent of total access and egress trips respectively (refer Figure 22) while in trips made by females 44, 26 and 13 percent respectively (refer Figure 23). Prominent mode of commute for last mile connectivity within 1km is walk, contributing about 98 percent of the total trips made in this particular distance range, auto and pedal rickshaw in distance range of 1.1 – 3km and 2 wheeler, auto and bus in distance range of 3 – 5km (refer

Figure 23). This indicates people's dependency on intermediate para-transit and public transport modes for longer trips. Parallel to that, it has been observed that the use of auto and pedal rickshaw increases with the income (refer Figure 25).

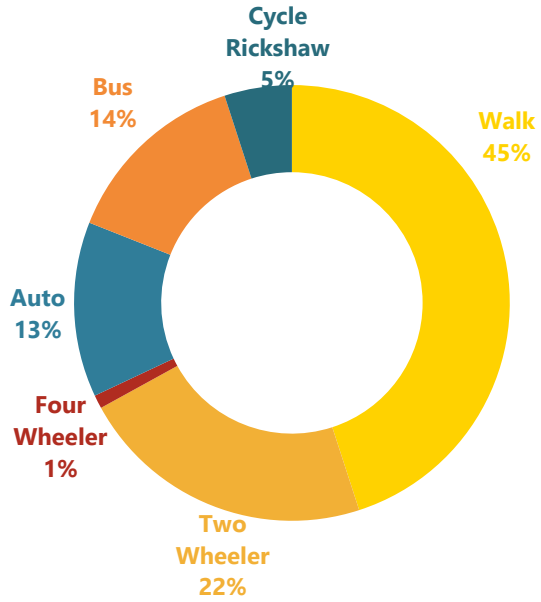


Figure 22: Mode split for metro access and egress trips (source: primary survey)

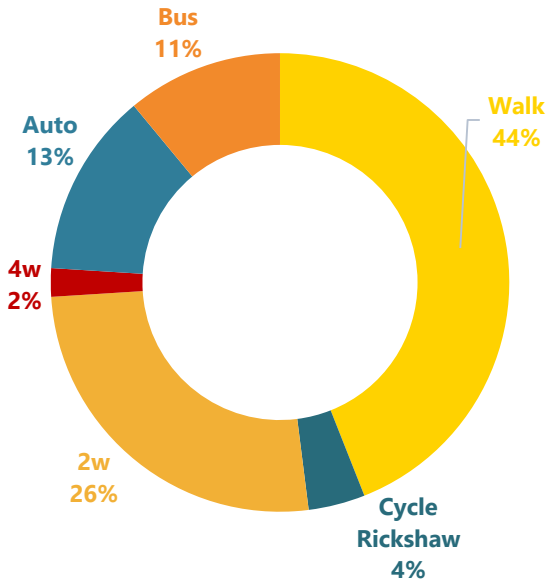


Figure 23: Mode split for metro access and egress trips made by female (source: primary survey)

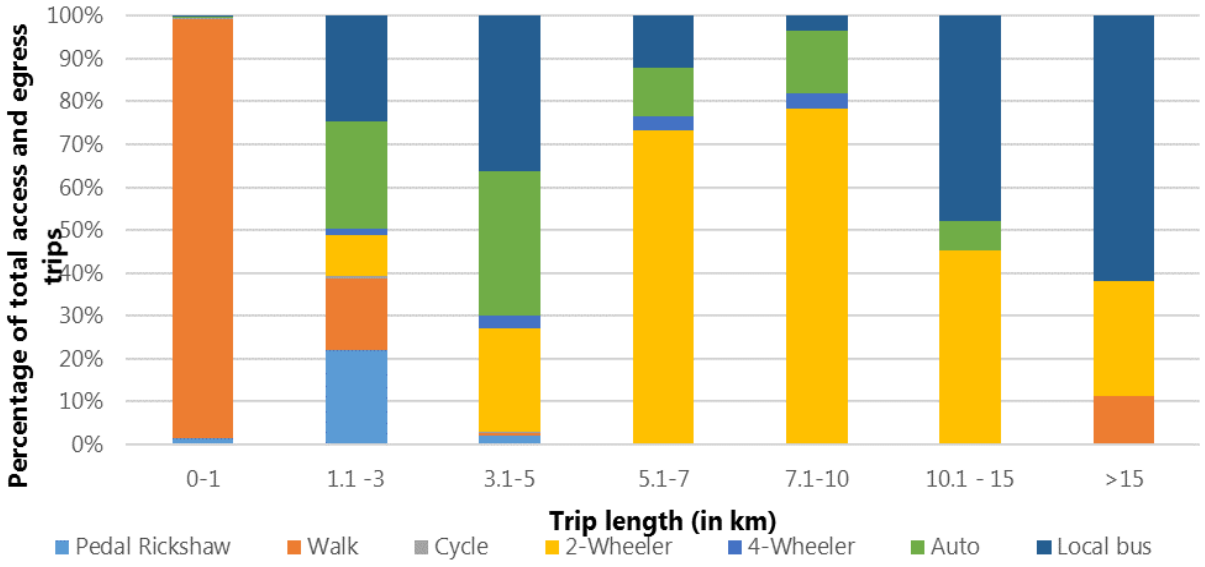


Figure 24: Metro: mode choice and trip length for access- egress trips (source: primary survey)

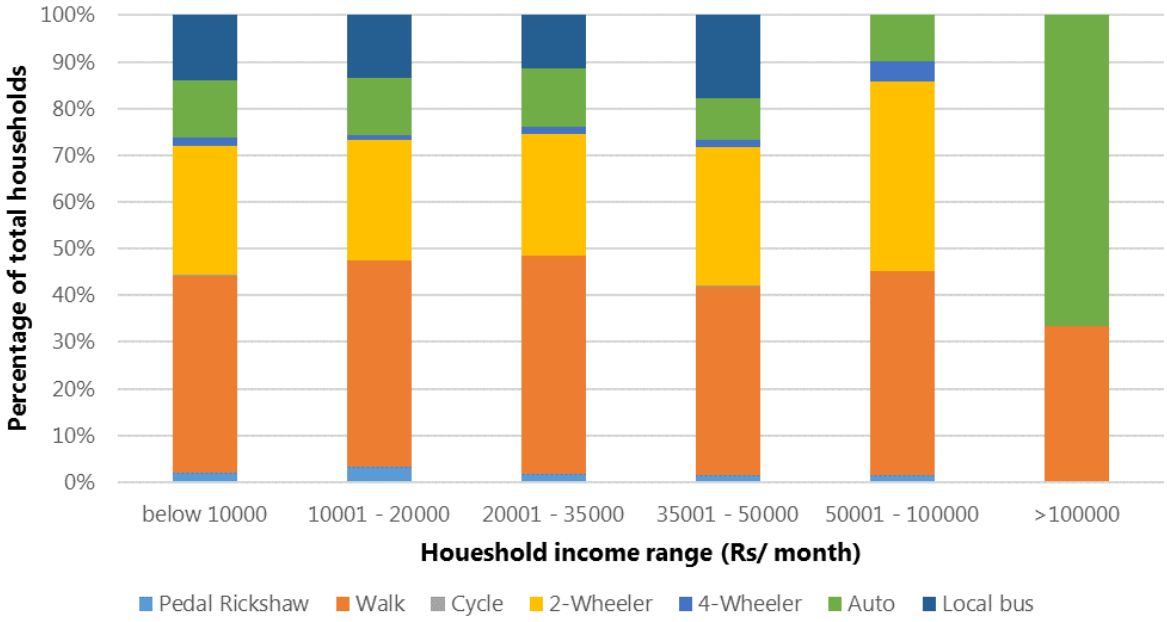


Figure 25: Metro: mode choice and income (source: primary survey)

4.7.2 Bus

95 percent of the access and egress trips made by bus users are on walk, while 97 percent trips made by female bus users are on walk, which is alarmingly high (refer Figure 26)
67 percent of the trips happen within the range of 1km and 33 percent happens for distances between 1 to 3km. Ideally, from this, trips 2 – 3km in length will be potential users of the PBS system.

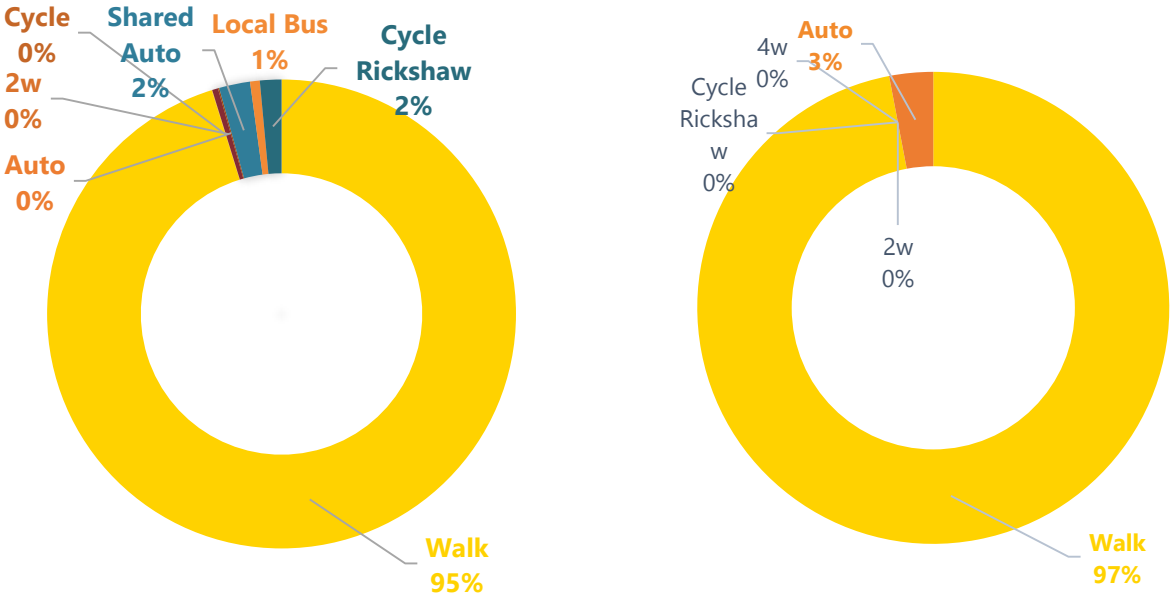


Figure 26: Left - Modal Split: last mile for bus users(source: primary survey)
Right - Modal split: last mile for female bus users (source: primary survey)

Observation and inferences of last mile connectivity is as follows:

- Significant amount of trips depend on non-motorized and public transport i.e. around 72 percent and 70 percent respectively of the total trips in Dwarka are made within 5km of trip length.
- 63 percent and 16 percent trips are made on walk and bus respectively from the total trips made by women.
- For last mile connectivity to metro rail, 45 percent of the population used walk as their access and egress mode of travel. And to bus, 95-97 percent people used walk as their access and egress mode.

This calls for economical and personalized last mile connectivity options and also for positive reinforcement in terms of street safety such as safe pedestrian facilities, luminous edge to street edges, and shaded walkways. PBS will not only improve connectivity options in Dwarka but will also increase people's safety on the streets.

Considering Dwarka's land use which has stretches of residential land use, fragmented section of commercial patches, and very less mixed land use; the overall activity on street is visibly low compared to places which have more mixed land use, such as in Ahmedabad. In Dwarka, streets tend to get deserted after peak traffic hours, which is a major concern for women safety. Connecting the city with PBS also opens up the opportunity to look into issues of women safety and make them a better place for all.

5. DEMAND ASSESSMENT AND SYSTEM PHASING

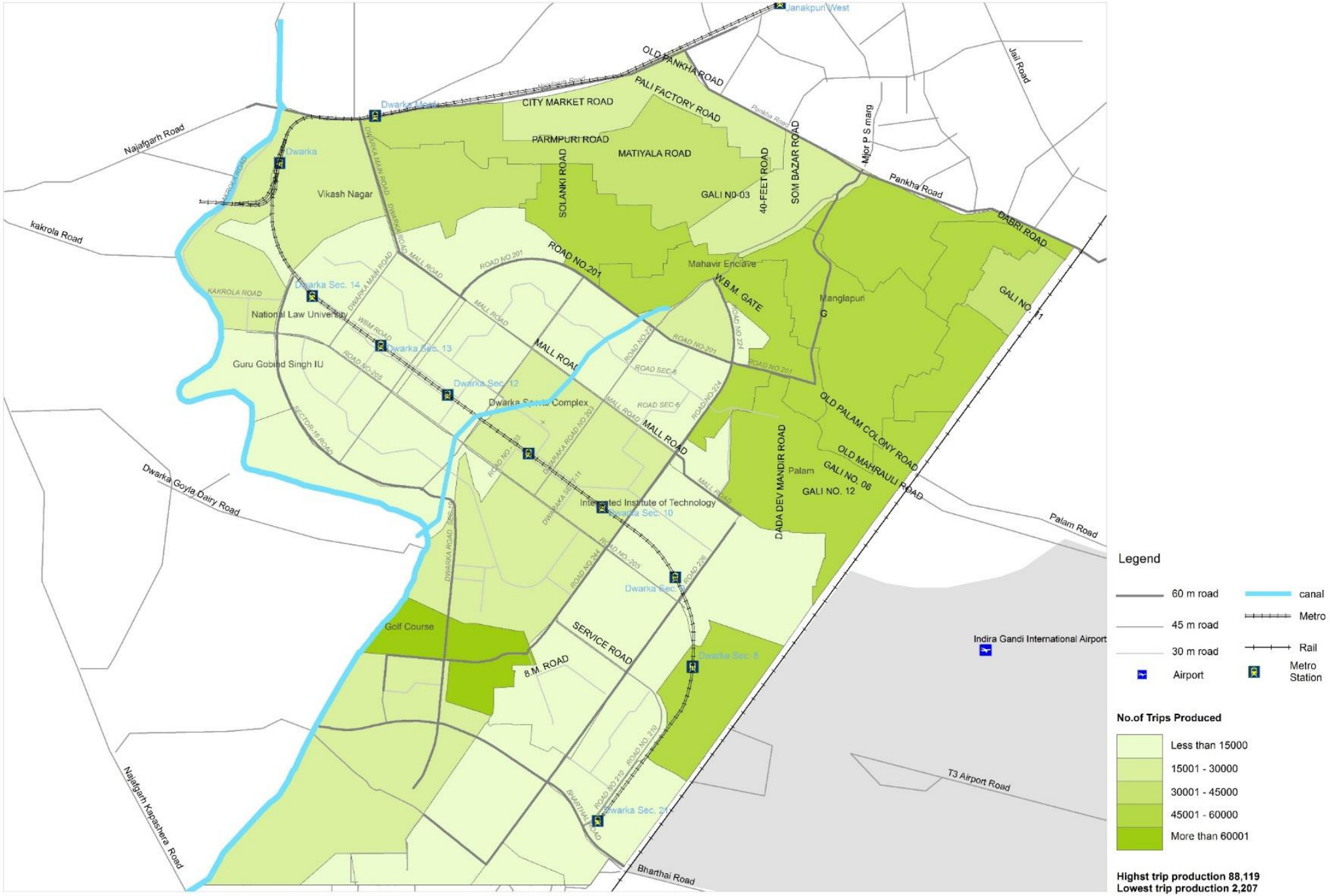
Demand assessment process is to assess demand, identify the trip attraction demand and trip production demand for TAZs, and then estimate the size of the system based on potential users. As discussed in the previous chapter, Dwarka is in need of alternative modes for last mile connectivity. In order to assess the demand following steps were followed:

- Understanding the travel characteristics (chapter 3) and trip generation pattern
- Estimating potential users
- Estimating the fleet size
- System phasing
- Determining the station location and its size

As mentioned in topic 1.5 (Data Base), to understand social, economic and travel characteristics, household surveys have been done. And to know perception about PBS and travel diary, user perception surveys have been conducted at metro stations and bus stops.

5.1 Understanding trip generation pattern

The correlation between various parameters such as socio economic characteristics, land use and travel characteristics results in mobility demand from the population. Due to sectorial planning and less mixed use structures, Dwarka has a huge difference in the number of production trips and attraction trips in each zone (refer Map 9 and Map 10). Due to high disparity in terms of density, unauthorized and authorized colonies have huge differences in terms of demand. Apart from this, TAZ no. 6, 10, 12 with market area experiences a high attraction demand (refer Map 10)

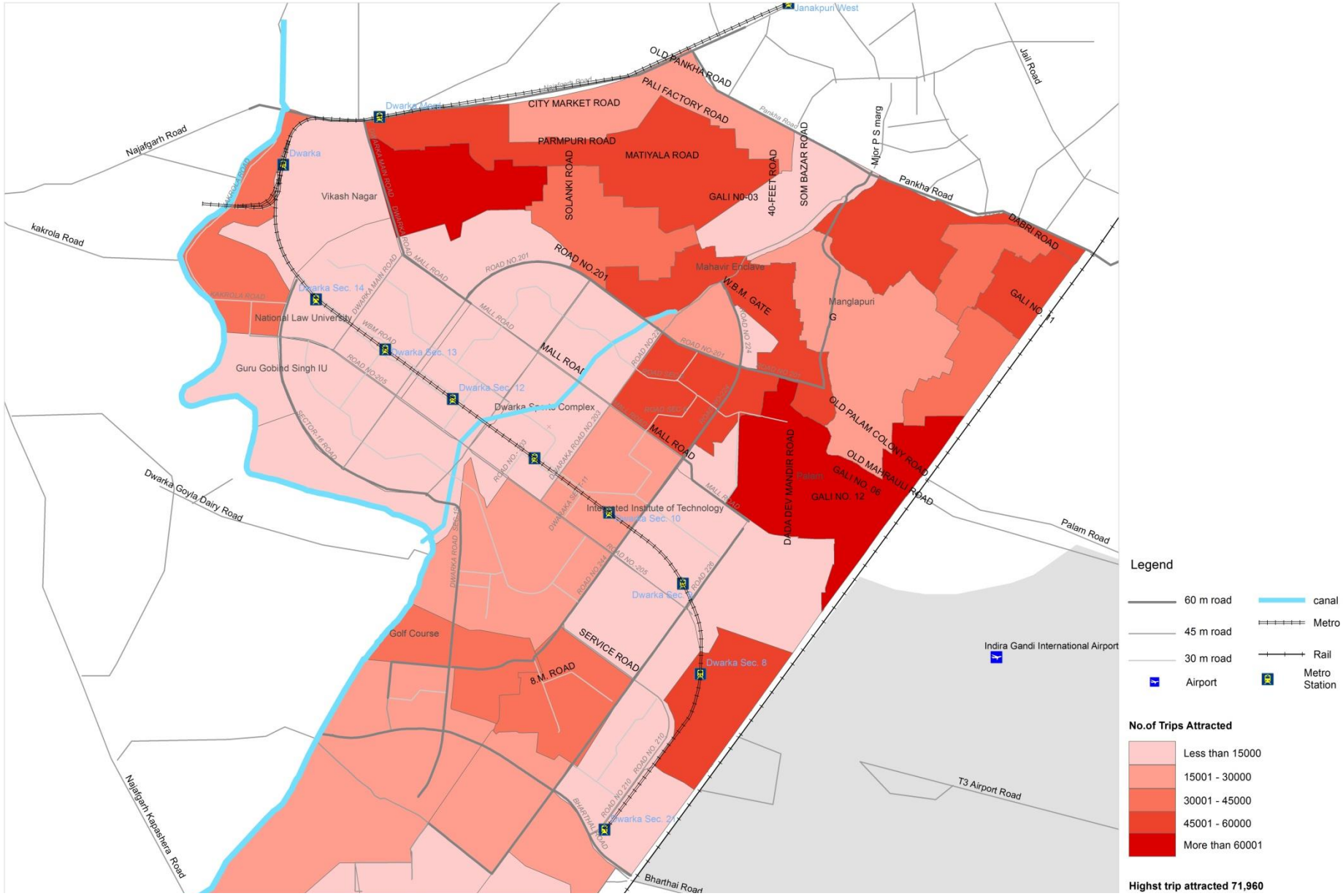


PUBLIC BICYCLE SHARING for DWARKA, New Delhi | Zone map: Production trips

MoU for technical assistance between Delhi Development Authority and Centre for Green Mobility |

0 2 4 6 8 Kilometers

Map 11: TAZ Wise Production Trips of Dwarka



Map 12: TAZ Wise Attraction Trips of Dwarka

Scale 0 0.5 1 2 Kilometers

5.2 Estimating potential users

To calculate the potential trips on PBS, from the surveys excel based modeling has been done. The demand has been calculated in terms of number of trips, number of bicycles, number of docks, number of stations and the station size. To analyze all possible probabilities, three scenarios have been created i.e., most conservative, mid-conservation and optimistic. Following parameters have been considered while estimating trip demand:

- Trip purpose
- Trip distance
- Mode of travel
- Age of the user
- Willingness to shift to PBS

Trips within 5 kilometers of trip length (12 minutes of walking distance) are major target groups for PBS. The main trips within five kilometers except the ones on public transit have been considered from household survey data. Public transit trips and access-egress trips to public transit have been considered from user perception surveys done. Figure 27 represents the consideration of trips:

Target group for PBS
(Trips under 5 km)

A. User perception surveys on Public transport
(Last mile connectivity)

B. Household survey data
(Main trips except trips on public transit)

Figure 27: Components for Demand Assessment

5.2.1 Demand calculation from user perception surveys

As mentioned above various parameters have been considered to arrive at scenarios in terms of number of trips. Total demand of access- egress trips were screened using the parameters mentioned above in stepwise process (refer Figure 28). Steps have been explained below:

Step 1: TAZ wise, numbers of trips were taken of the people who expressed their willingness to use PBS during user perception surveys.

Step 2: Second step was based on an assumption that even if people are willing to shift to PBS, there is probability of them not availing the services of the system due to factors such as their age, health issues etc. Assumptions has been considered that people falling under the age group of 20 – 45 would be the primary users of the proposed system and therefore the trips of same age group people have been taken into consideration from all people who are willing to use the PBS.

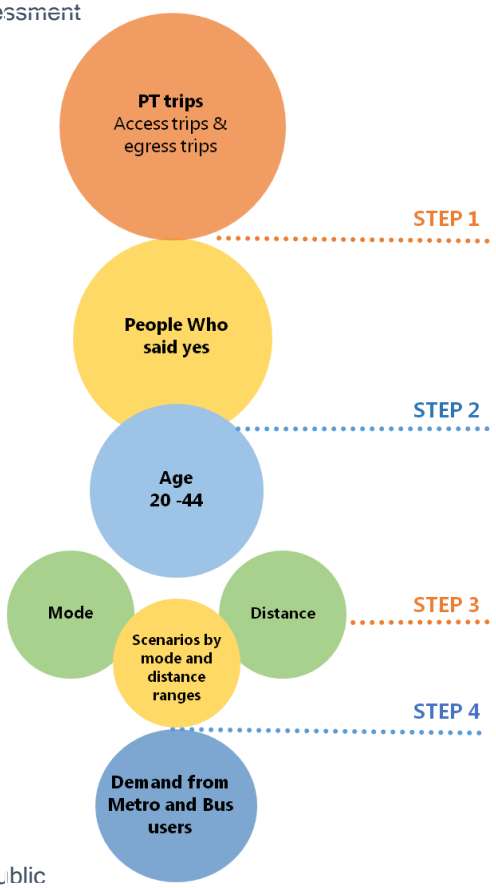


Figure 28: Screening Procedure for Public Transit

Step 3: The third step was the screening done based on trip length by mode. This was based on an assumption that even if the users are willing to shift to PBS, the trip length and current mode of travel will be a major factor to rethink about the acceptability of the system.
Three scenarios were thus prepared using mode and trip length. Bus user scenarios and metro user scenarios were prepared differently due to their distinct difference in trip length and current mode of travel. Scenarios for metro system user and bus users have been stated in Table 9

Table 9 Metro and Bus Users: Mode and Distance Scenarios for Demand Calculation (source: primary survey)

Mode	Distance range	Metro users: Last mile trips			Bus users: Last mile trips		
		Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Walk	0-1	0%	0%	0%	0%	0%	0%
	1-3	5%	7%	10%	5%	7%	10%
Cycle	all	10%	25%	30%	-	-	-
Two wheeler	0-3	10%	20%	30%	-	-	-
	3-5	7%	10%	15%	10%	20%	30%

	5-7	0%	0%	10%	-	-	-
Four wheeler	**0-5**	5%	10%	15%	-	-	-
	5-7	0%	0%	0%	-	-	-
Auto	**3-5**	30%	60%	80%	-	-	-
	5-7	0%	0%	0%	-	-	-
Shared auto	**0-3**	50%	60%	80%	50%	60%	80%
	3-5	10%	15%	20%	30%	50%	80%
	>5	0%	0%	10%	0%	0%	5%
Local bus	**0-3**	20%	40%	60%	20%	40%	60%
	3-5	5%	10%	15%	20%	40%	60%
	>5	0%	0%	0%	0%	0%	0%
Pedal rickshaw	**0-1**	50%	50%	100%	50%	50%	100%
	1-3	20%	30%	50%	60%	80%	90%
	3-5	0%	20%	30%	50%	60%	80%
	>5	0%	0%	2%	-	-	-

5.2.2 Outcome

From all the above procedure, demand has been calculated in terms of number of trips. After these procedures, potential trips from public transport users have been shown below:

Table 10 Potential Trips from Public transport

Type of PT trip	Scenario1	Scenario2	Scenario3
Trips from metro users	5273	7660	11899
Trips from bus users	1162	1601	2091

5.2.3 Demand calculation from household surveys

As mentioned in topic 4.2 various parameters have been considered to arrive at scenarios in terms of number of trips. Total demand of trips excluding trips on public transit were screened using the parameters mentioned above in stepwise process (refer Figure 29). Steps have been explained below:

Step 1: After considering, only short trips i.e. trips falling under 5km first step was based on an assumption that there is probability of people not availing the services of the system due to factors such as their age, health issues etc. An assumption has been considered that people falling under the age group of 20 – 45 would be the primary users of the proposed system and

therefore the trips of same age group people have been taken into consideration from total trips.

Step 2: Third step was the screening based on purpose of the trip. Various scenarios were made for different purposes according to trip length and mode. Screening was based on the argument that even if users are willing to shift to PBS, the purpose of the trip along with trip length and current mode will be major factor to rethink the acceptability to the system.

Step 3: Three scenarios were thus prepared using trip purpose, mode and trip length. Bus user scenarios and metro user scenarios were prepared differently due to the distinction in trip lengths and current mode. Scenarios for household survey have been stated in Table 11.

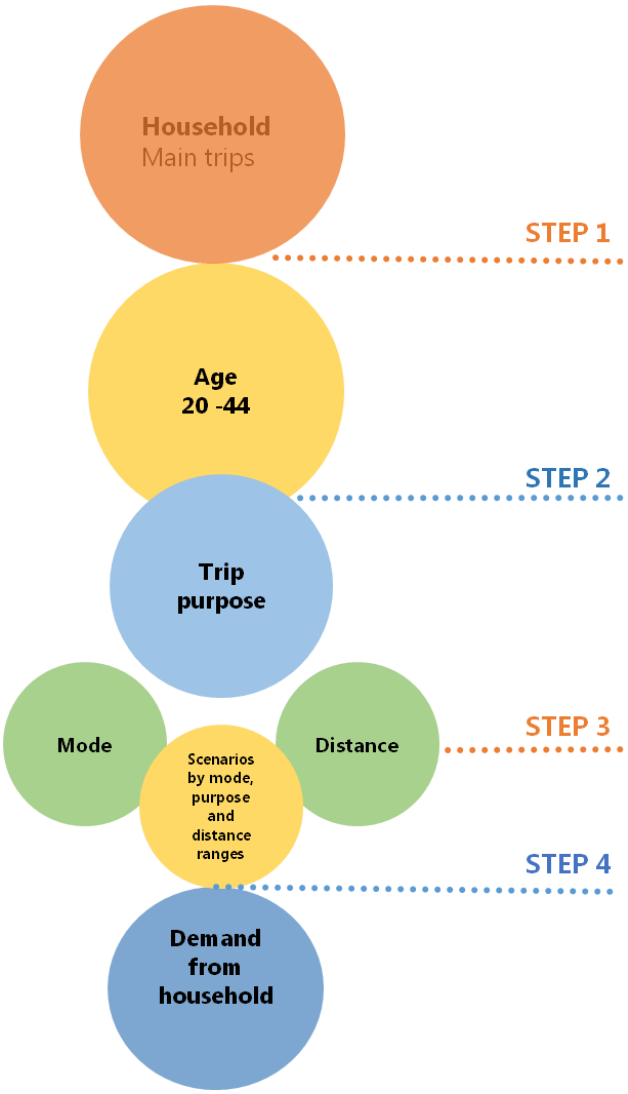


Figure 29: Demand Assessment: Screening procedure for Household survey

Table 11 Household Trips: Trip Purpose, Mode and Distance Scenarios for Demand Calculation

Mode	Distance range (In km)	Work trips			Educational trips			Recreational trips		
		Scenarios			Scenarios			Scenarios		
		1	2	3	1	2	3	1	2	3
Walk	0-1	2%	4%	7%	1%	3%	6%	1%	1.5%	2%
	1-3	7%	9%	12%	7%	9%	12%	4%	6%	9%
	3-5	3%	4%	7%	-	-	-	-	-	-
Cycle	0-1	1%	3%	6%	1%	3%	6%	0%	0%	0%
	1-3	1%	3%	6%	-	-	-	1%	3%	6%
	>3	2%	4%	7%	-	-	-	-	-	-
Two wheeler	0-1	1%	3%	6%	-	-	-	-	-	-
	1-3	7%	9%	12%	-	-	-	-	-	-
	3-5	3%	4%	7%	3%	5%	8%	1%	3%	6%
Four wheeler	3-5	1%	3%	6%	-	-	-	1%	3%	6%
	5-7	-	-	-	-	-	-	-	-	-
Three wheeler	3-5	7%	9%	12%	-	-	-	7%	9%	12%
Shared 3w	3-5	10%	12%	15%	10%	12 %	15%	10%	12%	15%
Pedal rickshaw	0-3	10%	12%	15%	-	-	-	10%	12%	15%

5.2.4 Outcome

From all the above procedure, demand has been calculated in terms of number of trips, after this procedure, it was arrived at that 4713, 6570 and 10003 are potential users from household main trips in scenario 1, 2 and 3 respectively (refer Table 12)

Table 12: Potential Trips from Household Trips

Type of trips	Scenario1	Scenario2	Scenario3
Trips from household main trips	4713	6570	10003

5.2.5 Summary

The combined public bicycle sharing system demand has been projected at 11146, 15827 & 23988 in scenario1, 2 and 3 respectively which is 0.57 percent, 0.81 percent and 1.23 percent of total trips (refer

Table 13). For proposal of PBS, most conservative demand has been taken in to consideration.

Table 13: Estimated Demand

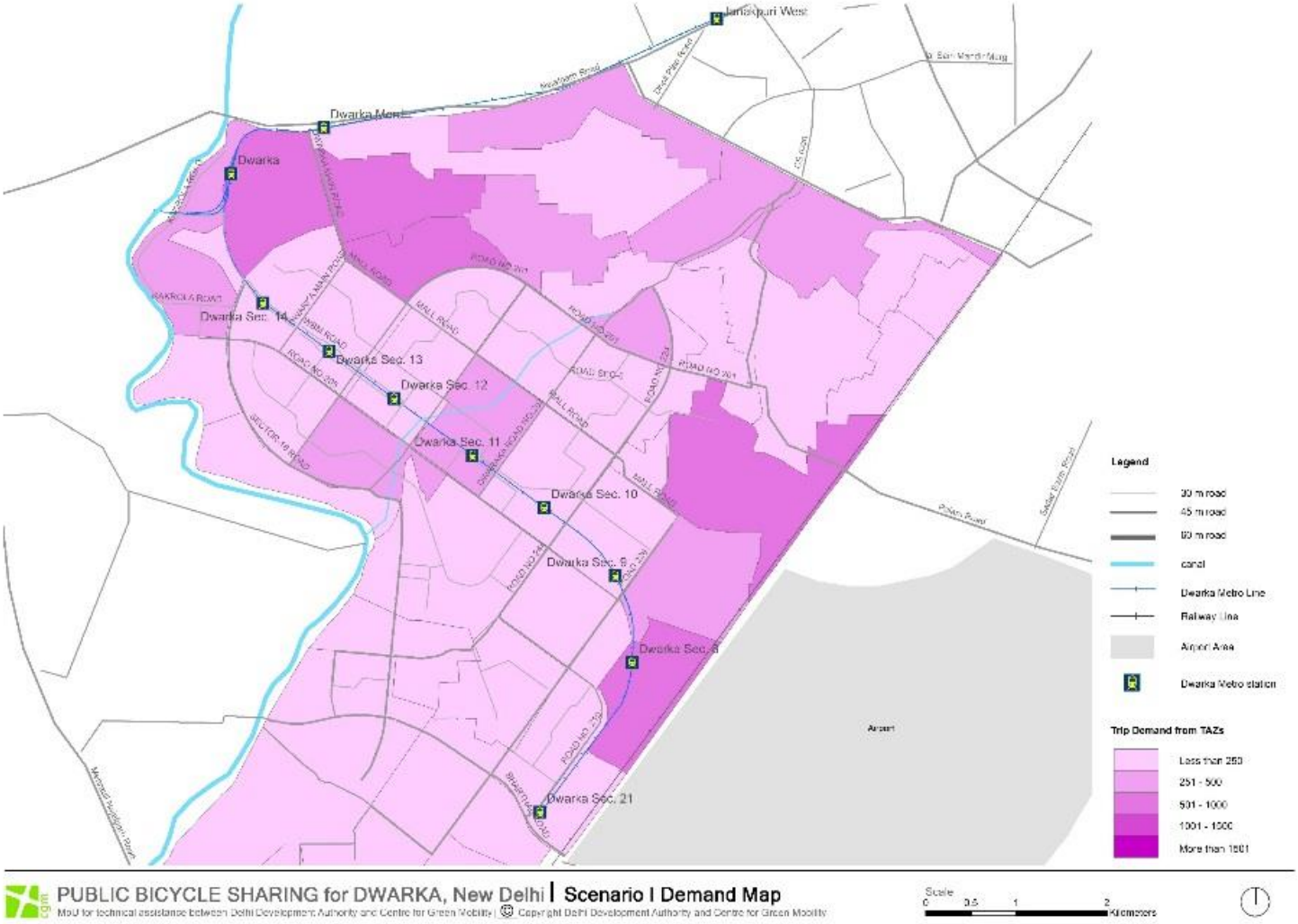
	Total trips	Scenario1	Scenario2	Scenario3
Total demand	19,49,281	11,146	15,827	23,988
Percentage of total trips	100	0.57	0.81	1.23

5.3 Estimating fleet size

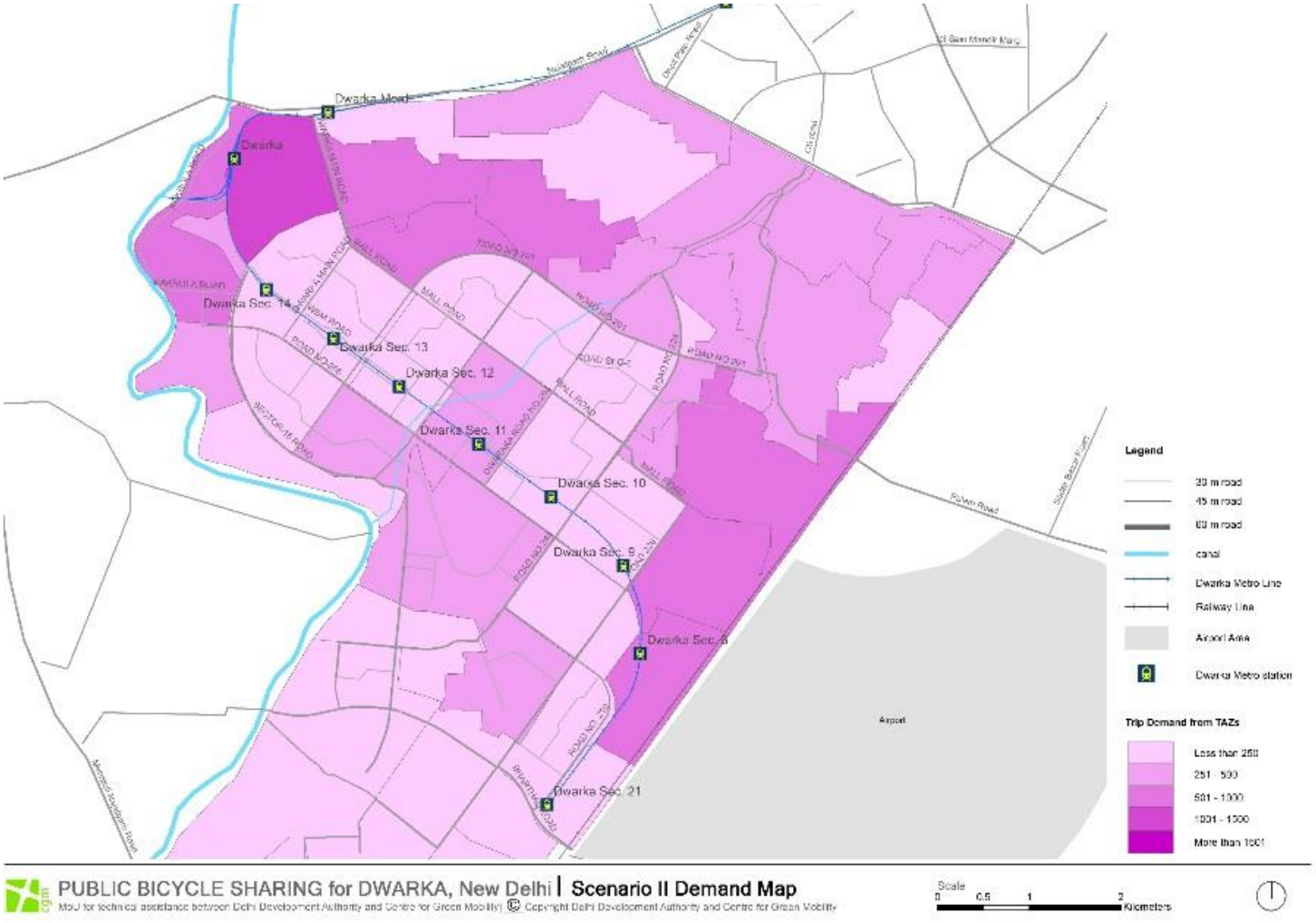
Based on the potential demand and coverage area, the initial calculation of station size and fleet size has been arrived at. Case studies state that in public bicycle sharing system all over the world, a single bicycle is normally used for anywhere between 3 to 4 trips per day. Considering the most conservative estimated for the number of shares per bicycle of 2.5 trips per bicycle, we would arrive at 4459, 6331 and 9595 bicycles for scenario1, 2 and 3 respectively (refer Table 14).

Table 14 Summarized Demand in terms of Trips for entire Dwarka

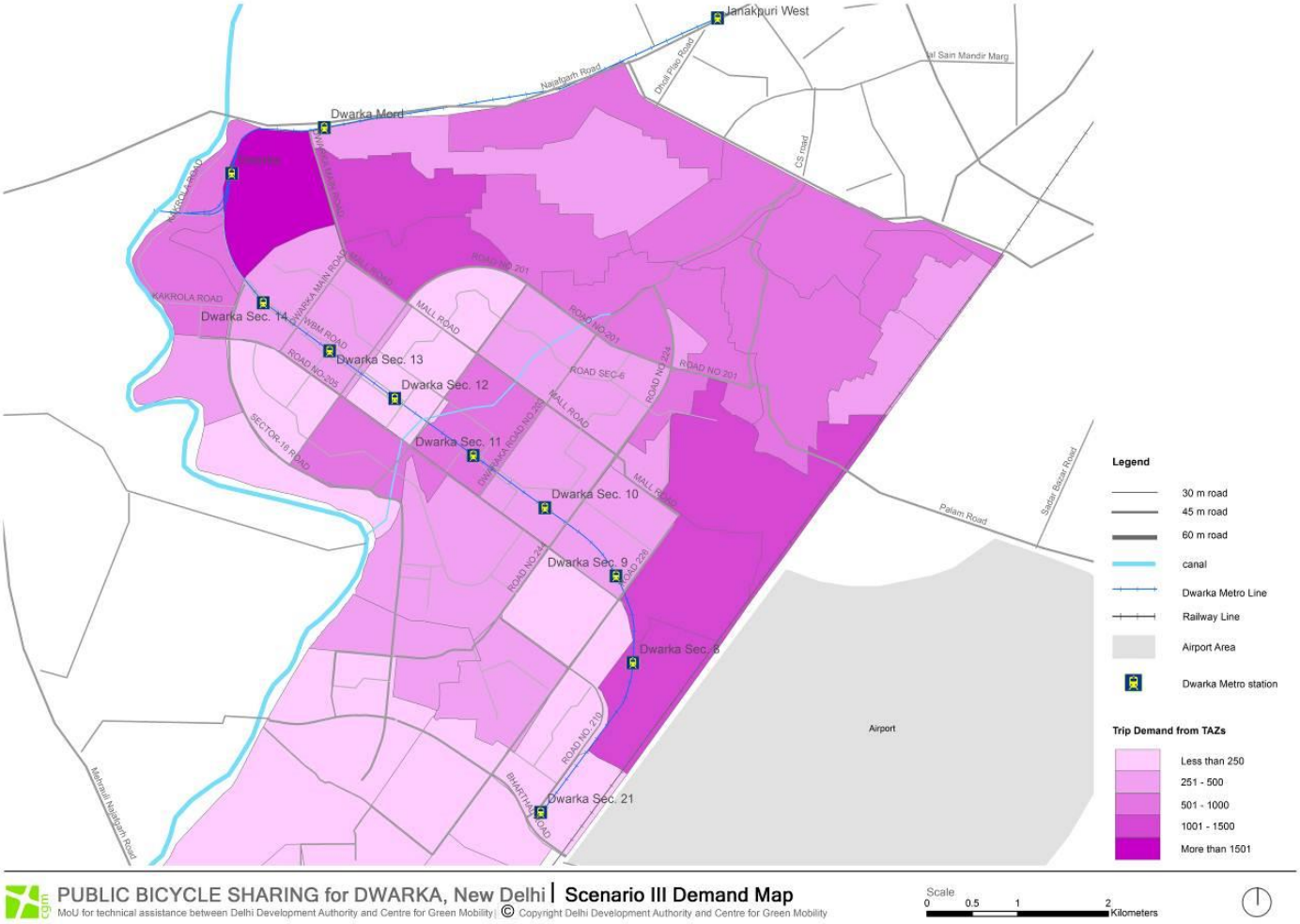
Sr. no	Topic	Scenario1	Scenario2	Scenario3
1	Total demand	11,146	15,827	23,988
2	Percentage of total trips	0.57	0.81	1.23
3	No of bicycle by 3 shares	3715	5276	7996
	Spare bicycles	100	100	200
	Total no. of bicycles by 3 shares	3815	5376	8196
4	No of bicycle by 2.5 shares	4458	6331	9595
	Spare bicycles	100	100	200
	Total no. of bicycles by 2.5 shares	4558	6431	9795



Map 13: Demand Scenario-I map of Dwarka



Map 14: Demand Scenario-II map of Dwarka



Map 15: Demand Scenario-III map of Dwarka

5.4 System Phasing

System phasing is the strategy to build the system in parts, depending on available resources, viability of project and also ensuring it's acceptability in the society. Dwarka has been divided in three levels of planning. Phase IA. IB and then Phase II. The criteria of phasing and numerical findings are given below.

5.4.1 Phasing parameters

Following parameters were considered while initial phasing:

1. Demand of trips within study area

In the study most conservative scenario has been considered for further analysis and estimations. The demand map (Refer map 13) show high demand around Dwarka metro station in the north eastern TAZs and adjoining TAZs on the right which engulfs the unauthorized areas of Dwarka. TAZs around metro station sector 11 and sector 8,9 shows high trip demand. The railway station of Palem located on the Dwarka boundary on the right also attracts high trip.

2. The existing public transit and major road network in the Dwarka

Dwarka has sectoral development with planned 60meter, 45 meter and 30 meter roads within the authorized area, while narrow winding streets are found on the northern part of the study area. The bus service is available in the entire city, while metro cuts cross from the center of the city and caters widely to the people living within the proximity of central part of the city. (Refer Map 10).

3. Major markets, institutions, residential, transport nodes and other attraction points

Major market, school colleges, transport nodes and other activity nodes that attract trips are located by large in the central part of the city and some bus stops are located in the outer edge of the study area, in the north. The heat map created, shows the density of various nodes within the study area. (Refer Map 9)

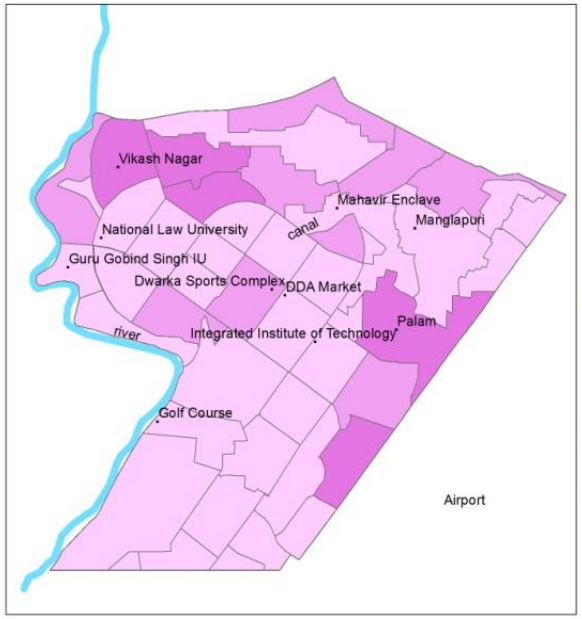
4. Demand of ridership at various transit location

The ridership data of metro and bus within Dwarka study area shows the central part of the city and outer edge in the north as the areas with high ridership. The white pocket shown in the map 16 indicates areas with lack of public transit.

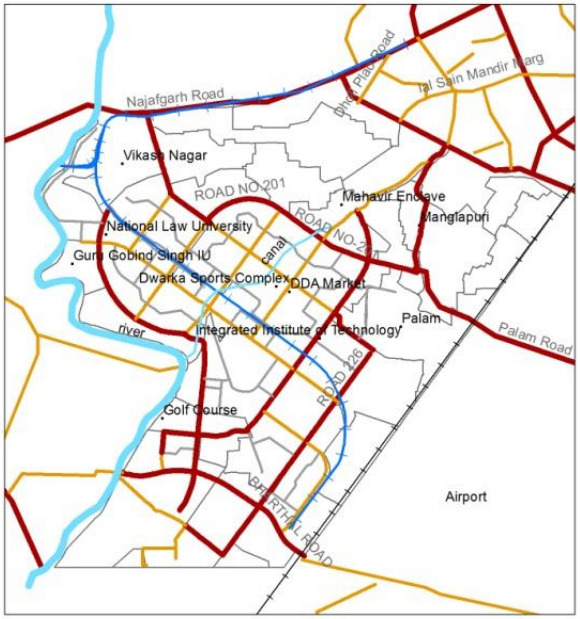
5. Phasing of proposed project of non-motorized vehicle lanes

Dwarka has proposal of building NMT lanes. The proposal has identified the central part of the city encircling the Metro corridor has the study area. (Refer Map 16). This project will ensure availability of safe infrastructure support system for NMV.

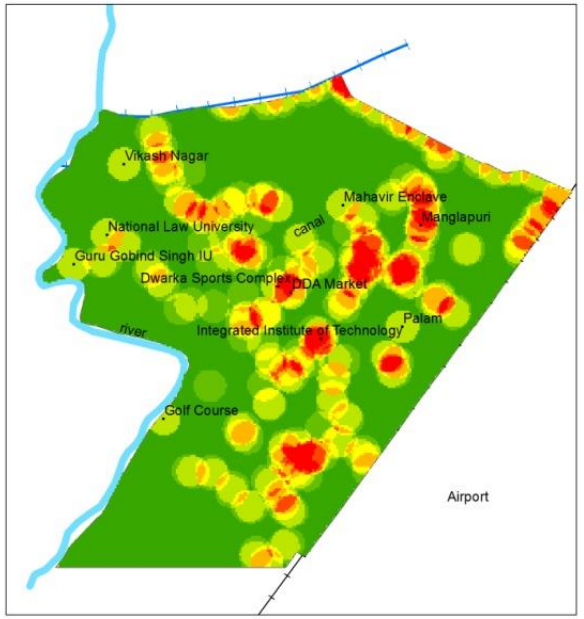
By, studying the parameter mentioned above, the area delineation for phase I have been considered. The high demand of trips are amongst the northern TAZs but the rest of the features by large engulfs the central part of the study area. For that reason Phase I has been delineated considering the central area with adjoining high demand TAZs. (Refer Map 17)



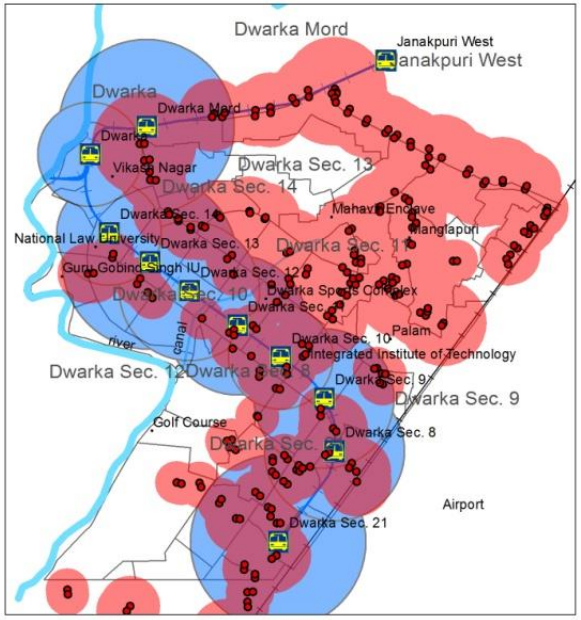
Trip Demand Scenario I Map



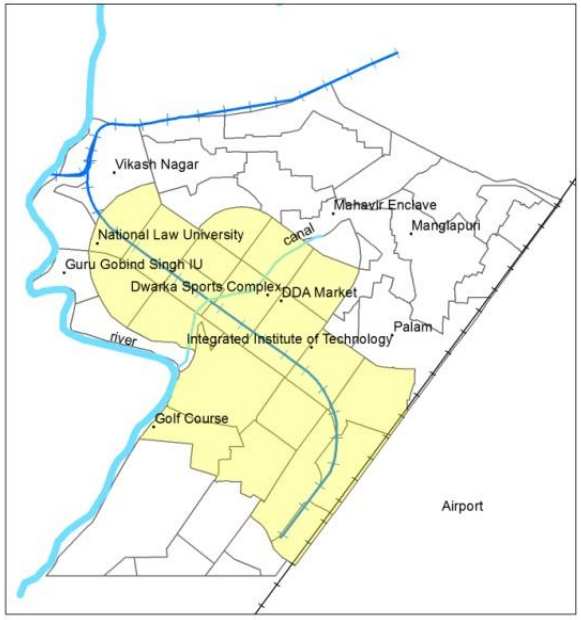
Road Network



Heat Map



Public Transport Ridership



NMV Project Study Area

Legend

Trip Demand of Scenario I

- Less than 250
- 251 - 500
- More than 500

Road Network

- 60 m road
- 45 m road
- 30 m road
- Other roads
- Metro Rail (Blue Line)
- Railway Line
- Canal
- River
- Metro Station

Heat Map, from activity nodes and transit nodes

- Low density
- High Density

NMV project study area

- Study area
- Traffic Analysis Zone (TAZ)

Ridership of Public Transport Dwarka

- 7 More than 40,000
- 6 20,001 - 40,000
- 5 10,001 - 20,000
- 4 5001 - 10000
- 3 1,001 - 5000
- 2 501 - 1,000
- 1 Less than 500

Map 16: Stages of Phase Delineation of Dwarka

The further phasing should expand the system. The expansion can be either be, by increasing the coverage area or strengthening the existing system within the same coverage area. Phasing should also consider the surrounding area which has potential of growth. (Refer Map 17)

5.4.2 Numerical findings from Phasing

The city has total area of 52sq.km. Phase I is of 30sqkm and covers around 68 percent of the total demand of Dwarka. Phase I is further divided in two parts, the first year of implementation is referred as Phase IA, and second year of Implementation is referred as Phase IB. (Refer Map 17). Thirty square km of area in Phase I will require nearly 2,500 bicycles as per the demand and assumption of 2.5 shares / bicycle. Phase IA has been assigned 60% of the bicycles (1,500 bicycles) and in the second year of implementation (Phase IB) remaining 40% share (1,000 bicycles) will strengthen the system.

And to cater the remaining demand of Phase II, additional 2000 bicycles will be required for 20 sq km area. For phase II, two shares per bicycle have been considered as; it includes areas which currently has low demand.

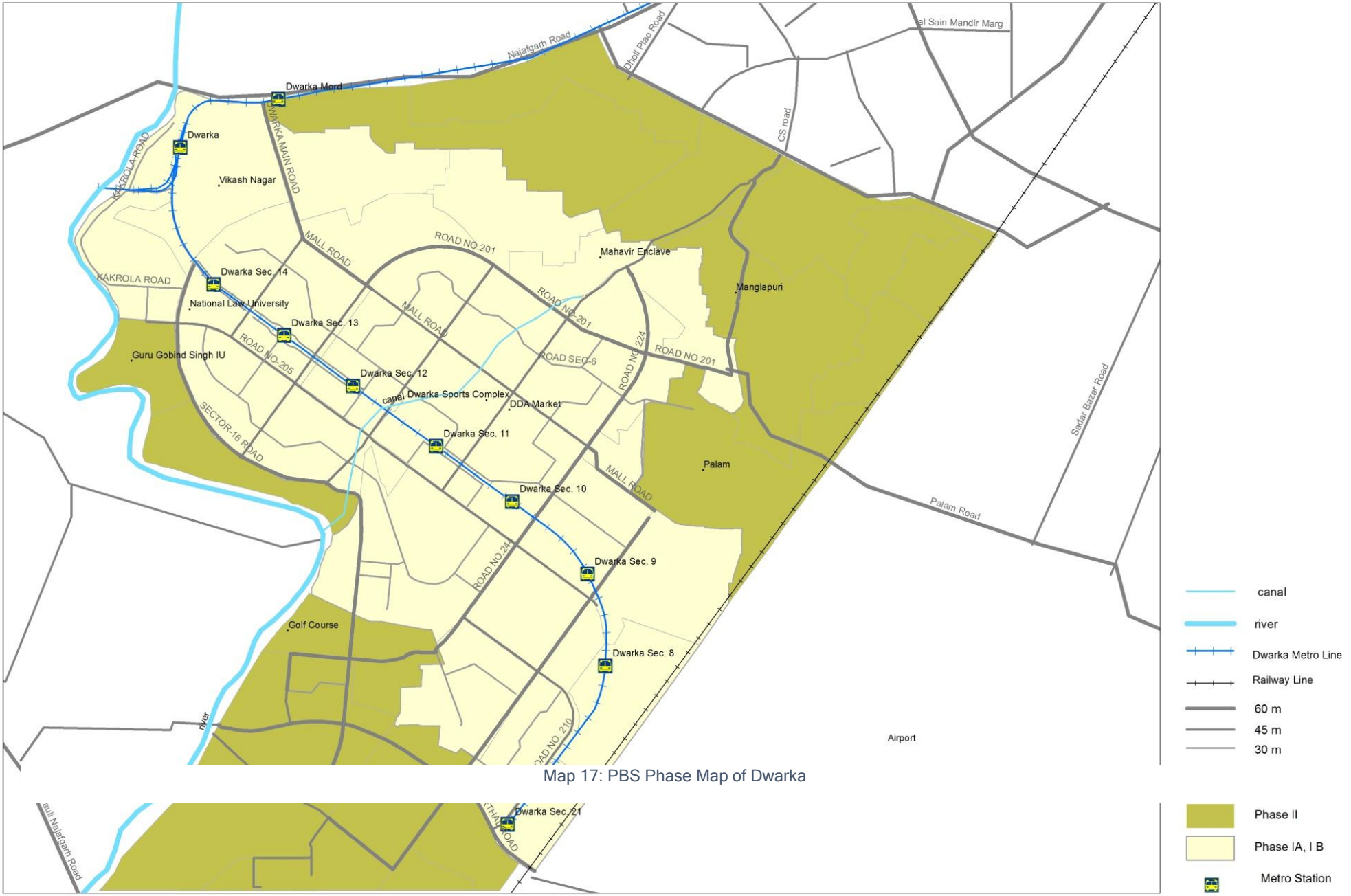
Phasing details have been explained below (refer Map 17 and Table 15):

- **Phase IA details (1st year of implementation):**
  - Coverage Area: 30sqkm
  - Stations: 100
  - Bicycles: 1500
  - Docks: 2025
- **Phase IB details (2nd year of implementation)**
  - Coverage Area: 30sqkm (same coverage area as phase I)
  - Stations to be added: 80
  - Bicycles to be added: 1000
  - Docks to be added: 1500
- **Phase II details (5th year of implementation)**
  - Coverage area to be added: 20sqkm
  - Stations to be added: 170
  - Bicycles to be added: 2000
  - Docks to be added: 3000

Distance between stations: 300-450m approximately.

Table 15: Demand Based on System Phasing

		Phase I				Phase II	
Scenarios	**Total demand of trips (overall Dwarka)**	**Total demand of trips (Phase I)**	**No of bicycle by 2.5 shares (Phase I)**	**Number of bicycles in Phase IA**	**Number of bicycles in Phase IB**	**Total demand of trips (Phase II)**	**No of bicycle by 2.5 shares (Phase II)**
1	11,146	7629	3052	1500	1500	3517	1407
Recommended Fleet size (with an allowable variation of 500 bicycles in Phase 1B and Phase 2)				1500	1000		2000



Map 17: PBS Phase Map of Dwarka

5.5 Station location and sizing

5.5.1 Identifying the station zones

Station zones identification is the step ahead process of identifying the station location. From the parameters of phasing delineation (refer Map 18), the most attractive zones were identified for whole of Dwarka. These attracting points are the point of origin and destination. Based on the zones identified, individually the locations were studied for identifying the station location.

Parameters considered for identifying the station zones;

1. Transit Location of Metro and Bus with demand for ridership
2. Attracting Nodes (commercial, institution, market, recreational etc)

Zones identified are the area expected to have demand for PBS. Also the zones identified are primarily on the higher order roads, mostly connecting the destinations, while the origin points will get covered when individually station location will be marked.

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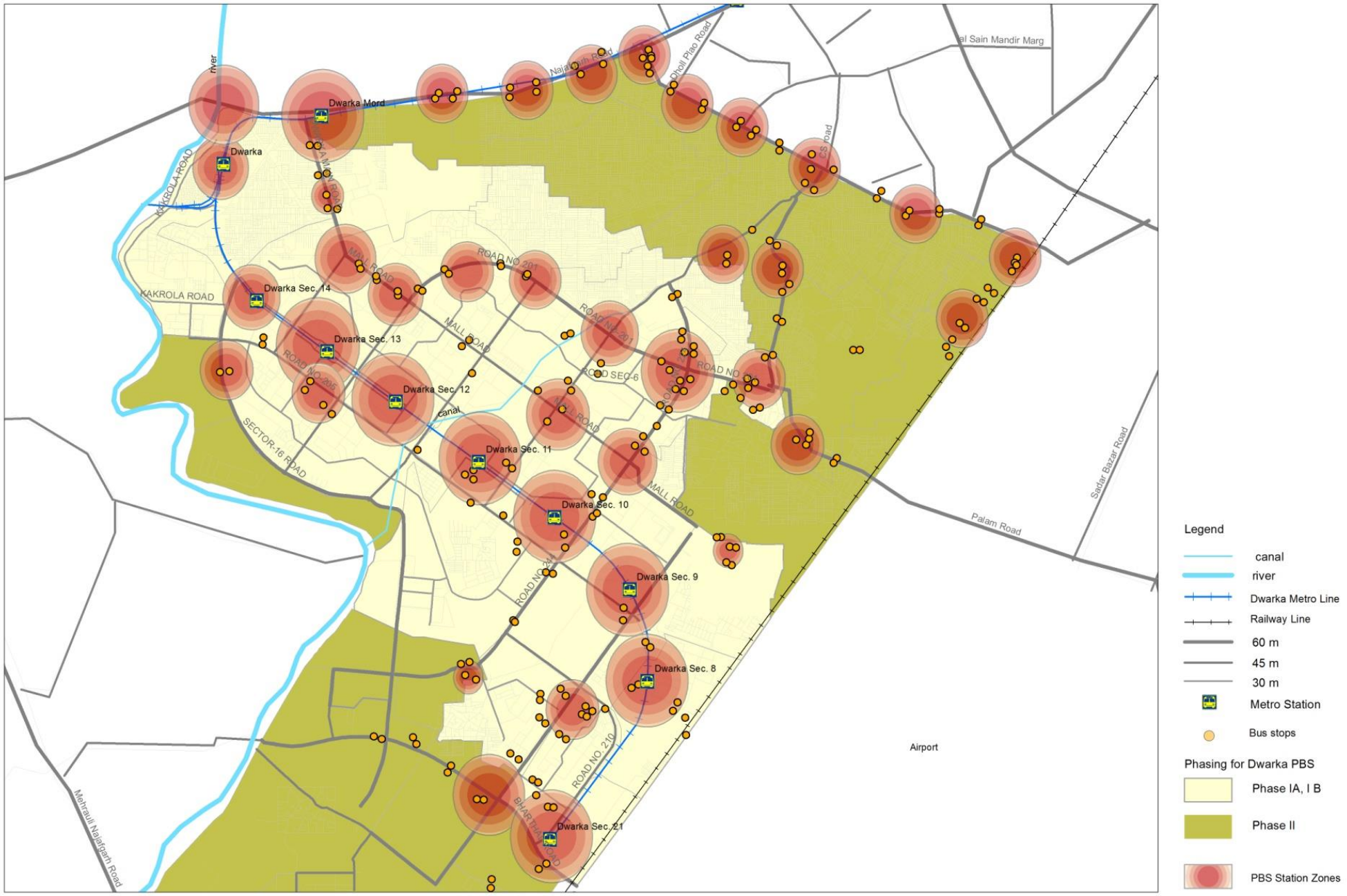


Map 18: PBS station zones of Dwarka

5.5.2 Identifying the station locations

To determine the station location parameters like accessibility, land use, colony entrances and parking space have been considered. The size of the station will be a function of the anticipated demand and the attractions of a particular area, and station's location will depend on the actual environment. Total 320 stations have been proposed for whole for Dwarka, of which phase I has 180 stations. This 180 stations have been further divided into two implementation, of Phase IA and IB. Phase IA has 100 PBS stations while phase IB has addition 80 stations. The entire Phase I is distributed within 30sqkm area of central Dwarka. The remaining 100 stations are further distributed in Phase II 22 sq km area. Refer Map 19

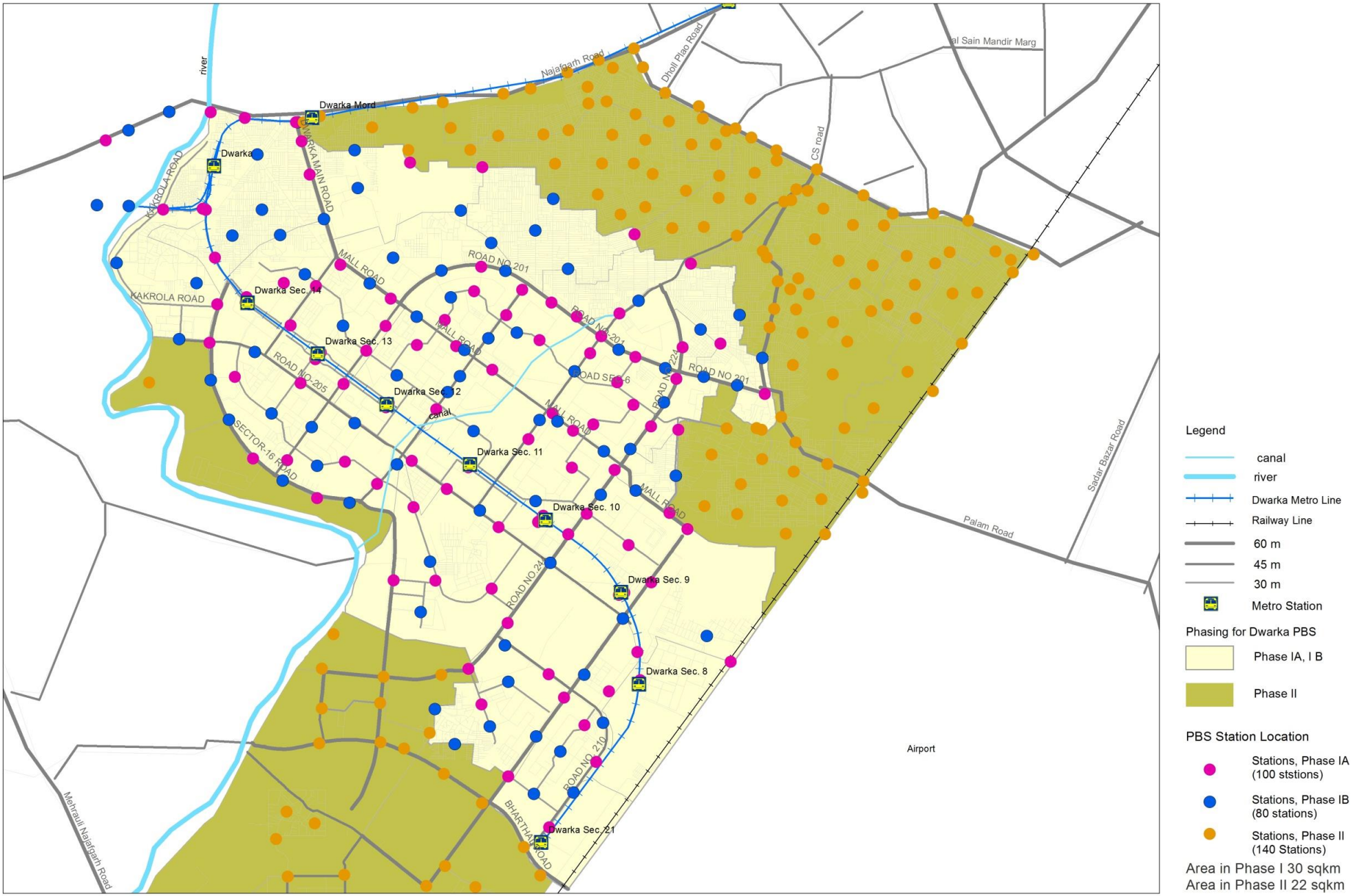
The locations are tentative at this stage and needs to be finalized after following steps:

- Ground-truth verification
- Public consultation at various levels
- Government officials' consultations at various levels

The tentative station locations have been decided considering following guidelines;

- Station distance at 250-400m to ensure mostly dense and uniform coverage in high demand area; and 400-600m in low demand areas.
- Stations near mass transit stations or transit stops.
- Stations located preferably near bicycle lanes/tracks, if present, or at places on the street that are safe to access by bicyclists.
- Stations best situated on or near junctions, so that users can access and egress from multiple directions.
- Stations located inside residential cores but preferably accessible from the streets.
- Stations located near important public institutions or places like, school, colleges, parks, markets, commercial areas and other activity nodes.

In the map Phase IA and IB has PBS stations equally distributed at a distance of 250 – 400m, while the stations of phase IB strengthens the first implementation (phase IA), by adding several intermediate stations between the attraction and origin points. The network of PBS will get well distributed by the end of phase I. On the other hand Phase II covers the rest of Dwarka. Which includes the unauthorized colony; areas that have proposed land use of open land, and some areas with existing open land will get converted to residential in the near future as per the proposal (Refer map 6). From the Proposed land use, and primary survey demand data, stations for Phase II has been distributed by large in the northern Dwarka, and some in the proposed residential area of southern Dwarka. (Refer Map 19).



Map 19: PBS phase wise station location in Dwaraka

5.5.3 Determining the station size

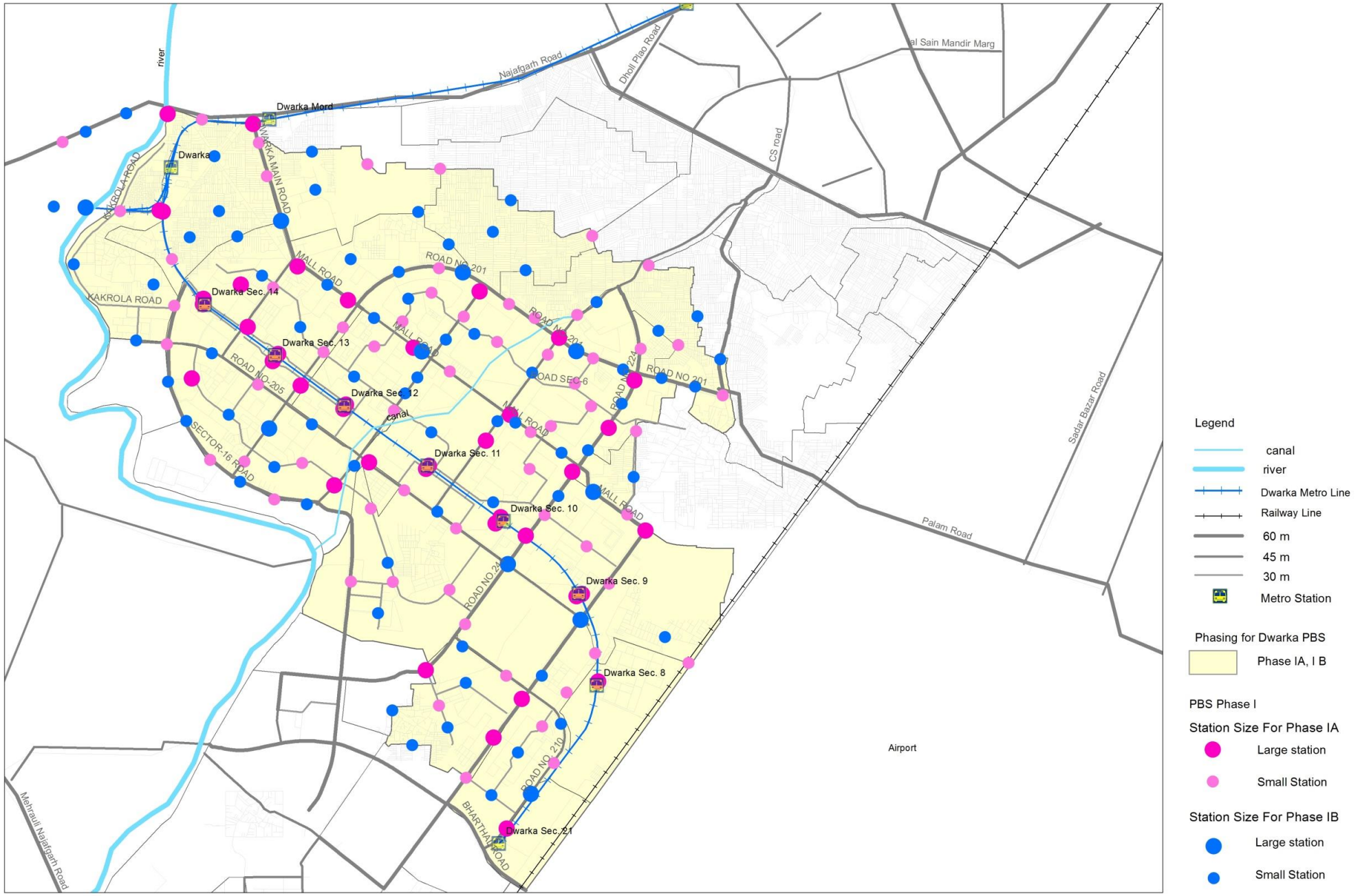
Stations have been categorized into two type i.e. main stations and intermediate stations with 45 and 10 docks respectively. Station size may vary as per space availability on site. Phase IA and IB station sizes have been shown in Map 20. Station size has been determined considering following parameters:

- Infrastructure design to support the expansion of module of the stations
- Docks per bicycle ratio: the average number of docking spaces per bicycles.
- Station Density Ratio: the average number of stations in the area and the minimum fixed amount of bicycles it will have.
- Transit node: the stations near major points of attraction which will require increment in station size.
- Distance between stations: minimum distance is to be 300m, but if it increases beyond that, the station size is to be increased accordingly.

Station sizing for Phase I (IA and IB) has been done at this stage. Large station has been assigned to locations that have high ridership, high demand, and also placed next to cluster of attraction points. While the intermediate stations are connecting, mostly the two large PBS stations; and point of origins or residential areas of Dwarka. The percentage of large station is drastically less in phase IB, because the motive of Phase IB is to strengthen the existing system, therefore all major nodes were identified in phase IA.
The sizing of station is also dependent on the availability of spaces. In areas where the demand is high, but the availability of space is less, there after ground truth verification process, more number of small stations will be placed to cater the demand.

Table 16: Station Sizing, Dwarka PBS

	Phase IA	Phase IB
Total Stations	100	80
Large Stations	40	10
Intermediate Stations	60	70



Map 20: PBS station sizes of Dwarka for phase-I

6. INFORMATION TECHNOLOGY & OPERATIONS

IT system can store, retrieve and transmit information, and connects the actual hardware of the bicycles, docks, terminals with the control center. It is, in essence, the link between the various communication portals. The application of information technology can make PBS a cost-effective transportation solution on a larger scale, with IT not only the transfer of information will be more accurate, but its speed could also be measured in seconds rather than hours or days. Before the introduction of IT systems, a typical PBS would rely heavily on human resources. Technology has also played huge role in reducing theft and vandalism of cycles.

Therefore considering the shortcomings of manual based systems, its associated theft vandalism and poor resource utilization; Dwarka PBS has been proposed as a fully automated PBS system. In fully automated system the IT application is high and involves the application of automated docking systems, use of terminal and mobile based applications and the use of smart card/ key for access. The information dissemination and tracking accurate information depends on strong internet networking. Fully automated system is a third generation system and most commonly found in most of the bicycle sharing schemes all over the world.

6.1 Proposed components and application of ITS

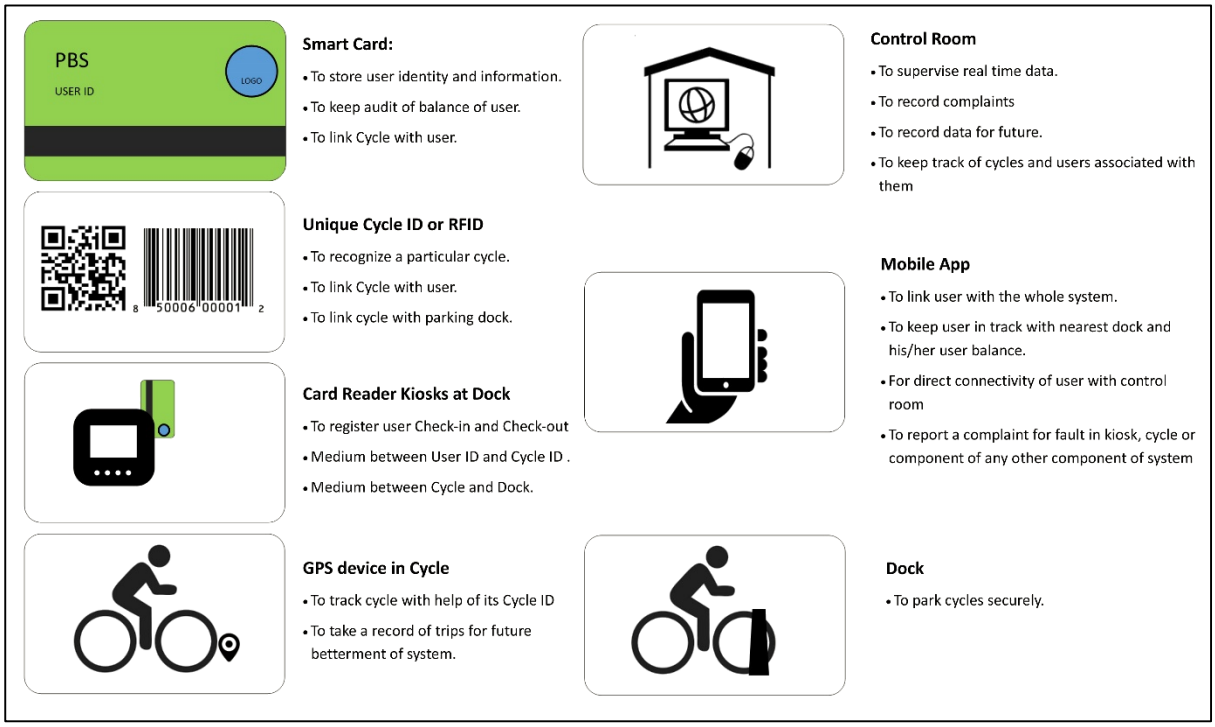


Figure 30: Proposed Components of PBS

The PBS system proposed for Dwarka, New Delhi will be managed by ITS infrastructure. People of Dwarka are already aware of some components of the automated system in Delhi Metro, such as smart card, terminal- to recharge and balance check, locate station and fare structure. PBS in addition will add validation of the user to this with complete registration

process to ensure the safety and security of bicycles. The proposed IT components for the city PBS are

- Bicycle tracking module-GPS and RFID installed bicycles
- Transaction terminals,
- Operation Control Centre
- Central fare management system- with
    - Easy recharge,
    - Online web based registration
    - App/SMS based information dissemination.

Utilizing various components the following applications needs to be active:

6.2 User access, registration and validation

Registration:

Dwarka system will facilitates user to register, pay and use the system. Proposed system has to allow users to alter, check or update their accounts, and to have their changes take immediate effect. Payment processing is also automated and instantaneous, making even small payments cost -effective, and eliminating the possibility of users avoiding payment.

Validation:

The IT system validates individual user while checking out/in bicycle from PBS station. System after authenticating registration process of user will give out the smart card to its user.

Access:

IT systems in Dwarka will allow people to access information on web page as well as over a mobile based application:

- System specification
- Location of station
- Availability of bicycle
- Membership information etc.

Supporting Elements:

- Chip based smart card which will be attached with individual's identity, to ease out the registration validation and payment procedure. Chip based smart card will be attached with person's bank account; this will strengthen the security and minimize the probability of theft.
- Terminals at all the stations with user information like bicycle availability, fare structure, less congested routes, nearest station etc, along with locking/unlocking mechanism.

To access all the information given in 'Access', all the components have to be interlinked with operation control room.

Figure 31: Kiosk with registration and smartcard reader facility, PBS, Ottawa, Canada source: Bicycle Sharing Guide Ottawa, 2009)

6.3 Fare collection

Multiple options of fair collection help to attract more users to the system. In Dwarka, the following explained system has been proposed for the same.

6.3.1 Smart card (RFID) based Fare management

Process and output:
As mentioned in the previous topic, this system will have smart card as the medium for the fare payment and hence the terminals primarily operate using smart card as the fare payment device. The smart card will be based on the standard Mifare technology which is widely used in transport applications. The user requires loading currency value of their choice on the smart card which will enable them to operate and pay for the PBS system.

Supporting Elements:
Centrally connected interface will serve the purpose of efficient authentication and process management. To support the above procedure, the following components have to be provided:

- Chip-based smart card
- Smartcard readers attached to the locking / unlocking mechanism on the terminal.
- A terminal authorization device connected to the central ITS infrastructure via mobile communication device.

6.4 Station capacity and Bicycle availability

Process and output:
The Control Centre will relay station capacity to the following user platforms,

- Station terminals,
- Websites,
- Phone apps and
- Other transport operators.

Communicating the availability of bicycles and open docks at various stations will help the operator manage the redistribution system, and users to get informed about available bicycles and station information.

Figure 32: Parking Dock, Citibicycle, NYC, Bicycle Share

Supporting elements:
The proposed system will be supported by the following components:

- GPS on bicycle
- Sensor on docks
- Screen on station terminals
- Terminals connected to operation control centre

An example is given through the following photographs.

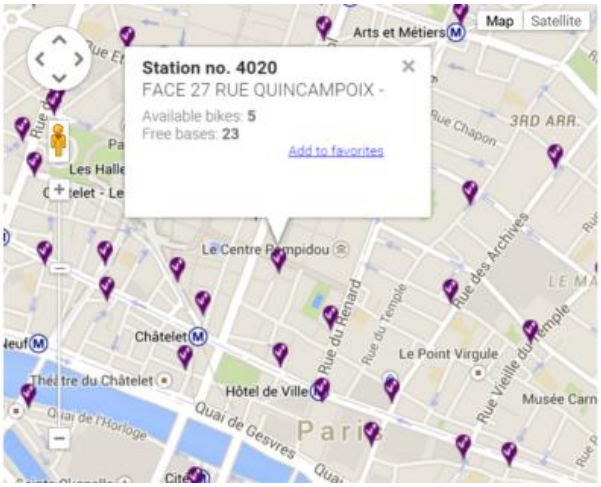


Figure 33 Left: Bicycle station location and availability and other features, in smartphone app, China; Right: Online portals showing the real time information of bicycle availability, Velib Paris

6.5 Data Tracking and Dissemination

Process and output:
A well-designed IT system will ensure the accuracy of the collected data. Besides trip pattern data, it will provide information on user profiles and preferences, which will be used to adjust the operational and revenue models and maximize efficiencies. The IT functionality of the system will serve a larger utility such as allowing public use of the system data, which will enhance the user experience.

Supporting elements:
For the above said system, the elements provided in Dwarka are:

- Smartphone applications, which will allow a user to tap their phone to find the closest station and its current capacity.
- Inter linkages between other transit modes and the bicycle sharing stations will also be provided through apps.
- Trip-planning apps using real-time availability will suggest routes, times and availability of a PBS with respect to other modes of transport

6.6 Bicycle Tracking

Process and output:

The movement of the bicycle at any given point would be tracked with the help of GPS and RFID tags with the latter associating it with the user, while the RFID reader will actively glean tag's information as soon as the tag will come in its contact. Interlinking the bicycles with docks, terminals and operation control centre will help in comprehensive records of the user's account or bicycle history which will include information such as the type of account, good or bad standing with the system, previous trip data, and any balance on the account.

Supporting Elements:

In Dwarka, bicycle tracking system has been provided with the following components:

- RFID tags: These tags are electronic tags that will hold the identity (of the user or the bicycle) in a small chip. There have to be two types of RFID tags:
  - One that identifies the user and which is housed in a card
  - The other which identifies the bicycle and is housed in the bicycle.

  Both these tags will be passive in nature, meaning they will be simply used as storage devices of the identity.
- RFID reader: These readers will be placed in the docks, the terminals and in any other device that will be required to read the identity of the user's card or bicycle.
- GPS enabled bicycles

6.7 Operations Control Centre

Proposed operation center will serve as a central authority where a large physical facility or physically dispersed services will be monitored. It will serve the user with information and also coordinate with the online portals, and keep account of bicycles whereabouts, by looking at the IT infrastructure.
Procedure of control center has been shown in the following graph.

Figure 34: Control Centre, Delhi Metro, Shastri Nagar

- **Supporting Elements**:
  Control center will have connection with all the stations, bicycles and the users though IT. Basic infrastructure in control center would be:

  - Multiple electronic display
  - Control panels conducting video surveillance and recording for security and personnel accountability purposes
  - GPS tracking unit
  - Electrical system to manage electronics and mechanical units.

- **Functions:**
  This will process following functions:
  1. Fleet Management
     - Disseminate information regarding redistribution of bicycles
     - Respond to the breakdown of bicycle reported by a station in charge or user
     - Tracking of bicycles through GPS

  2. User Interface Management
     - Provide information to the user on bicycle/dock availability via app, sms, phone call
     - Authorization of smart card/ key or code used by the user to sign into the system at any PBS station.
     - Maintain the website and disseminate information online –via app, sms, phone call, about station location, subscription detail, user fee and other information concerning the user. The terminals act as interface between the user and control room in this process as well.
     - Track information the user through RFID tags installed in their smart card/key or code generated through the terminals.

  3. Fare collection
     - Centrally manage fare collection.

  4. System Management

- Staff management
- Prepare daily weekly and Monthly report

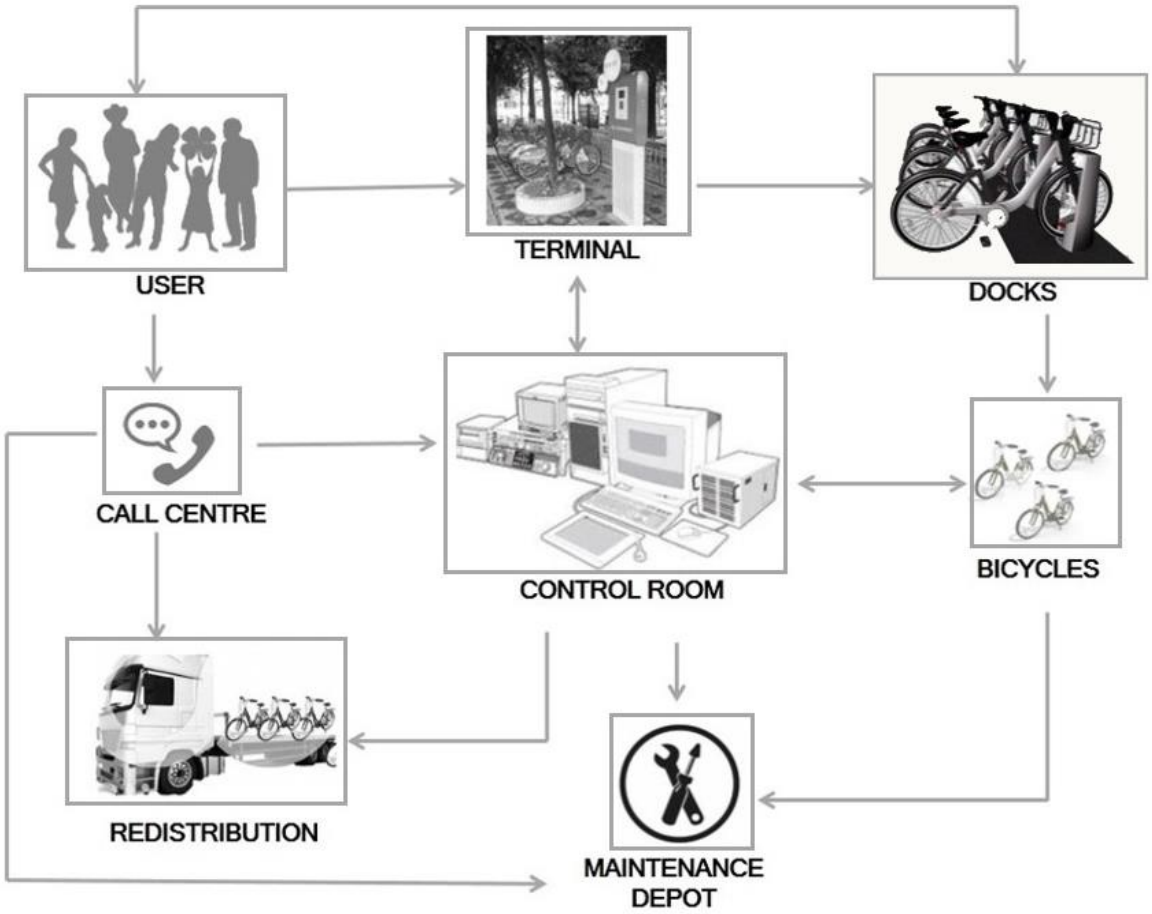


Figure 35: Flow Chart Showing OCC Work Procedure

7. SYSTEM SPECIFICATION

7.1 Bicycle specification

The bicycle, in a PBS system, is the most important component that promises to offer the convenience of access and the appeal of a modern, safe and smart vehicle.
Considering use of commute by people of all age, gender and size, the proposed bicycle has versatile and unique characteristics to provide flexibility, ease of use and unique identity. Also considering that in Dwarka, 40 percent of the trips are made by females, it forms a very significant proportion of the population that needs to be planned and designed for. Specifications of the bicycles in Dwarka PBS system have been given below and the same has been shown in the following picture:

- Unisex frame bicycle: which can be used by all kinds of people; even women dressed in traditional Indian attire like saree.
- Alloy material for all the frames, to avoid effect of the changing weather conditions.
- GPS enabled bicycles. Placement of GPS has be done while manufacturing of the bicycle to avoid vandalism of GPS itself.
- One piece handlebar with grips
- Light load carrying front basket
- Adjustable seat positioning
- Rear and front lights to make the bicycle more utilitarian.
- Covered cables, derailleur and chain protector
- Puncture resistant tires with non-standard size of 20, 23 or 27 inches
- Mud-guard with advertisement space
- Internal Hub-brake mechanism
- Internal Hub-dynamo for recharging of GPS module

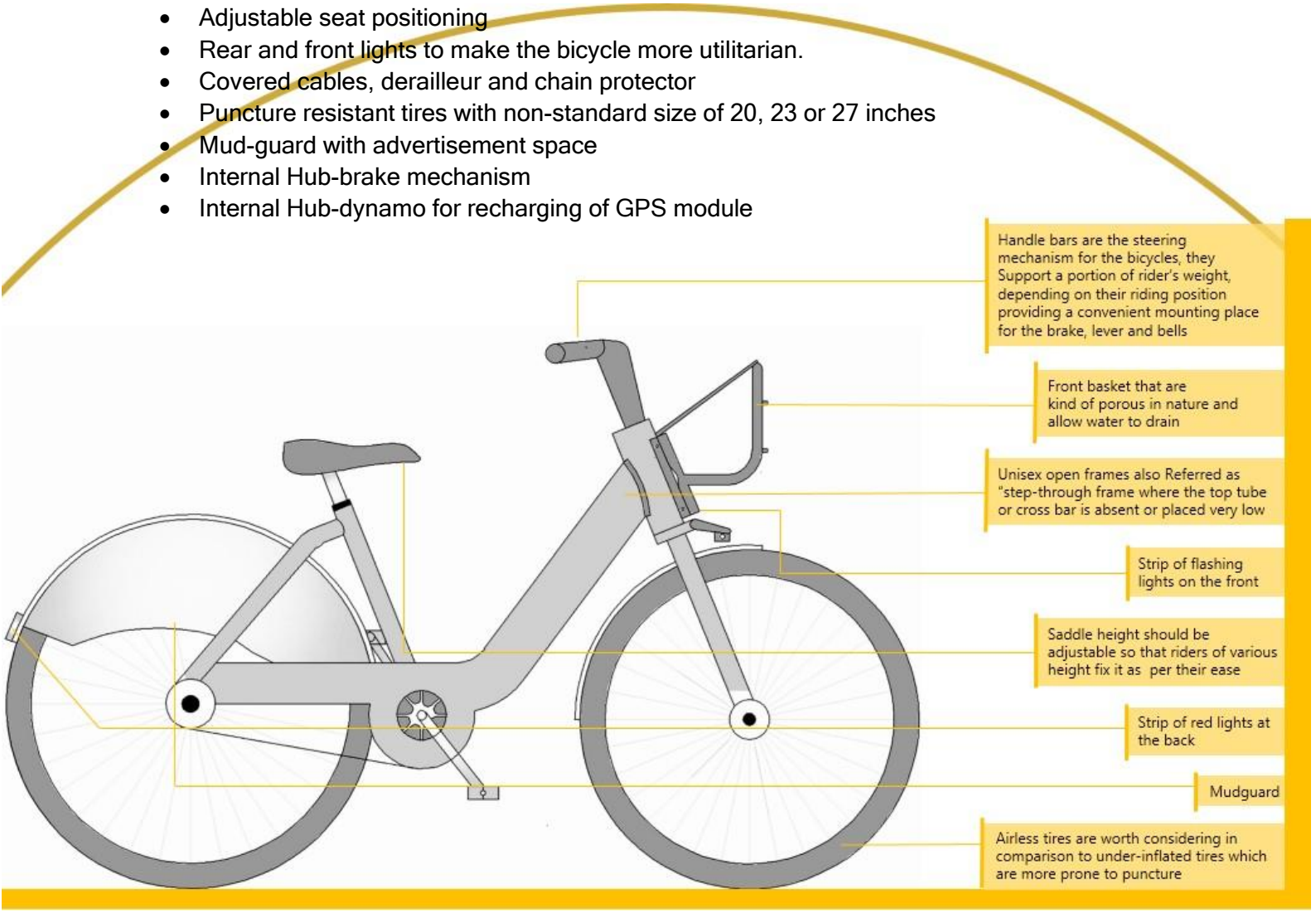


Figure 36: Bicycle Specifications

7.2 Station specification

7.2.1 Station Type and Design

Two types of stations have been proposed i.e. main stations and intermediate stations. Main stations will be placed at major attraction zones such as transit nodes, market areas, high density residential areas, etc., while the intermediate stations will be placed between main stations to minimize the distance two consecutive main stations. Characteristics of the stations are given below:

- A module of minimum five docks, which can further be multiplied to arrive at bigger stations.
- Main stations and intermediate stations designs are different considering their placement either on edge of the street, at the metro stations, at market places etc.
- Both types of stations will be designed as an open structure, which can be completely covered if required by slight modifications in the structure.
- Main stations will be provided with docks, shelter, terminal and facilities like food plaza, private bicycle parking and kiosks.
- Intermediate stations will be provided with only docks, shelter and terminal.
- A covered shelter for the protection of bicycles against rain and heat.
- Low cost durable materials for shelter
- Space for advertisement on station panels and backlit advertisement panels.

Integration of the station with the street has been dealt carefully. The diagram below explains orientation of the station on the street. Following parameters have been considered while locating the station on the street.

- High visibility of the bicycle and the user catering to the safety of both.
- Stations have been oriented towards the bicycle tracks.
- Possibly towards bus shelters and metro exit gates.

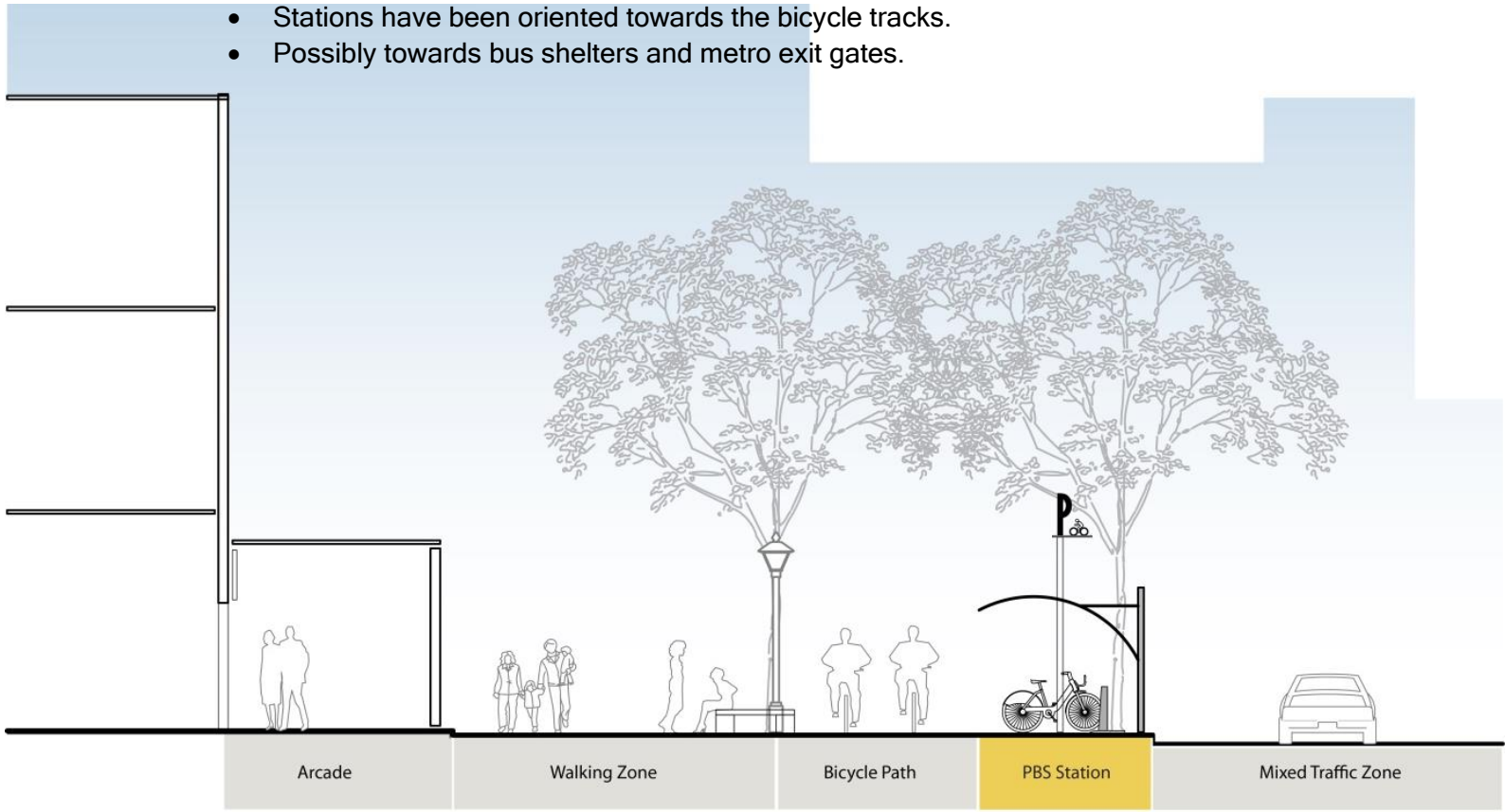


Figure 37: Conceptual Street Section

7.3 Docks Specification

A dock is the structural unit where the bicycle is parked and which supports and secures a bicycle when not checked out by a user. Docks are an integral part of automated systems. The dock will release a bicycle once a smart card is tapped. An interface of RFID will confirm that the user is subscribed in the system and the reverse occurs upon returning the bicycle to the dock. There are typically two kinds of docks:

7.3.1 Bollard-style docks specifications

Bollard style docks are proposed considering that they can be fixed to the ground without any vertical support. Specifications of such docks have been given below.

- Two bicycles per dock have been accommodated.
- Low docking station
- IT enabled with RFID reader on top of each dock
- Stationary in nature

Figure 38: Melbourne Bicycle Share, Melbourne Bollard Docking

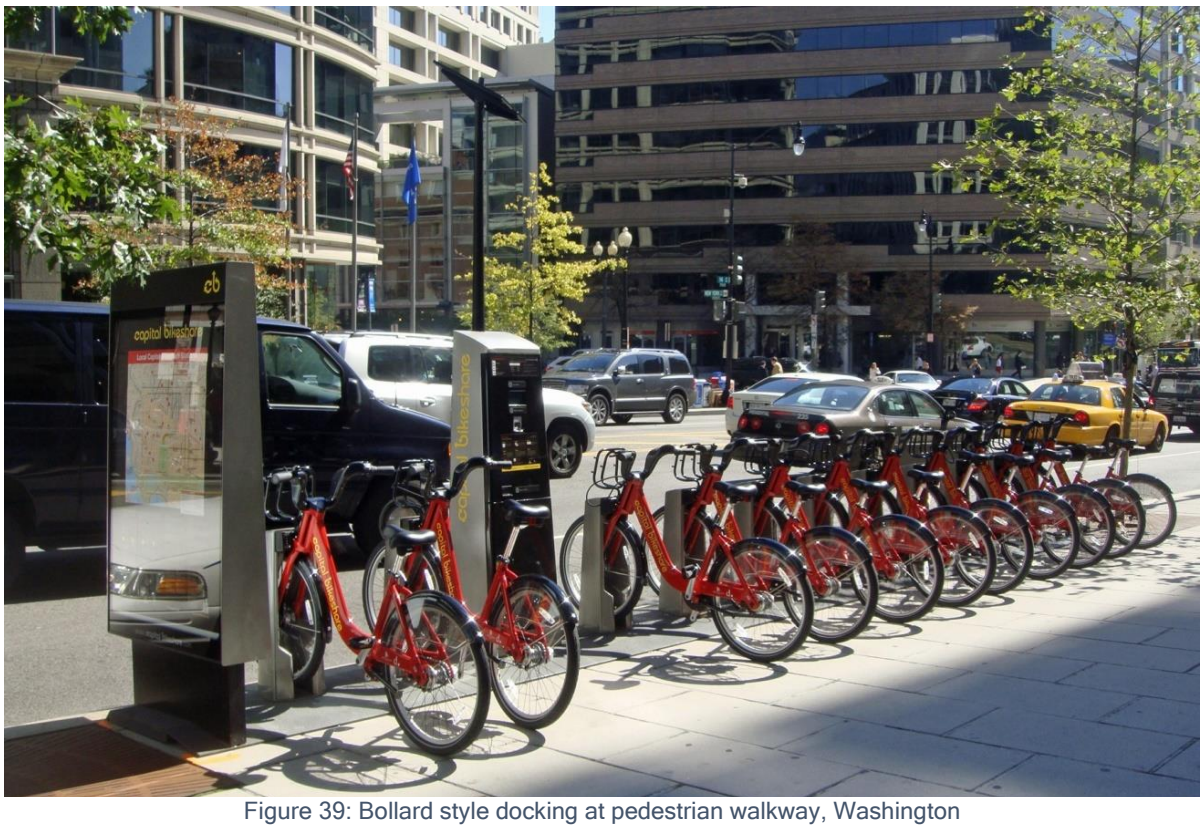


Figure 39: Bollard style docking at pedestrian walkway, Washington

7.4 Terminal Specification

The terminal is the central processing unit for each station. They will provide the interface between the user, the docking station and the control center. They will communicate via hard-wire to the docking station and via wireless communication (e.g. GPRS, 3G, and 4G) with the control center. It will offer an interactive touch screen interface through various menu options displayed on a screen. Designed terminals have to show the following details:

- user-specific subscription information
- account balance
- subscription type
- availability of bicycle
- station capacity

- details of the user's latest rides
- calories burned or CO_2 off seated

All of this information will be provided in two languages; Hindi and English. Examples of terminals are shown below.

Figure 40 Left: Terminal of Velo Lyon, France; Right: Terminal of Hubway, Boston PBS

7.5 Depot Specification

The depot is where bicycles are kept while serviced or stored; it provides all the facilities and equipment for management, repair, cleaning and has a mobile maintenance unit which will be responsible for repairs. Depots may be provided with a control room for monitoring and redistribution of vehicles which will act as an opportunity for cost sharing. The depot also provides with a storage unit for bicycles and stations for Public Bicycle Sharing.

7.5.1 Proposed Specification

Depot space is proposed to have a space for spare cycles, stations, parts, maintenance equipment and storage space for redistribution vehicles. In the case of damaged bicycles, the operator would normally fix minor repairs on-site, while collecting bicycles that need major repairs to be done at the depot. Therefore, the minimum specifications of a depot are:

7.5.2 Semi covered space

- Semi-covered storage and parking space for spare fleet.
- Semi-covered parking space for the vehicles of the staff members.
- Semi-covered space for washing and drying of spare fleet.

7.5.3 Covered Space

- Covered space to take care of the repair and maintenance with space for repair instruments.
- Covered storage space to hold the terminals and ITS components.
- Covered room for resting purpose and leisure activities.
- Covered small area for eatery purpose.

7.6 Procedure of Use

7.6.1 Getting the smart card

A smart card will be a user interface of the PBS system for which users can apply via internet, at metro stations or through nearby available kiosks. Users can submit the required verification documents and then collect the card or it can be delivered at their place. Once the verification and validation of data, the card will be activated for the users

7.6.2 Check out and check in

Every station will have terminals, where the user can sign in the card and will allow the user(s) to check out the bicycle(s). Once the bicycle is checked out, it can be returned and checked in after the ride is done.

Figure 41: Graphic Check in - out

7.6.3 Incident management

In case of any accident or any damage to the bicycle, after the user has checked out a bicycle, the repair will reach the user with a phone call. The user is supposed to call on the help-centre number and report the problem with the location of the incident to get required help as early as possible.

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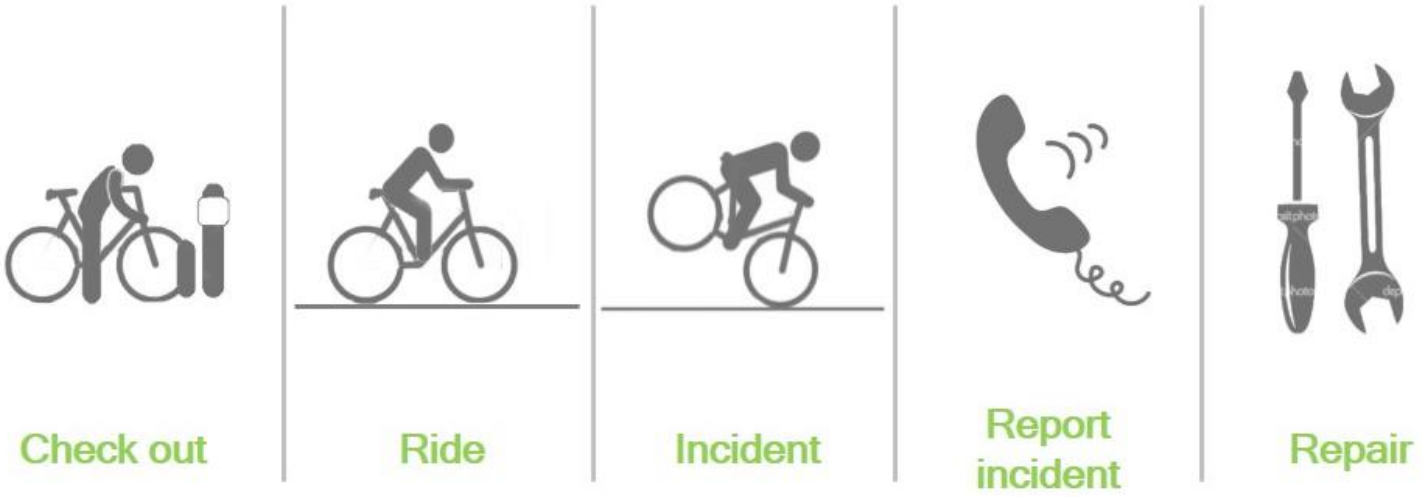

Figure 42: Graphic showing Incident Management Procedure

7.6.4 Redistribution

Whenever there are lesser number of fleet at the station, the station in-charge or the security in-charge at the station can ring on the available call-centre numbers and report the amount of bicycles required. The redistribution vehicle will distribute the bicycles evenly at every station

Figure 43: Graphic showing Redistribution procedure

8. FINANCIAL AND OPERATIONS MODEL

The proposal includes system infrastructure cost, operations cost and the financial model. The system cost have been calculated considering the cost of equipment, infrastructure, Information Technology system, control centre, preparation of website, branding and marketing, training of control centre people, operational expenses etc. In order to arrive at realistic cost, the costs have been assessed after a market research. The capital costs have been calculated for phase I with depot and control centre.

8.1 Capital cost

Capital cost includes the cost of procuring assets. These are fixed costs of the system and can vary each time the system goes into expansion. The capital expenditure for Dwarka PBS includes following assets:

Table 17 Particulars of Capital Cost for Dwarka PBS

Capital Expenditure for system setup	• Bicycle • Dock • Terminal • Stations (Small & large) • Call and Operational control centre (OCC) • Design consultancy
Capital Expenditure for operation setup	• Redistribution vehicles • Vehicles for maintenance • Setting up of depot

Total capital cost for phase-I has been divided into two years of instalment i.e. 2015 and 2018, i.e. phase-I(a) and phase-I(b). The overall capital cost at January 2015 price level for phase-I works out to be 28.6 crore while for the second phase it comes out to be 17.34 crore. Phase-I will have 1500 bicycles, 2025 docks and 100 stations, followed by 1000 bicycles, 1500 docks and 80 stations in phase-II (refer

Table 18 and

Table 19). Operator will incur Rs. 1.37 crore and Rs 0.45 crore in phase IA and IB respectively.

Table 18: Estimated Unit Capital Expenditure in phases (In INR)

Sr.No.	Item	Unit Cost	No. Of Units (Phase IA)	No. Of Units (Phase IB)	Amount in crore (Phase IA)	Amount in crore (Phase IB)
1	Bicycles	24,000	1,500	1,000	3.60	2.40
2	Docks	50,000	2,025	1,500	10.13	7.50
3	Terminals	1,80,000	100	80	1.80	1.44
4	Small Stations	6,00,000	60	70	3.60	4.20
5	Large Stations	18,00,000	40	10	7.20	1.80
6	Call &OCC	2,00,00,000	1	0	2.00	0.00
7	Design Consultancy for stations	30,00,000	1	0	0.30	0.00

Sr.No.	Item	Unit Cost	No. Of Units (Phase IA)	No. Of Units (Phase IB)	Amount in crore (Phase IA)	Amount in crore (Phase IB)
9	Total				28.6	17.34

Table 19: Estimated unit Capital Expenditure on operations in phases (In INR)

Sr.No.	Item	Unit Cost	No. Of Units (Phase IA)	No. Of Units (Phase IB)	Amount in crore (Phase IA)	Amount in crore (Phase IB)
1	Redistribution Vehicles	800000	10	5	0.8	0.4
2	Maintenance Vehicles	50000	15	10	0.07	0.05
3	Setting up Depot	5000000	1	0	0.5	0
4	**Total Capital Expenditure**				**1.37**	**0.45**

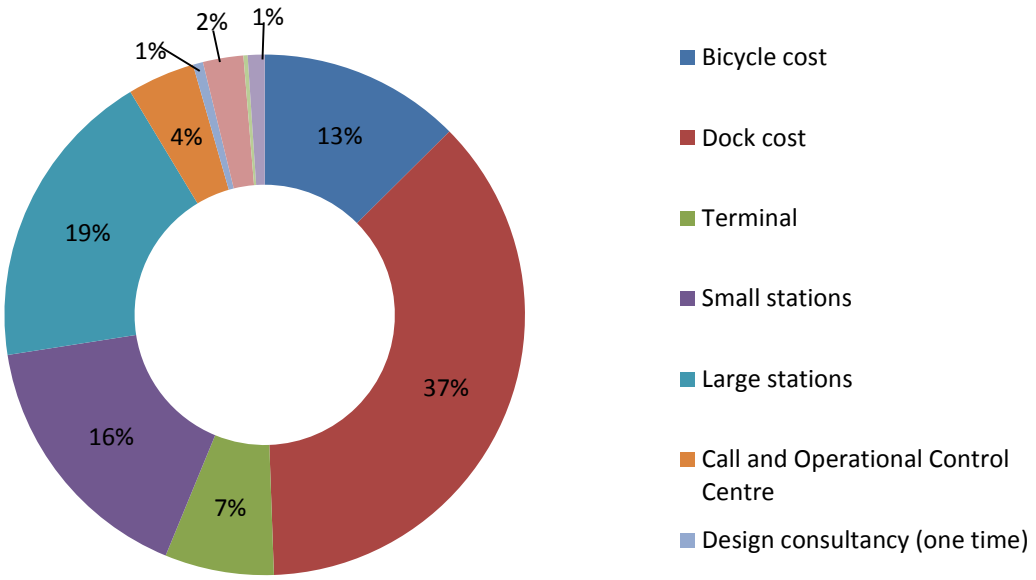

Figure 44 Estimated Capital Expenditure, Dwarka PBS

8.2 Operational costs

These are costs associated with operating the system. Operational costs maybe and be highly dependent on availability of man-power across cities and therefore may entail a risk buffer for the operators over the long term.

Table 20 Estimated Operational Expenditure

		Estimation of O&M Expenditure	Unit Cost	Unit	Detail	No. Of Units (Phase IA)	No. Of Units (Phase IB)	Total Units
		Interval of periodic maintenance(years)			For 5 year			
		Risk buffer			10%			
1	VARIABLE COST	Bicycle cleaning	10,000.00	Person	Monthly	25	0	25
2		Bicycle small repair & checking	10,000.00	Person	Monthly	15	0	15
3		Bicycle mechanics (depot)	12,000.00	Person	Monthly	10.0	0.0	10
4		Mechanic assistants	8,000.00	Person	Monthly	10.0	0.0	10
5		Redistribution teams	12,000.00	Person	Monthly	30.0	10.0	40
6		Operation manager	60,000.00	Person	Monthly	5.0	0.0	5
7		Fuel	1,00,000.00	Number of redistribution vehicles	Monthly	10.0	5.0	15
8		Smart Card	100	Number	for phase 1 and 2	50,000.0	0.0	50000
9	FIXED COST	Driver	10,000.00	Person	Monthly	30.0	10.0	40
10		Customer service agents	10,000.00	Person	Monthly	10.0	0.0	10
11		Customer relation managers PoS kiosks	10,000.00	Person	Monthly	200.0	80.0	280
12		Accounting assistant	12,000.00	Person	Monthly	5.0	0.0	5
13		Account manager	40,000.00	Person	Monthly	1.0	0.0	16
14		Senior project manager/CTO	1,00,000.00	Person	Monthly	2.0	0.0	2
15		Marketing manager	60,000.00	Person	Monthly	1.0	0.0	1

		Estimation of O&M Expenditure	Unit Cost	Unit	Detail	No. Of Units (Phase IA)	No. Of Units (Phase IB)	Total Units
16		Spare parts bicycle (for 5 years)	3,000.00	Number	Annually	1,500.00	1,000.00	2500
17		Spare parts stations (for 5 years)	10,000.00	Number	Annually	100.00	80.00	180
18		Setting up of Depot	50,00,000.00	-	Single time	1.0	0.0	1
19		Insurance on Redistribution Vehicle	25,000.00	Number	Annually	10.0	5.0	15
20		Legal services	8,333.00	-	Monthly	1.0	0.0	1
21		Stationary and admin	20,000.00	Number	Monthly	1.0	0.0	1
22		Redistribution vehicles	8,00,000.00	Number	for phase 1 and 2	10.0	5.0	15
23		Vehicles for maintenance team	50,000.00	Number	for phase 1 and 2	15.0	10.0	25
24		Insurance on maintenance vehicles	2,000.00	Number	Annually	15.0	10.0	25
25	SEMI-VARIABLE COST	Maintenance of System	200	Number	Monthly	1,500.0	1,000.0	2500
27		Electricity	1,00,000.00	Number	Monthly	1.0	1.0	2
28		Internet / mobile phones	3,500.00	Number	Monthly	100.0	80.0	180
29		IT maintenance (5 years)	10,00,000.00	Number	For 5 years	1.0	0.0	1

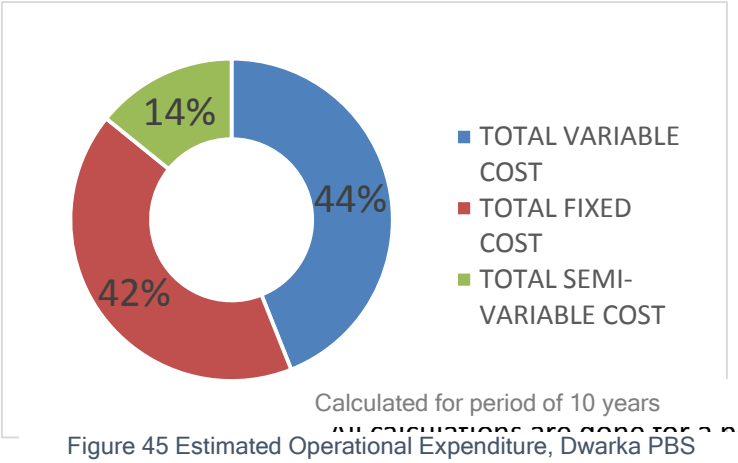

Figure 45 Estimated Operational Expenditure, Dwarka PBS

The total estimated operational expenditure for the next 10 years have been categorized into three types of costs; namely, fixed cost, variable cost and semi-variable cost. The variable cost, accounting for the maximum share of the operational expenditure i.e. 44 percent consists of expenses such as bicycle cleaning, bicycle repairing, cost of petrol, operator charges, smart card cost etc.

The variable cost is the fixed cost which accounts for 42 percent of total expenditure, consisting of expenses such as driver, legal services, accounting services, insurance cost etc. The minimum yet significant contribution to the expenditure is from semi-variable expenses, including cost of the electricity required by the system, internet usage etc.

8.3 Fare structure

Type of system defined in last chapter will play a major role in determining the fare collection and fare structure. As fully automated system have been proposed, advantage of fare collection system would be of high convenience to users and operator, quick data analysis, reliable service, easy revenue sharing in terms of joint venture etc.

8.3.1 Willingness to pay

Perception surveys have been conducted to understand the people's desire and capability of payment, payment mode, payment duration etc. Survey reveals that nearly 78 percent of people who are willing to use the system, prefer to pay Rs.120 – 150 for an hour charge on monthly basis, 16 percent prefer Rs.150 – 180 and 3 percent, 2 percent and 1 percent are ready to pay Rs.180 -210, Rs.210 – 250 and greater than Rs.250 respectively (refer Figure 46).

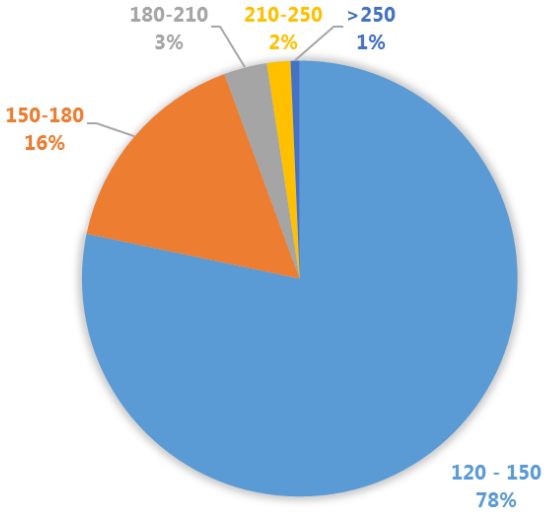

Figure 46: Willingness to Pay (source: primary survey)

8.3.2 Preferred mode of payment

Survey reveals that approximately 76 percent preferred mode of payment is cash and 22 percent of population prefers credit card. Only 2 percent of the public transport users prefer using debit card (refer Figure 47)

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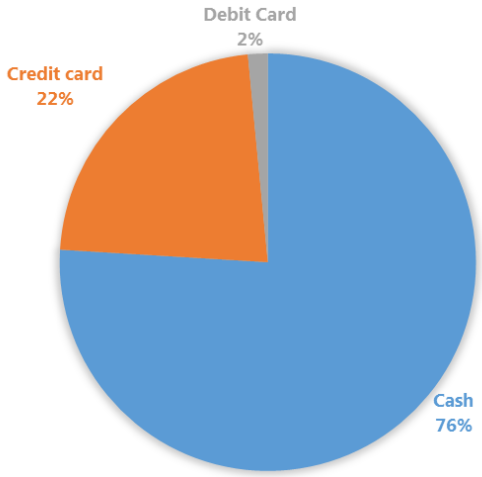


Figure 47: Preferred Mode of Payment (source: primary survey)

8.3.3 Proposed Fare structure

Proposed fare structure is based on global case studies and primary survey response regarding the system. The fare structure has been set in terms of type of subscription, fees of each subscription and mode of payment. Case studies infer that the ridership is directly proportional to alternatives for payment available. The proposed modes of payment are: Credit card, debit card, wallet system, online payment through net banking and cash. The following fare structure has been proposed keep in mind the above mentioned factors:

Table 21 Proposed Fare Structure and Type of Subscription

User Fee (in INR)		
Sr. no.	Type	charges
1	First 29 min	0
2	Second 30 min	10
3	Every 30 min after an hour	20

8.3.4 Type of subscription

Objective of designing a subscription alternative is to encourage short term uses, compelling users to promptly return the bicycle to a station (or to terminate their session in case of a flexible system). All over the world, systems have a grace period, usually half an hour, during which the usage is free; and afterwards fees grow exponentially with every additional half an hour of use. Inferring the data from other countries and studying characteristics of users in India, the following subscription structure has been proposed in India (refer Table 24)

Table 22: Types of Subscription

	Subscription Type
Sr. no.	Type
1	Annual
2	Monthly
3	Weekly
4	Daily
5	Student pass
6	Senior citizen pass
7	Family weekend pass

Table 23: Type of Subscriptions, all over the world

Cities	System name	Owner	Operator	Subscription					
				Long term	Short term				
				Annual	Month	7 days	3 days	2 days	1 day
Barcelona	Bicing	municipality	Clear Channel	✓	×	×	×	×	×
Boston, Massachusetts	Hubway	-	Alta Bicycle Share	✓	✓	×	✓	×	✓
Denver, Colorado	B Cycles	-	Denver Bicycle Sharing	✓	✓	✓	×	×	✓
London	Barclay Bike Hire	TfL	SERCO group	×	✓	✓	×	×	✓
Lyon	Vélov'	municipality	JCDecaux	✓	×	×	×	×	✓
Montreal	Bixi	-	Bixi	×	×	×	×	×	×
New York	CitiBicycle	-	Alta Bicycle share	✓	×	✓	×	×	×
Paris	Vélib'	municipality	JCDecaux	✓	✓	✓	×	×	✓

8.4 Expected revenue sources

The proposed system will have income from parking fees, user fee, subscriptions, advertisements, and system sponsorship. The proposed system in Dwarka will not depend on user fee or subscription. Mix of all revenue sources will help in running good system with high ridership.
Potential revenue sources have been explained below:

Parking: Parking fee will form a major source of revenue under NMT cell. According to NMV project decision, under working group meeting, 100km of road length have been approved for parking.

User fees and Subscriptions: This system will share micro part of total revenue. To encourage short trips user fees for first 29 minutes have been kept zero. There will be multiple subscription options.

Advertising rights and system sponsorship: In Dwarka, sponsorship against advertisement rights contributes will contribute a major amount to the revenue. In initial years it will difficult to get sponsorship as the system would still be getting in place at its pace. In this case, initial four years, space on the stations and bicycles will be rented out for advertisements. Fifth year onwards it will be followed by giving rights of advertisements against sponsorships.

To calculate parking revenue following assumptions have been taken:

Table 24: Assumptions for Parking Revenue

Parking Revenue Model	Units		
Total length of road where parking is allowed (NMV project on 100km roads as approved by Working Group)	100	Cumulative (km)	Percentage
1st year implementation of NMV	17	17	0.0
2nd year implementation of NMV	24	41	0.0
3rd year implementation of NMV	24	65	0.0
4th year implementation of NMV	24	89	0.0
5th year onwards implementation	11	100	0.0
parking slots per km per side	40.0	ECS(equivalent car space)	
Occupancy	80%		
ECS capacity per km per side	32.00	ECS(equivalent car space)	
Parking charge per hour per ECS	15.0	Rs	
Growth rate for charges	5%		

Table 25: Assumptions for User Fees and Subscription revenue

User fees and Subscription

		Fees		% of total users		days	month
User fees	For first half hour users	0.0	Rs/half hour	4,577.4	60%	25.0	12.0
	For Second half hour users	10.0	Rs/half hour	2,288.7	30%	25.0	12.0
	For third half hour users	20.0	Rs/half hour	762.9	10%	25.0	12.0
	Total trips per day	7,629.0					
Growth rate for trips	Year 1 to 3	15%					
	Year 4 to 8	10%					
	Year 9 & 10	5%					
User subscription	No of subscription	3814.5					
	Subscription fees	250.0	Rs/year				
Growth rate for user subscription	Year 1 to 3	100%					
	Year 4 to 8	50%					
	Year 9 & 10	10%					

Table 26: Assumptions of Advertisement and Sponsorship Revenue

	Item	Revenue
Advertisements	Revenue per station per month	15,000.0
	Revenue per bicycle per month	100.0
Sponsorships	Annual Revenue on System	6,00,00,000

8.5 Financial Analysis

As mentioned above, financial analysis has been carried out for a period of ten years. Following assumptions were adopted for such an analysis:

- Phase-I construction is assumed to be completed within first year.
- Revenue will be generated from the second year
- Tax= 34%
- Project operation will be fixed on monthly basis

From the cash flow analysis it is clear that, project expense including capital expenditure can be recovered till the eighth year, given the condition that proposed operation model has been followed and the stated revenue has been collected. Cash flow statement shows that till seven years, closing cash flow is lower than net cash flow.

8.5.1 Capital Cost

Table 27: Estimated Capital Expenditure (Rs. In crores)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Bicycle cost	3.6	0	0	2.4	0	0	0	0	0	0	0
Dock cost	10.12	0	0	7.5	0	0	0	0	0	0	0
Terminal	1.8	0	0	1.44	0	0	0	0	0	0	0
Small stations	3.6	0	0	4.2	0	0	0	0	0	0	0
Large stations	7.2	0	0	1.8	0	0	0	0	0	0	0
Call and Operational Control Centre	2	0	0	0	0	0	0	0	0	0	0
Design consultancy (one time)	0.3	0	0	0	0	0	0	0	0	0	0
Total Capital Expenditure (1) (on system) (Rs.in crore)	28.62	0	0	17.34	0	0	0	0	0	0	0
Redistribution vehicles	0	0.8	0	0.4	0	0	0	0	0	0	0
Vehicles for maintenance team	0	0.07	0	0.05	0	0	0	0	0	0	0
Setting up of Depot	0	0.5	0	0	0	0	0	0	0	0	0
Total Capital Expenditure (2) (on operations) (Rs In crore)	0	1.37	0	0.45	0	0	0	0	0	0	0
Total Capital Expenditure(1+2) (Rs in crore)	28.63	1.38	0.00	17.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00

8.5.2 Operational Cost

Table 28: Estimated operational cost (Rs. In crores)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Bicycle cleaning	0.00	0.30	0.32	0.34	0.36	0.39	0.41	0.44	0.46	0.50	0.53
Bicycle small repair & checking	0.00	0.18	0.19	0.20	0.22	0.23	0.25	0.26	0.28	0.30	0.32
Bicycle mechanics (depot)	0.00	0.14	0.15	0.16	0.17	0.18	0.20	0.21	0.22	0.24	0.25
Mechanic assistants	0.00	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17
Redistribution teams	0.00	0.43	0.46	0.61	0.65	0.69	0.74	0.79	0.84	0.89	0.95
Operation manager	0.00	0.36	0.38	0.41	0.43	0.46	0.49	0.52	0.56	0.59	0.63
Driver	0.00	0.36	0.38	0.51	0.54	0.58	0.62	0.66	0.70	0.74	0.79
Customer service agents	0.00	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.19	0.20	0.21
Customer relation managers PoS kiosks	0.00	2.40	2.56	2.04	2.18	2.32	2.47	2.63	2.80	2.98	3.17
Accounting assistant	0.00	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13
Account manager	0.00	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.08	0.08
Senior project manager/CTO	0.00	0.24	0.26	0.27	0.29	0.31	0.33	0.35	0.37	0.40	0.42
Marketing manager	0.00	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13
Spare parts bicycle (for 5 years)	0.00	0.45	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.85	0.90
Spare parts stations (for 5 years)	0.00	0.10	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.20	0.22
Petrol	0.00	1.20	1.28	1.92	2.04	2.17	2.31	2.46	2.62	2.79	2.97
Insurance on Redistribution Vehicle	0.00	0.30	0.32	0.48	0.51	0.54	0.58	0.62	0.66	0.70	0.74
Legal services	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Maintenance of System	0.00	0.36	0.38	0.64	0.68	0.72	0.77	0.82	0.87	0.93	0.99
Electricity	0.00	0.12	0.13	0.26	0.27	0.29	0.31	0.33	0.35	0.37	0.40
Internet / mobile phones	0.00	0.42	0.45	0.80	0.86	0.91	0.97	1.03	1.10	1.17	1.25
IT maintenance (5 years)	0.00	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.15	0.17	0.18
Stationary and admin cost	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Insurance on maintenance vehicles	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Smart Card Cost	0.00	0.50	0.53	0.57	0.60	0.64	0.68	0.73	0.77	0.83	0.88
Operator Charges	0.00	1.73	1.72	2.22	2.14	2.28	2.42	2.58	2.74	3.12	3.32
(G) Total Revenue Expenditure(Rs. in crores)	0.00	10.14	10.09	13.04	12.62	13.43	14.29	15.21	16.19	18.50	19.69

8.5.3 Revenue sources

Revenue calculations have been done assuming that the phase-I of NVM project will be completed by 2017. For that, availability of parking space and parking charges have been calculated per hour, per day as well as annually; as shown in Table 29.

Estimated Parking Revenue

Table 29: Estimated Parking Revenue

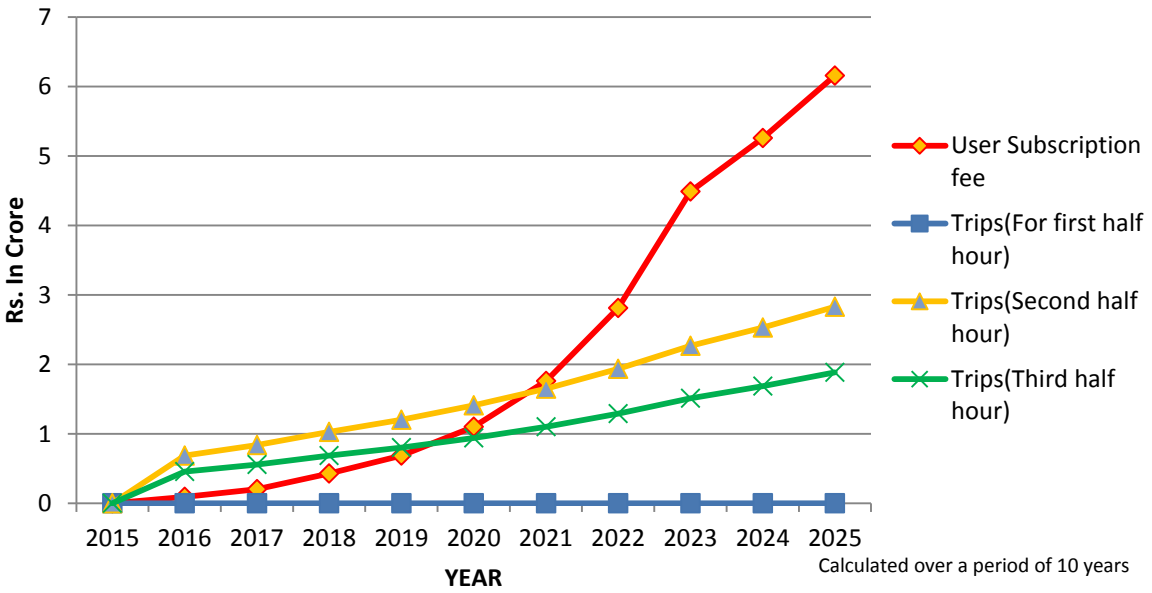
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
No. of parking available (ECS)	0	544	1088	1088	2624	4160	5696	6400	6400	6400	6400
Parking charges per hour(Rs.)	0	15	15	15	15.75	16.54	17.36	18.23	19.14	20.1	21.11
Parking charges per day(Rs.)	0	120	120	120	126	132.3	138.92	145.86	153.15	160.81	168.85
Total Parking Revenue per day (Rs. In Lakh)	0	0.65	1.3	1.3	3.3	5.5	7.9	9.33	9.8	10.29	10.8
Total Parking Revenue per year(Rs. In Crore)	0	2.4	4.8	4.8	12.1	20.1	28.9	34.1	35.8	37.6	39.4
Total Parking Revenue(Rs. in crores)	**0**	**2.4**	**4.8**	**4.8**	**12.1**	**20.1**	**28.9**	**34.1**	**35.8**	**37.6**	**39.4**

Estimated User fee and subscription revenue

Table 30: Estimated User fee and Subscription Revenue

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2015
No. of trips	For First hour(In Lakh)	0	13.73	15.79	1.81	19.97	21.97	24.17	26.58	29.24	30.71	32.24
	Second half hour(In Lakh)	0	6.86	7.89	9.08	9.98	10.98	12.08	13.29	14.62	15.35	16.12
	Third half hour(In Lakh)	0	2.28	2.63	3.02	3.32	3.66	4.02	4.43	4.87	5.11	5.37
	No. of Subscription(In Thousand)	0	3.8	7.6	15	22.88	34.33	51.49	77.24	115.866	127.45	140.2
			0	0	0	0	0	0	0	0	0	0
Trip Charges	For first half hour users(Rs.)	0	0	0	0	0	0	0	0	0	0	0

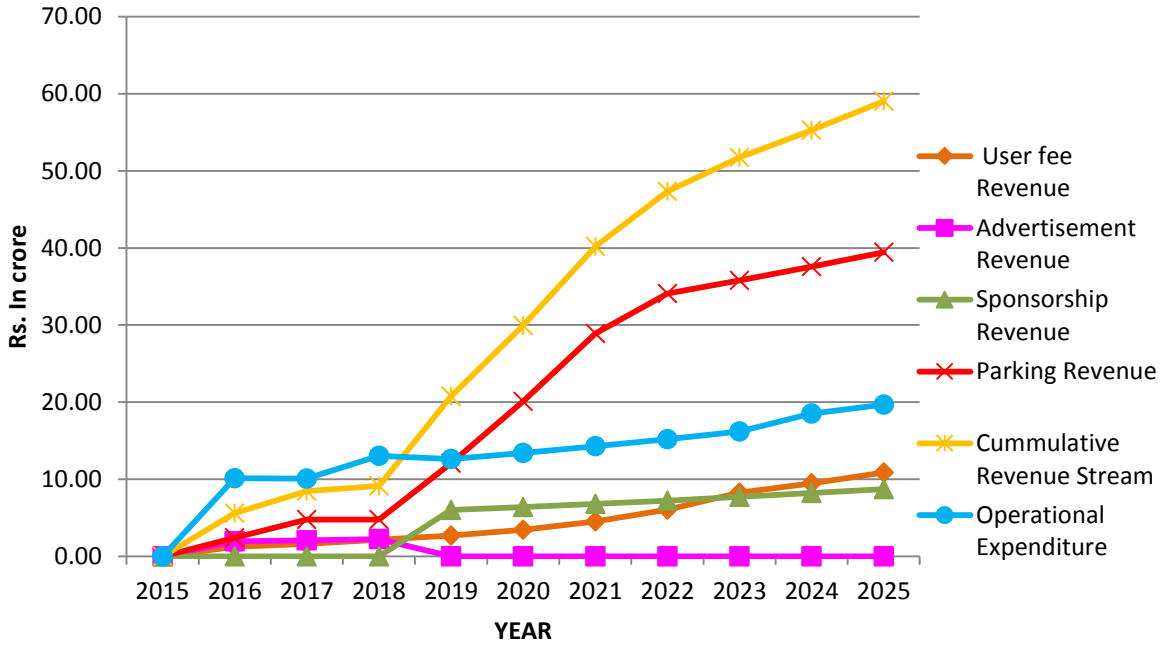
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2015
	For second half hour users(Rs.)	0	10	10.65	11.33	12.07	12.85	13.68	14.56	15.5	16.5	17.57
	For third half hour users(Rs.)	0	20	21.29	22.67	24.13	25.69	27.35	29.12	31.00	33.00	35.13
User Subscription	Subscription Fee(Rs.)	0	250	266.2	283.3	301.7	321.1	341.9	364.0	387.5	412.5	439.2
Total Fee Calculation (in Lakh)	Trips(For first hour)(Rs.)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Trips(Second half hour)(Rs.)	0	68.66	84.06	102.92	120.52	141.14	165.28	193.55	226.66	253.37	283.22
	Trips(Third half hour)(Rs.)	0	45.77	56.04	68.61	80.35	94.09	110.19	129.03	151.11	168.91	188.81
	User Subscription fee(Rs.)	0	9.54	20.30	43.23	69.04	110.25	176.05	281.14	448.95	525.75	615.68
	Total Revenue from user fee(Rs. in crores)	0.0	1.24	1.60	2.15	2.70	3.45	4.52	6.04	8.27	9.48	10.88



Revenue from user fee is one of the components of the total revenue that would be generated by the PBS system. The user fee collection system has been divided in various intervals for the ease of collection. The user would be able to avail the services for free for the first 29 minutes and thus the revenue generated for the first 29 minutes of the use of the system would be nil, but as the user time increases, the fee would increase exponentially every half an hour and thus the revenue generated would depend on the time the user has used the bicycle, basing the time in half an hour intervals. Since, PBS aims at encouraging shorter trips, the revenue generated for the third half an hour would be lower than that of the second half an hour.

Figure 48: Revenue Generation Trend of User Fee and Subscription Fee, 2015-2025, Dwarka PBS

Although the user fee for the first 29 minutes would be zero, the users initially need to subscribe to the system. No of subscription will contribute to revenue generation which is expected to increase over time.



Calculated over a period of 10 years

Figure 49: Revenue sources vs Operational Expenditure, 2015-2025; Dwarka PBS

Of the total revenue generated will come from parking charges, other revenue generating sources include, registration fee, user fee, advertisement charges and sponsorship charges. As can be seen in the graph, the parking charges account for the maximum revenue generation source and while the operation cost would be high in the initial years of the project, eventually, the cumulative revenue generated from the system would surpass that cost and result in positive returns.

Estimated Advertising rights and revenues

Table 31: Estimated Advertisment Revenue in crore

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Revenue from advertisement on stations	0.00	1.8	1.92	2.04	0	0	0	0	0	0	0
Revenue from advertisement on bicycles	0.00	0.16	0.17	0.18	0	0	0	0	0	0	0
(E ^{3})Total Advertisement revenue	0.00	1.96	2.09	2.22	0	0	0	0	0	0	0

Estimated Sponsorship Revenue

Table 32: Estimated Sponsorship Revenue

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Revenue from sponsorship on stations, bicycles, smart cards, website, kiosk etc.(Rs.)	0.00	0.00	0.00	0.00	6	6.39	6.80	7.24	7.71	8.21	8.74
(E ^{4}) Total Sponsorship revenue(Rs. in crores)	0.00	0.00	0.00	0.00	6	6.39	6.80	7.24	7.71	8.21	8.74

*E= $E^1 + E^2 + E^3 + E^4$

8.5.4 Cash Flow and Income expenditure

Calculation of cash flow and income expenditure has tax component referred as “I” (in the table below), which is 34%.

Table 33 Cash Flow of PBS Dwarka, year 2015-25 (Rs. in crore)

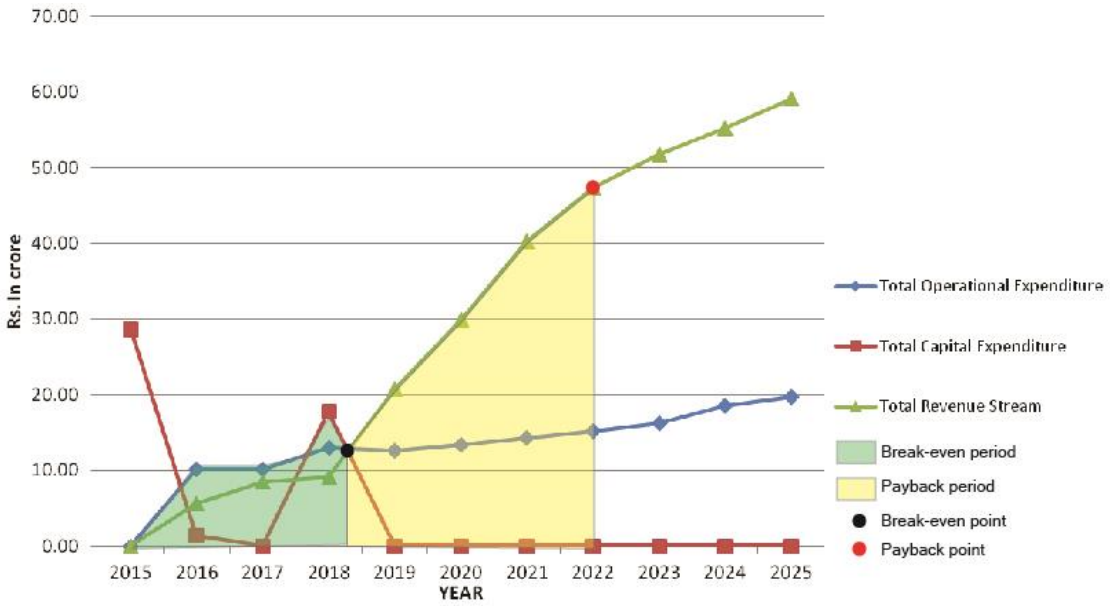
Year		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TOTAL EXPENDITURE (J)	(F+G+I)	28.63	11.52	10.09	30.83	13.60	17.22	21.25	24.27	26.40	29.11	31.18
NET CASH FLOW	(E-J)	-28.63	-5.93	-1.63	-21.69	7.17	12.71	18.94	23.08	25.35	26.14	27.87
OPENING BALANCE		0	-28.63	-34.56	-36.19	-57.89	-50.72	-38.02	-19.07	4.01	29.35	55.49

CLOSING BALANCE		-28.63	-34.56	-36.19	-57.89	-50.72	-38.02	-19.07	4.01	29.35	55.49	83.37

Calculation of cash flow and income expenditure has tax component referred as "I" (in the table above), which is 34%.

Table 34: Income Expenditure of PBS Dwarka, year 2015-25 (Rs. in crores)

Year		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Total Non-Cash Expenditure (G)		0.0	3.0	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
TOTAL EXPENDITURE (IN CRORES)(RS.) (H)	(F+G)	0.0	13.1	13.1	18.3	17.8	18.7	19.5	20.4	21.4	23.7	24.9
EBITA (I)	(E-H)	0.0	-7.6	-4.6	-9.1	2.9	11.3	20.7	26.9	30.3	31.5	34.1
TAXES (J)	34%	0.0	0.0	0.0	0.0	1.0	3.8	7.0	9.1	10.2	10.6	11.5
EARNINGS AFTER TAX (K)	(I-J)	0.0	-7.6	-4.6	-9.1	1.9	7.5	13.7	17.9	20.1	20.9	22.6



Capital expenditure are the initial expenditure incurred during implementation stage while the operational expenditure will keep the system running. The capital expenditure marks steep rise with implementation of Phase II in 2018. Payback period is marked up to year 2019, and reaches the break-even point. The revenue marks steep rise from 2018. (refer Figure 50)

Figure 50: Cash Flow and Income Expenditure graph, 2015-2025, Dwarka PBS:

8.6 Operational model

PBS Operations run on different business arrangements between the Government, Operator and a Sponsoring/ Advertising partner in different cities globally, depending on local context, government's experience in PPP projects, technical capacity available to run the system and the goal of the government to provide last-mile service to its people. While most of the Chinese cities are provided and run by government or government-owned companies, many European cities have PBS system run in an arrangement between the Operator and Advertiser with sharing of revenue from advertisements. Operating a PBS system requires considerable technical efficiency and man-power management and therefore is a cost-intensive job.

8.6.1 Proposed operational model

The major principle for designing operational model is to provide high quality PBS without profit making motive. Keeping a larger motive of managing all NMV matters under one roof, creation of a NMT cell/ steering committee has been proposed considering minutes of consultation meeting (consultations between the Government, operators and technical consultations).

After planning and design and having agreement on the financial plan of the system, it is time to initiate the implementation process of PBS system. For this, the very first step would be to establish a governance structure/ monitoring structure or project team with its own officials who will spearhead the implementation and be responsible for decision-making process and handling of various elements. Typically, forming a more long term governance structure at this stage and Dwarka should look at either enhancing the existing governance structure like strengthening existing transit authority or creating a fresh one. The structure helps in providing required technical inputs to the system at every stage and also monitoring the system in the longer run.

For this, we need to hold consultations within DDA and within city officials to formulate a long term structure to monitor and expand the project and additionally, an interim structure to help spearhead the process of implementation of PBS (that my dissolve/ merge with the main body after the successful implementation of PBS project).

The PBS Governance structure should be composed of:

8.6.1.1 Delhi Development Authority

Delhi development authority is the main Municipal body in the city which takes all the development related decisions for Delhi and hence will be highest authorized unit responsible for the implementation and operation of PBS system in Dwarka Sub-city. It will have the highest authority, and will appoint officials to form NMT cell.

8.6.1.2 NMT cell

The NMT cell can function as a department under the DDA to bring focus on NMT related projects. It will have planning powers to help plan for NMT infrastructure and Bicycle Sharing systems and Regulatory powers to help manage on-going NMT projects. It will also provide technical guidance to the SPV or the Operating Agency from time-to-time and function as a single point for all knowledge base on NMT in the city. It will prepare and guide on NMT and PBS schemes and also coordinate and technically support the project.

The NMT cell will be headed by the DDA officials. There are three major components of operational model (refer Figure 51).

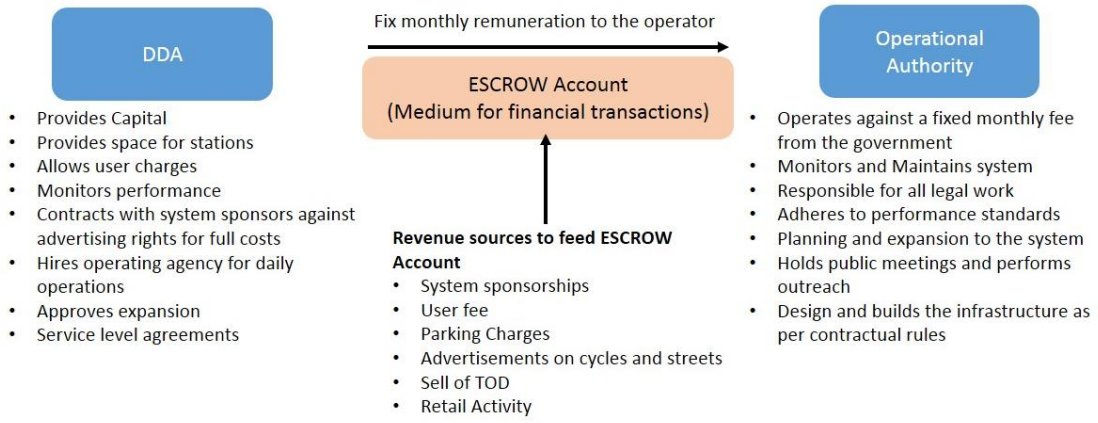


Figure 51: Components of Operational Model

8.6.1.3 Transit Authority/SPV

DDA can form Special Purpose vehicle (SPV) or enhance the existing transit authority to run the PBS system. The Transit Authority shall help monitor performance standards and shall take help of NMT Cell from time-to-time for technical guidance when required. The Transit Authority will act as an implementing agency at the time of installing of the project, will work in tandem with the existing staff with focus on implementing PBS system and later will manage the operations and finance. The transit authority when acts as an implementing agency will manage the project, coordinate for implementation of PBS, ensure optimal technical quality and service delivery.

8.6.1.4 Operator

The company/agency which will operate the bicycles, docks, tools, machinery, etc. It will operate against a fixed monthly fee from the government to monitor and maintain the system. The operating agency is responsible for all legal work, provides user interface, hold public meetings and markets and brand the system. The operating agency also builds the infrastructure as per contractual rules.

9. IMPLEMENTING PBS

The timeline for implementation will start soon after the contract is signed and the operator gets a head start for beginning the tendering process and procurement. The primary need is to be ready with the specifications on Terms of Reference and the parameters to be considered for Service Level Benchmarking. The process of installation is as important as monitoring. Evaluating and optimizing the system enhances the longevity of the project and keeps up with standard checks required to attain the envisioned. Other very important step in the implementation is to carry out a communication and marketing campaign to promote the system. Implementation requirements are as follows;

- Establish the governance system and monitoring structure, define their scope of work
- Activity scheduling of PBS
- Determine the Performance standards for operations
- Communication and Outreach plan

After planning and design and having agreement on the financial plan of the system, it is time to initiate the implementation process of PBS system. Implementation of the PBS system in Dwarka will require extensive consultations and meticulous planning of all the small and major tasks that need to be carried out. DDA, experts and stakeholders will have to formulate team with their roles and responsibilities and gear them up for the extensive process of implementation.

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9.1 Establish the governance system and monitoring structure

Implementation process will start with establishing a governance structure/ monitoring structure or project team with its own officials who will spearhead the implementation and be responsible for decision-making process and handling of various elements. Typically, forming a more long term governance structure is preferable at this stage. The structure helps in providing required technical inputs to the system at every stage and also monitoring the system in the longer run. The board of Delhi Development Authority (DDA) approved formation of NMT cell for Dwarka PBS and also gets its own PBS policies. The roles of other authorities (refer chapter 8.6 Operational Model) is given below;

- **Role of NMT cell**

NMT cell is for day-to-day management of Bicycle Share system, policy support and implementation and for planning of NMT, a cell needs to be formed under the ULB This cell may be named as NMT Cell and shall perform the following functions:

1. Prepare NMT and PBS policy, regulations and guidelines
2. Preparation of various NMT-related planning documents:
    a. Road Hierarchy Map
    b. Preparation of Cycling Master plan
3. Preparation/ guidance on NMT and PBS schemes.
    a. Preparation of pilot projects and monitoring of implementation.
    b. Provide technical guidance on bicycle sharing system and NMT lane provision/ planning
    c. Provide guidance on expansion of NMT
    d. Make budgetary proposals for various ULBs for NMT implementation

4. Coordination and Technical Support
    a. Coordinate with various agencies for implementation of NMT projects and PBS initiatives.
    b. Provide hand-holding support to government officials on creating NMT infrastructure
    c. Organize important meetings and discussions/ seminars on NMT with various institutions in Delhi
    d. Be the nodal point of all information related to NMT and shall provide relevant technical advice to various government bodies for developing NMT guidance for their areas and design and engineering details.
5. The Technical support of staff and secretarial assistance to this cell shall be provided by the ULB.

- **Role of Project Implementation Unit (PIU)**

The PIU is an implementation body. It is expected to work in tandem with the existing staff with focus on implementing PBS system as per defined plan. The PIU shall assist the NMT Cell in carrying out the following activities:

i. Project management and co-ordination for implementation of PBS
ii. Ensuring optimal technical quality in project implementation and service delivery
iii. Monitoring project progress in co-ordination with other departments
iv. Preparation of reports for various bi-lateral agencies, if funding supported by them in any form.
v. Engaging and managing service providers and external experts for implementation of projects.
vi. Day-to-day monitoring of on-ground implementation of the project. Project testing, reporting and providing feedback to the government on the specified interval.
vii. Providing logistics and administration support during consultations.

- **Role of Transit Authority/ SPV**

The formation of SPV/ Transit Authority will ensure faster, reliable and advanced operation of PBS. The SPV's main function is to run and operate the system. Special purpose vehicle (SPV) or any transit authority is to ensure fast reliable and efficient functioning of the system SPV are mostly formed on PPP basis.

i. Will monitor the system, sign contract with system sponsor against advertising rights or full cost
ii. Will run various departments, such as Human resource, Administrations, Infrastructure, Operation and IT
iii. It will have team to handle the infrastructure, revenue, control room , or else will hire experts to run the same
iv. It will have Transport planner to plan and optimize the system

- **Role of Operator**

i. Will operate the system as per the contract with the transit authority or SPV, against fixed monthly fee

ii. Will monitor and maintain the system
iii. Responsible for all leg work
iv. Adheres to the performance standards

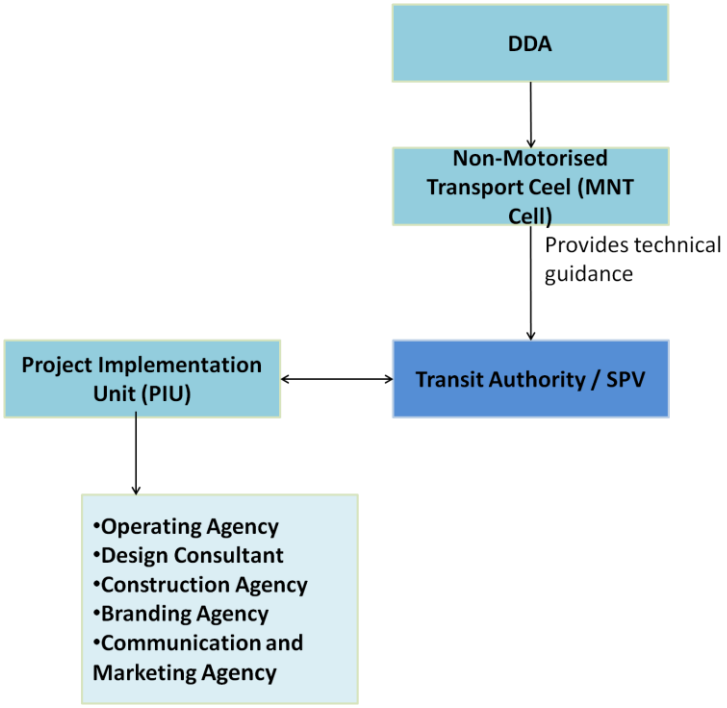

Figure 52: PBS Implementation Structure

9.2 Activity scheduling of PBS and roles and responsibility matrix

Activity scheduling is the list of activities involved for implementing PBS for Dwarka. The activities are as follows;

- Preparation of DPR
- Submission and approval of the project
- Establishment of PBS Governance structure
- Creation of PIU
- Preparation of Operation tender and procurement letter
- Hiring of Operator and procurement of equipment
- Project Implementation- Installation of Station, Hardware, Recruitment of staff, launch of web bed applications, Public out reach
- Testing of system- IT, Hardware, Trail Run
- Handling over the project to transit authority
- Monitoring of Operation
- System Optimization
- System Expansion

Table 35 Roles and Responsibility Matrix

Activities/ Authorities	NMT Cell	Transit Authority/ SPV	PIU	DDA
Preparation of DPR	P			I
Submission and approval of the project	P			I
Establishment of PBS Governance structure	P			S

Activities/ Authorities	NMT Cell	Transit Authority/ SPV	PIU	DDA
Creation of PIU	P			S
Preparation of Operation tender and procurement letter	S	S	P	
Hiring of Operator and procurement of equipment	S	P	P	I
Project Implementation- Installation of Station, Hardware, Recruitment of staff, launch of web bed applications, Public out reach	S	S	P	I
Testing of system- IT, Hardware, Trail Run	S	S	P	
Handling over the project to transit authority	S		P	I
Monitoring of Operation	S	P		
System Optimization	S	P		I
System Expansion	S	P		I

P: Primarily Responsible, S: Support, I: Informed

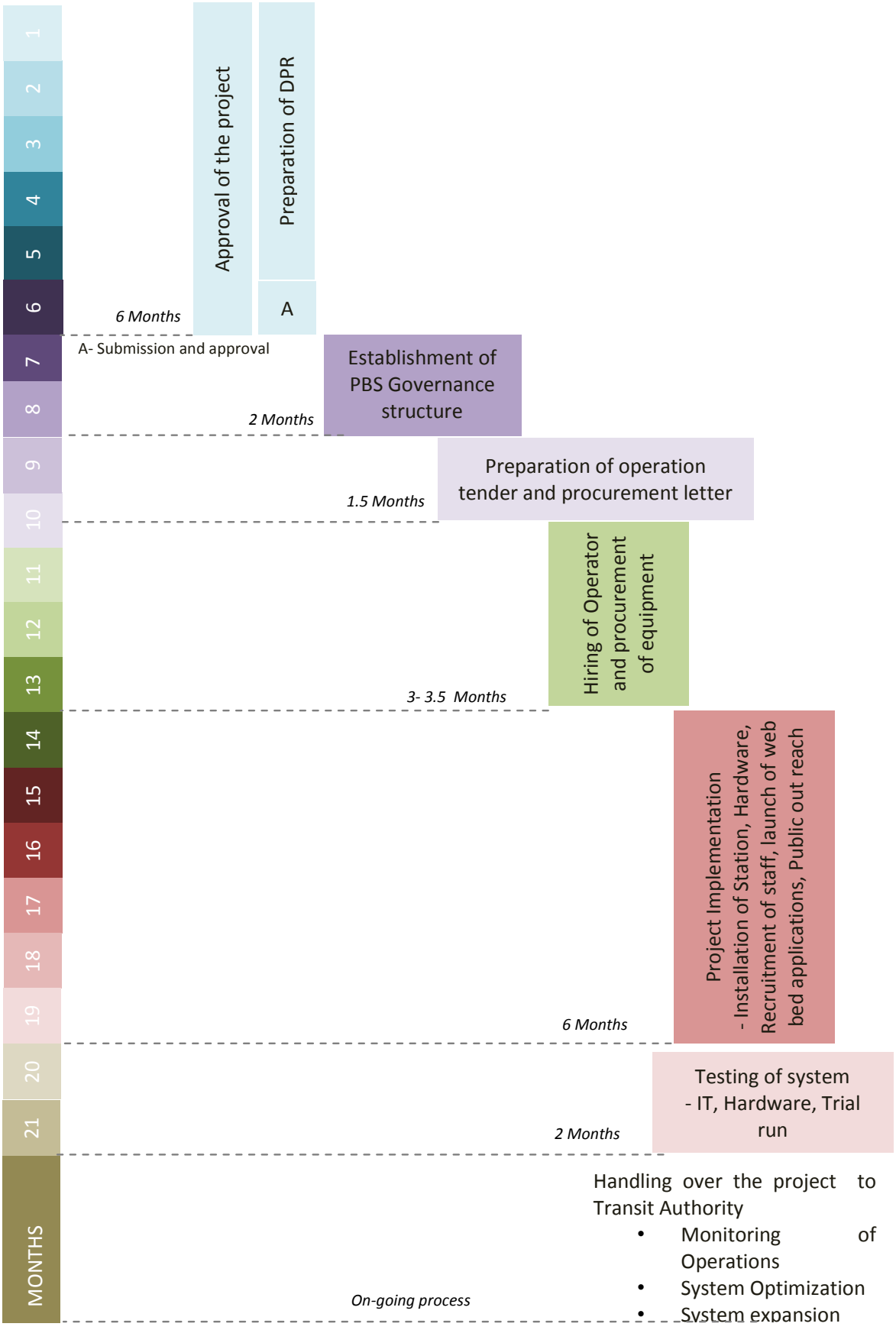

Figure 53: Activity Scheduling Timeline for Implementation

9.2.1 Hiring of consultants for design

Separate consultant must be appointed for the design and implementation of the various aspects of the PBS system after taking into account the advisor's terms of reference, these include station shelter design, integration with the street, branding and marketing and overall project management.

9.2.2 Finalizing equipment

For the successful functioning of a PBS system it is important to procure the right kind of equipment including but not exclusively docking stations, bicycles, docking terminals, monitoring and surveillance equipment like CCTV cameras, GPS tracking devices, RFID sensors, Smart card recharging stations etc., these should be finalised after duly studying other similar systems and prototypes. Durability of the system, operation and maintenance costs and other such expenses must be kept in mind as shortlisting criteria before finalising a particular supplier or system.

9.2.3 Hiring of an Operator

Tendering for the operations: Tendering for operations should be done bearing in mind the financing model for operations. The know-how and ease of the operator in working with sophisticated PBS systems must be evaluated before evaluating and awarding the tender. Standard operator costs can be arrived at after inviting tentative bids from the potential suppliers.

Selecting an operator: An operator must be selected based on his past experience and ability to deliver the project at this scale. It is important that the operator is well versed with how PBS systems works and is maintained, they must also be well versed with the challenges of operating in complex contexts and environments.

9.2.4 Procurement, installations and commissioning & testing

Procurement and installation of the various components of the Public bicycle Sharing system would entail sourcing of various components and parts related to the PBS system and their installation at the site. Prior to procurement and installation, the client must seek samples for all the components and approval of the advisor and consultant must be sought before proceeding on the full order. Also testing reports and certification on the durability of the various components and materials of the system must be sought and perused by the client, the consultant and the advisor. The client must also seek full scale mock-ups to understand the running of the system before the entire system is in place.

Before the full system is installed provision must be made for the installation of prototypes for due signoff's from the client representatives, the advisor and the consultants.

9.2.5 Determine the Performance standards for operations

The relationship between the governing body and the operator, no matter which operational structure is chosen, is a crucial aspect of a successful PBS. This relationship is best defined in a contract between the governing body and the operator, with a performance management system put into place to incentivize and reward the operator for excellent performance. The means to do this is Service Level Agreements that defines & quantifies the various pre-agreed "performance indicators". (Schroeder 2014). These could potentially include:

- Evaluating the performance of operator
- Overall system functionality- monthly/ weekly report
    - Subscription to system, Daily ridership, Trips/bicycle
    - Bicycle Modal share- modal report
    - Cyclist Fatality Rate- monthly report
    - Feedback from the users- weekly report
    - Stations in service, Bicycles in service- daily report
    - Bicycle cleanliness, station cleanliness- report every 3 days
    - Bicycle distribution – Monthly report
    - Website in service/ ITS performance- Monthly report
    - Report theft- monthly report

Service Level Agreement, New York

CitiBicycle of New York Service Level Agreement- designed to deliver improved service, increase accountability and transparency of the system.

The service level has specified nineteen parameters- measures the performance against the service level agreement.

- Station inspection and litter removal- station are inspected twice a week
- Station and bicycle cleaning- every station and bicycle are cleaned once in 14 days
- Bicycle maintenance- full mechanical check once in a calendar month
- Station cleaning after discovery or notification- has to be cleaned within 48 hours of notification
- Bicycle cleaning after discovery or notification- has to be cleaned within 96 hours of notification
- Emergency station repair/removal-in case of emergency, station to be removed or repaired as soon as possible, but no later than 12 hours
- Station Deactivation or removal, operational docks- to be done within 48 hours
- Station reactivation or replacement- to be done within 24 hours
- Snow removal: If the program is shut down due to snow event: Equipment must be operational and reasonably free of snow within 5 hours of the program's reopening. If the program did not shut down due to snow event: Equipment must be operational and reasonably free of snow within 12 hours of end of snow event
- Station Uptime: Stations must be fully functional including al communications and transaction systems, excluding major upgrades to the Central Computer System providing that NYCBS has given reasonable advance notice to DOT and the customers of the program
- Website Availability, Central Computer system outage- must be fully functional
- Bicycle fleet: The operator will ensure that all bicycles are in circulation as agreed upon by all parties. The bicycle fleet size shall not go below 90% of the program fleet
- Peak hour distribution and non-peak hour distribution: should be balanced
- Call centre should answer 80% calls

Figure 54: Delivery of report as agreed upon schedule, for Citi bicycle it is monthly. (NYCBS 2014)

9.2.6 Communication and Outreach plan

Communication and outreach plan is the means to part or communicate the information to the concerned stakeholders. The information distribution involves primarily through print media and the press, photography, advertising, cinema, broadcasting (radio and television), and/or publishing.
A consultant has to be hired for communication and outreach plan. The following concepts can be considered for communication outreach plan

- Organize public events, promotional campaigns, and workshops to reach out to the community. Social marketing also provides avenues to integrate the system with existing transport system. The existing stigma of using bicycles as mode of commute needs to be changed with the help of public events and social marketing.
- Develop a multi-fold media strategy covering announcements in newspaper, magazines, community flyers, radio and television.
- Involve key political and administrative figures to send messages about cycling and healthy living.
- Identify brand ambassadors who can help create a positive image of cycling.
- Interact with media and communication professionals and share information of the goals and operations of the system. Share results of surveys and field studies. Sharing of information will bring in transparency and acceptance.
- Use social program
- Use social media platforms to engage with youth. Design special programs for targeted users
- Hold public debates and write articles on blogs, newspapers and websites on the benefits of cycling and its impact on the city's health and environment.

10. BRANDING AND MARKETING

10.1 Branding, Communication media and Marketing Research

Branding is central to creating an identity for the Dwarka PBS system. Identity will inform the people about the system – it's functioning and services. Communication strategy and social marketing is the means to send the message created through branding to its people. A well planned and designed bicycle share system requires befitting identity and good promotion for better and successful implementation.

10.2 Branding- Name Logo and Tag line

Dwarka PBS will aim to create an appropriate branding identity to establish the right image in the mind of the customers. A system name will be something that

- A local will be able relate to and
- Sends out a clear message about the system

While the name will be something

- To which a layman will be able to easily associate with and
- Not too difficult to pronounce or spell, which might otherwise lead to loosing the flair that could have better the position of the system in minds of the public.

Many PBS systems tag their city's name with colloquial words related to cycling or transport to give the system a very distinctive touch and identity.

Logos helps in the creation of a brand identity for the system. It is like a signature that symbolizes the entire system. PBS logo of Dwarka will be

- Illustrative
- symbolic
- textual or
- Combination of all three.

It will function as a unique identity, and through colors, fonts and images will provide essential information about the system that will allow the users to identify with the system's core brand.

Boosting the systems name and logo with a tag line or a slogan will help defining and highlighting the various aspects of the system. The PBS tag lines generally will stress on the health fitness aspects, carbon saving, easy access, convenience of transport system and modernity of the system. The new systems image, brand name, logo and slogan should be protected by trademark and copyrights. The copyright should be held by the public authority and not be any of the related private sector firms such as the operators or marketing firms.
For the selection of the brand logo and name, a competition is proposed, where after a consultation the final logo and name would be chosen.

Figure 55 : PBS Brands and Logos

10.3 Communication Media

Communication media is the means to part or communicate the information to the concerned stakeholders. The information distribution primarily involves print media, press, photography, advertising, cinema, broadcasting (radio and television), and/or publishing. For Dwarka PBS the prime lookout of communication media will be to change the existing stigma, that using bicycles as mode of commute is only for a specific group or class of people, and advertise the benefits of using the PBS service. The following methods or ideas can be adopted to spread the word of PBS;

- Identifying spear head such as political and administrative figures to send messages about cycling and healthy living.
- Identify brand ambassadors who can help create a positive image of cycling.
- Interact with media and communication professionals and share information of the goals and operations of the system. Share results of surveys and field. Develop a multi-fold media strategy covering announcements in newspaper, magazines, community flyers, radio and television. Involve key studies. Sharing of information will bring in transparency and acceptance.
- Use social media platforms to engage with youth. Design special programs for targeted users
- Hold public debates and write articles on blogs, newspapers and websites on the benefits of cycling and its impact on the city's health and environment.

The prediction of choice of media is based on budget, ability to reach target audiences, the desired impact and the message to be communicated.

Figure 56: Boris Johnson and Arnold Schwarzenegger participating in inauguration of Barclay Bicycle Hire, Popularized as “Boris Bicycle”. (Decor&Style 2014)

Figure 57 Left: Guangzhou's Director of Communication Commission, promoting PBS of the city.
Right: Philippines, Pasig’s Mayor Maribel Eusebio, at the launches of the bicycle sharing systems. (Schroeder 2014)

10.4 Market Research

For preparation of an effective marketing plan, tactics and strategies it is necessary to understand the customers – their profile, motivations, perceptions, behavior and needs in respect to the choice of transit. These steps will help set the targets for marketing campaign and identify user segments and facilitate message development.
Some of the commonly used marketing research tools are:

Personal interviews or questionnaires: Used to capture demographic traits, needs and behavior. User Perception survey has captured the initial feedback about PBS, but a feedback after implementation is also needed to rationalize the system

Focus Groups: Allows in-depth discussions on specific issues with a randomly selected user or non-user group. It helps in determining the most effective marketing campaign or change in service, etc.

Socio-economic study: The household survey, origin-destination survey of the commuter is also one of the important sources to understand the travel behaviour and willingness to go with

any change in the public transport supply in terms of both quality and quantity. The input helps operator/owner to integrate these views with necessary system modification and study its impact on further operation in terms of maximum revenue generation with minimum utilization of resources and operating cost.

Blogs and social networks: They give customers an opportunity to express their opinions on social forum.

10.5 Measurement of Marketing Effectiveness

Measuring the effectiveness of a marketing campaign and making changes in the campaign or service is equally important. The effectiveness of campaign and course corrections required can be best estimated by conducting marketing research which could be in the form of customer satisfaction surveys and ridership studies. The outcome helps improve current operations system to achieve goals through socially, economically and environmentally sustainable development.