DRAFT DETAIL PROJECT REPORT

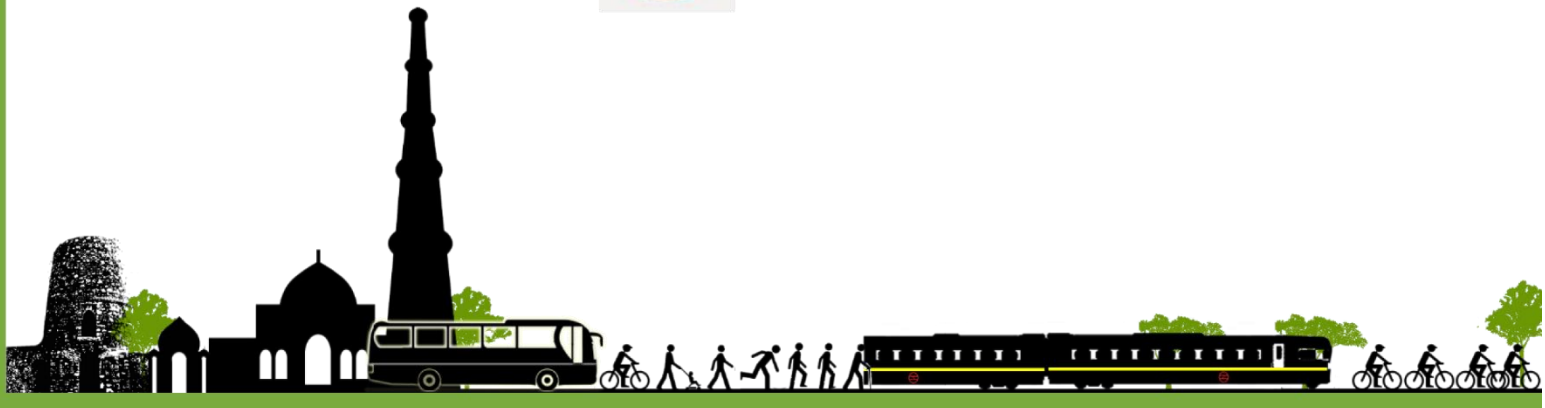
on PUBLIC BICYCLE SHARING SYSTEM

For SDMC

September 2015

Supported by:
SHAKTI Sustainable Energy Foundation

Prepared by:
Centre for Green Mobility



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Centre for Green Mobility Ahmedabad, is a Section 25 non-profit Company, which helps cities envision a sustainable and a joyous future that is achieved through great urban design and an efficient and equitable transportation system.

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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
MoUD:	Ministry of Urban Development
MPD:	Master Plan Delhi
NCT:	National Capital Territory
NH:	National Highway
NMT:	Non-motorized transport
NUTP:	National Urban Transport Policy
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

South Delhi Municipal Corporation (SDMC) has identified various aspects of urban transportation and desires to strengthen non-motorized and eco-friendly transportation network. Keeping in mind the current needs of public transport and with a view towards a better future, an integrated solution for Public Bicycle Sharing (PBS) system had been proposed by the Centre for Green Mobility (CGM), for SDMC. It was decided to take part of SDMC area as initial pilot study and implementation project.

CGM had entered into a non-financial Memorandum of Understanding (MoU) with SDMC, on 3rd March 2014 to provide technical support in carrying out tasks related to plan and assist in implementation of PBS, such as study and detailing out the proposal, assisting in procurement of services and infrastructure and monitoring the system. This project is supported by Shakti Sustainable Energy Foundation (SSEF).

1.2 Public Bicycle Sharing (PBS)

"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 leg journey. The dense network of station 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.

Today more than 500 cities in 49 countries host advanced bike-sharing programs, with a combined fleet of over 500,000 bicycles (Larsen, 2013). Urban transport advisor Peter Midgley notes that "bike sharing has experienced the fastest growth of any mode of transport in the history of the planet". More than ever 2011 to 2013 have experienced doubling of bike share globally. As of April 2013 there were around 535 bike-sharing programmes around the world, made of an estimated fleet of 5.2 lakh bicycles. While in May 2011 there were around 375 schemes comprising 2.4lakh bikes. The system is experiencing explosive growth globally.
In a PBS network, bicycles are available throughout a defined area in a community whereby the user can take a bicycle from one PBS station and return it to any other PBS station in the network. The unique feature of PBS system is that the flexibility of the system in route planning and usage, that is the user is free to choose their route and timing just like one can do in private vehicle, yet without really owning the bicycle or being worried for its docking/parking, maintenance, theft etc. Second greatest advantage of PBS is the system design that enables maximum utilization of resources or bicycles within the network.

PBS for Indian cities

In Indian cities, commuting mode choices are a clear function of the family income. This could be either because of inadequate and inefficient public transport or wide range

opportunity to own private vehicle. Subsequently this has impacted on cycling mode share in most Indian cities, and today most of the cyclists are the one, who have no choice other than to cycle in order to reduce their travel expenses. Such cyclists are referred as the captive cyclist. The PBS system is not to shift the existing cyclist but encourage other mode user to shift and opt cycle as their mode of travel.

As a rule of thumb, potential PBS users are those making short trips (less than 5kms). In smaller Indian cities, the average trip lengths are small - second tier cities like Vishakhapatnam and Rajkot have average trip lengths of 4.0 km and 3.5 km (source LCMP surveys 2012). Even in Metro cities, a large share of trips still remains short.

Target Users

- **Daily commuters** who could use PBS as a medium for short trip or last-mile connectivity
- **Residents and office employees** who could use PBS to run general errands in the vicinity. Employees could use the system while not risking bringing their vehicle in a congested commercial set up with poor parking facilities;
- **Time and budget sensitive tourists** who could use the system to experience more landmarks in the city at their own convenience; and
- **School and college going students** who can ride a few kilometre instead of pulling out their private vehicle or waiting for the para transit. The potential of this user group is amply visible through the multiple college-specific PBS initiatives seen in India.

Depending on the target user group, the approach to planning and designing the PBS system will change. Insensitivity to the different needs of each user group may impact the ultimate success of the project.

What does the City hope to achieve through PBS?

A PBS system by itself cannot be an end goal. It must fit into a city's larger mobility vision. In most cities around the world, PBS implementation has been preceded by the implementation of other measures to improve the cycling environment as part of a city-wide strategy for sustainable mobility. In the Indian context, it is important to identify the goals of a city with respect to PBS, such that complementary measures could be implemented simultaneously to ensure success. The possibilities of what a city can achieve through PBS schemes include, but are not limited to the following:

- **Increased cycling on city streets**, where cycle friendly infrastructure has already been constructed;
- **Improving access to high order transit** by providing targeted first/last mile connectivity;
- **Change in the socio-psychological perception of cycling**, leading to use of cycles by choice riders (not captive); and
- **Changing the nature of vehicular travel within central city** streets for short trips, by substituting motorised transport with NMT alternatives, including PBS.

In general, by increasing the cycle user base and erasing the social stigma associated with cycling, a high quality affordable bicycle share system, combined with policies that support NMT, can ensure the development of a comprehensive cycle infrastructure which can benefit all segments of the society.

Sl. No.	Issues/ Challenges of PBS	Mitigation Strategies and case studies
1	Inadequate Service Area & Station Density	**PBS system should be developed as network connecting origins/residences with destinations like transit node, market place, school college, office etc. and should not be developed as a corridor.** **Lyon, France - Velo'v**: Covers an area of 62.96 sq km within the cities of Lyon of Villeurbanne. It is currently equipped with a fleet of 4000 cycles distributed through 6,600 docking points at about 347 stations. **Montreal, Canada-Bixi**: Covers an area of 90 sq km within the cities of Montreal. It is currently equipped with a fleet of 5200cycles distributed through 9276 docking points at about 460 stations **New York, U.S-CitiBike**: Covers an area of 32 sq km within the CBD area of New York city. It is currently equipped with a fleet of 6000 cycles distributed through 11,192 docking points at about 332 stations
2	Theft and Vandalism	**IT enables system with RFID tag in the bicycles and smart card/key helps track the bicycle and the user, substantially reducing the chances of theft and vandalism.** **Montreal, Canada:** Anti-Theft Locking Mechanism **Lyon, France - Velo'v:** Electronic cards (CPU) that contain unique ID information and engage with the docks when 'locked'.
3	Complex Access Management	**Montreal, Canada** ITS Integration: The system uses wireless Radio Frequency Identification (RFID) for wireless real-time connection payment Bike stations are located at every 300 m distance Redistribution System: It is facilitated through real time information of bicycle and station status, by carrying cycles from crowded bicycle station location to empty ones.
4	Affordability Vs. Branding	**Lyon, France - Velo'v** Velo'v's unique third generation design directly undercut the previous impression of a cycle as a poor man's vehicle, and made it chic and cool. This enhanced its acceptability among all user classes.
6	Lack of Political will & Legislative Support	**London, U.K.** Political Support: Mayor's Boris Johnson's support and espousal of the Cycle Hire system went a long way in creating a positive impression of it.
7	Financing Challenges	**Montreal, Canada:** Publicly funded scheme with financial support from city and sponsors .The distribution of docks can be altered based on demand, allowing system optimization at minimal cost; **London, U.K.** Financed through user-generated revenues. Additional funding has been arranged through a substantial sponsorship deal with Barclays Bank, a premier London-based bank. **Lyon, France - Velo'v:** Public private partnership between city and JCDecaux
8	Topography	**London, U.K. :** Redistribution System **Lyon, France - Velo'v:** 3 Gear System Bicycles

9	Accidents/Safety	**Lyon, France - Velo'v** Sturdy handle bar with attached front light and basket, Adjustable seat and saddle, Rear lights for additional security, Disk brakes Dedicated bicycle track and NMV infrastructure can ensure safety of cyclist.
10	Social Stigma	**London, U.K.:** Political Support: Mayor's Boris Johnson's support and espousal of the Cycle Hire system went a long way in creating a positive impression of it. **Lyon, France - Velo'v:** Velo'v's unique third generation design directly undercut the previous impression of a cycle as a poor man's vehicle, and made it chic and cool. This enhanced its acceptability among all user classes
11	Travel Time	**Montreal, Canada:** Integration of Public Transport (OPUS and BIXI)
12	Competitive Alternatives	**Montreal, Canada**: Availability: 411 stations covers an area of 82 sq km with an average distance of 300 m 7% off all trips on bicycle and the bicycle mode share o up to 12% in the summer.

1.3 Non-Motorised Transport Policy, India

Figure 1 Existing policies on NMV.L-R: NUTP Policy 2014, Public cycle sharing systems toolkit for Indian cities, Bicycle design specification for India PBS, Public bicycle schemes

1.3.1 NUTP, 2006

National Urban Transport Policy (NUTP) adopted by MoUD (Ministry of Urban Development), Government of India in April 2006 highlights its vision towards NMT (Non-Motorised transport) which says that:

- The safety concerns of cyclist and pedestrians must be addresses by encouraging and construction of segregated lanes for bicycles and pedestrians. Segregation of vehicles moving at different speeds would improve traffic flow.
- Segregated NMV paths are required not only along arterials but also access roads to public transport terminals. This will increase the use of public transport system particularly when combined with the construction of NMV parking.
- It is essential that NMT facilities be designed and constructed by consulting experts and community (i.e., potential users).
- Activities on footpaths such as street vendors must be properly controlled to secure pedestrian safety.
- Pedestrian and cycle facilities including crossing facilities at busy intersections should be well-maintained and kept free of encroachments.
- Cycle rickshaw should form a part of UT planning process and be provided with the necessary infrastructure such as stabling and waiting places.
- NMT facilities should be created so that cities would be encouraged to explore the possibility of a public bicycle sharing program, where people can rent a bicycle for use in specially designated areas.

1.3.2 Public Cycle Sharing Systems – A planning toolkit for Indian Cities

This planning toolkit is a comprehensive guiding document for planners and decision makers to introduce Public Bike Sharing systems in Indian cities, prepared by ITDP for the Ministry of Urban Development. It broadly highlights various features and elements for conceiving, planning and implementing PBS system in the Indian context. The document entails the concept of PBS to become an integral part of an inclusive mobility plan for the city, by serving as a last mile connecting medium to transit, reducing the burden from transit and paratransit services, increasing the modal share for cycling by setting in a cycling culture in the urban context and reducing congestion from the busy roads. The document features a genuine attempt at understanding the user and an interface that needs to be developed to deliver efficient services – while making sure that the system does not incur losses. The

toolkit cites best practices pertaining to the different features and sets benchmarks to achieve quality outcomes. Also provided in the appendix is a rich resource of the supporting infrastructure and capital costs which play a crucial role in determining the fate of an implemented system. An attempt has been made at answering to the different frequently asked questions that could take the form of resisting opposition from investors and other municipal bodies. This document is an outcome of several rounds of planning.

1.3.3 Bicycle Design Specification for India PBS (Draft1)

Ride-a-Cycle-Foundation which has launched Namma PBS in Bangalore assisted the Ministry of Urban Development in preparing specifications for a cycle that would be unique to Indian urban spaces. The document takes a sneak peak at the models of cycle used by operators like Velib, BIXI etc. to spot its best features. Attempts have been made to figure out specifications to secure the bike from theft and low maintenance. A cycle distributing vehicle on pedals has been designed to re distribute cycles across stations, a cost efficient unique feature for the Indian context.

1.3.4 Public Bicycle Schemes: Applying the concept in Developing Cities

This report presents an analytical overview of the PBS concept while detailing along key recommendations as policies and guidelines. Examples of best practices from Europe and Asia are cited, followed by a detailed account of the emerging scene of bicycle rental schemes in Delhi and Pune. Comparative and analytical exercises draw out the potential opportunities and threats to the concept in India while generating a discussion on the formulation of the program for the Indian context.

1.4 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[1], 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 Non-motorized transport (NMT) 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] Delhi Development Authority Website: https://dda.org.in

1.5 Bicycle sharing policy

The salient features of cycle sharing policy are as follows:

1. The policy defines Public Bicycle Sharing System as a form of a public transport system and talks about key difference between bicycle renting and bicycle sharing.
2. The key features of bicycle sharing systems as per the policy are:
    - A dense network of stations across the coverage area, with a spacing of approximately 300 m between stations for access within approx. 3-min walk.
    - Bicycles with specially designed parts and sizes to discourage theft.
    - A fully automated locking system at stations that allows users to check bicycles in or out with no need for staffing at the station.
    - Radio frequency identification devices (RFIDs) to track where a bicycle is picked up, where it is returned, and the identity of the user.
    - Real-time monitoring of station occupancy rates through General Packet Radio Service (GPRS), used to guide the redistribution of bicycles.
    - Real-time user information provided through various platforms, including the web, mobile phones, and/or on-site terminals.
    - Pricing structures that incentivise short trips, helping to maximize the number of trips per bicycle per day.
3. It highlights the role of various institutions like Municipal Corporation, Implementing agency, private operator in PBS system.
4. It encourages an Operation Control Centre (OCC) to be established, which will operate and manage the overall PBS system.
5. It emphasizes on a single common mobility card/ smart card which would (at minimum) be usable in all public transport systems.
6. It suggests three types of models for revenue sharing between the private operator and public agency.
7. It also talks on the infrastructural development like depot specifications, parking and IT based systems.

1.6 Aim and Objectives

The aim of the project is to propose and implement Public Bicycle Sharing (PBS) System in the study area 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 the study area are stated below (Refer Figure 2)

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 costs 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.

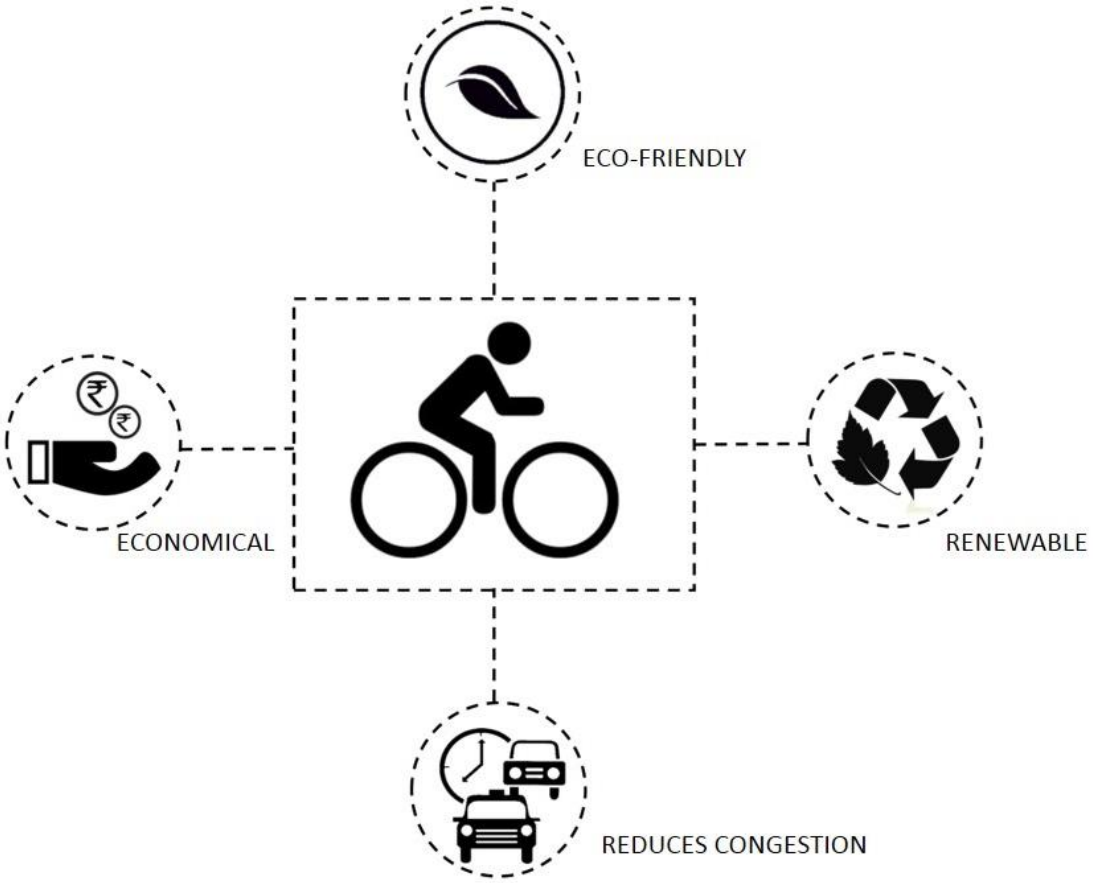


Figure 2 Objectives of PBS System

2. METHODOLOGY

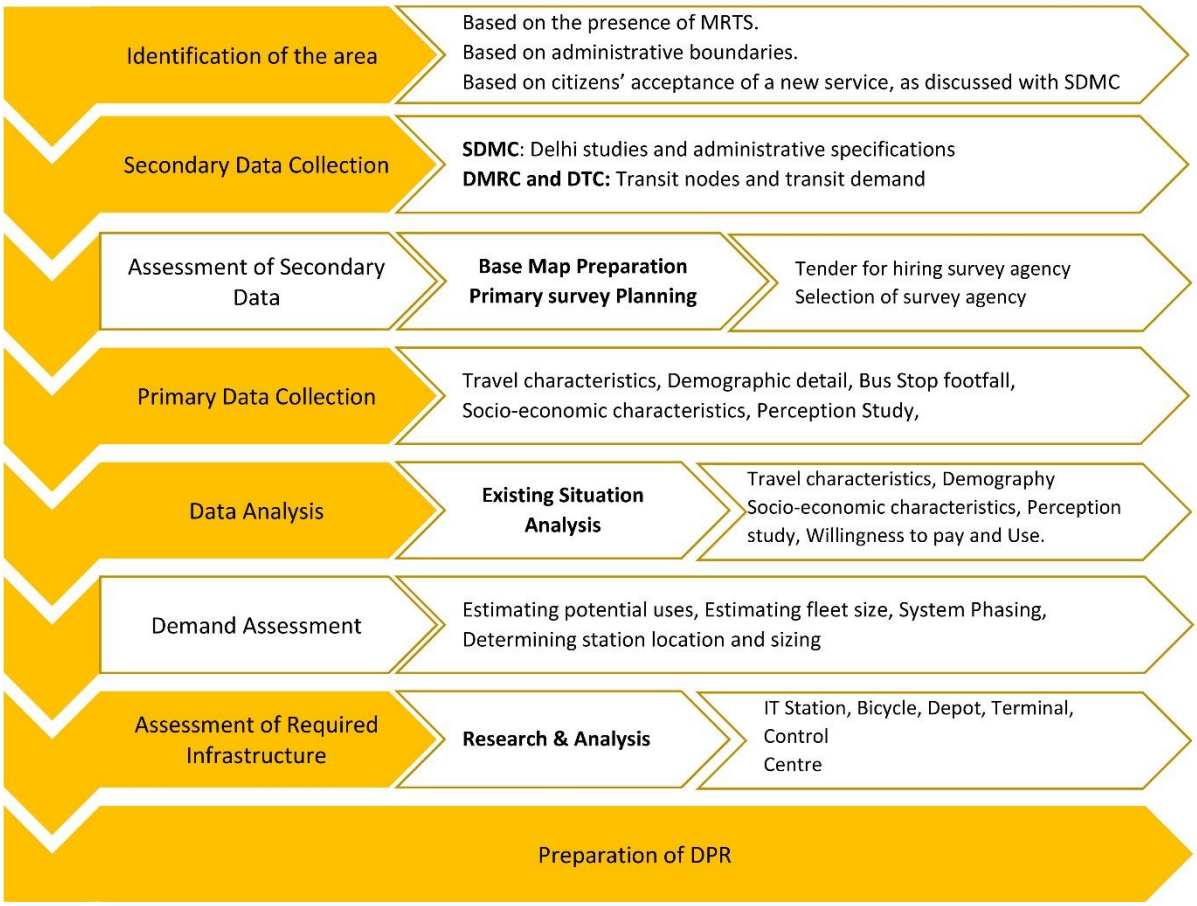


Figure 3 Methodology for SDMC bicycle share system

2.1 Identification of the area

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. The area was delineated on the basis of three parameters:

1. Presence of Mass Rapid Transit System (MRTS)
2. Administrative boundaries
3. Citizen's acceptance for new system, as discussed with SDMC

2.2 Data Collection

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 the study area, data has been collected through secondary sources and primary surveys.

2.2.1 Secondary data collection

To understand the area, information from secondary data was collected from sources such as: (Refer Table 1).

Table 1 Secondary data Collection Details

Sr. no.	Information	Sources	Usage
1	Master plan and proposed projects	Delhi Master Plan (MPD) 2021	To understand the area and incorporate future developments in the proposed project.
2	Administrative boundaries and demographic information	SDMC, Census of India,2011	To determine population densities and determine a sample size for the survey.
3	Metro stations and its ridership	Delhi Metro Rail Corporation (DMRC)	To understand the potential user group.
4	Metro station foot fall	DMRC	To decide a sample size for user perception surveys at metro stations.
5	Bus stops list and its ridership	Delhi Transport Corporation (DTC)	To understand the potential user group

Secondary data gives understanding of available data and required data for the project. From the census data and SDMC report, base map, traffic analysis zone (TAZ) map was generated. And considering data required for the project and data availability, type of survey and their sample size were decided. Assessing secondary data also means preparation for primary survey of the study area. Questionnaire for the same were prepared along with formulation of Terms of References (ToRs) to hire survey agency and conduct surveys.

2.2.2 Primary data collection

The surveys were carried out by the survey company based on the questionnaire prepared (Refer Table 2). Random sampling was done taking into account of parameters such as travel pattern, demographic information and willingness to shift. The household sample size in traffic analysis zones along the metro stations were given higher weightage. The survey agency faced on-ground difficulty on collecting samples from some of the localities in the study area like Greater Kailash. (Refer Table 3)

Table 2 Primary data Collection Details

Sr. no.	Information	Sources	Usage
1	Socio economic information	Household Survey	To understand social and economic background; income, age.
2	Major attraction and production points	OD from House hold survey	To study the travel demand estimate transport supply
3	Origin destination of population	OD from House hold survey	To study the travel demand estimate and transport supply
4	Trip rate, trip length and Trip cost	Travel diary from House hold survey	To understand travel scenarios in the study area, short trip numbers.

5	Mode of travel	Travel diary from House hold survey	To understand travel scenario in the study area and target potential users.
6	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.
7	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
8	Willingness to pay	User perception survey	To estimate fixed charges for membership subscription for the system.
9	Mode of payment	User perception survey	To estimate how the users will choose to pay for the services and subscription.
10	Physical infrastructure drawings	Total Station Survey	To collect information on existing land features and prepare execution drawings accordingly.

Table 3 Sampling Details of Primary Surveys for SDMC

Sr. no	Type of surveys	Units	Sample size	Percentage of sample
1	Household survey	Households	1,777	1.0
2	Boarding alighting surveys	Bus stops	437	100
3	User perception survey at Bus stops	Person	4,990	1.5
4	User perception survey at metro stations	Person	3,057	0.4

2.3 Data Analysis

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.

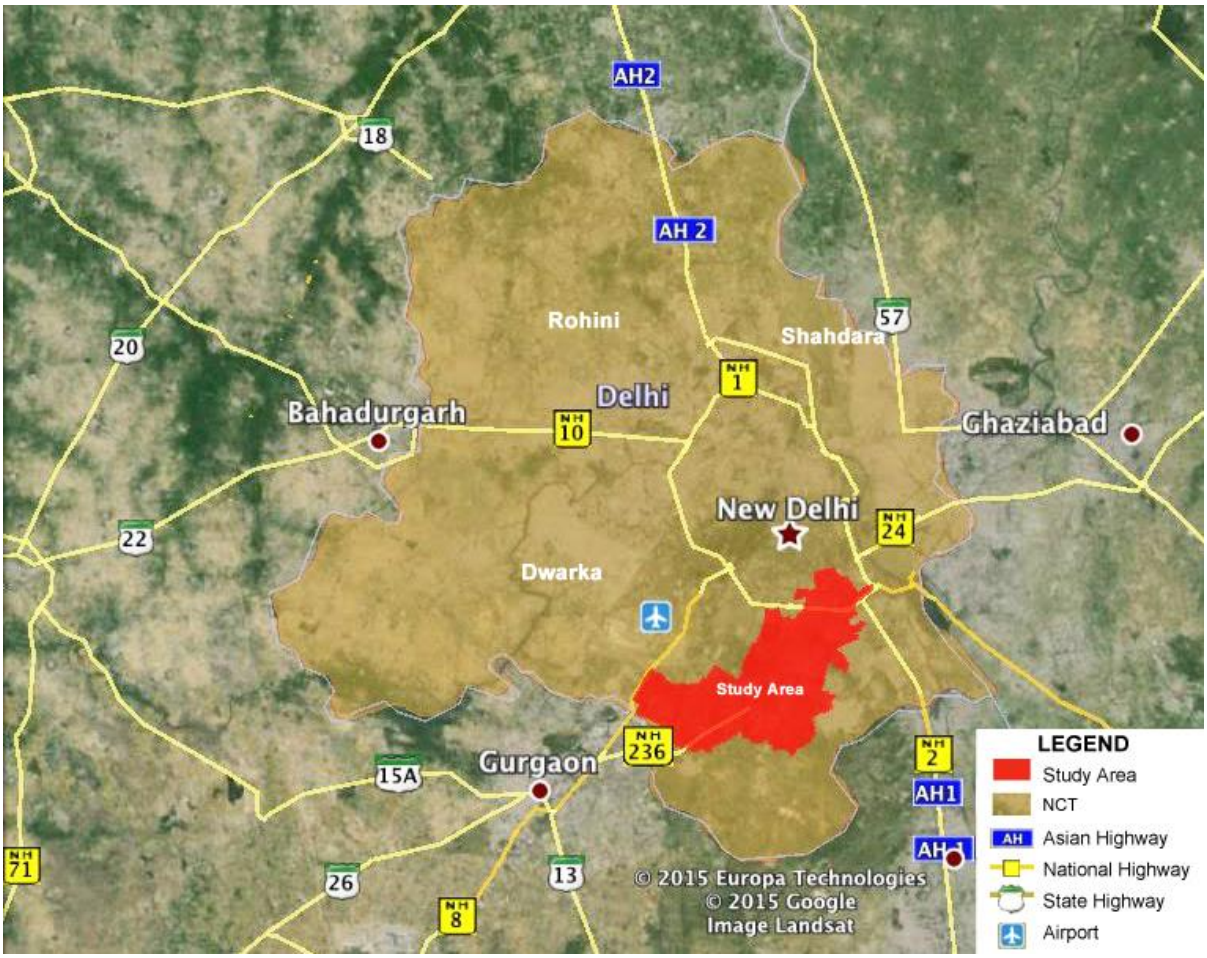
After gathering all the secondary and the primary data from all sources, the existing situation of the study area was analysed. From the data, a demand assessment was carried out to estimate the potential users of proposed PBS which further helped in arriving few other conclusions such as the required 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.

2.4 Preparation of DPR

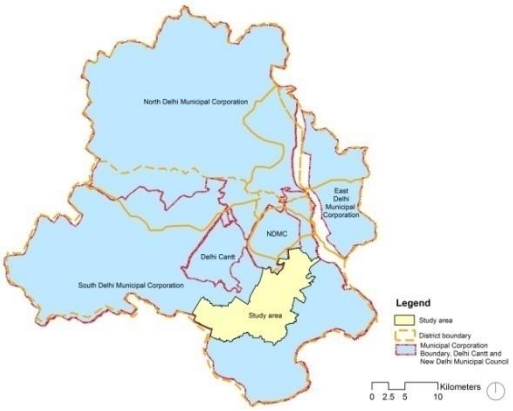
After all the research, data collection, data analysis and planning of the project, a Detailed Project Report (DPR) was prepared. The report consisted of all the details of the surveys conducted, the analysis done and the consequent conclusions. The DPR has all the details pertaining to the proposed project in the study area along with aim and objectives.

The document provides project detail on area planned for PBS, the number of bicycles proposed, the locations of the PBS stations, etc. along with a primary financial analysis required to get the project on ground.

3. ABOUTSTUDY AREA



Map 1 Location Map of study area, Delhi



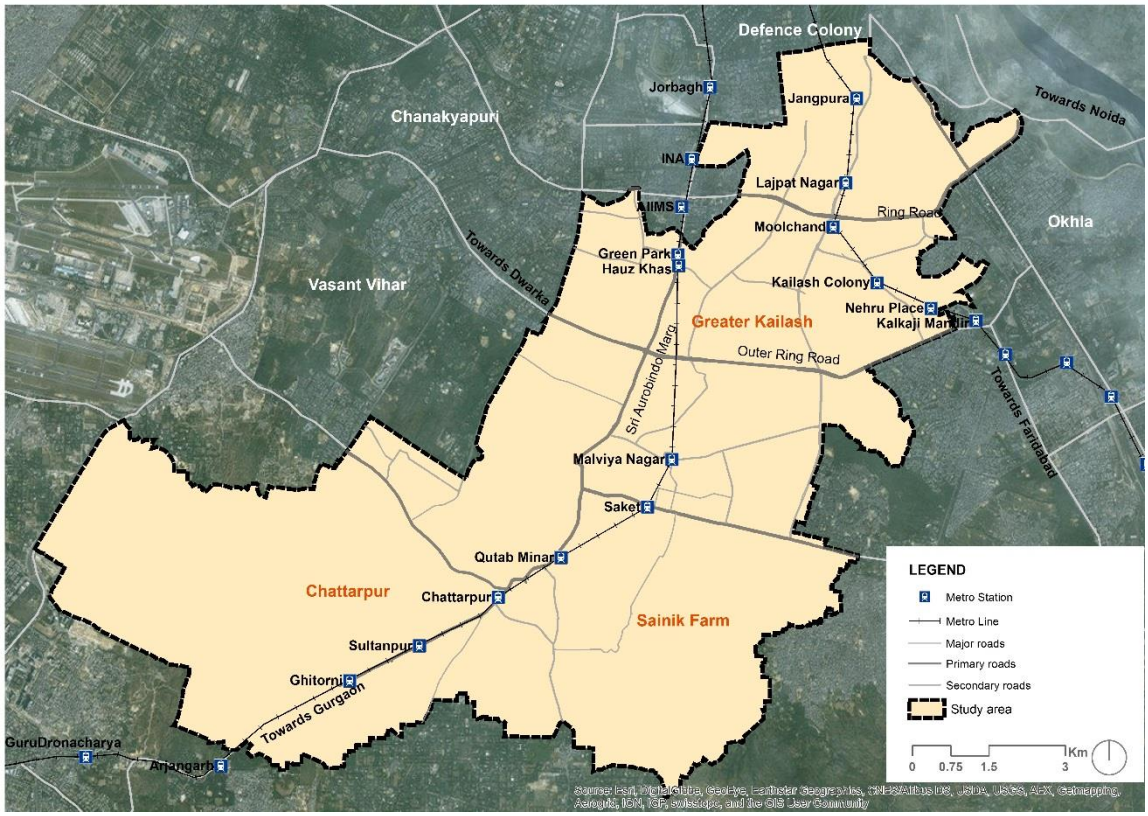
Map 2 Corporation boundary, district boundary and location of study area

The study area is located in the south-east Delhi district of National Capital Territory of Delhi (Refer Map 1) and is situated approximately 12kms away from the Indira Gandhi International Airport (Refer Map 3). It is surrounded by NH-8, Safdarjung road, Lodhi road, NH-2 and Gugaon-Faridabad road. The study area has a population of approximately 9.6 lakhs. It is well connected to rest of the Delhi through road ways and metro service.

The city has three municipal corporations, North Delhi Municipal Corporation, South Delhi Municipal Corporation, East Delhi Municipal Corporation. It also has New Delhi Municipal Council and Delhi Cant. Our study area comes under South Delhi Municipal Corporation. (Refer Map 2)

The study area is majorly residential unit with several commercial centres, renowned institutions and known places of tourists' interest such as Qutub Minar, historic Hauz Khaz

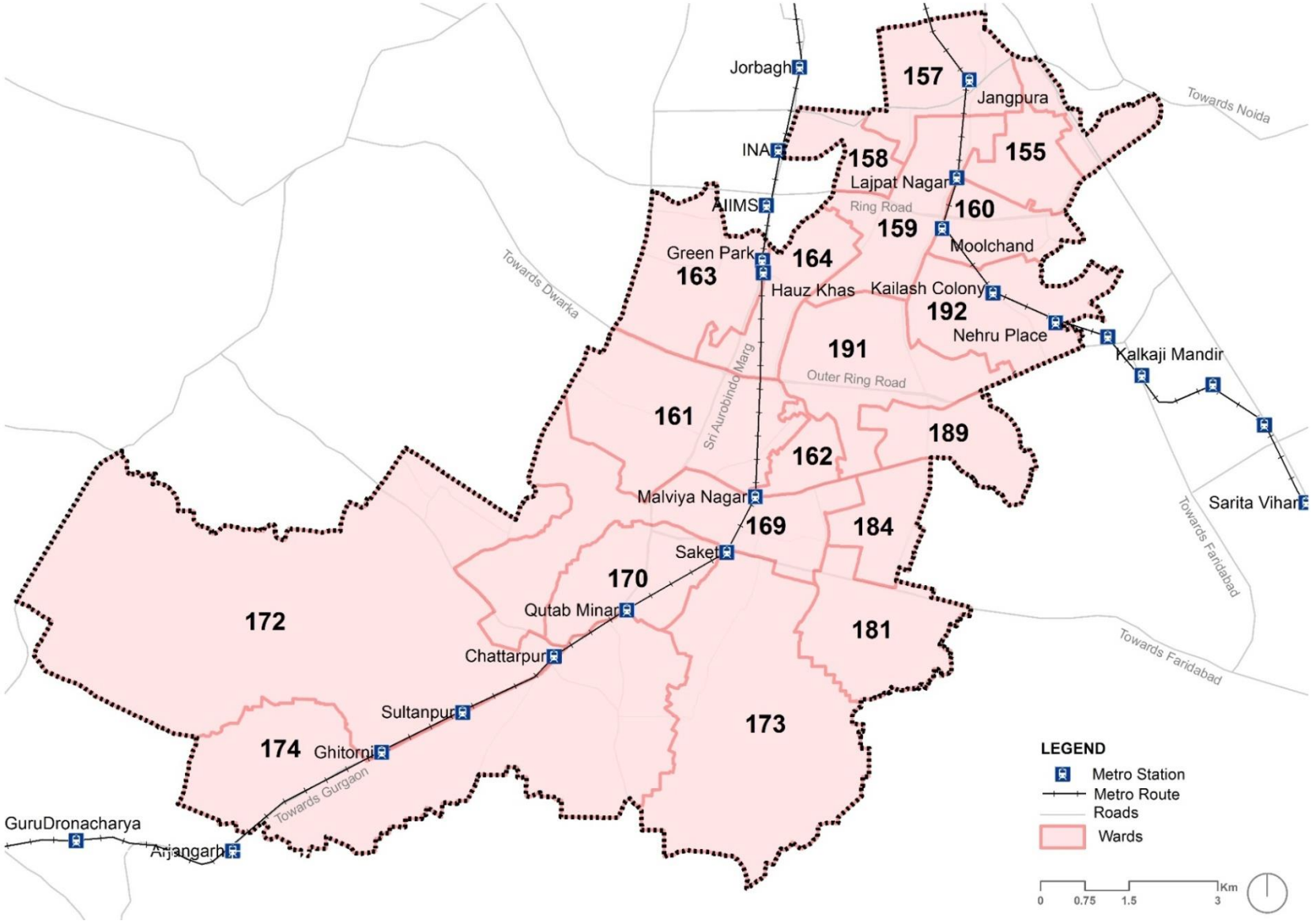
complex, Chattarpur temple and many Mughal era monuments. The study area houses affluent residential neighbourhood such as Lajpat Nagar, Greater Kailash and Vasant Kunj.



Map 3 Study area, SDMC

The study area includes twenty-two wards and is spread across 97sqkm or 9700 hectares (Refer Map 4). For ease of traffic analysis the wards have been divided into 179 Traffic Analysis Zones (TAZ) (Refer Map 5). 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 analysing data.
- The zones represent the catchment of trips generated on a primary route.
- Natural or physical or administrative barriers such as metro line, ward boundary etc. can form convenient zone boundaries.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Lajpat Nagar
Moolchand
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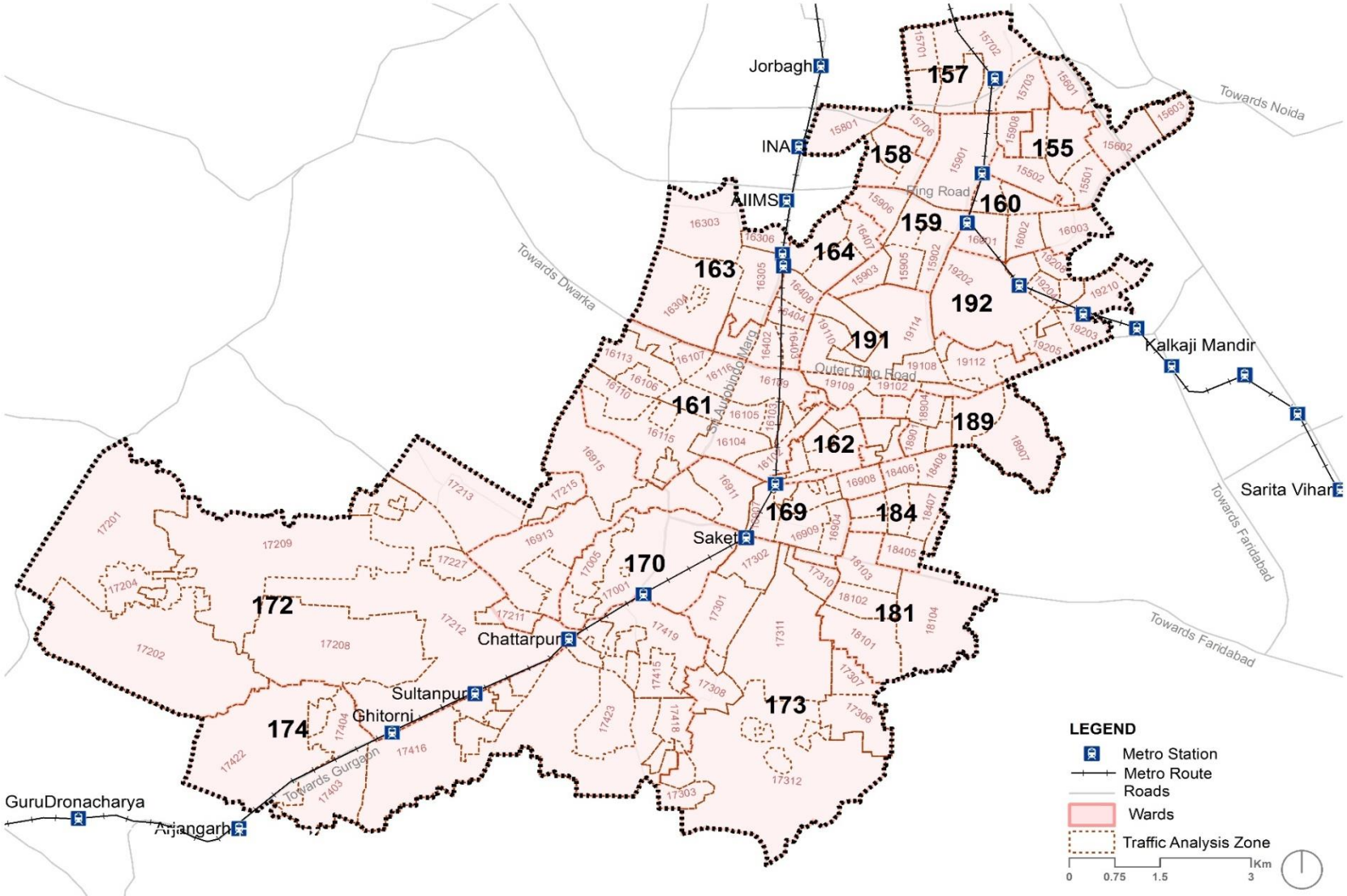
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Map 5 TAZ map

3.1 Demography

The study area houses 9.6 lakh people within 96sqkm area. And it falls within two districts of Delhi, namely South and South-West (Refer Map 6). Workforce participation ratio in the study area is 38 percent (CGM, 2015) (Refer Figure 4).

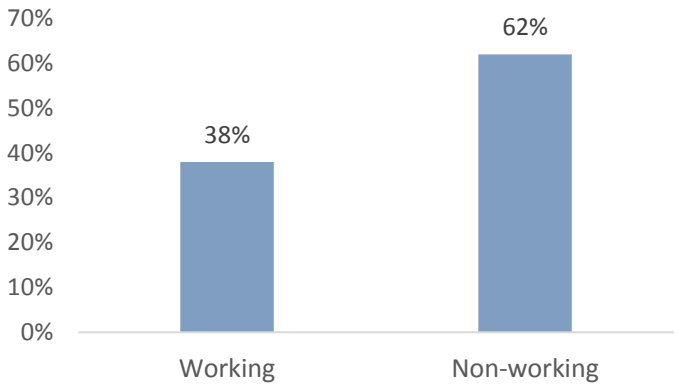


Figure 4 Workforce participation (primary survey)

The area's population density is around 168 person per hectare, which is less compared to its districts population density of 160ppha. Below graph shows the density for various districts in Delhi. (Refer **Error! Reference source not found.**).

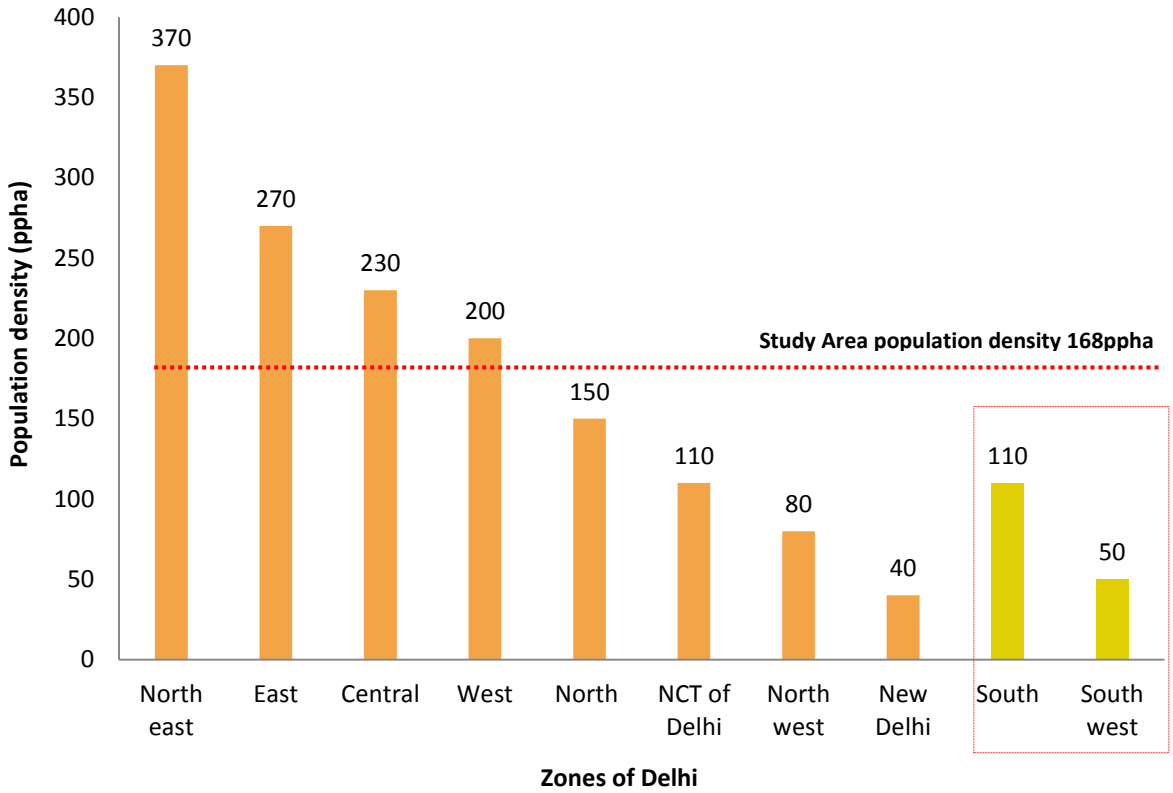
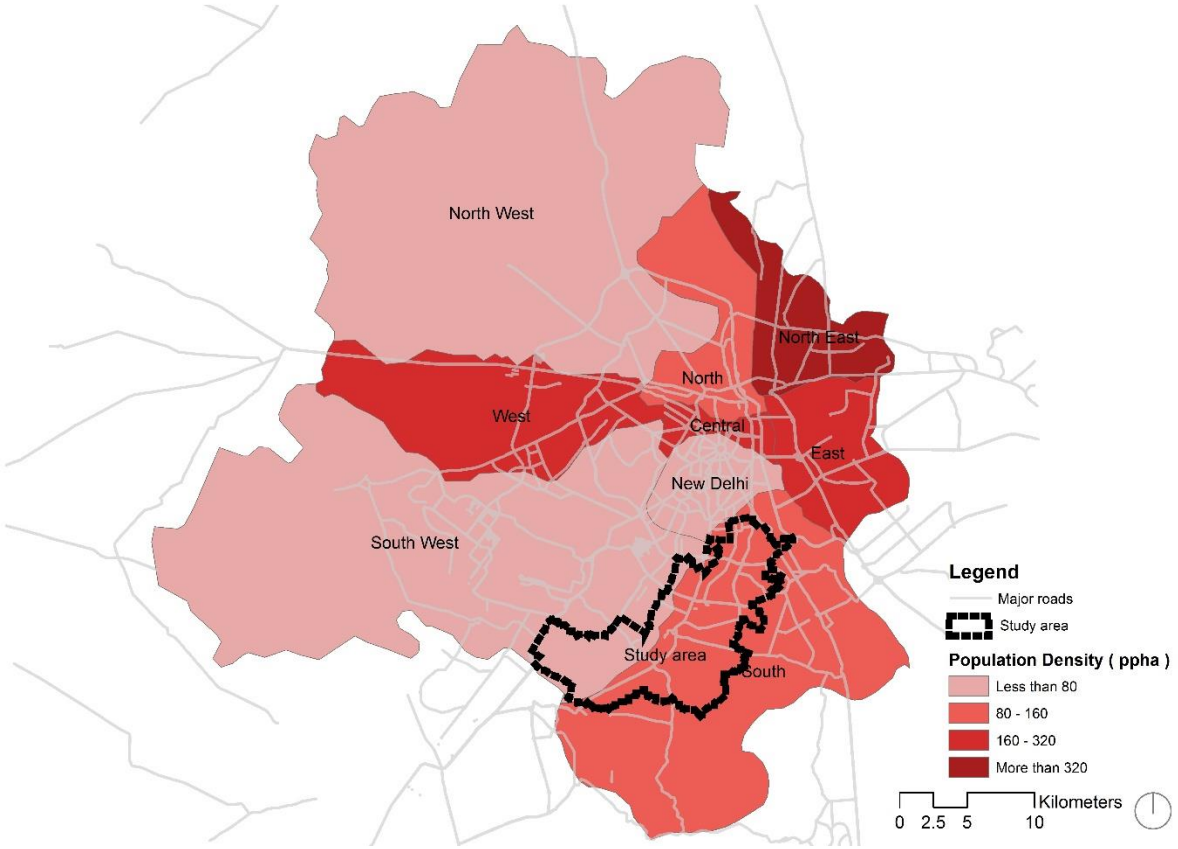


Figure 5: Population density per hectare in various districts of Delhi (Census of India, 2011)

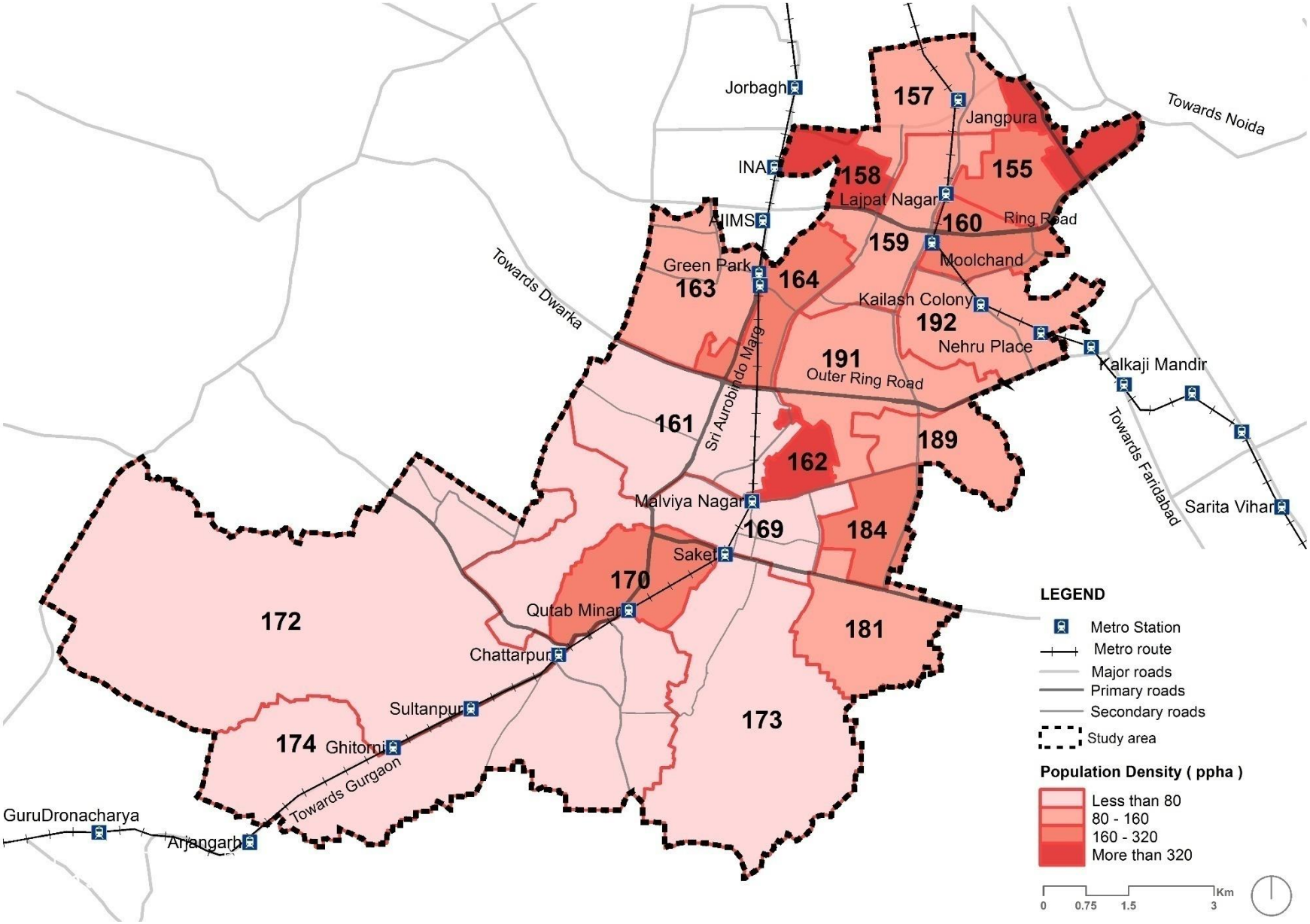
Ward 162,184 in east and 155, 156, 158 and 160 in north has highest population density with more than 160 ppha. The northern part of the study area has overall high population density compared to the rest of the area. The minimum population density in the study area accounts for 27 people per hectare in ward number 172 (Map 7). The inferences drawn are shown (Refer Table 4).

Table 4: Population density classification, Study Area 2011 | Source: SDMC

Population Density	Ward	Characteristics
Very high	Bhogal,Kotlamubarakpur,Village Haus Rani	Mostly low rise and unplanned colonies with Public semi -public and recreational activities
High	Lajpat Nagar,Amar Colony,Pushp Vihar	Mostly high rise planned colonies
Medium	Hauz Khas,Mehrauli,Greater Kailash,Safdarjung Enclave,Kasturba Nagar,Andrews Ganj,Chirag Delhi,Khanpur,Shahpurjat	High rise, planned and organized townships with some percentage of less organized housing units
Low	KishanGarh,Said Ul Ajaib,Lado Sarai,Chattarpur,Malvia Nagar	Large part is vacant and occupied by informal settlements like slums. IGNOU also falls in one of these wards



Map 6 District wise population density



Map 7 Study area population density

3.2 Land use

The study area is majorly a residential development, with significant commercial, famous institutions and tourists' places inside it. It has a mixed land use serving to a population of 9.6 lakhs.

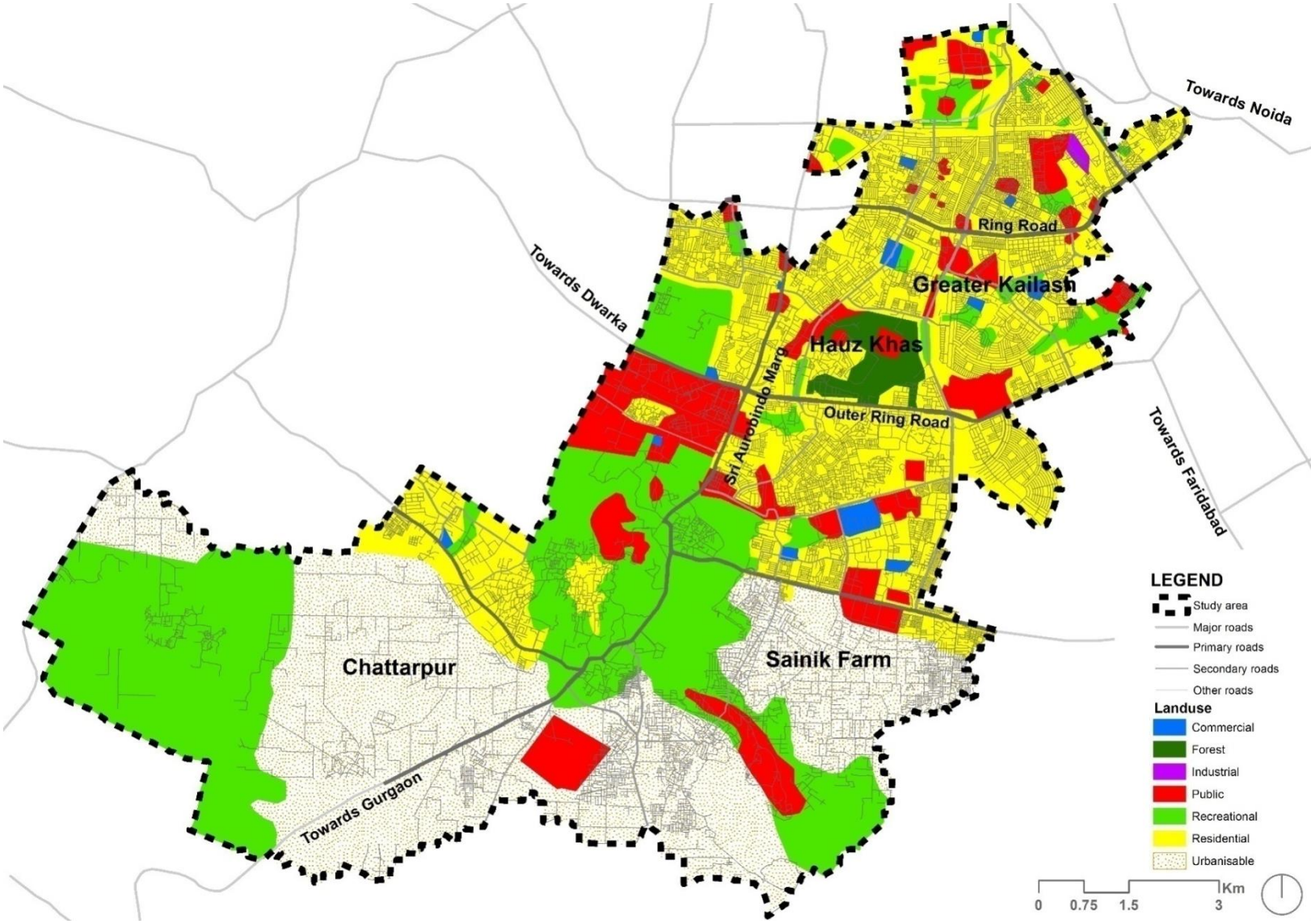
It houses wealthy colonies such as Lajpat Nagar, Greater Kailash and Vasant Kunj with many of the historical buildings and renowned institutions like IGNOU, IIT, NCERT, IILM etc. Being a mixed use development, people find it very easy to fulfil their daily needs from the nearby shops/markets. A large part of the land in south is proposed to be an urbanisable area. Currently this land has very less dwelling units and is by large vacant. (Refer Map 8).

32% of the study area is proposed to be residential, 1% to be commercial and 11% to be public and semi-public as per the Master Plan of Delhi (MPD) for the year 2021. The land use distribution of various other categories is shown in table below (Refer Table 5).

Table 5 Proposed Land use Details

Sr. no	Use	Area (in ha.)	Percentage[2]
1	Residential	3968	32
2	Commercial	95	1
4	Public & Semi public	1367	11
5	Industrial	14	0.1
6	Recreational	3382	27
7	Urbanisable	3698	30

[2]The percentage distribution is as per calculations in GIS.



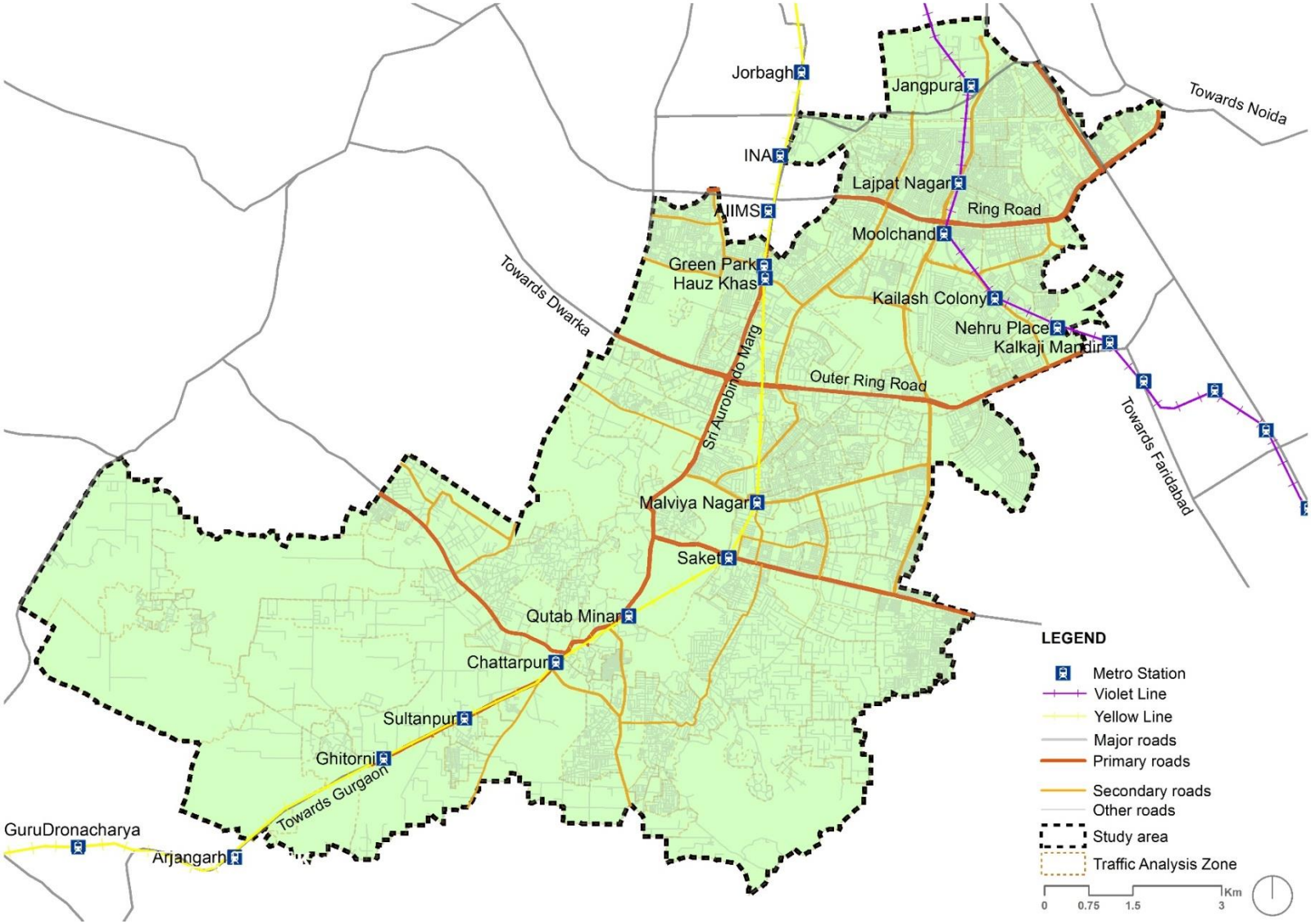
Map 8 Proposed land use map (Source: MPD 2021)

3.3 Road Network

The study area is well connected with North-Delhi in North, Gurgaon in South, Faridabad in East and Dwarka in West. NH-236 also known as Aurobindo Marg connects the study area to Delhi in North and Gurgaon in South. Other major roadways include the inner ring road and outer ring road (Refer Map 9).The study area also has metro connectivity in north-south and north-east direction. Affluent areas like Greater Kailash, Lajpat Nagar, Vasant Kunj has organized road network pattern, while the other parts witness more of an organic road network pattern. Lengths of various road categories have been specified inTable 6.

Table 6 Road Categories by Length

Sr. no	Road Hierarchy	Total length
1	Primary roads	80km
2	Secondary roads	90km
3	Others	1225km
	Total	1395km



Map 9 Road network map

3.4 Traffic generating activities

Traffic generating activities are referred to those nodes that contributes to trip generation and traffic movement within the study area (Refer Map 10 and Map 11). In study area, traffic generating nodes are identified, such as:

1. Commercial centre/ Market places

Lajpat nagar, South extension 1 & 2, Mehrauli market, Spice market, and Hauz-khas market are the prime commercial places in ward 160, 158, 159, 170, 169 and 164 of study area.

2. Public/ Semi-public

Public/ Semi Public includes, urban local body offices, police stations, Delhi Public library, Art Gallery, Embassy of Taiwan, Law centre, Human Right Law Network, CBI, Tibet House museum, and many other offices, hospitals, religious places like- churches, mosques and temples.

3. School/ colleges/ institutions

Major colleges like IGNOU, IIT, NCERT, Kamla Nehru College, NRAI, Academy of fine arts and literature, LSRC, DAV, IILM and schools like DPS, Canbridge school, Heritage school, Kendraiya Vidyalaya Pushpvihar, New green field school and many other eminent schools and colleges comes in the study area.

4. Sports and recreational

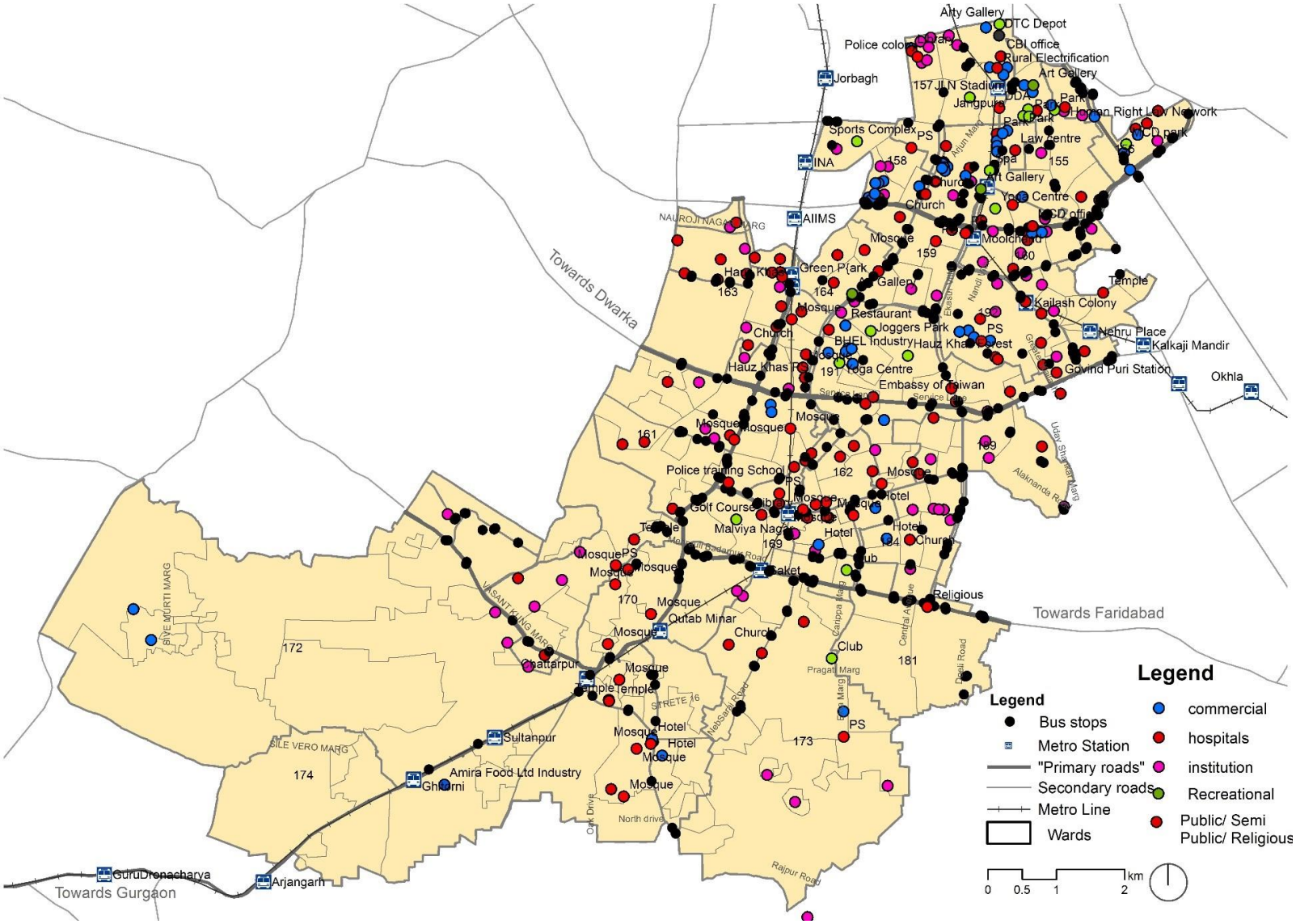
Siri Fort sports complex, Qutab Golf course, Thyagaraj sports complex are the recreational sites in the area.

5. Public Transit stations

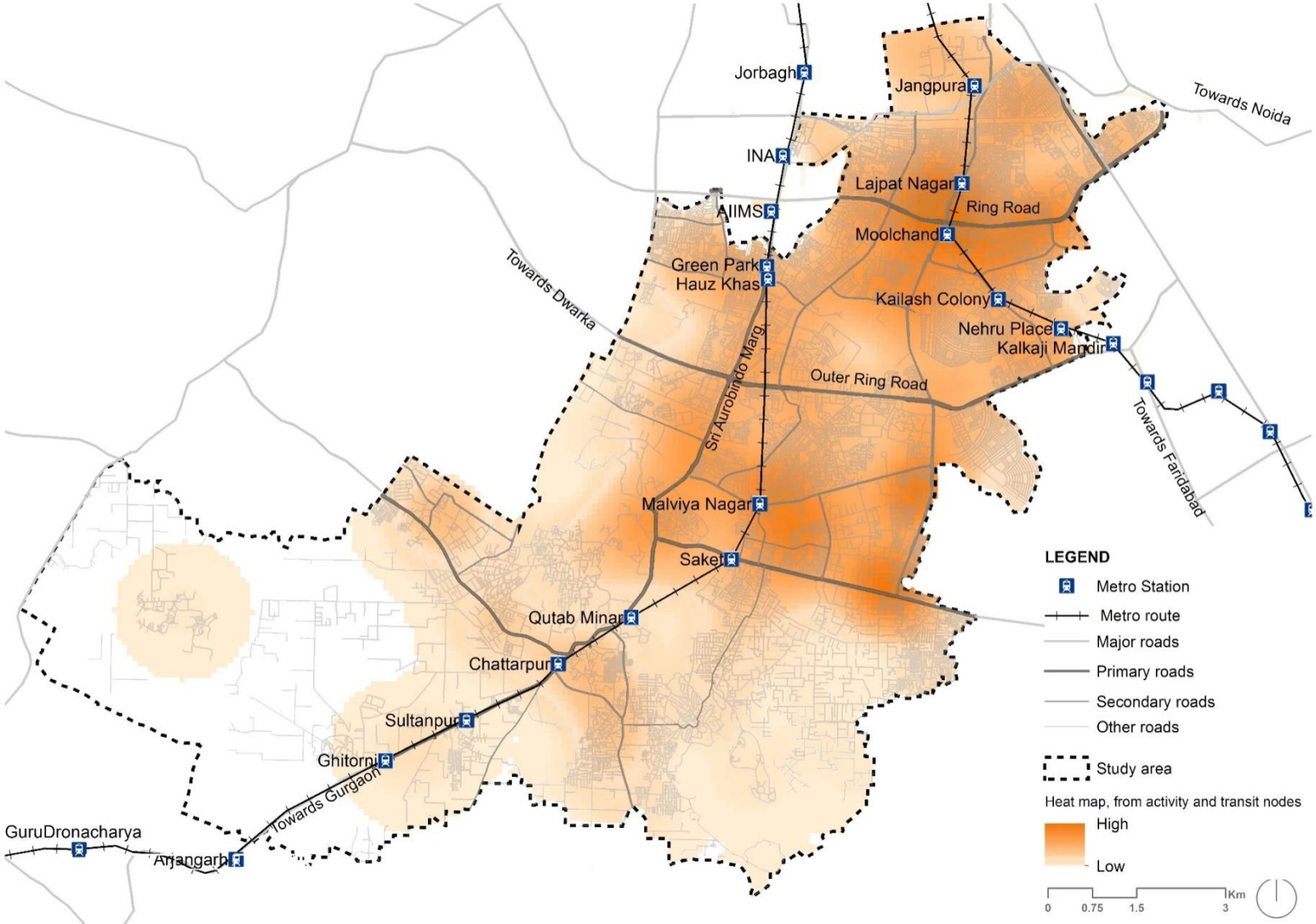
The study area has 13 metro stations which connects it with New Delhi, Dwarka, Gurgaon and Badarpur, And 437 bus stops. DTC bus depots also located within the study area.

Figure 6 Queue of IPT near Hauz khas Metro station, Source:(IRFAN)

Figure 7 DTC Bus near Panchsheel, Source: (CGM)



Map 10 Traffic generating nodes



Map 11 Heat map

3.5 Transport in Study area

The study area is catered with bus services and metro rail, provided by Delhi Transport Corporation (DTC) and Delhi Metro Rail Corporation Limited (DMRC) respectively. There are 437 bus stops connecting the local areas with the prime destinations. Also, DMRC has two metro lines connecting the study area with rest of the city i.e. yellow line and violet line. From the boarding-alightning data, ridership at Malviya nagar, Saket, Hauz khas, Chattarpur, AIIMS, and INA has high metro ridership. Also bus and metro ridership at Nehru place, Lajpat nagar, and Moolchand are also high. (Refer Map 12 and Map 13). Intermediate para transit like, pedal rickshaw, metro feeder buses, auto rickshaw, shared auto rickshaw or chakda forms integral part of city's mobility.

Figure 8 L-R: Metro Feeder Bus (Shukla), Pedal Rickshaw, Source (mandrekarkabir)

Figure 9 L-R: Auto Rickshaw, Chakda, Source (CGM)

Various issues in daily urban transport activities have also been viewed in the study area. These are discussed as:

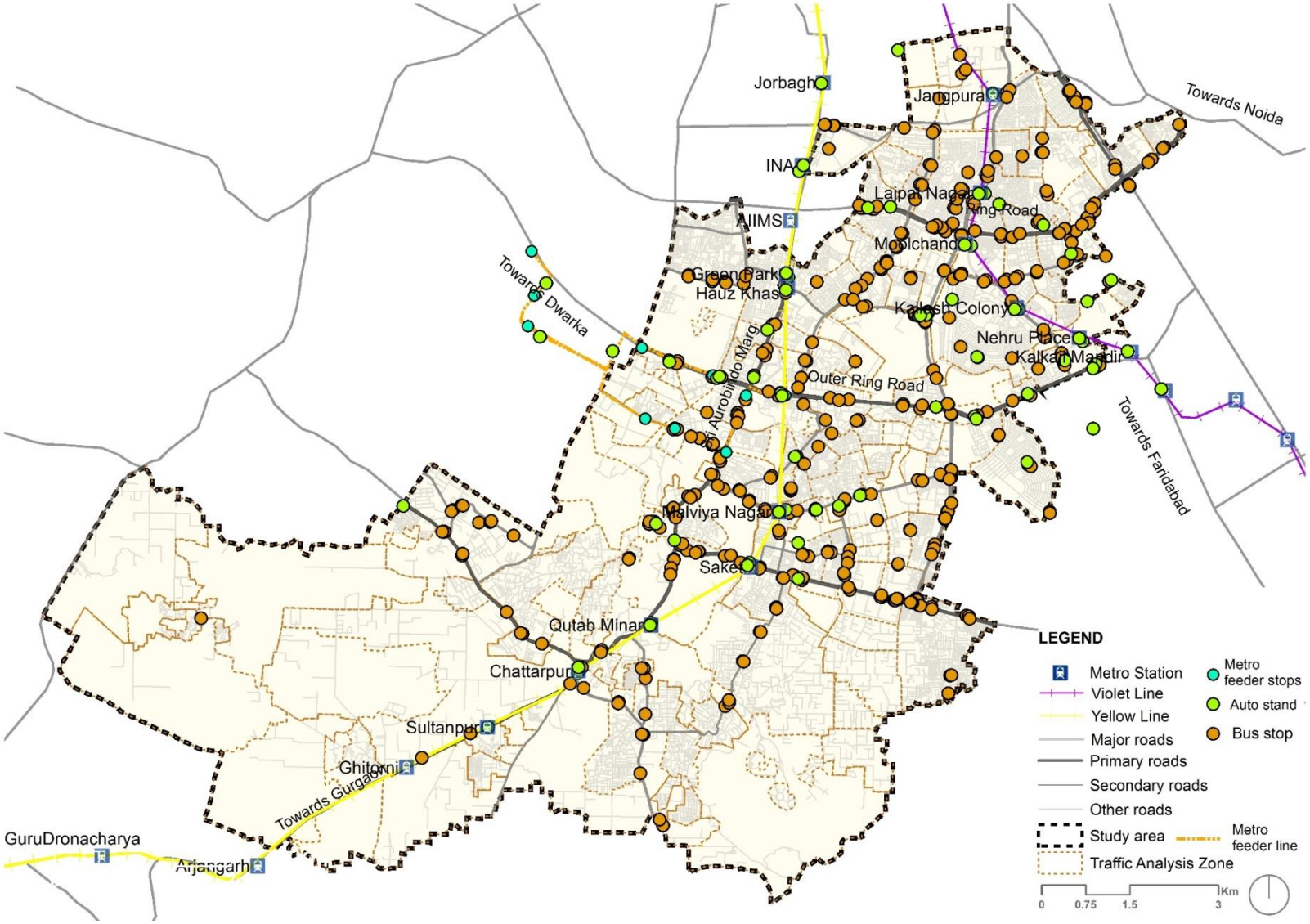
.

Figure 10 Broken footpaths results in jaywalking near aurobindo and mehrauli badarpur road, Source: (CGM)

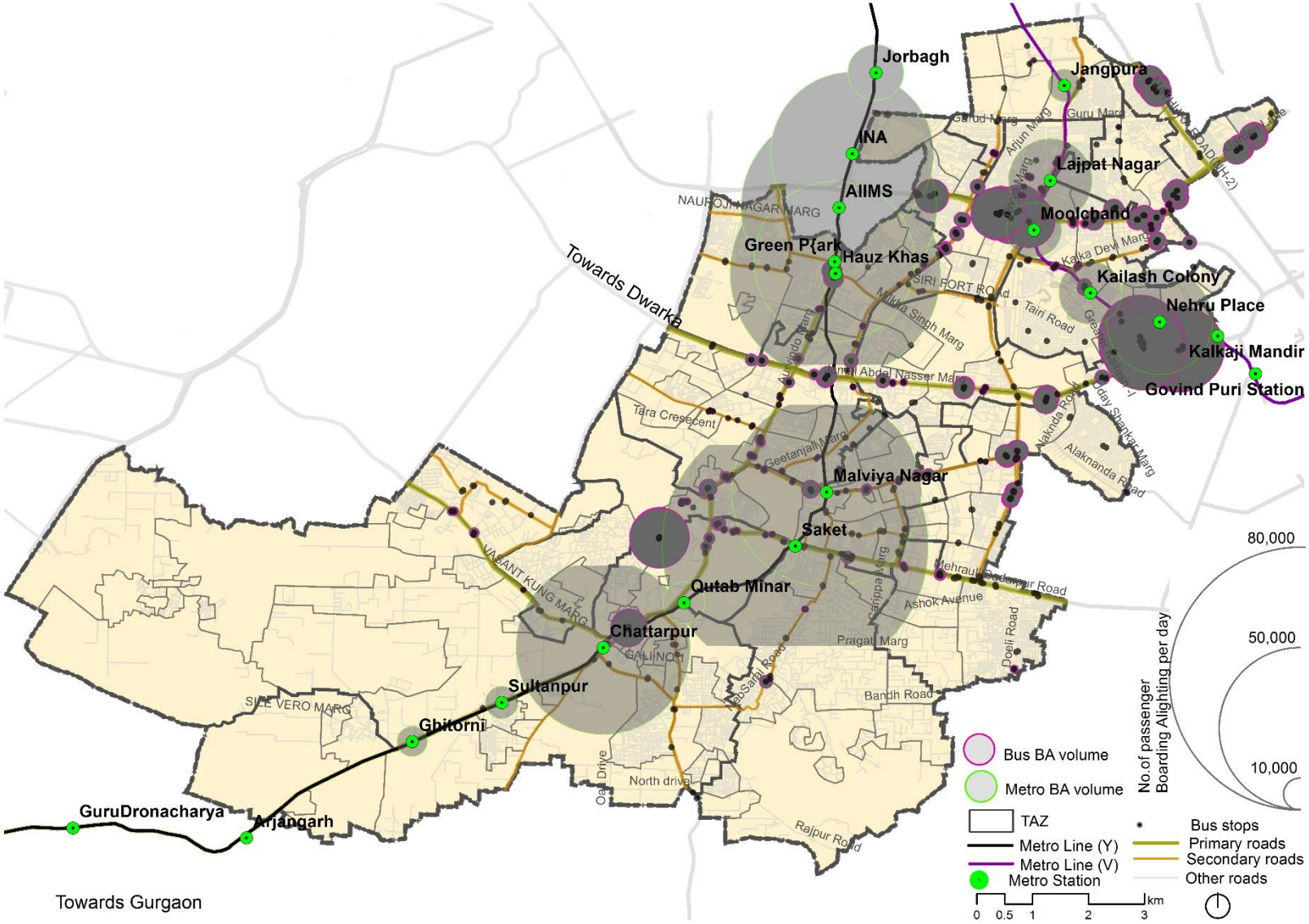
Figure 11 Encroached footpaths near Press Enclave R, Source: CGM

Figure 12 Open garbage dumping reduces the effective road width and creates unhealthy environment near Press Enclave R, Source: CGM

Figure 13 Cyclists on josip bros tito marg, Source: (CGM)



Map 12 Transit Map



Map 13 Ridership map

4. SOCIO ECONOMIC AND TRAVEL CHARACTERISTICS

4.1 Introduction

Socio-economic and travel patterns are described in terms of income, occupation, education, trip rate, mode choice, trip length, geographical distribution etc. This chapter analyses travel data from surveys conducted at residences and transit stations. 36% of the sample size is from female respondents. The samples also highlights the last mile connectivity of the study area which is a crucial database for the study. From the analysis, 77% trips of the study area are internal to internal trips, internal to external and external to internal trips are of 9% each. Remaining 5% is external to external trips.

4.2 Educational and Occupational and income structure

Educational structure breakup of people states, only 7% of the total population do not have formal education and only 33% has received education up to primary level (Refer Figure 14). The occupational structure breakup states that study area has 32% of student population followed by, 25% house wife, 20% of private service employee, 7% government employee, 7% businessmen and 3% unemployment. With this distribution, by large it can be said that the study area has dominance of student population and employee catering to tertiary sector. (Refer Figure 14)

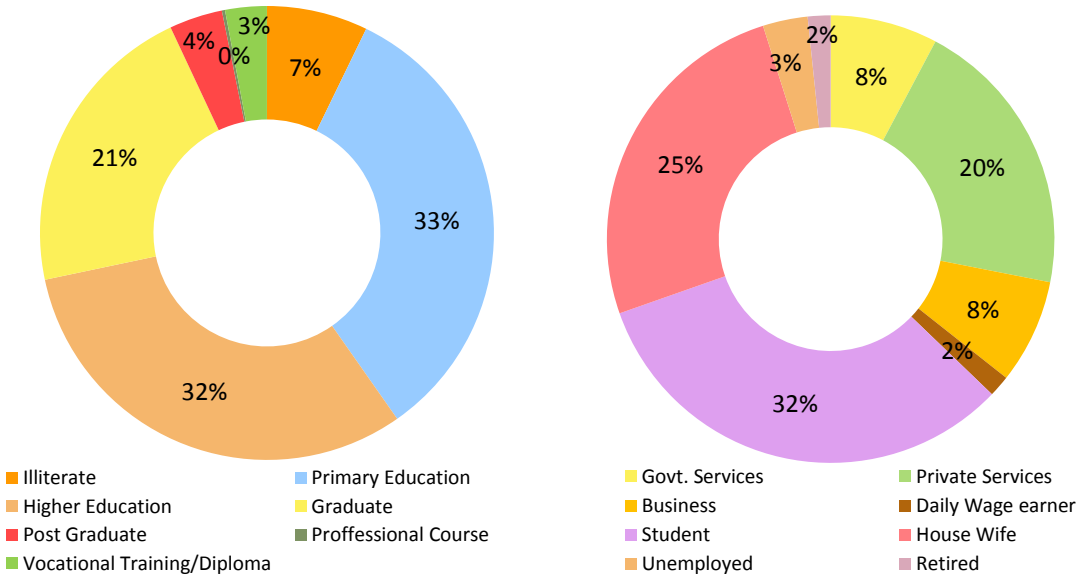


Figure 14 Educational level and occupational level. (Source: Primary survey)

The percentage distribution of education level with their respective occupation demarcates high percentage share of higher education and graduate for government services. Illiterate percentage is higher on daily wage earner. Overall unemployment percentage is 3% but the share of illiterate is high. Housewife has more or less equal distribution of primary education, higher education and graduates in their category. Post graduate serves government, business and retired sector mostly (Refer Figure 15).

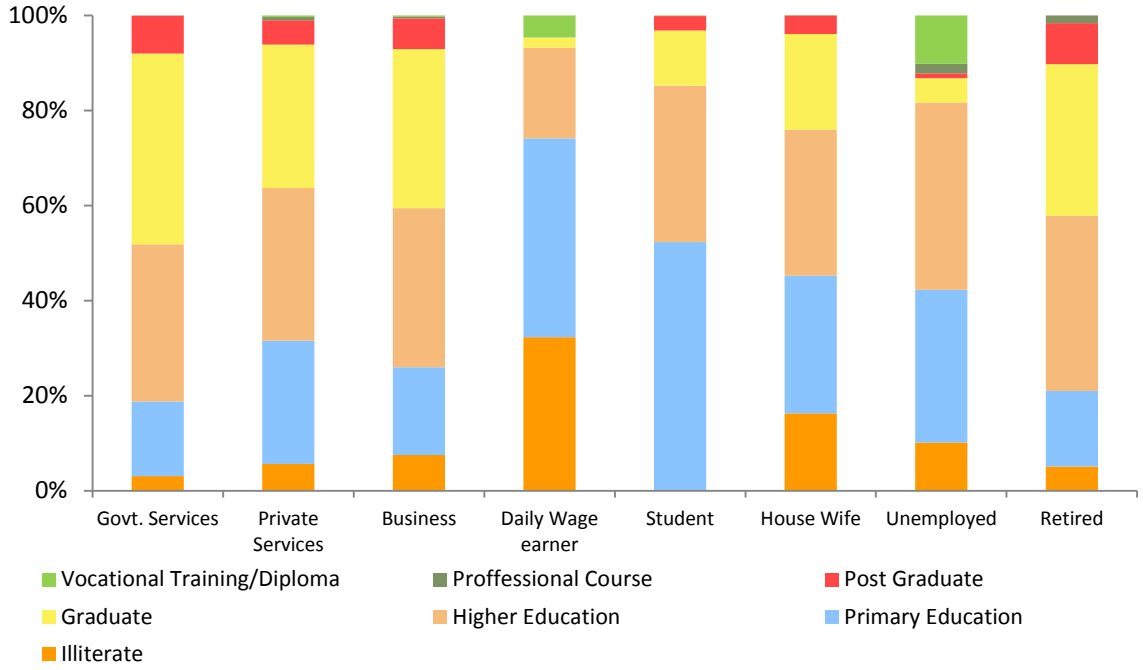


Figure 15 Percentage distribution of education level with occupation. (Source: Primary Survey)

The household survey revealed that 2% of the households come under Economically weak Section (EWS) with less than Rs.5,000 monthly salary. 12% of the household belongs to Low Income Group (LIG) with monthly income of up to Rs.10,000 (Refer Figure 16).

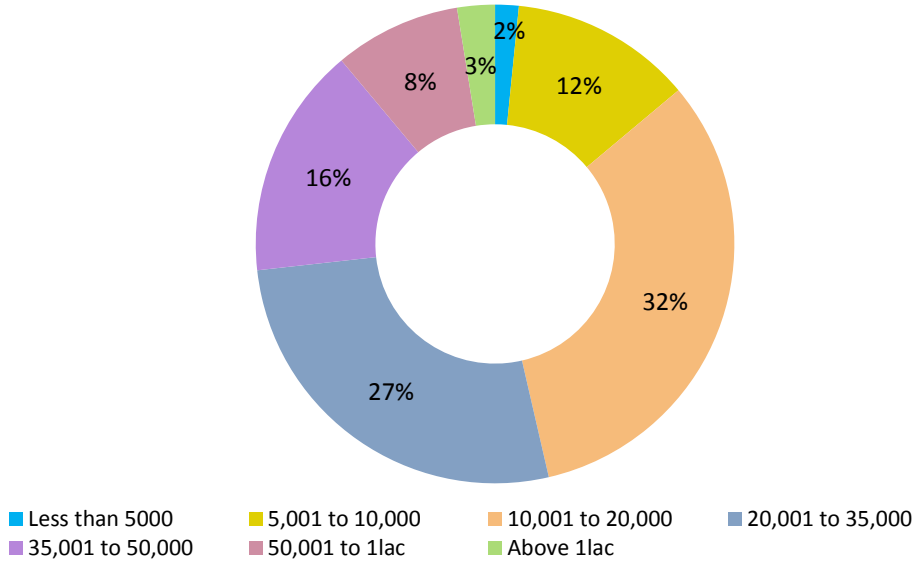


Figure 16 Monthly Household Income Classification (source: primary survey)

4.3 Modal Split

The dominant transport mode in study area is walk. It contributes to 46% percent of the total trips made. The percentage share is high compared to whole of Delhi which has 34 percent walk trips. Also 67 percent and 10 percent of total females in study area use walk and bus respectively; this indicates a need of a women sensitive PBS system. The total trips made by all non-motorized modes is nearly 50% which is significant and justifies the requirement of better infrastructure to cater to it. Nearly 18% of the population uses public transport which is less than the average share of Delhi at 35 percent. Use of IPT, which includes auto rickshaw,

shared auto or chakda, pedal rickshaw and metro feeder bus, is considerably high with 8% share. Private modal share accounts for 25% of the modal share (Refer Figure 17).

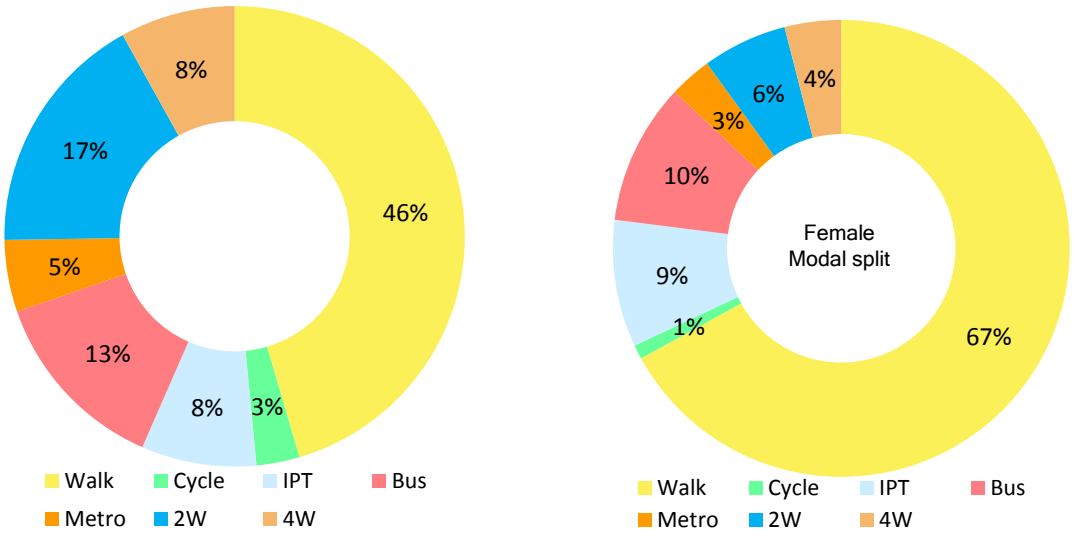


Figure 17L-R: Modal Split in study area, Female modal split (source: primary survey)

The walk trips are high majorly for shopping, social, recreational, and religious based trips. Share of two-wheeler is high for work trips. Schools buses and walk dominates educational trips. Share of IPT and 4Wheeler increases in medical trips as people choose private mode or private travel over public mode. Share of bus is high for work-related trips as well. Majority of metro users make work, shopping, medical and others category trips. Trip purpose of 'other' category includes 'pick up drop off' trips and 'transfer' trips. Figure 18 shows the distribution of mode as per trip purpose including walk trips. Figure 19 shows the same distribution excluding walk trips.

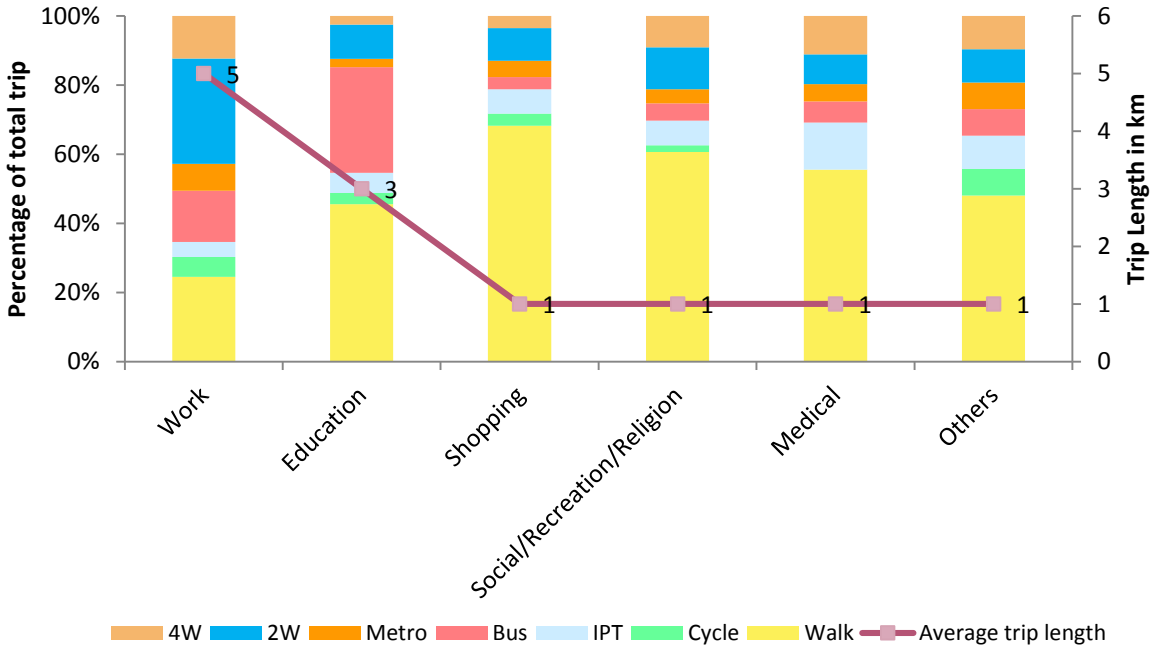


Figure 18: Trip Purpose by Mode and Average Trip Length by Purpose in study area including walk (source: primary survey)

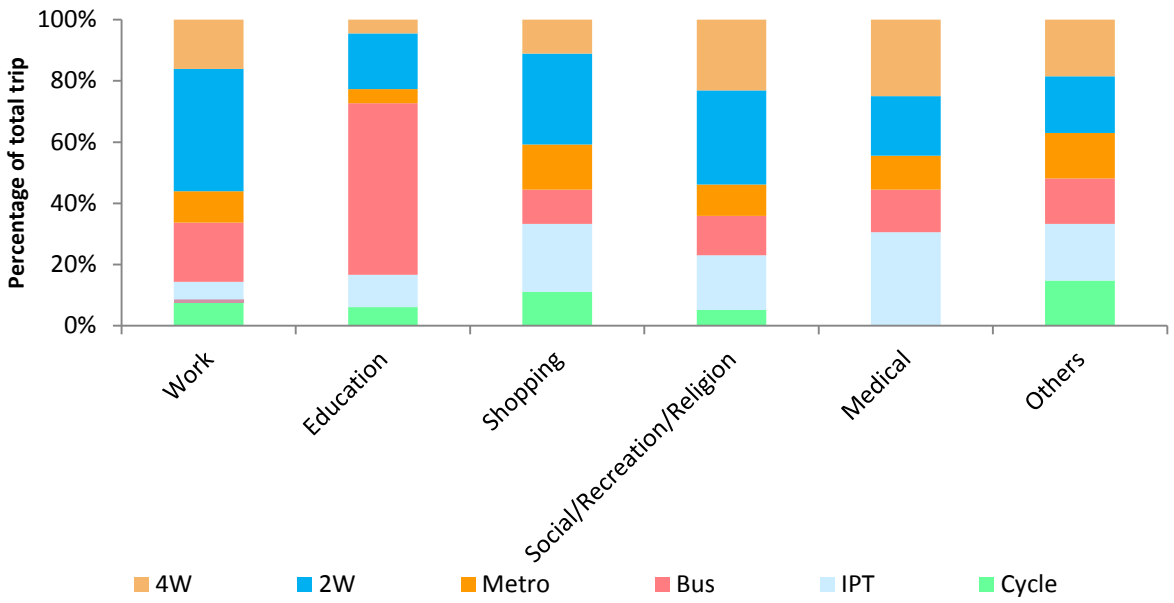


Figure 19Trip Purpose by Mode and Average Trip Length by Purpose in study area excluding walk (source: primary survey)

4.4 Trip length

Mode wise average trip length of study area is similar in comparison to Delhi's, except for metro whose average trip length in the study area is 5km additional to Delhi's average of 13km (Refer Figure 20). Interestingly 67 percent of the trips in study area have trip length less than 5km and 80 percent of the total trips made by females also fall within 5km of trip length (12 minute walking time). Hence, it increases the number of potential users of the PBS system (Refer Figure 21). The main target of the PBS system should be short trips i.e. IPT trips, pedal rickshaw trips and also last mile trips for metro and bus users. The mixed land use of the study area explains the average trip length of work as 5km, school as 3km and rest other purpose like recreational, medical, social as 1km of average trip length (Refer Table 7).

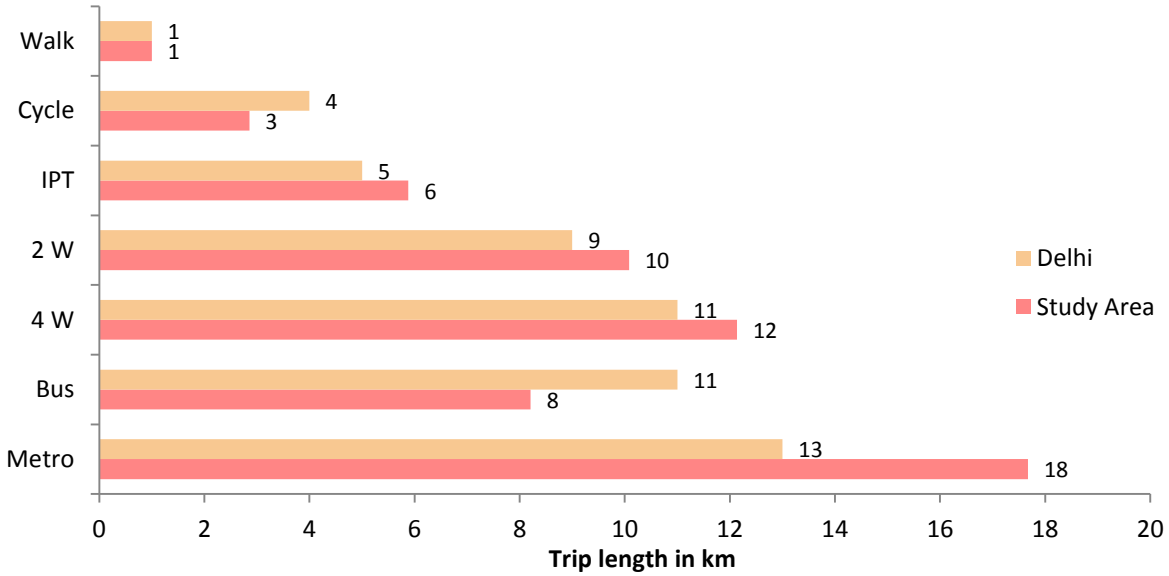


Figure 20 Average trip length mode wise for Delhi and study area (source: RITES, 2007 and primary survey)

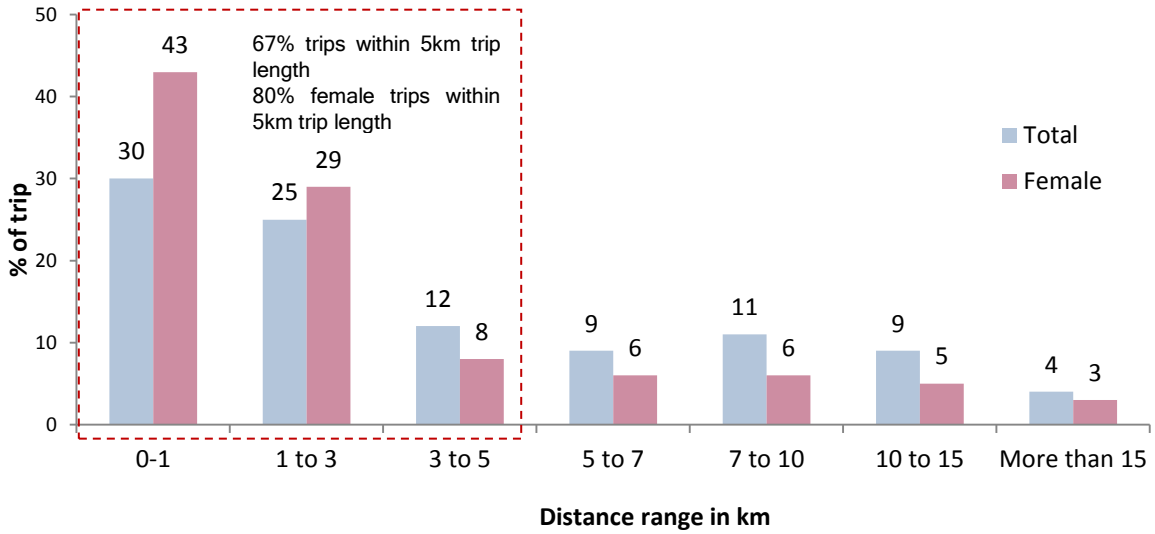


Figure 21Trip length distribution for study area (source: primary survey)

Table 7 Average trip length as per trip purpose (Source: Primary survey)

Trip purpose	Average trip length in km
Work	5
School/ Education	3
Recreation/social/religion	1
Medical/Health	1
Other	1

4.5 Trip rate

Population of 9.6 lakh within study area makes19, 06,929 trips daily. Based on surveys the per capita trip rate including walk in study area is 1.9 trips per day. The highest trip rate is for work and education at 0.21 and 0.15 respectively (Refer Table 8).

Table 8 Trip Rate (trips per day) by Purpose (source: primary survey)

Trip purpose	Trip rate
Work	0.21
School/Education	0.15
Shop/Market	0.09
Recreational/Social/Religion	0.02
Medical/Health	0.02
Return home	0.50
Total Daily PCTR[3]	**1.99**

4.6 Trip purpose

Keeping aside the return home trips, which forms fifty percent of the total trips, work trips and educational trips constitute nearly 21 percent and 15 percent of the total trips respectively. Interestingly shop/market trips make up 9 percent of the total trips (Figure 22).

[3]Per capita trip rate

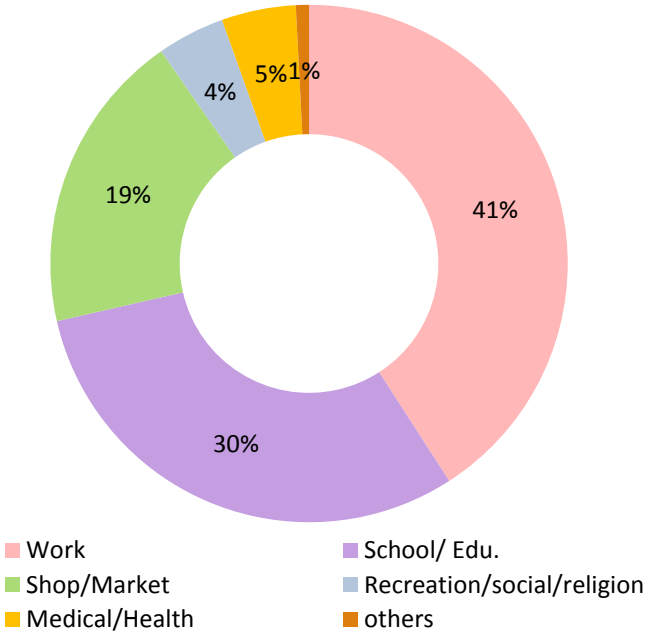


Figure 22 Trip purpose distribution (excluding return home trips)

4.7 Vehicle ownership

Household vehicular ownership in study area is high for two wheelers with 56% compared to 44% of Delhi's data, followed by car and bicycle. Percentage ownership of bicycle for whole of Delhi is 18% which is high compared to study area's share of 16% (Refer Figure 23). Perception surveys for public transport reveals that due to lack of reliable, direct and integrated public transport in study area, people are left with no choice other than using private modes. Also in line with other urban areas, the percentage of private vehicle use is increasing with an increase in income (Refer Figure 24).

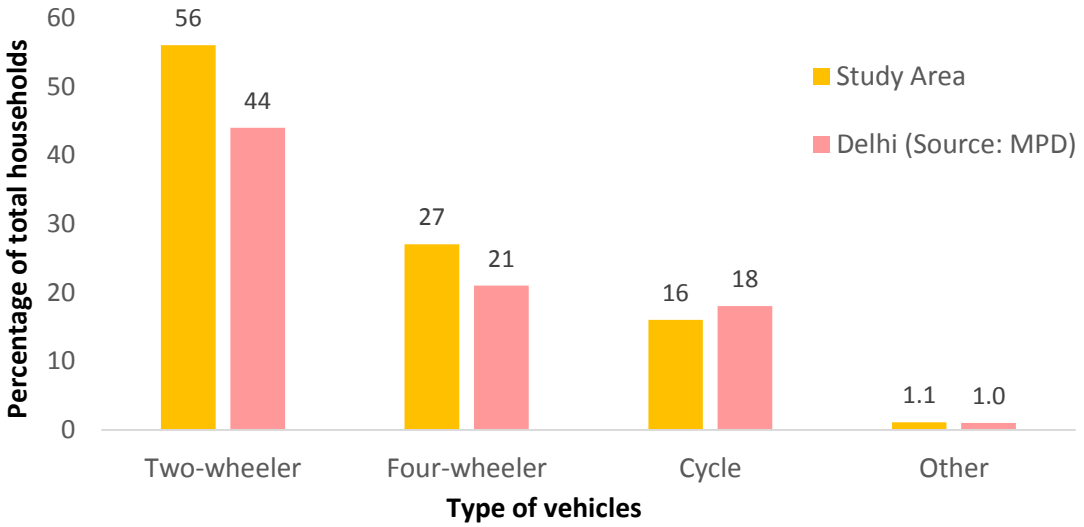


Figure 23: Vehicular Ownership of Household in Delhi and study area (source: primary survey)

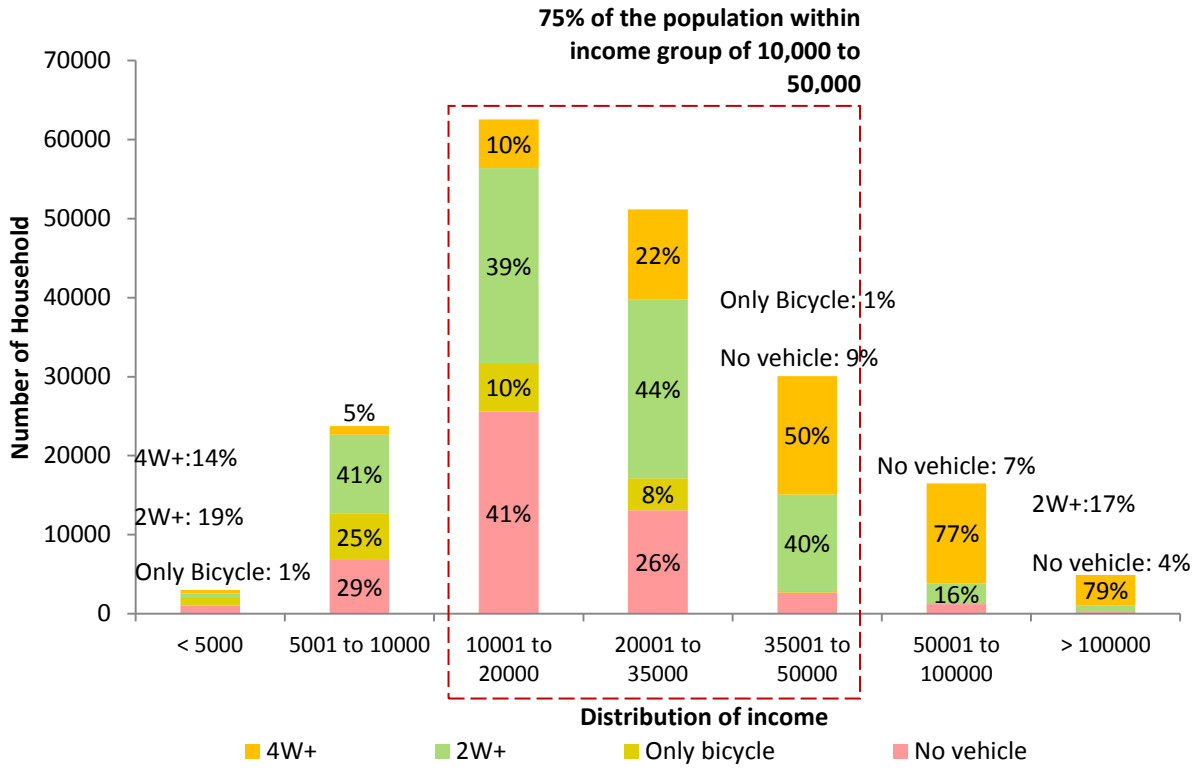


Figure 24: Household vehicle ownership and Income (source: primary survey)

The vehicle ownership distribution in comparison to income group shows the increase in dependency of car with increase in income and increase use of two wheeler among the middle income group (Refer Figure 24). The surveys also reveals that substantiate number of household in the study area do not own any vehicles. The possibility of no vehicle category could be either low average trip length or high dependency PT and IPT.

4.8 Last mile connectivity

Metro and DTC bus service are the life lines of study area. But the last mile of the commute is still dependent on auto rickshaw and pedal rickshaw. Availing of these IPT modes increases dependency and hence it is required to encourage PBS system for last mile connectivity. From user perception survey, 44% metro users and 63% bus users have shown their interest in using PBS system for their last mile commute.

4.8.1 Metro Rail

The dominant modes of metro access and egress trips are walk, bus and IPT contributing, 67, 14, and 17 percent of total access and egress trips respectively (Refer Figure 25) while in trips made by females are 64, 16, 18percent respectively (Refer Figure 25). Prominent mode of commute for last mile connectivity within 1km is walk, contributing about 88 percent of the total trips made in this particular distance range, IPT such as auto and pedal rickshaw in distance range of 1.1 – 3km and also 2 wheeler, IPT and bus in distance range of 3 – 5km are dominant modes (Refer Figure 26). This indicates people's dependency on intermediate para-transit and public transport modes for longer trips.

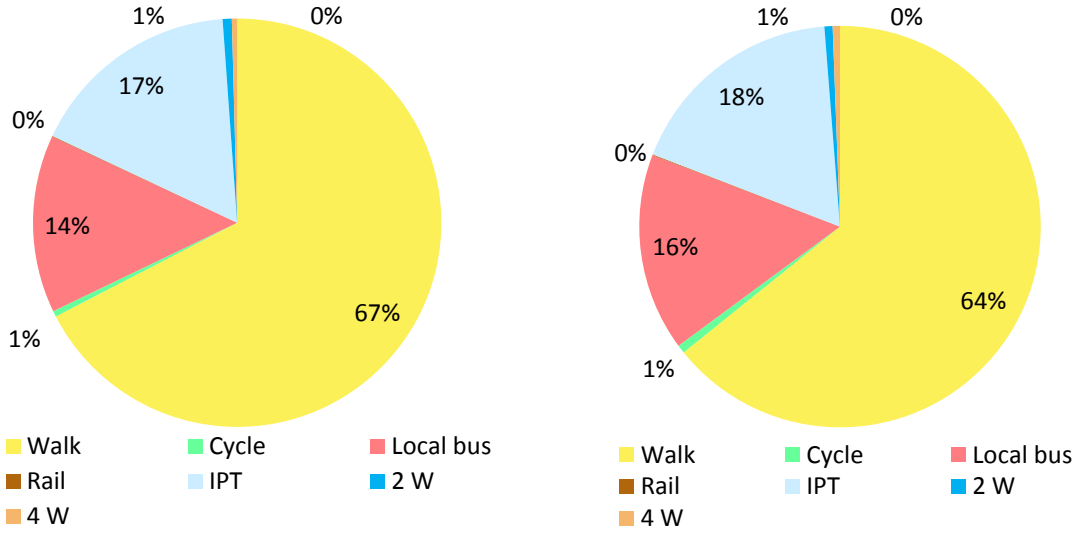


Figure 25 L-R: Mode split for metro access and egress trips (source: primary survey), Mode split for metro access and egress trips made by female (source: primary survey)

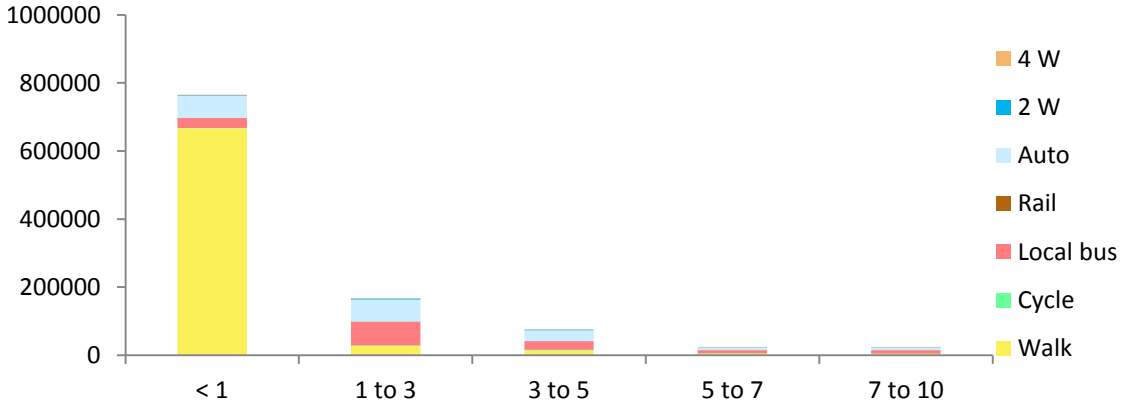


Figure 26: Metro: mode choice and trip length for access- egress trips (source: primary survey)

4.8.2 Bus

97 percent of the access and egress trips made by bus users are by walk, the data stands same for female bus users as well (Refer Figure 27). All last mile trips are within 1km of trip length, which can be potential trips for PBS system.

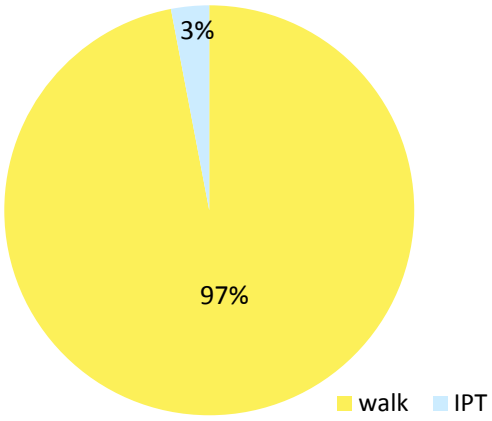


Figure 27: Modal Split: last mile for bus users (source: primary survey)

Observation and inferences of last mile connectivity is as follows:

- Almost 80% of the last mile trips are within 1km trip length, while 90% trips get completed within 3km trip length.
- Significant amount of walk trips (above 80%) contributes to last mile connectivity both for metro user and bus user. But the percentage share of bus user is tremendously high with 97% for walk trips.
- Local bus service caters 14% of last mile trips to metro users.
- IPT forms prime mode for last mile contributing almost 10% share.

PBS system will not only strengthen the existing short trip of South Delhi, but will also create opportunity to attract more users to use existing public transit. South Delhi is characterized by mixed land use and service like PBS will not only improve city's connectivity but will also look into issues of women safety and make it a better place for all.

5. DEMAND ASSESSMENT AND SYSTEM PHASING

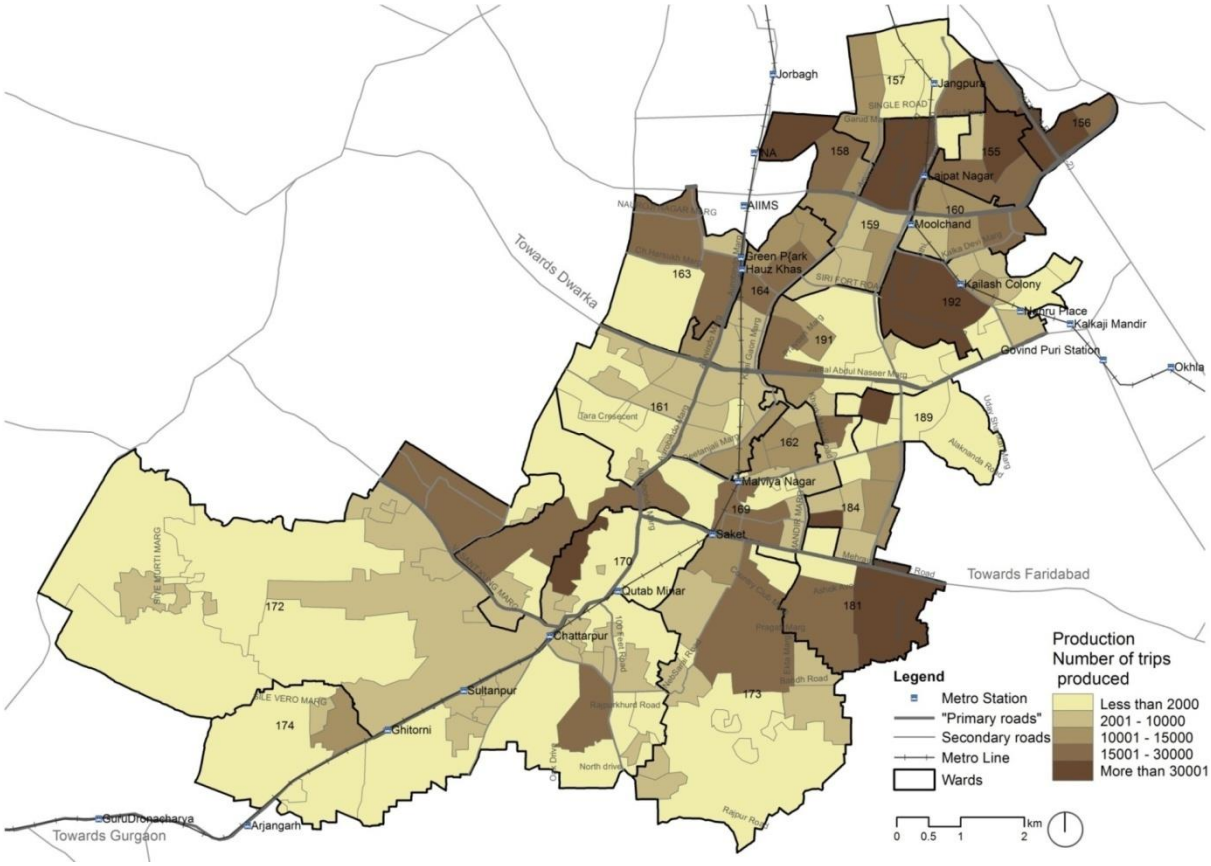
Demand assessment process is to assess demand, identify the trip attraction demand and trip production demand for TAZs, and then estimate the size of the system based on potential users. As discussed in the previous chapter, the study area is in need of alternative modes for last mile connectivity. In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

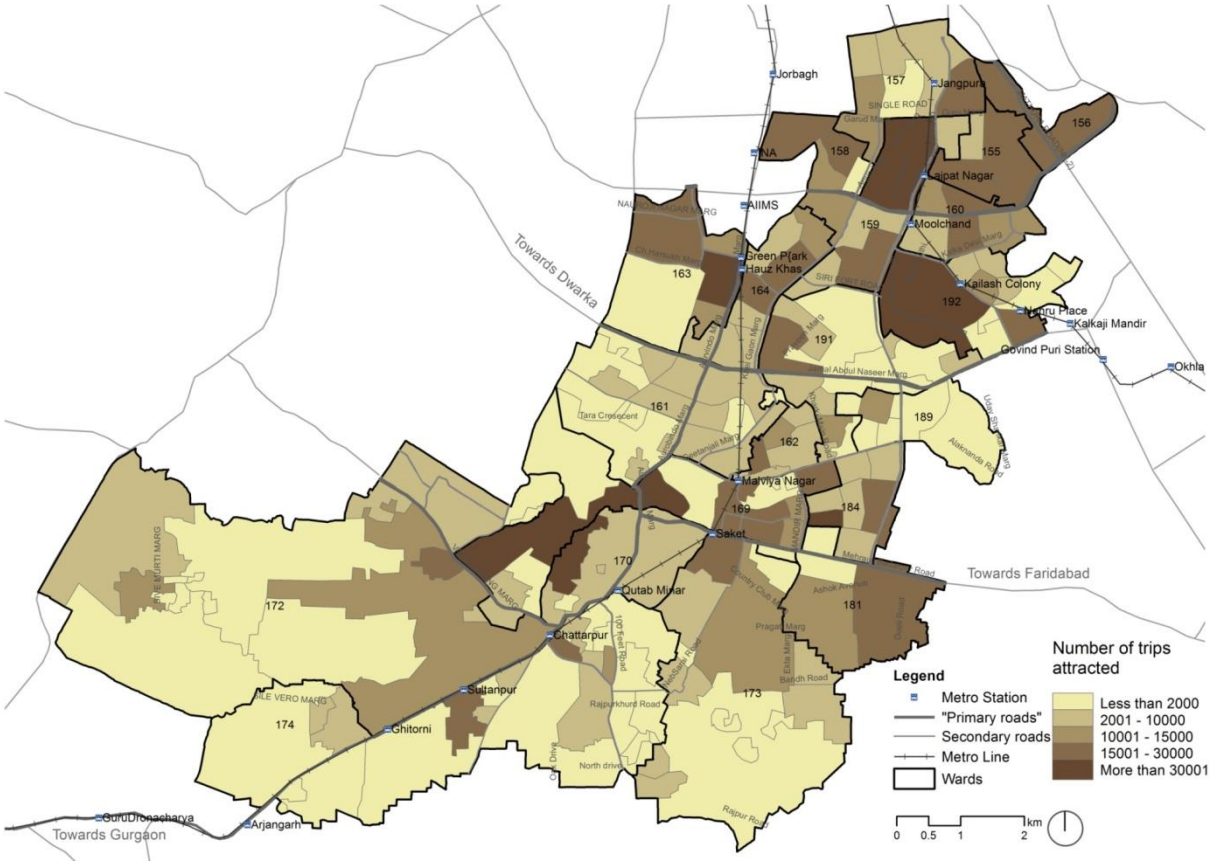
As mentioned in topic 1.5 (Data Base), to understand social, economic and travel characteristics, household surveys have been done. And to know perception about PBS and travel diary, user perception surveys have been conducted at metro stations and bus stops.

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. The current study area has TAZs of vacant land, low density area, medium density area and high density area. Attraction production map (Refer Map 14 & Map 15) clearly demarcates areas such as, chattarpur, Mehrauli, Khanpur, Nehru place, Prem Nagar, Lajpat nagar, Andrew ganj and Kasturba Nagar are high on production trips. Places like Mehrauli, Kishan Garh, Nehru Place, Andrew ganj, Safdarjung enclave and Green Park are high on trip attraction. Places like Mehrauli, Nehru Place, Andrew ganj are essentially of mixed land use, with both residential as well and commercial places



Map 14 TAZ wise production trips



Map 15 Taz wise attraction trips

5.2 Estimating potential users

To calculate the potential trips on PBS, excel based modelling has been done from the survey findings. 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 analyse 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 kilometres of trip length (12 minutes of walking distance) are major target groups for PBS. The main trips within five kilometres 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 28represents the consideration of trips:

Target group for PBS
(Trips within 5 km)

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

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

Figure 28: 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 (referFigure 29). 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

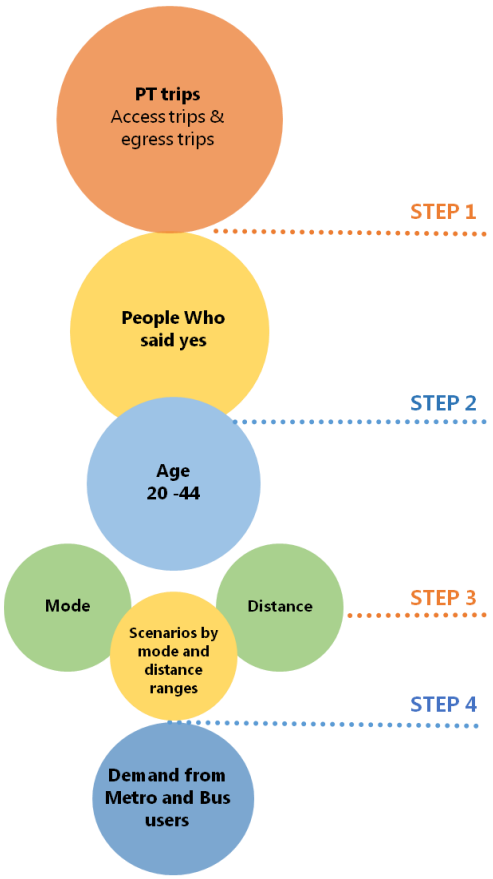


Figure 29 Methodology for demand calculation, last mile trips

been taken into consideration from all people who are willing to use the PBS.

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. The percentage shift has varied from 0% to 10%.

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		
		Scenario1	**Scenario2**	**Scenario3**	**Scenario1**	**Scenario2**	**Scenario3**
Walk	**0 to 1**	0%	0%	0%	0%	0%	0%
	more than 3	5%	7%	9%	-	-	-
Bicycle	**all**	10%	12%	14%	-	-	-
Two wheeler	**0 to 3**	10%	12%	14%	-	-	-
	3 to 5	7%	9%	11%	-	-	-
Four wheeler	**0 to 5**	5%	7%	9%	-	-	-
Auto	**0 to 3**	10%	12%	14%	-	-	-
	3 to 5	7%	10%	15%	-	-	-
Shared auto	**0 to 3**	7%	9%	11%	10%	15%	20%
	3 to 5	5%	7%	9%	-	-	-
Local bus	**0 to 3**	7%	9%	11%	-	-	-
	3 to 5	5%	7%	9%	-	-	-

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: (Refer Table 10).

Table 10 Potential Trips from Public transport

Type of PT trip	Scenario1	Scenario2	Scenario3
Trips from metro users	13,328	17,306	21,529
Trips from bus users	93	139	185

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 30). 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.

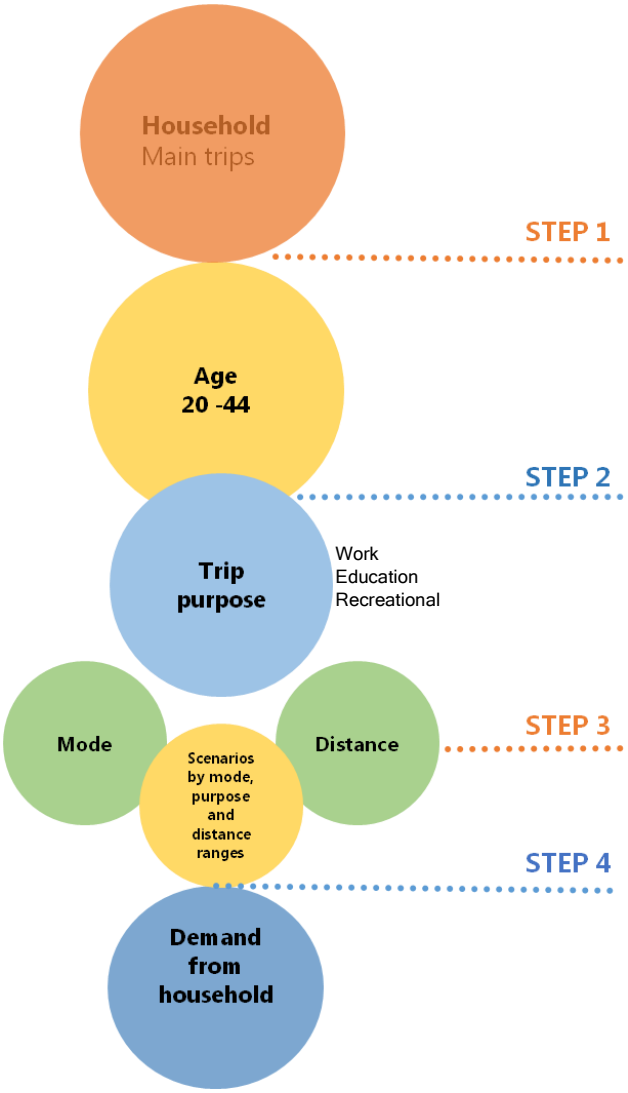


Figure 30: Demand Assessment: Screening procedure for Household survey

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%	6%	2%	4%	6%	1%	2%	3%
	1-3	5%	7%	9%	5%	7%	9%	3%	5%	7%
	3-5	-	-	-	-	-	-	-	-	-
Bicycle	0-1	1%	3%	5%	-	-	-	1%	2%	3%
	1-3	2%	4%	6%	1%	3%	5%	1%	3%	5%
	>3	5%	7%	9%	2%	4%	6%	2%	4%	6%
Two wheeler	0-1	-	-	-	-	-	-	-	-	-
	1-3	5%	7%	9%	-	-	-	1%	3%	5%
	3-5	3%	5%	7%	3%	5%	7%	1%	3%	5%
Four wheeler	1-3	3%	5%	7%	-	-	-	1%	3%	6%
	3-5	1%	3%	5%	1%	3%	5%	1%	3%	5%
Three wheeler	1-3	-	-	-	7%	9%	11%	-	-	-
	3-5	3%	5%	7%	3%	5%	7%	3%	5%	7%
Shared 3w	0-1	-	-	-	-	-	-	-	-	-
	1-3	-	-	-	3%	5%	7%	1%	3%	5%
	3-5	2%	4%	6%	1%	3%	5%	1%	3%	5%
Pedal Rickshaw	0- 3	2%	4%	6%	2%	4%	6%	1%	2%	3%
	3-5	5%	7%	9%	5%	7%	9%	3%	5%	7%

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 5194, 9390 and 13588 are potential users from household main trips in scenario 1, 2 and 3 respectively (ReferTable 12)

Table 12: Potential Trips from Household Trips

Type of trips	Scenario1	Scenario2	Scenario3
Trips from household main trips	5,194	9,390	13,588

5.2.5 Summary

The combined public bicycle sharing system demand has been estimated 18615, 26835 &35302 trips in scenario1, 2 and 3 respectively which is 1%, 1.4% and 1.9% 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	19,06,929	18,615	26,835	35,302
Percentage of total trips	100	1.0	1.4	1.9

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 (refer Table 14) . Considering conservative trip share for the study,2.5 trips per bicycle has been considered. Giving estimate of7564, 10834 and 14321bicycles for scenario1, 2 and 3 respectively (referTable 15).

Table 14 Case studies showing average trip/bicycle

Sl.no.	Cities	Trips/bicycle	Sl.no.	Cities	Trips/bicycle
1.	New York	6.7	9.	Rennes	2.4
2.	Lyon	8.3	10.	Hamburg, Germany	2.2
3.	Warsaw, Poland	7.1	11.	Chicago, Illinois	2.1
4.	Hangzhou	4.1	12.	Nantes	1.7
5.	Paris	5.5	13.	Orléans	1.5
6.	Montreal	4.0	14.	Vienna, Austria	1.4
7.	Guangzhou	4.0	15.	Boston, Massachusetts	1.4
8.	London	3.0	16.	Melbourne, Australia	0.8
					Average trip/bicycle: 3.5

Table 15 Summarized Demand in terms of Trips for entire study area

Sr. no	Topic	Scenario1	Scenario2	Scenario3
1	Total demand	18,615	26,835	35,302
2	Percentage of total trips	1.0	1.4	1.9
3	No of bicycle by 3 shares	6,205	8,945	11,767
	Spare bicycles	100	100	200
	Total no. of bicycles by 3 shares	6,305	9,045	11,967
4	No of bicycle by 2.5	7,446	10,734	14,121

Sr. no	Topic	Scenario1	Scenario2	Scenario3
	shares			
	Spare bicycles	100	100	200
	Total no. of bicycles by 2.5 shares	7,546	10,834	14,321

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. The area has been divided in two levels of planning. Phase I 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 (Refer Map 17, Figure 31 Phasing parameters):

1. **Density of population; attraction and production zones**

The TAZs with high population density and high production characterise high potential TAZs for origin, which mostly includes residences, transit nodes. And TAZs with high attraction characterize high potential for trip destination which will be mostly work place, commercial centres, school colleges and shopping centres. The density map, land use map, attraction production map was used more as guideline and reference to identify the high potential areas for phasing (Refer Map 7, Map 15 and Map 14).

2. **Land use**

The study area is by large dominated by residential land use with a good spread of public semi-public use, forested area and parks and gardens. The initial phasing includes by large residential, public semi-public and pocket of commercial areas.

3. **The existing public transit and major road network**

Study area is well connected by metro rail service, bus services and several IPT and feeder services. The prime roads include Arobindo marg, inner and outer ring road and also the Josip BrozTito marg. Along with major activities are seen. The dense inner roads ensure the connectivity of local neighbourhood with the destination points (Refer Map 12).

4. **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 northern part of the city. The heat map created, shows the density of various nodes within the study area (Refer Map 10).

5. **Demand of ridership at various transit location**

The ridership data of metro and bus within the study area shows high volume of boarding alighting at Nehru place, Malviya nagar, Hauzkhas, Qutub Minar, Chattarpur metro stations mostly (Refer Map 13)

6. Transit buffer map

Along the metro corridor 12min cycling distance has been calculated with 3km buffer. The buffer of metro yellow line and violet line merges in the northern part of the city. The northern half up to outer ring road has been considered as the potential area for first phase.

The further phasing has expanded the system. The expansion will strengthen the existing system within increase in coverage area and system size. Phasing should also consider the surrounding area which has potential of growth.

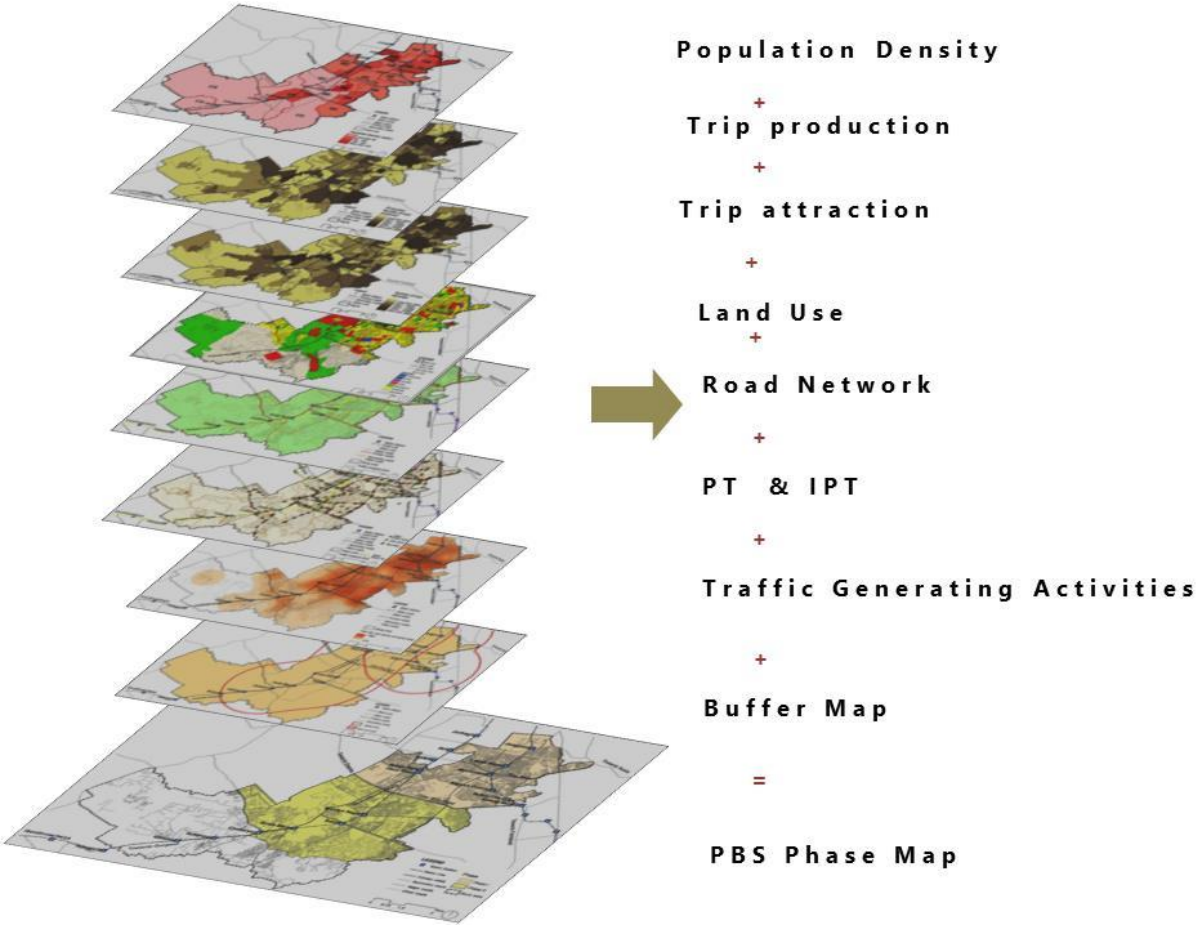
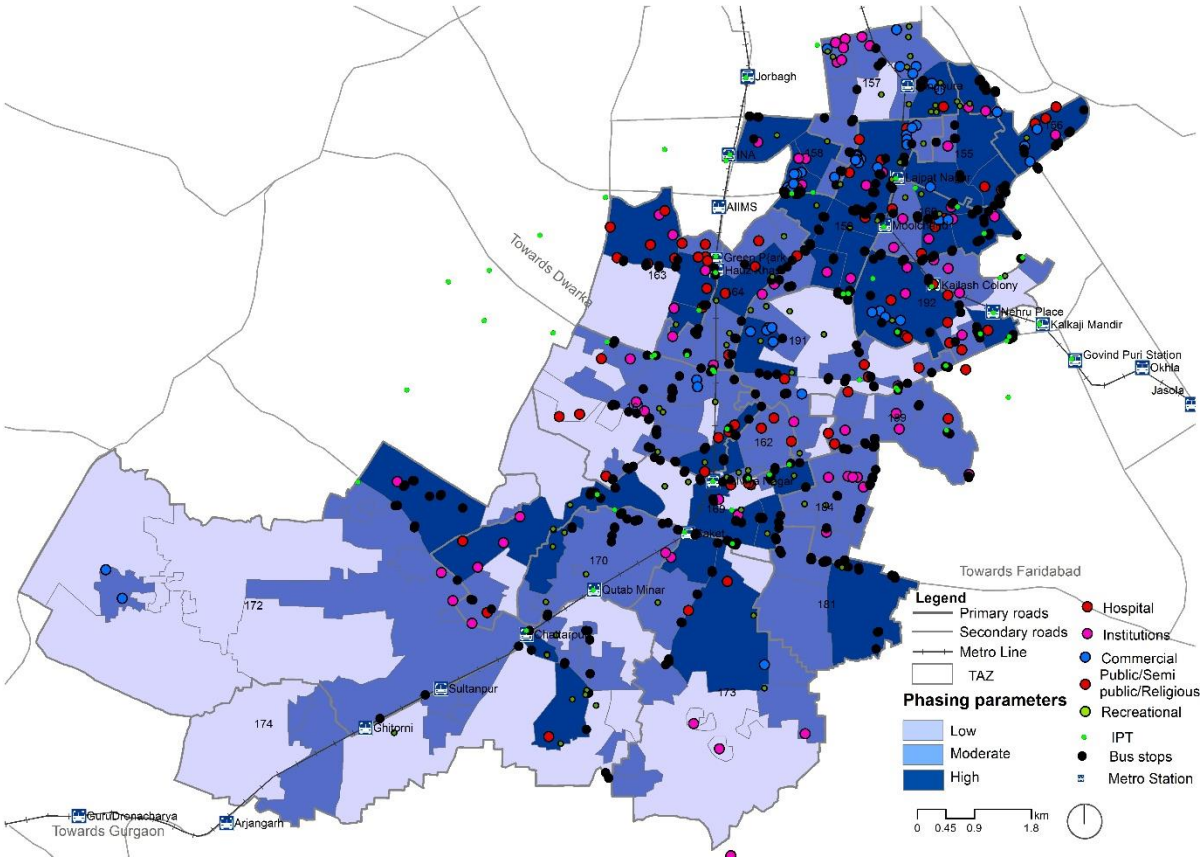


Figure 31 Phasing parameters

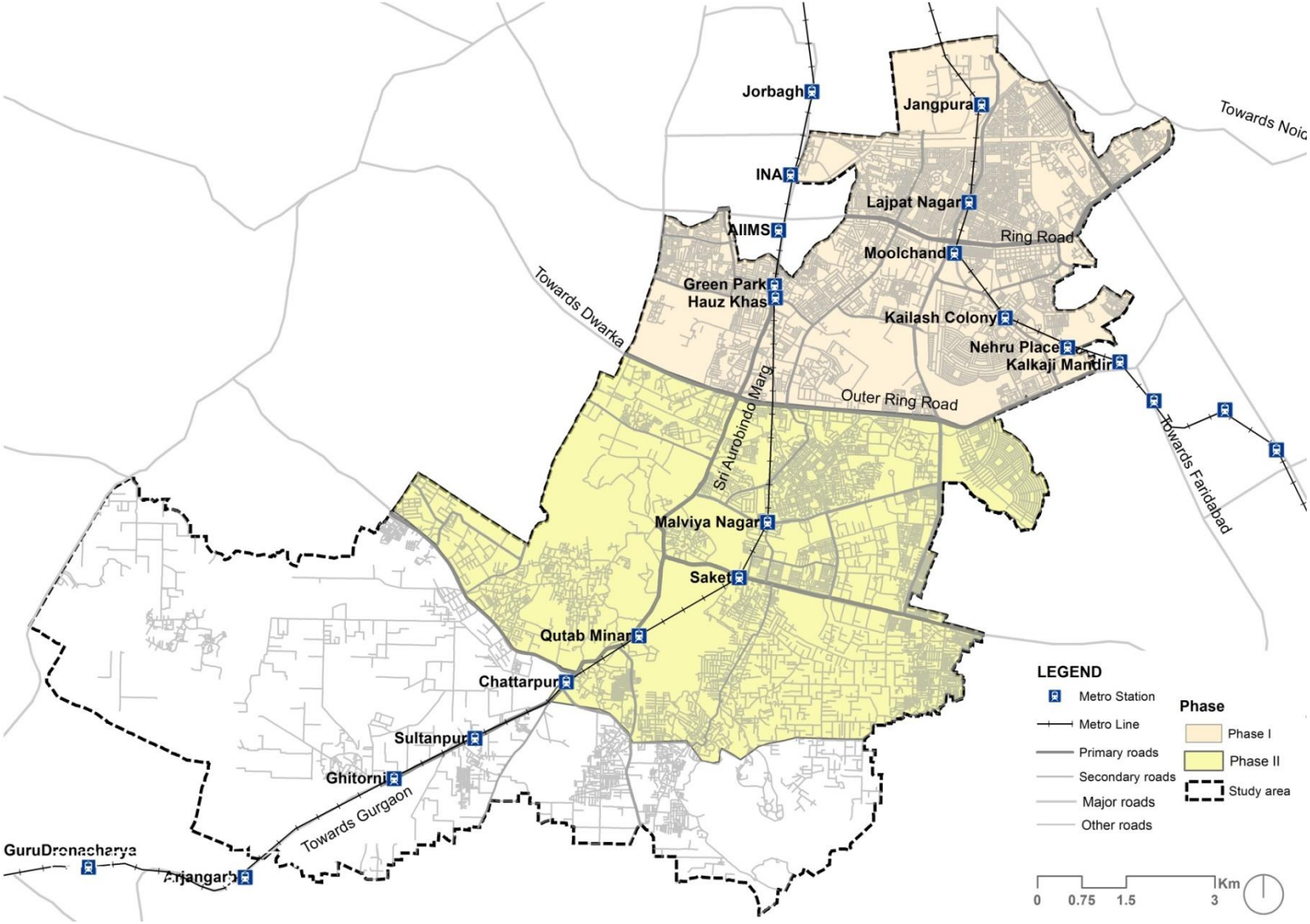
Weightage was assigned to each parameter on the basis of the range classified, (Refer Table 1). And then, taking account of individual TAZ's weight, further reclassification was done to find the low, moderate and high potential TAZs (Refer Map 16 below).This map obtained is used for defining PBS phases in the study area.(Refer Appendix A, Matrix)

Table 16 Weightage matrix of phasing parameters

	Low weightage	Moderate weightage	Higher weightage
Population density (in ppha)	≤ 80	81-160	>160
Trip production (no. of trips)	≤ 2000	20001-15000	>15000
Trip attraction (no. of trips)	≤ 2000	2001-15000	>15000
Traffic generating activities (Count of transit stations and traffic generating activity nodes)	≤ 2	3-10	>10
Proximity to metro (TAZs within the buffer)	Beyond 3km	In between 1.5-3km	Within 1.5km
Weight assigned	**1**	**2**	**3**



Map 16 Potential Tazs based on phasing parameter



Map 17 Phase map

5.4.2 Numerical findings from Phasing

The area has total area of 96sq.km. Phase I includes the northern part of the study area that has the overlapped 3km buffer of metro corridor, major commercial places like Nehru nagar, residential hubs. It also include inner ring road and extends up to outer ring road. The area for phase I is 25sqkm. (Map 17). 25sqkm of area in Phase I will require nearly 3300 bicycles as per the demand and assumption of 2.5 shares / bicycle.

And to cater the remaining demand of Phase II, additional 4200bicycles will be required for 32sqkm area. For phase II also 2.5 shares per bicycle have been considered. Station spacing for phase I varies between 200- 300m, while station density in phase II varies from 300-500m.

Phasing details have been explained below:

- **Phase IA details (1st year of implementation):**
  - Coverage Area: 25sqkm
  - Stations: 234
  - Bicycles: 3300
  - Docks: 4950
  - Station density/sqkm: 8

- **Phase II details (3rd year of implementation)**
  - Coverage area to be added: 32sqkm
  - Stations to be added: 166
  - Bicycles to be added: 4200
  - Docks to be added: 6300
  - Station density/sqkm: 5

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 **Error! Reference source not found.**), the most attractive zones were identified for whole of the study area. 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)
3. Density of population
4. Attraction zones, production zones

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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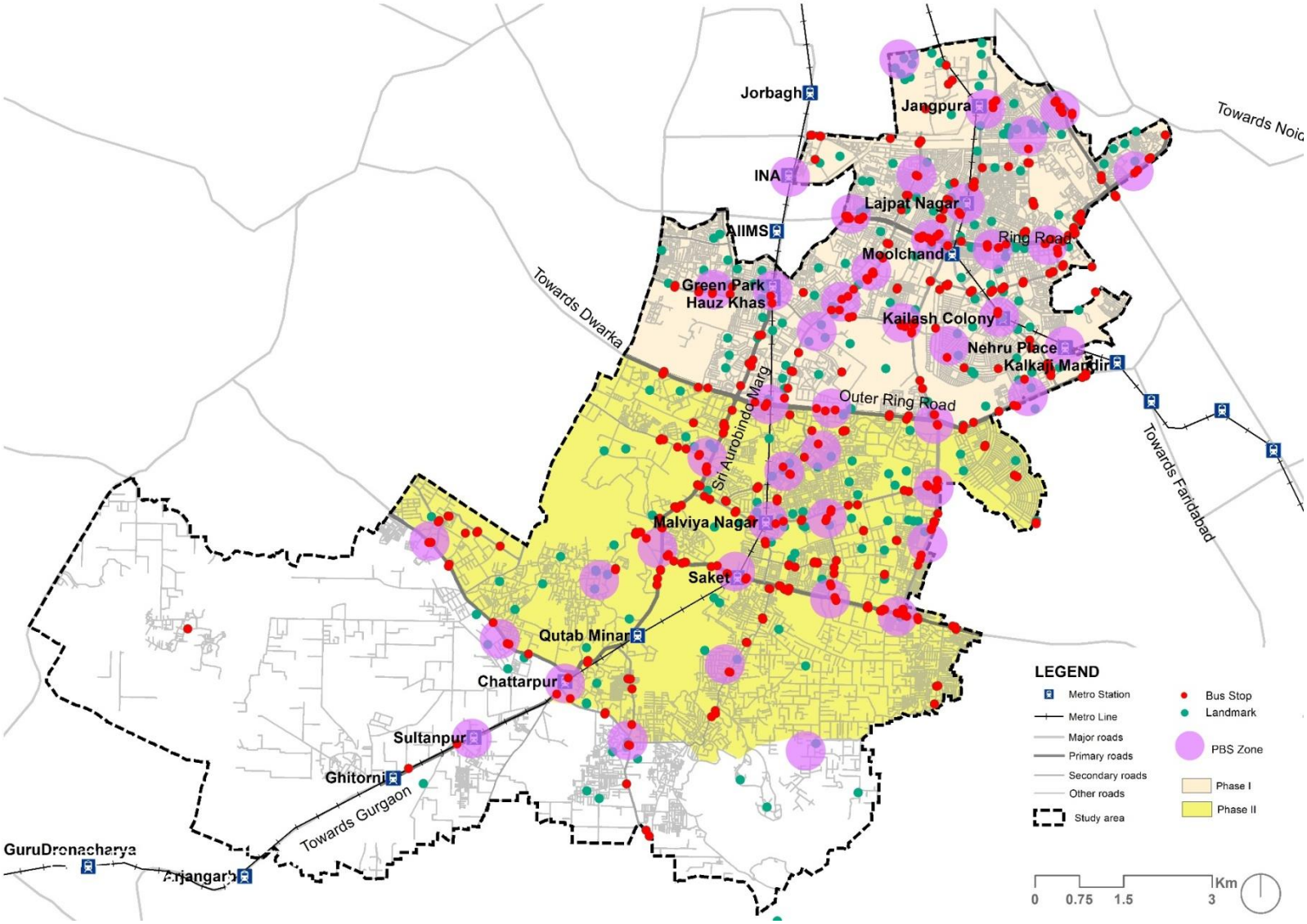


Map 18 PBS station zones

5.5.2 Identifying the station locations

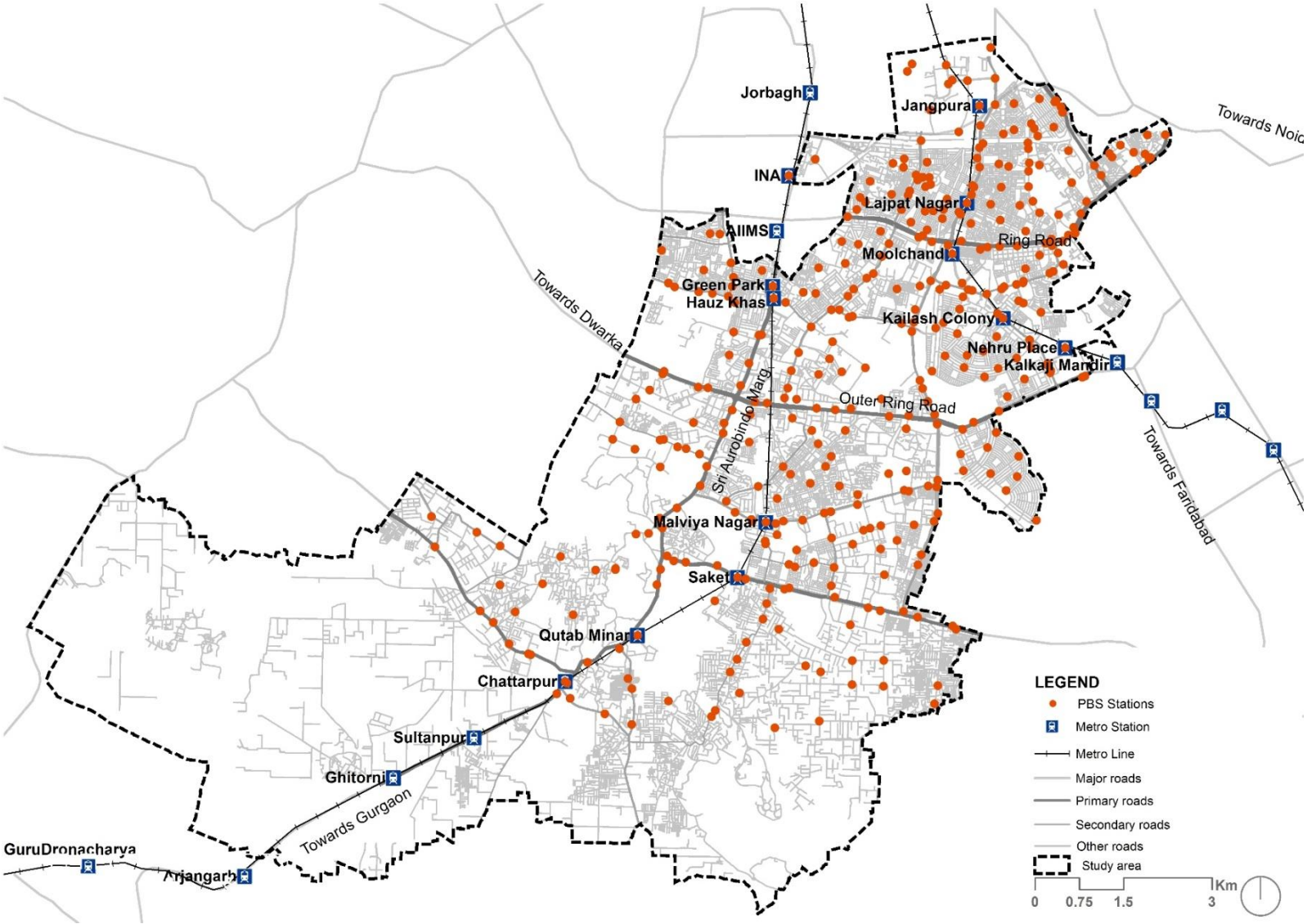
To determine the station location parameters like accessibility, land use, colony entrances and parking space have been considered. The size of the station will be a function of the anticipated demand and the attractions of a particular area, and station's location will depend on the actual environment. Total 400 stations have been proposed for study area, of which phase I has 234 stations. The entire Phase I is distributed within 25sqkm area of northern study area, up to outer ring road. The remaining 166 stations are further distributed in Phase II 32sqkm 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 200-300m to ensure mostly dense and uniform coverage in high demand area; and 300-500m in Phase II area.
- 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.



Map 19 PBS station locations

5.5.3 Determining the station size

Stations have been categorized into three type i.e. high capacity stations and intermediate capacity stations and low capacity stations with 20,15,10 bicycles and 30, 23 and 15 docks respectively. Station size may vary as per space availability on site. Phase I station sizes have been shown in **Error! Reference source not found.** and **Error! Reference source not found.**Station size has been determined considering following parameters: (Refer Map 20 and Map 21)

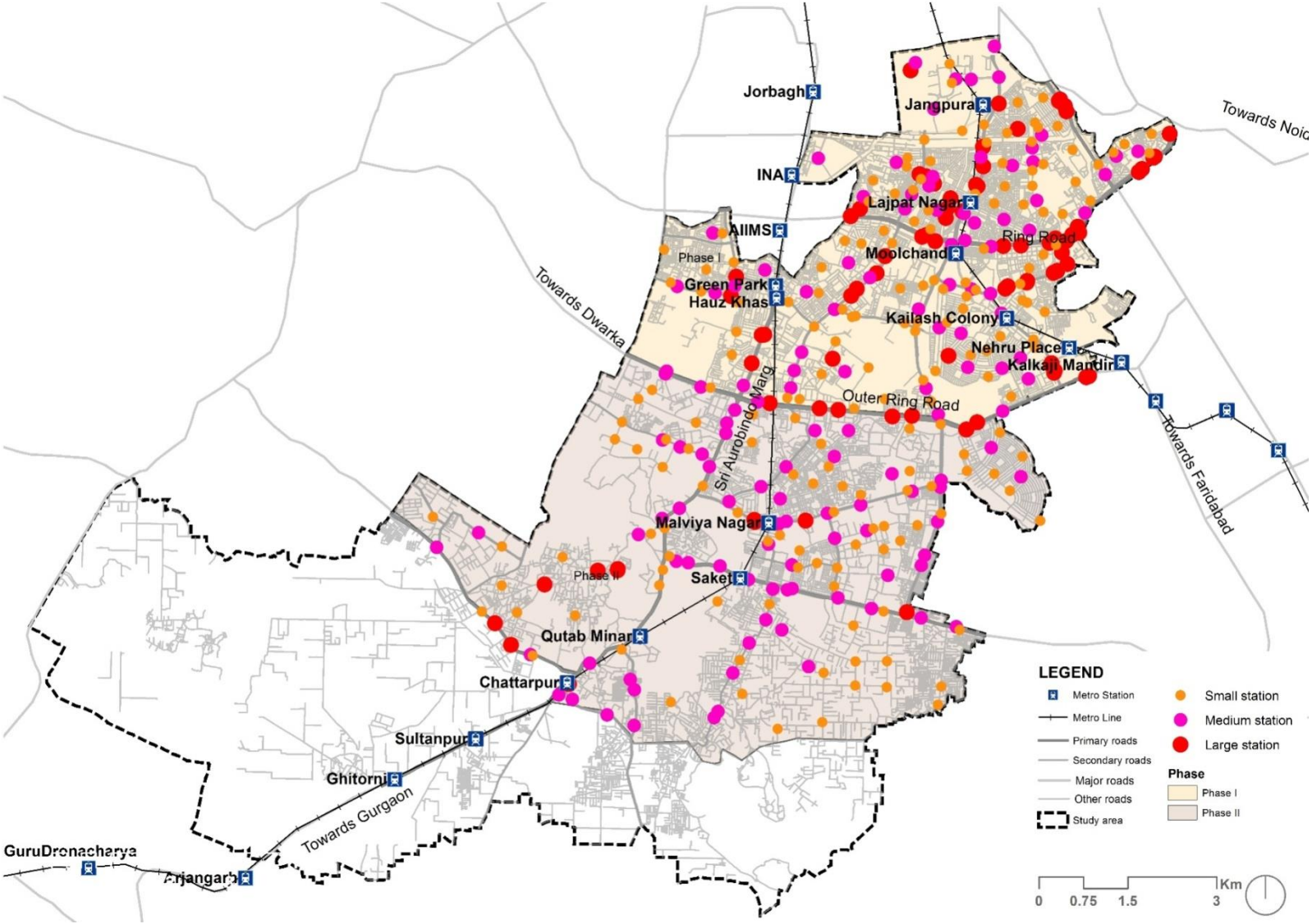
- Infrastructure design to support the expansion of module of the stations
- Docks per bicycle ratio: the average number of docking spaces per bicycles.
- Station Density Ratio: the average number of stations in the area and the minimum fixed amount of bicycles it will have.
- Transit node: the stations near major points of attraction which will require increment in station size.
- Distance between stations: minimum distance is to be 200m, but if it increases beyond that, the station size is to be increased accordingly.

Table 17 Parameters consider to station sizing

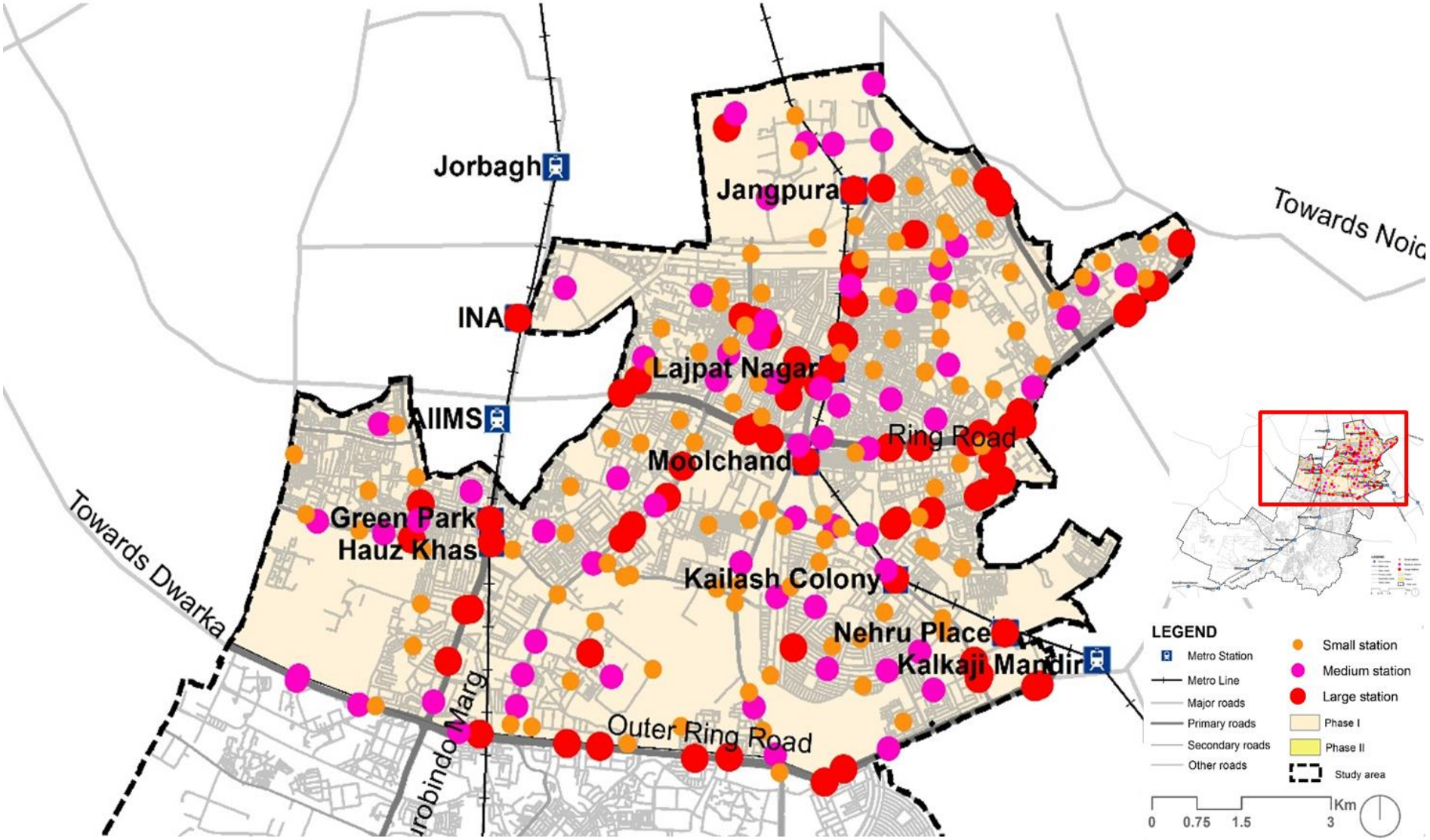
	High Capacity Station	Intermediate capacity Station	Low Capacity Station
Transit Ridership	At the entry gates of Metro station and next to bus stations with high ridership more than 20,000	At the entry gates of Metro station and next to bus stations with high ridership 20,000-10,000	At the entry gates of Metro station and next to bus stations with high ridership less than 10,000
Traffic generating activity nodes	Cluster of 4-6 nodes within the 200m buffer of nodes	Cluster of 3-4 nodes within the 200m buffer of nodes	Cluster of 1-3 nodes within the 200m buffer of nodes
Attraction /Production	TAZ with high Production	TAZ with intermediate attraction and production	TAZ with high attraction

Table 18: Station Sizing, study area PBS

	Phase I	Phase II
Total Stations	234	166
High capacity stations	72	23
Intermediate capacity stations	62	65
Low capacity stations	100	78



Map 20 PBS station size



Map 21 PBS station, 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 bicycles.

Therefore considering the shortcomings of manual based systems, its associated theft vandalism and poor resource utilization; Study area's 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

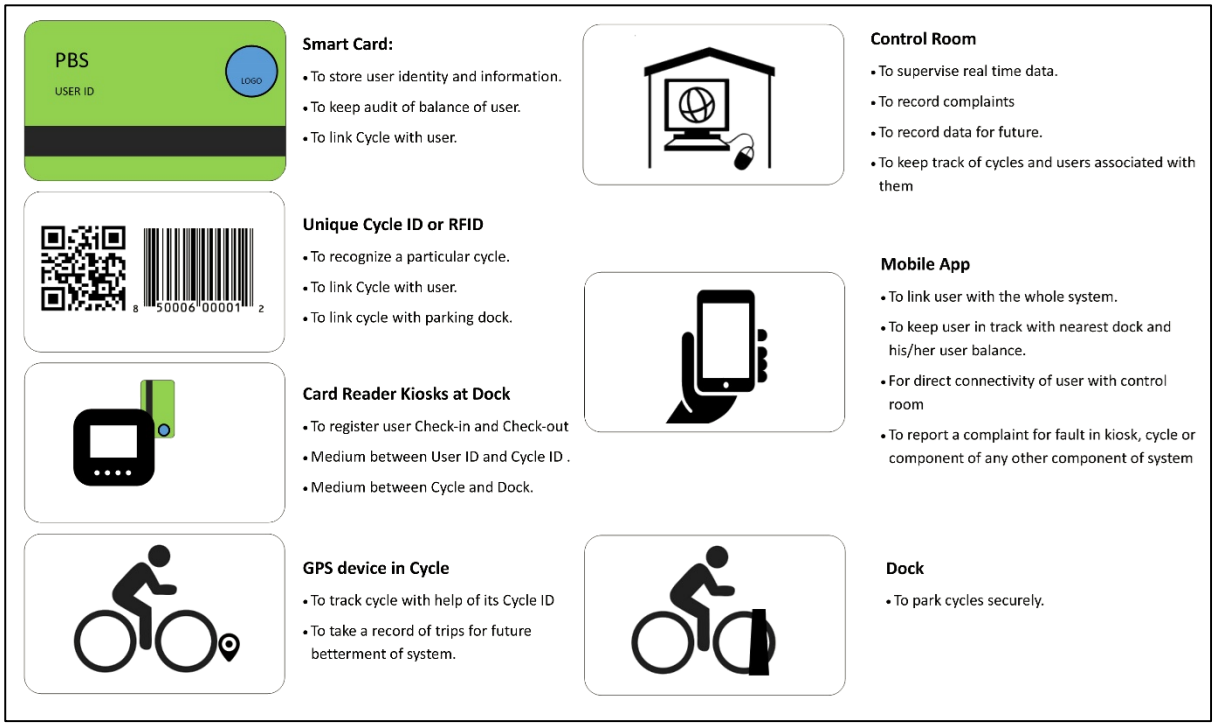


Figure 32: Proposed Components of PBS

The PBS system proposed for the study area, New Delhi will be managed by ITS infrastructure. People of study area 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:

Study area's 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 the study area 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 33: 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 study area, 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 34: 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.

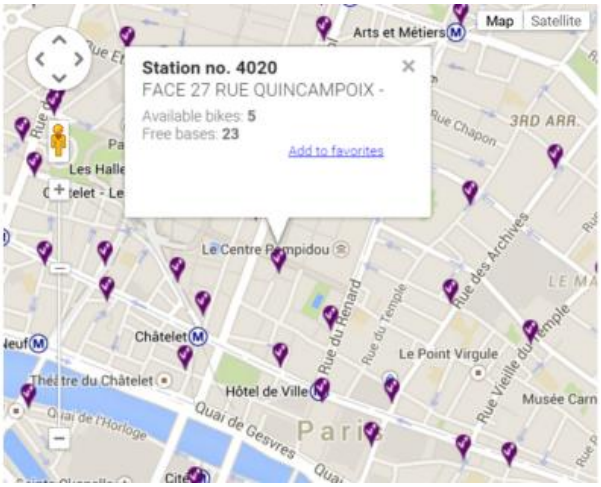


Figure 35Left: Bicycle station location and availability and other features, in smartphone app, China; Right: Online portals showing the real time information of bicycle availability, Velib Paris

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 the study area 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

6.5 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 study area, 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

6.6 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 36: 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

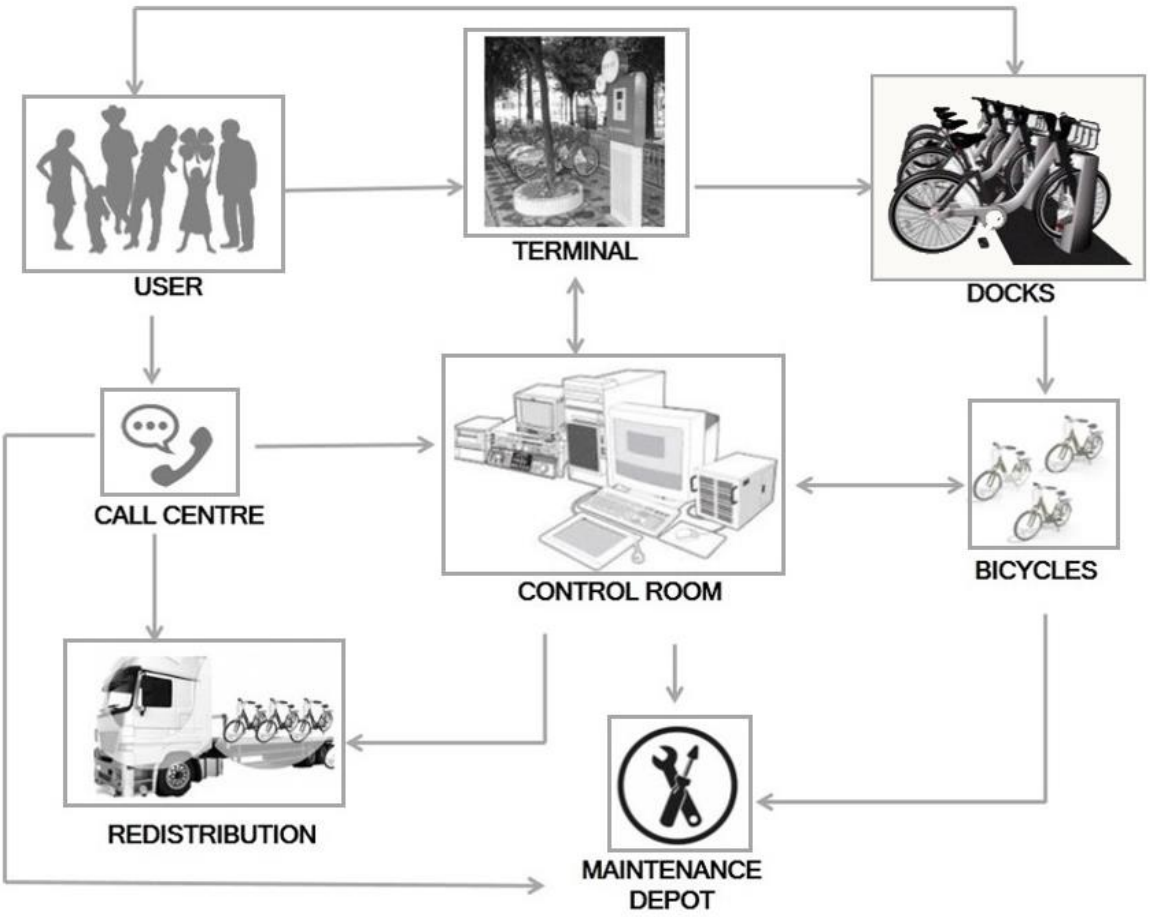


Figure 37: Flow Chart Showing OCC Work Procedure

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.
The proposed bicycle has versatile and unique characteristics to provide flexibility, ease of use and unique identity to its users. In our study area, considerable amount of the trips are made by females that needs to be planned and designed for. Specifications of the bicycles in study area's 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

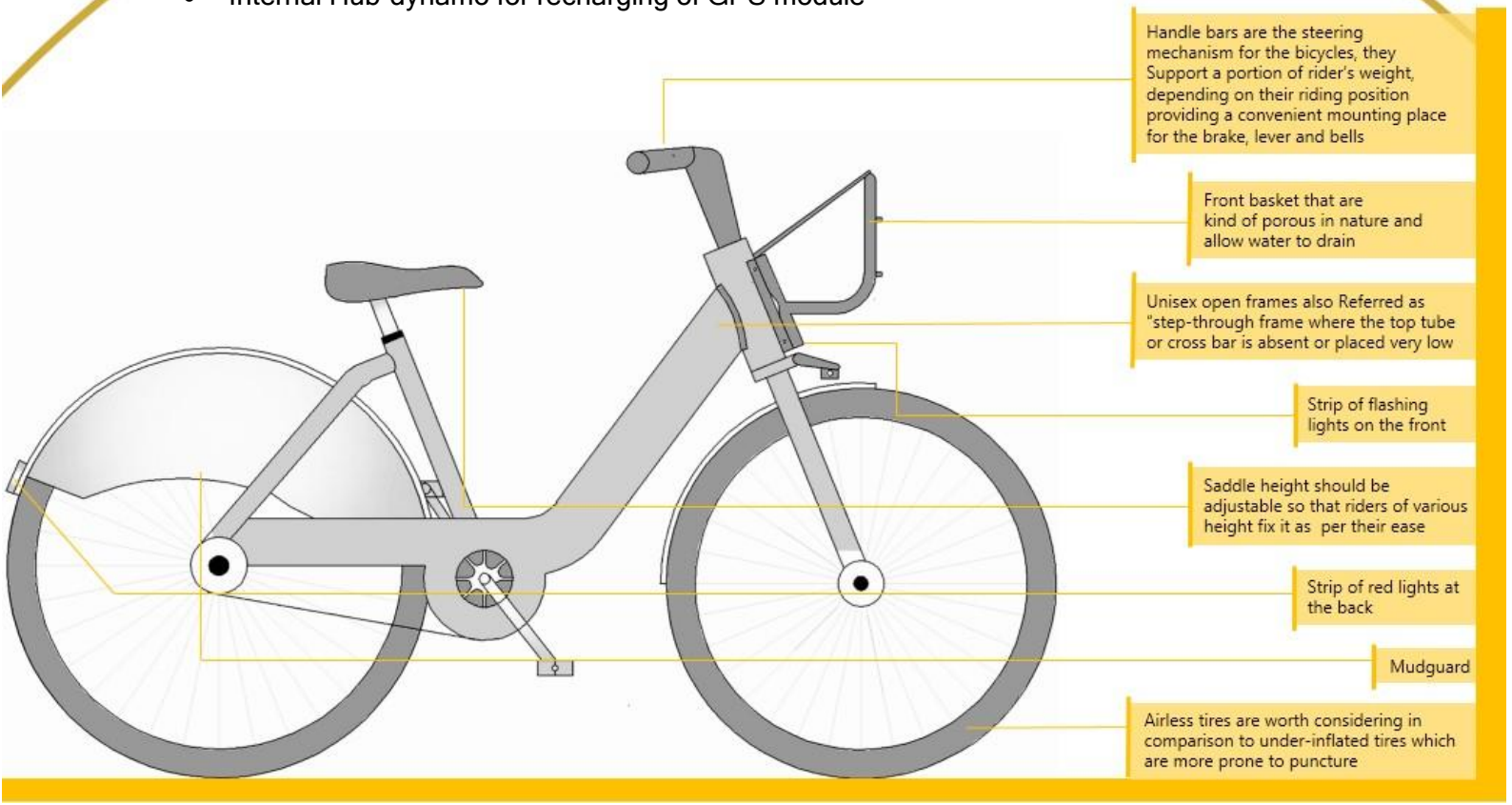


Figure 38: Bicycle Specifications

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.

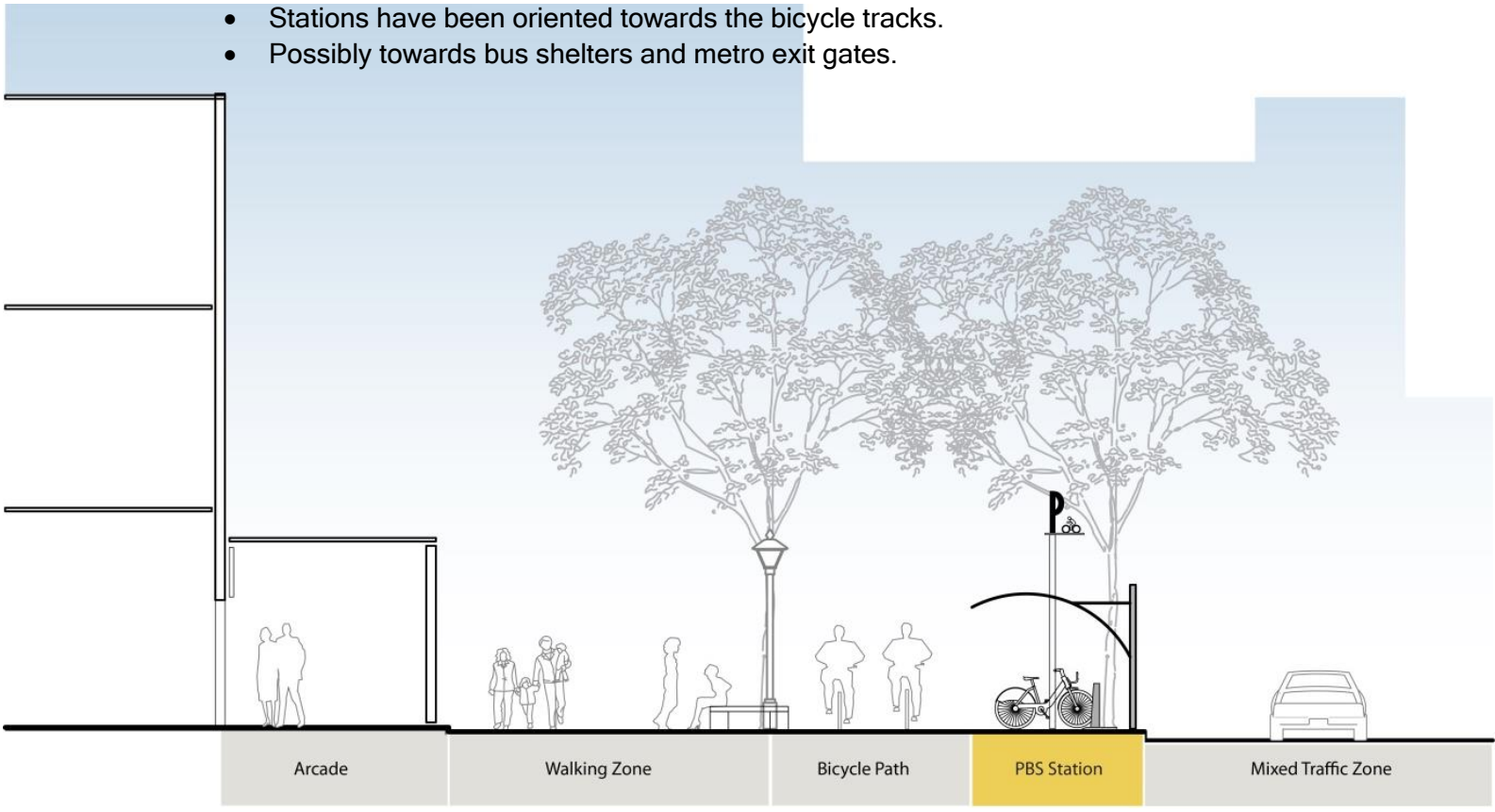


Figure 39: Conceptual Street Section

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 40: Melbourne Bicycle Share, Melbourne Bollard Docking

Figure 41: 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 42Left: 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 bicycles, 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 Street Design in study area

The designing of major roadsin the study area has been done with proposed PBS systems. The proposal given below is at conceptual level and meets consultation with the SDMC and groudtruth verification before finalizing the design. The design of these stretches along with their sections has been shown below:

Josip Bros Tito Marg

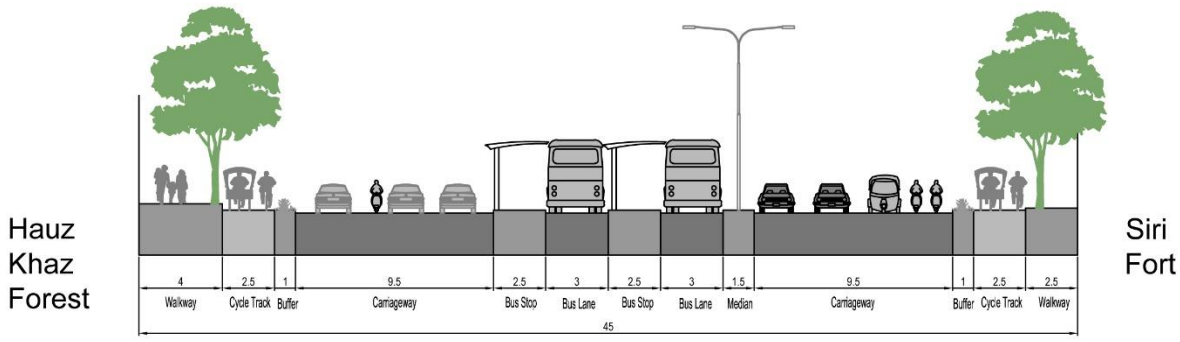


Figure 43 Existing cross section, Josip Bros Tito Marg

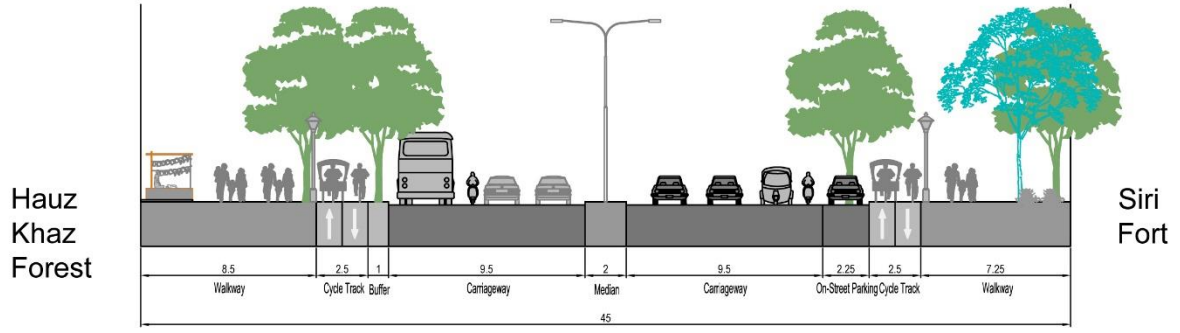


Figure 44 Proposed cross section, Josip Bros Tito Marg

Figure 45 Josip Bros Tito Marg, before and after PBS stations and cycle track

Sri Aurobindo Marg

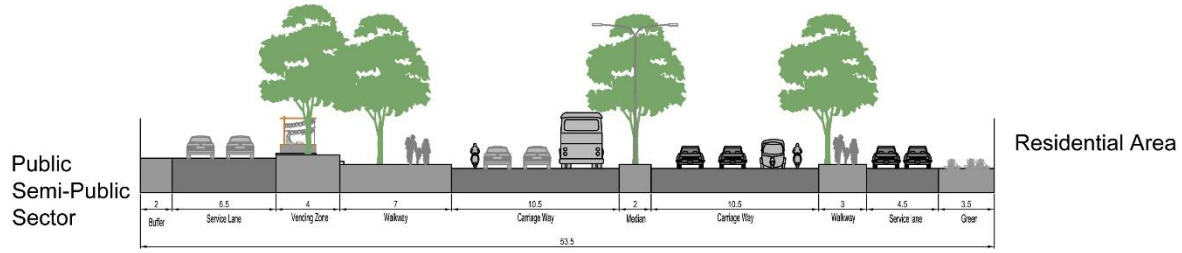


Figure 46 Existing cross section, Sri Aurobindo Marg

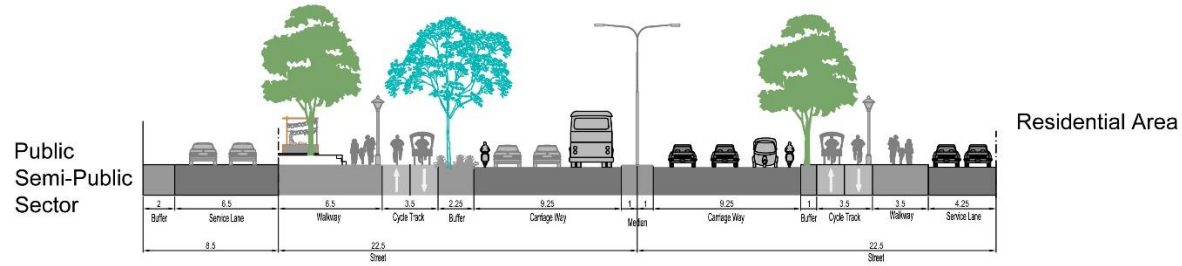


Figure 47 Proposed cross section, Sri Aurobindo Marg

Figure 48 , Sri Aurobindo Marg, before and after PBS stations and cycle track

Mandir Marg

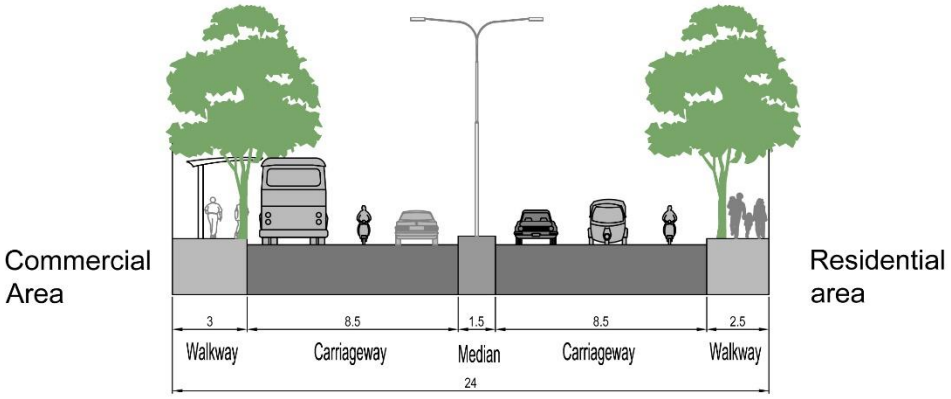


Figure 49 Existing cross section, Mandir Marg

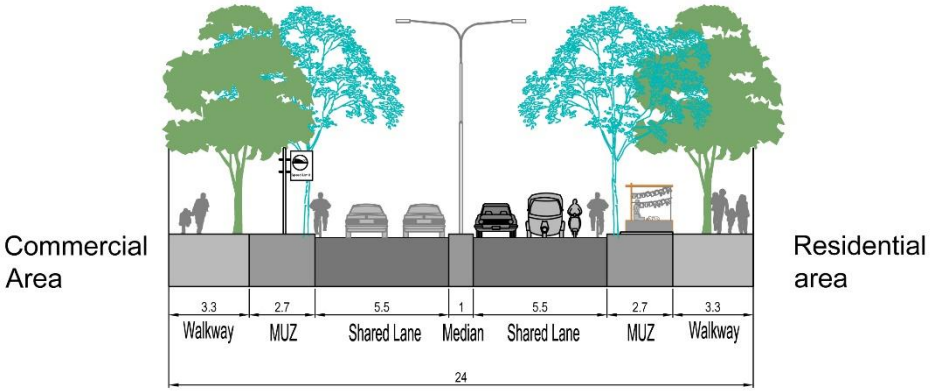


Figure 50 Proposed cross section, Mandir Marg

Figure 51 Mandir Marg, before and after PBS stations and cycle track

Outer Ring Road

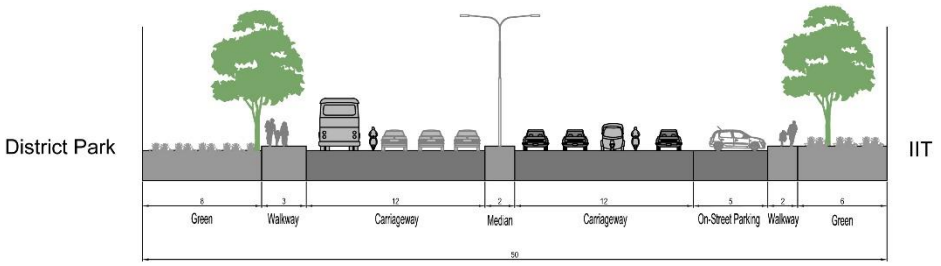


Figure 52 Existing cross section, Outer Ring Road

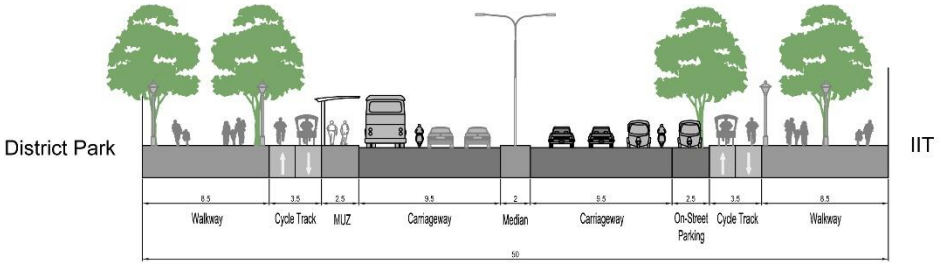


Figure 53 Proposed cross section, Outer Ring Road

Figure 54 Outer Ring Road, towards olof palme marg, before and after PBS stations and cycle track

Figure 55 Outer Ring Road, towards panchsheel marg, before and after PBS stations and cycle track

7.7 Procedure of Use

7.7.1 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

7.7.2 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 56: Graphic Check in - out

7.7.3 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.

Figure 57: Graphic showing Incident Management Procedure

7.7.4 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 58: 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 system set up includes, cost of bicycle, dock, stations, control room, and design consultancy. And to run the system the capital cost for operational setup includes, redistribution vehicles, vehicles for maintenance, and setting up of depot. Phase-I will have 3300 bicycles, 4455 docks and 234 stations, The capital expenditure for study area has been calculated considering two options, first option with smart Bike, and option two with automated docks. In both the options the cost of bicycle, dock, terminal and station differ, rest of the particulars remain same. (Refer Table 19)

Table 19 Estimated Unit Capital Expenditure in phases (In Rs)

Sr.no	Particulars	Unit Cost Rs.		Phase I Units
		Option I (Smart Bike)	Option II (Automated docks)	
1	Bicycle	50,000	24,000	3,300
2	Dock	8,000	50,000	4,455
3	Terminal	25,000	1,80,000	234
4	Small stations	4,00,000	6,00,000	162
5	Large stations	12,00,000	18,00,000	72
6	Call and Operational Control Centre	50,00,000	50,00,000	1
7	Design consultancy for urban landscaping &station design	30,00,000	30,00,000	1
8	Redistribution vehicles	8,00,000	8,00,000	10
9	Vehicles for maintenance team	30,000	30,000	15
10	Setting up of Depot	20,00,000	20,00,000	1

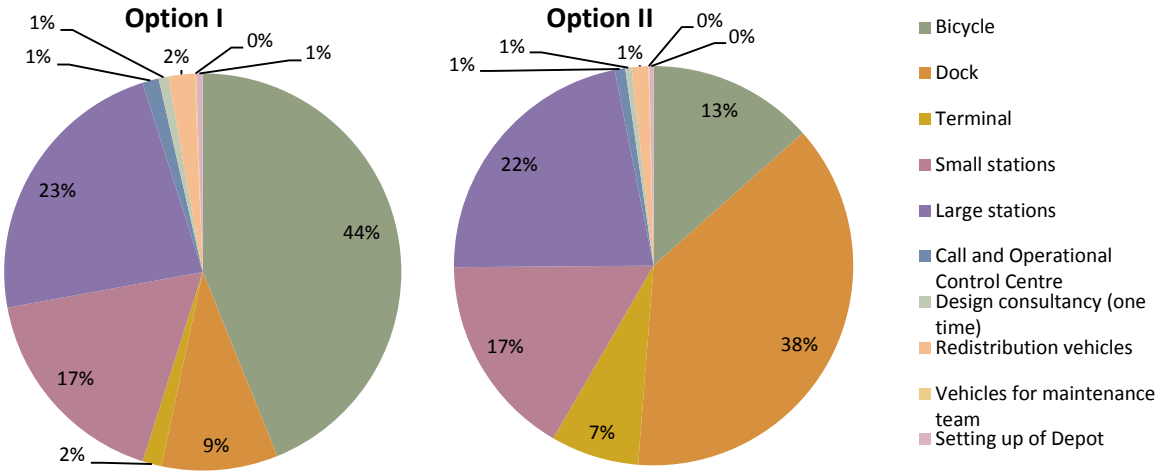


Figure 59 Percentage distribution of capital cost for Option I and Option II

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. Manpower for PBS system includes, staffs for bicycle cleaning, bicycle mechanic, mechanic assistants, redistribution teams, Operation manager, driver for redistribution vehicle, customer service agent, customer relation manager PoS kiosks, accounting assistant, accounting manager, senior project manager, and marketing manager. Insurance is required for, redistribution vehicle, maintenance vehicle, depot, bicycle, dock, terminal, stations and operational control centre. Miscellaneous includes, legal services, maintenance of system, electricity, internet/mobile phones, stationery and administrative cost. (Refer Table 20)

Table 20 Assumptions of estimated Operational cost

Sr. No	Particulars	Unit Cost (in Rs) Option I (Smart Bike)	Option II (Automated Docks)	Units	Duration	Phase I
1	Manpower cost	27,230	27,231	Person	Monthly	13.3
2	Spare part (bicycle & stations)	6,500	6,500	Kit	One time	1,767.0
3	Fuel cost for redistribution	1,00,000	1,00,000	Vehicle	Monthly	10.0
4	IT maintenance	10,00,000	10,00,000	-	Yearly	1.0
5	Smart card	100	100	card	Yearly	50,000.0
6	Insurance	13,135	13,547	-	Yearly	916.7
7	Miscellaneous	26,406	26,406	-	Monthly	707.4

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 54 percent of people who are willing to use the system. Of the 55% prefer to pay Rs.120 – 150 for an hour charge on monthly basis, 27% prefer Rs.150 – 180 and 14 percent, 3 percent and 1 percent are ready to pay Rs.180 -210, Rs.210 – 250 and greater than Rs.250 respectively (Refer Figure 60).

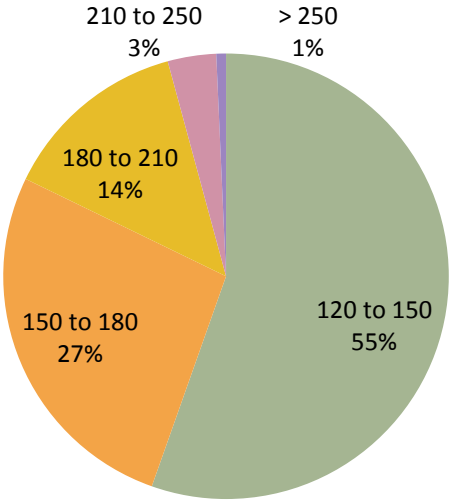


Figure 60 Willingness to Pay (source: primary survey)

Survey reveals that approximately 79 percent preferred mode of payment is cash and 20 percent of population prefers credit card. Only 1 percent of the public transport users prefer using debit card (Refer Figure 61)

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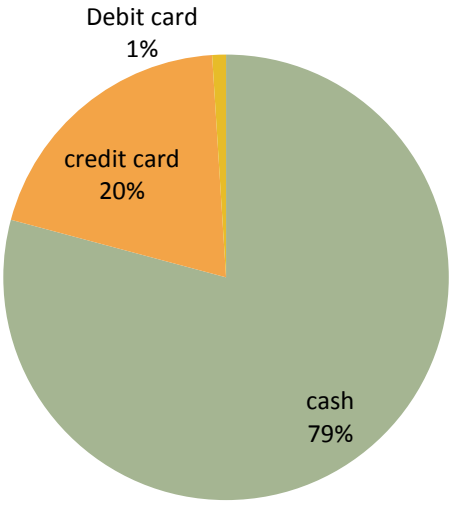

Figure 61 Preferred Mode of Payment (source: primary survey)

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 21Proposed 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	15

8.3.2 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 23)

Table 22Types 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 Study area 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 Study area, 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)
1st year implementation of NMV		10	10
2nd year implementation of NMV	add	20	30
3rd year implementation of NMV	add	25	55
4th year implementation of NMV	add	25	80
5th year onwards implementation	add	25	105
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		20.0	Rs
Growth rate for charges		5%	

Table 25 Assumptions for User Fees and Subscription revenue

		Fees		% of total users		days	month
User fees	For first half hour users	0.0	Rs/half hour	11,169.0	60%	25.0	12.0
	For Second half hour users	10.0	Rs/half hour	5,584.5	30%	25.0	12.0
	For third half hour users	15.0	Rs/half hour	1,861.5	10%	25.0	12.0
	Total trips per day	18,615.0					
Growth rate for trips	Year 1 to 3	15%					
	Year 4 to 8	10%					
	Year 9 & 10	5%					
User subscription	No of subscription	9307.5					
	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	Duration
Advertisement	Revenue per station per month	15000	Yearly
	Revenue per bicycle per month	100	Yearly
Sponsorship	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 crore)

	Option I (Smart Bike)		Option II (Automated Docks)	
Item	2016	2017	2016	2017
Bicycle cost	165000000	0	79200000	0
Dock cost	35640000	0	222750000	0
Terminal	5850000	0	42120000	0
Small stations	64800000	0	97200000	0
Large stations	86400000	0	129600000	0
Call and Operational Control Centre	5000000	0	5000000	0
Design consultancy for (one time)	3000000	0	3000000	0
Redistribution vehicles	0	8000000	0	8000000
Vehicles for maintenance team	0	450000	0	450000
Setting up of Depot	0	2000000	0	2000000
Total Capital Expenditure (Rs.)	365690000	10450000	578870000	10450000
Total Capital Expenditure (Rs. in crores)	**36.5**	**1.0**	**57.9**	**1.0**

8.5.2 Operational Cost

Table 28 Estimated operational cost (Rs. in crore)

Sl.no.	Particulars	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	Manpower cost	-	255,60,000	272,11,176	280,11,696	298,21,251	317,47,704	337,98,606	359,81,996	383,06,432	407,81,028	434,15,482
2	Spare part (bicycle & stations)	-	122,40,000	-	-	-	-	130,30,704	-	-	-	-
3	Fuel cost for redistribution	-	120,00,000	127,75,200	127,75,200	136,00,478	144,79,069	154,14,417	164,10,188	174,70,286	185,98,867	198,00,353
4	IT maintenance	-	10,00,000	10,64,600	11,33,373	12,06,589	12,84,535	13,67,516	14,55,857	15,49,906	16,50,029	17,56,621
5	Smart card	-	50,00,000	53,23,000	56,66,866	60,32,945	64,22,674	68,37,578	72,79,286	77,49,528	82,50,147	87,83,107
6	Insurance	-	72,00,400	76,65,546	81,09,384	86,33,250	91,90,958	97,84,694	104,16,785	110,89,710	118,06,105	125,68,779
7	Miscellaneous	-	348,60,295	344,73,829	347,44,795	369,57,009	393,12,132	444,25,536	444,88,629	473,30,294	503,55,531	535,76,198
	Total Operational Cost Rs. In crore	**-**	**10**	**9**	**9**	**10**	**10**	**12**	**12**	**12**	**13**	**14**

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 (Rs. in crore)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
No. of parking available (ECS)	0	544	640	640	1920	3520	5120	6720	6720	6720	6720
Parking charges per hour(Rs.)	0	20	20	20	21	22	23	24	26	27	28
Parking charges per day(Rs.)	0	160	160	160	168	176	185	194	204	214	225
Total Parking Revenue per day (Rs.)	0	87040	102400	102400	322560	620928	948326	1306912	1372258	1440871	1512914
Total Parking Revenue per year(Rs.)	0	31769600	37376000	37376000	117734400	226638720	346139136	477022997	500874147	525917854	552213747
Total Parking Revenue(Rs. in crores)	**0**	**3**	**4**	**4**	**12**	**23**	**35**	**48**	**50**	**53**	**55**

Table 30 Estimated User fee and Subscription Revenue (Rs. in crore)

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
No. of Trips	For First hour	0	3350700	3853305	4431301	4874431	5361874	5898061	6487867	7136654	7493487	7868161
	Second half hour	0	1675350	1926653	2215650	2437215	2680937	2949031	3243934	3568327	3746743	3934081
	Third half hour	0	558450	642218	738550	812405	893646	983010	1081311	1189442	1248914	1311360
	No. of Subscription	0	9308	18615	37230	55845	83768	125651	188477	282715	310987	342086
Trip Charges	For first half hour users(Rs.)	0	0	0	0	0	0	0	0	0	0	0
	For second half hour users(Rs.)	0	10	11	11	12	13	14	15	15	17	18
	For third half hour users(Rs.)	0	15	16	17	18	19	21	22	23	25	26
User Subscription	Subscription Fee(Rs.)	0	250	266	283	302	321	342	364	387	413	439
Total Fee	Trips(For first	0	0	0	0	0	0	0	0	0	0	0

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Calculation	hour)(Rs.)											
	Trips(Second half hour)(Rs.)	0	16753500	20511143	25111587	29407175	34437566	40328456	47227042	55305699	61822370	69106900
	Trips(Third half hour)(Rs.)	0	8376750	10255571	12555793	14703587	17218783	20164228	23613521	27652850	30911185	34553450
	User Subscription fee(Rs.)	0	2326875	4954382	10548871	16845492	26900566	42957513	68598853	109545508	128284362	150228685
	Total Revenue from user fee (in Rs.)	0	27457125	35721096	48216251	60956254	78556915	103450197	139439415	192504057	221017917	253889035
	Total Revenue from user fee (Rs. in crores)	**0**	**3**	**4**	**5**	**6**	**8**	**10**	**14**	**19**	**22**	**25**

Estimated User fee and subscription revenue

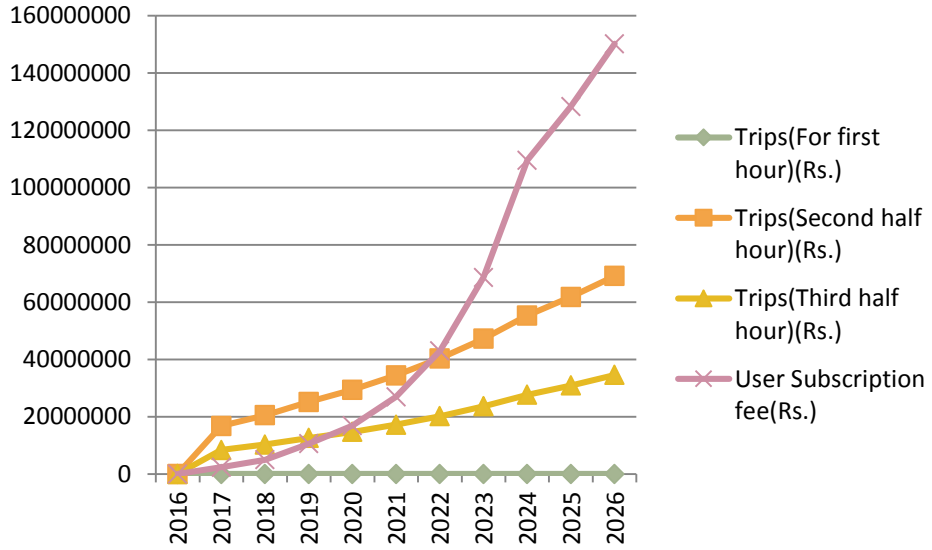

Figure 62 Revenue Generation Trend of User Fee and Subscription Fee, 2015-2025, SDMC PBS

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. (Refer Figure 62)

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.

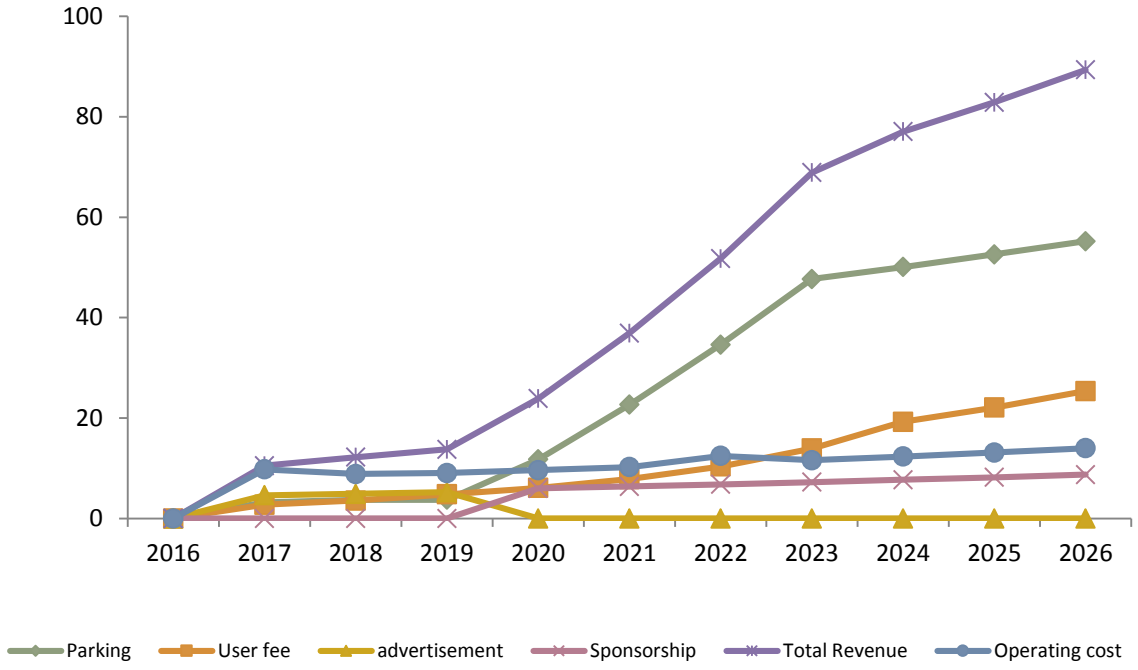

Figure 63 Revenue distribution vs operating cost, 2016-2016

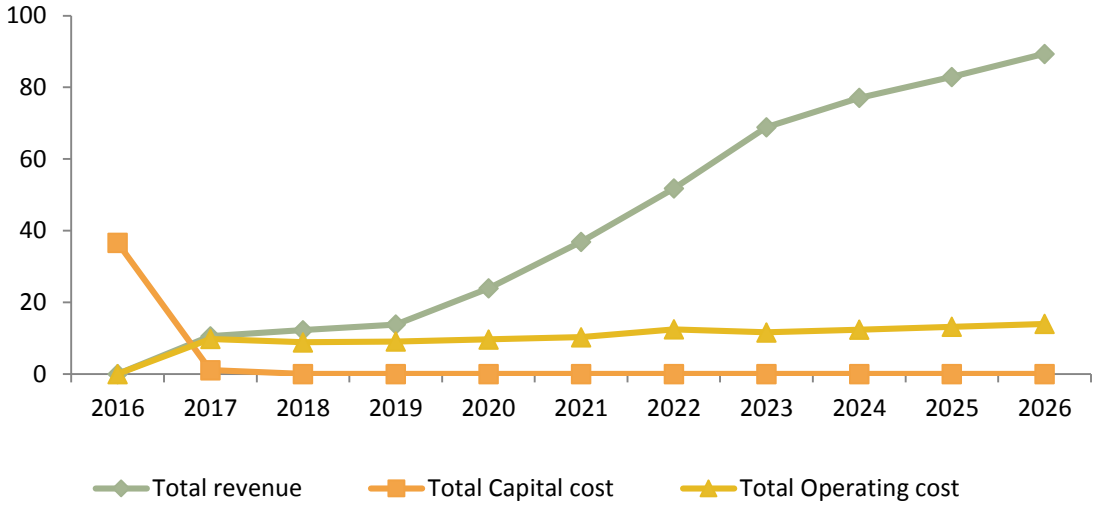

Figure 64 Operating cost, capital cost vs revenue earned, 2016-2026

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. Capital cost incurred one time in the first year of implementation. (Refer Figure 63 and Figure 64)

Estimated Advertising rights and revenues

Table 31: Estimated Advertisement Revenue (Rs. in crore)

	2016	2017	2018	2019
Revenue from advertisement on stations(Rs.)	0	42120000	44840952	47737677
Revenue from advertisement on bicycles(Rs.)	0	3960000	4215816	4488158
Total Advertisement revenue(Rs.)	0	46080000	49056768	52225835
Total Advertisement revenue(Rs. in crores)	**0**	**5**	**5**	**5**

Estimated Sponsorship Revenue

Table 32: Estimated Sponsorship Revenue (Rs. in crore)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Revenue from sponsorship on stations, bicycles, smart cards, website, kiosk etc.(Rs.)	0	0	0	0	60000000	63876000	68002390	72395344	77072083	82050940	87351430
Total Sponsorship revenue(Rs.)	0	0	0	0	60000000	63876000	68002390	72395344	77072083	82050940	87351430
Total Sponsorship revenue(Rs. in crores)	**0**	**0**	**0**	**0**	**6**	**6**	**7**	**7**	**8**	**8**	**9**

8.5.4 Cash Flow and Income expenditure

Table 33Income Expenditure of PBS year 2016-26(Rs. in crore)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Total expenditure	0.0	13.5	12.6	12.8	13.4	14.0	16.2	15.4	16.1	16.9	17.8
Total revenue	0.0	10.5	12.2	13.8	23.9	36.9	51.8	68.9	77.0	82.9	89.3
EBITA	0.0	-3.0	-0.4	1.0	10.5	22.9	35.5	53.5	60.9	66.0	71.6
TAX	0.0	0.0	0.0	0.3	3.5	7.7	12.0	18.0	20.5	22.2	24.1
earning after tax	0.0	-3.0	-0.4	**0.6**	**7.0**	**15.2**	**23.6**	**35.5**	**40.4**	**43.8**	**47.5**

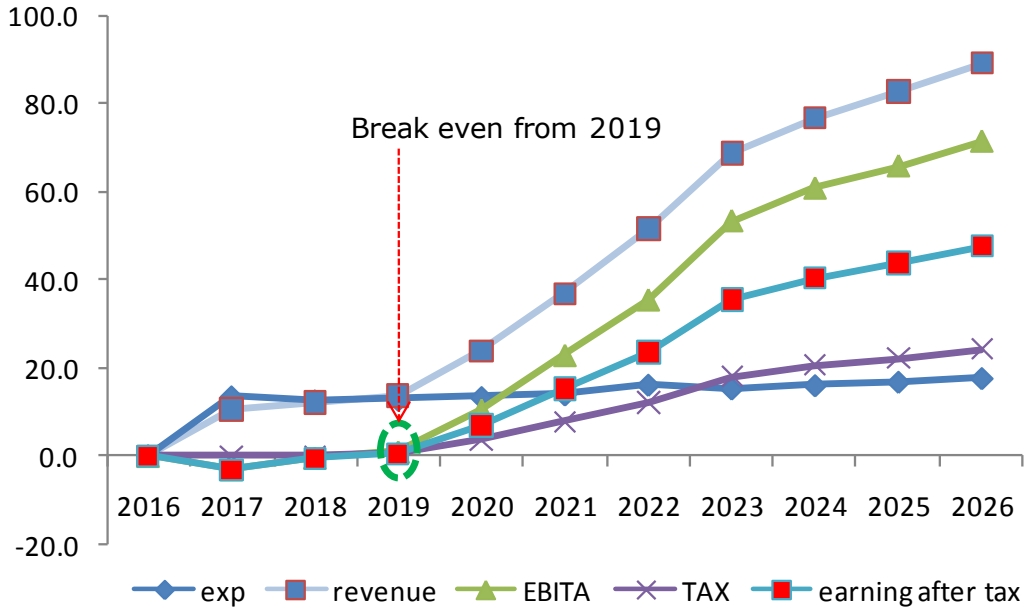

Figure 65 Cash flow and income expenditure

The Income expenditure statement includes total expenditure, the tax, EBITA, and the earnings after tax deduction. Total expenditure includes operating cost. EBITA refers to company's earnings before the deduction of interest, taxes and amortization expenses. Earning of the tax is the difference between EBITA and tax paid. The break-even period is 4 year i.e. in 2019 when the earnings after tax deduction becomes positive and hence after the earning grows steadily. (Refer Figure 65)

Calculation of cash flow and income expenditure has tax component which is 34%.

Calculation of cash flow and income expenditure has tax component, which is 34%.

Table 34 Cash Flow of PBS, year 2016-26 (Rs in crore)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Total expenditure	36.57	10.83	8.85	9.37	13.15	17.95	24.43	29.62	32.86	35.36	38.09
Total revenue	0.00	10.53	12.22	13.78	23.87	36.91	51.76	68.89	77.05	82.90	89.35
net cash flow	-36.57	-0.30	3.36	4.41	10.72	18.95	27.33	39.27	44.19	47.54	51.26
opening balance	0.0	-36.6	-36.9	-33.5	-29.1	-18.4	0.6	27.9	67.2	111.4	158.9
closing balance	-36.57	-36.87	-33.51	-29.10	-18.38	**0.57**	**27.91**	**67.17**	**111.36**	**158.90**	**210.16**

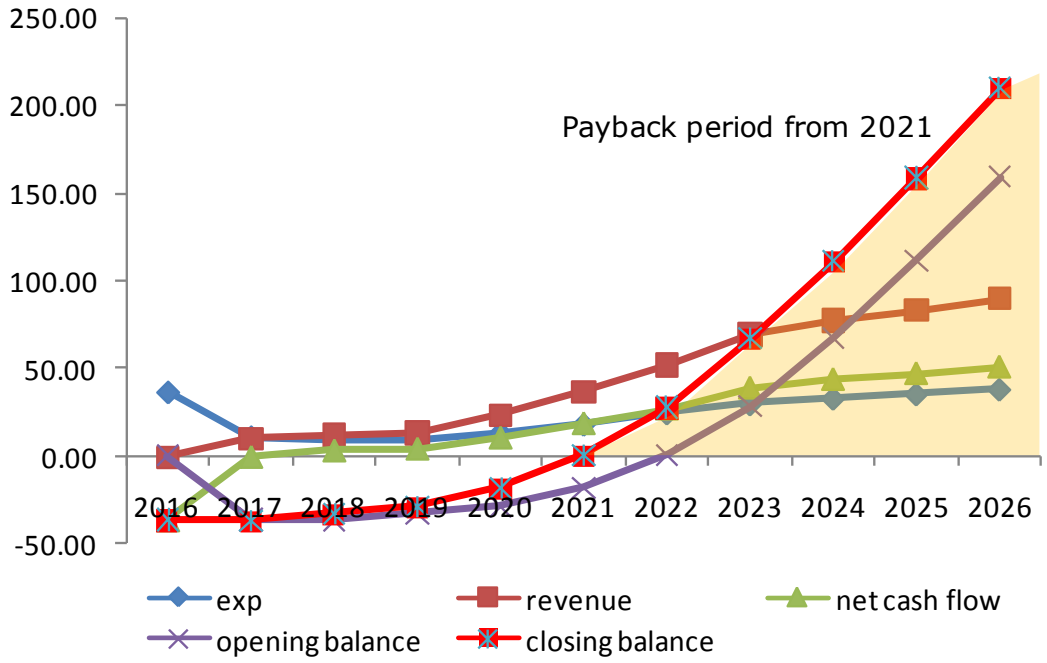

Figure 66: Cash Flow and Income Expenditure graph, 2016-2026

The cashflow shows the total expenditure versus revenue earned, net cashflow, opening ands closing balance. The total expenditure in cash flow is the sum of capital cost and operating cost. Net cash flow is the difference of total expenditure and revenue earned. Opening balance is the intial financial status after starting the system, and closing balance is the difference between the reveneue expenditure and previous years opening balance. The closing balance becomes positive from the year 2021, stating year after 2021 is the payback period. (Refer Figure 66)

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 Study area 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 SDMC 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).

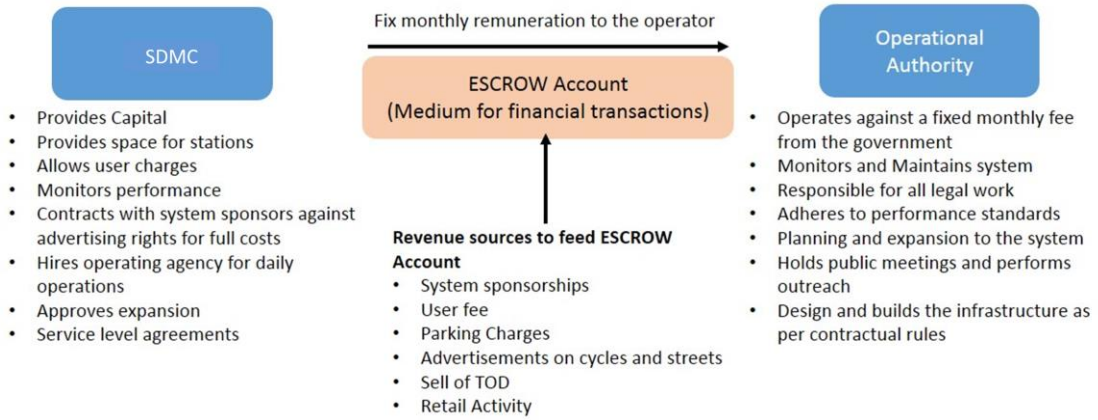

Figure 67 Proposed operation model, SDMC PBS

The PBS Governance structure should be composed of:

8.6.1.1 South Delhi Municipal Corporation (SDMC)

SDMC 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 SDMC. 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 SDMC 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 SDMC officials. There are three major components of operational model (refer Figure 67 Proposed operation model, SDMC PBS).

8.6.1.3 Transit Authority/SPV

SDMC 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

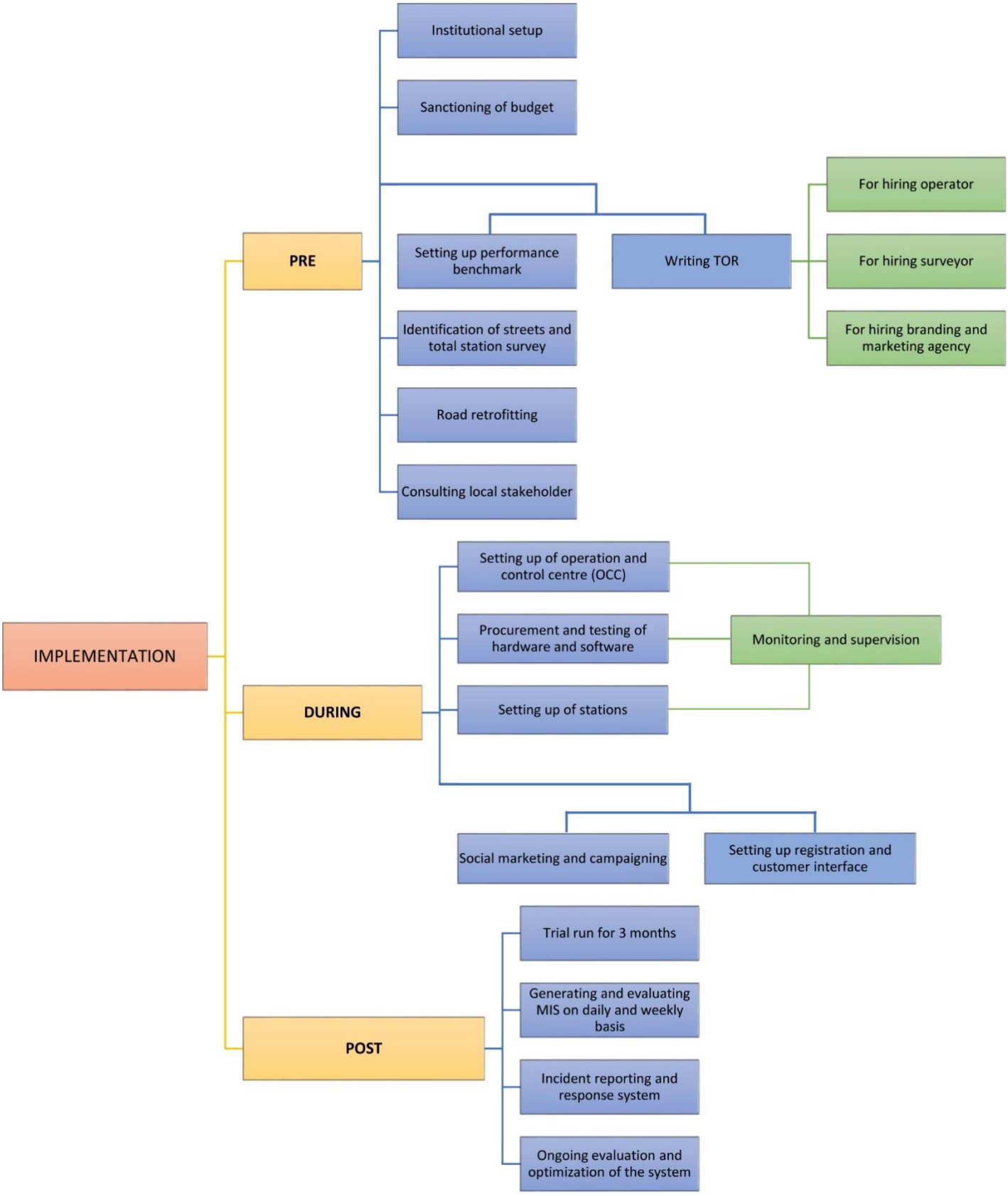

Figure 68 PBS Implementation flow chart

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 study area will require extensive consultations and meticulous planning of all the small and major tasks that need to be carried out. SDMC experts and stakeholders will have to formulate team with their roles and responsibilities and gear them up for the extensive process of implementation. The process will be carried out in three stages (Refer Figure 68).

- Pre Implementation
- During Implementation, and
- Post Implementation

9.1 Pre Implementation

9.1.1 Institutional setup

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 PBS and also gets its own PBS policies. SDMC can also adopt similar structure. 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. 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

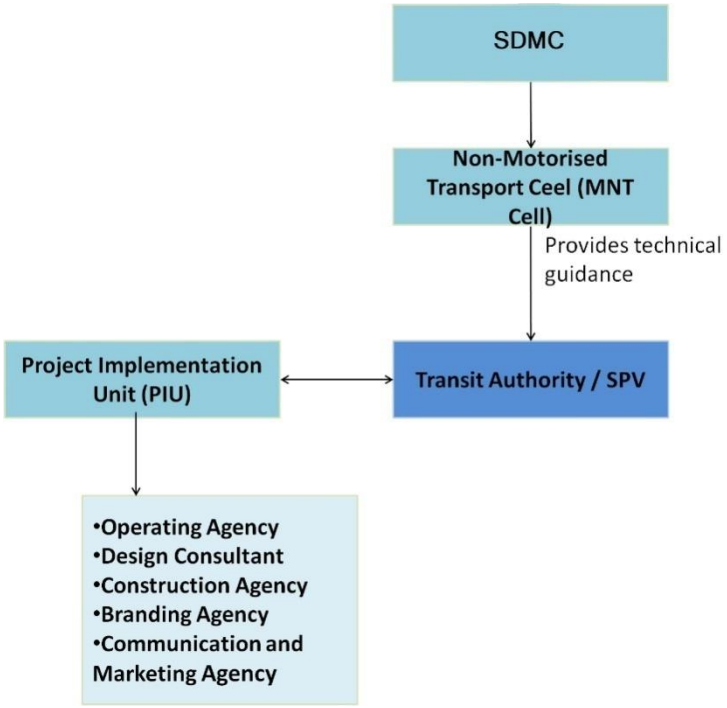

Figure 69 Structure of PBS authorities

9.1.2 Setting up performance benchmark

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

9.1.3 Writing TOR

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.

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.

9.1.4 Consulting local stakeholder

Consultation at various stage and with various stakeholders helps to make the planning process transparent, inclusive, well targeted and coherent. At this stage, consultation with the operator and equipment manufacturers is required to discuss the following.

- Consult with the operators and gather information on general feedback on PBS operation.
- Consult and start collecting data on available technology and equipment to know system capabilities.

All the consultation process involves government's participation and it is recommended to include the top level consultants for the decision making.

9.2 During Implementation

During implementation the first action is to set up operation and control centre or OCC (Refer chapter 6- Information technology and operations) followed by procurement and testing of hardware and softwareand monitoring and supervising the system operation. This stage of implementation also requires setting up of station (Refer Section 7.2-Station specification), and branding the system to create awareness about the system and help the citizen relate and adopt the new transportation mode.

9.2.1 Procurement, installation and testing of hardware

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.

9.2.2 Social marketing and campaigning

The marketing strategy for PBS should identify each of the appropriate medium of communication, such as direct out-reach, print, radio, television, hoardings- a means to propagate the system's message.

Strategies should be tailored for the target groups- which include the walk trips, private mode trips, IPT trips and existing public transport users. A well planned system can also fail if the system is not marketed well and the benefits of the system not communicated to the users.

Three key aspects to be considered while preparing a marketing strategy are:

- Selecting a system name which is catchy and reflects the aspirations of the community
- Designing a system logo and slogan that is easily identifiable and readable at various scales
- Carrying out a smart outreach campaign to reach out to a variety of users.

Branding is central to creating an identity for the study area's 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.

- **Branding- Name Logo and Tag line**

Study area's 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 losing 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 study area will be

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

It will function as a unique identity, and through colours, 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 by 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 71 PBS Brands and Logos

- **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 study area's 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 72: Boris Johnson and Arnold Schwarzenegger participating in inauguration of Barclay Bicycle Hire, Popularized as “Boris Bicycle”. (Décor & Style 2014)

Figure 73 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

Appendex A

Matrix for PBS phasing, based on parameters (Chapter no. 6.4)

TAZ	Population density	Trip production	Trip attraction	Traffic generating activities	Proximity to metro	Sum	Category
15501	3	3	3	2	2	13	High
15502	3	3	3	2	3	14	High
15503	3	3	3	2	3	14	High
15504	3	2	2	2	3	12	Moderate
15601	3	3	3	2	3	14	High
15602	3	3	3	3	2	14	High
15603	3	3	3	2	2	13	High
15701	3	2	2	2	3	12	Moderate
15702	3	1	2	3	3	12	Moderate
15703	3	3	3	3	3	15	High
15704	1	1	1	2	3	8	Low
15705	3	2	2	1	3	11	Moderate
15706	3	2	2	2	3	12	Moderate
15801	3	3	3	2	3	14	High
15802	3	3	3	1	3	13	High
15803	3	3	2	3	3	14	High
15804	3	2	1	2	3	11	Moderate
15901	3	3	3	3	3	15	High
15902	3	2	3	3	3	14	High
15903	3	2	2	2	3	12	Moderate
15904	3	2	2	3	3	13	High
15905	3	2	3	2	3	13	High
15906	3	2	2	3	3	13	High
15908	3	1	2	2	3	11	Moderate
16001	3	2	2	2	3	12	Moderate
16002	3	2	3	3	3	14	High
16003	3	3	2	3	3	14	High
16004	3	2	2	2	3	12	Moderate
16005	3	2	3	2	3	13	High
16101	3	2	1	2	3	11	Moderate
16102	3	2	2	3	3	13	High
16103	1	1	1	1	3	7	Low
16104	3	2	2	2	3	12	Moderate
16105	3	2	2	1	3	11	Moderate
16106	3	2	2	1	2	10	Moderate
16107	3	2	2	2	2	11	Moderate
16108	3	2	1	2	2	10	Moderate
16109	3	2	2	2	3	12	Moderate
16110	3	1	1	1	2	8	Low
16111	3	1	1	1	2	8	Low
16112	3	2	2	2	3	12	Moderate
16113	3	1	1	1	2	8	Low
16114	3	2	2	2	2	11	Moderate
16115	1	1	1	2	2	7	Low
16116	3	2	2	2	3	12	Moderate
16201	1	1	2	1	3	8	Low
16202	3	2	3	2	3	13	High
16203	3	2	2	2	3	12	Moderate

TAZ	Population density	Trip production	Trip attraction	Traffic generating activities	Proximity to metro	Sum	Category
16204	3	2	2	1	3	11	Moderate
16205	3	2	2	2	3	12	Moderate
16206	3	2	2	1	3	11	Moderate
16207	3	2	1	1	3	10	Moderate
16301	3	1	2	1	3	10	Moderate
16302	3	3	2	2	3	13	High
16303	3	3	3	3	3	15	High
16304	1	1	1	2	2	7	Low
16305	3	3	3	3	3	15	High
16306	3	2	2	2	3	12	Moderate
16401	3	2	2	2	3	12	Moderate
16402	3	2	2	2	3	12	Moderate
16403	3	2	2	2	3	12	Moderate
16404	3	2	2	1	3	11	Moderate
16405	3	3	3	2	3	14	High
16406	3	2	2	1	3	11	Moderate
16407	3	2	2	2	3	12	Moderate
16902	3	1	1	2	3	10	Moderate
16903	1	1	1	1	3	7	Low
16904	3	2	2	3	3	13	High
16905	3	1	1	2	3	10	Moderate
16906	1	1	1	2	3	8	Low
16908	3	2	3	2	3	13	High
16909	3	3	3	3	3	15	High
16910	3	3	3	3	3	15	High
16911	1	1	1	2	3	8	Low
16913	3	2	2	2	3	12	Moderate
16914	1	1	1	1	3	7	Low
16915	1	1	1	1	2	6	Low
17001	1	1	2	3	3	10	Moderate
17002	3	2	2	1	3	11	Moderate
17003	3	2	1	1	3	10	Moderate
17004	3	2	2	1	3	11	Moderate
17005	3	3	3	2	3	14	High
17201	3	1	2	1	1	8	Low
17202	3	1	1	1	2	8	Low
17203	3	1	1	1	1	7	Low
17204	3	2	2	1	1	9	Moderate
17205	3	1	1	1	1	7	Low
17206	3	1	1	1	1	7	Low
17207	3	2	1	1	1	8	Low
17208	3	1	1	1	2	8	Low
17209	3	1	1	1	1	7	Low
17210	3	2	1	1	1	8	Low
17211	3	2	2	1	3	11	Moderate
17212	2	2	2	3	3	12	Moderate
17213	3	3	2	3	2	13	High
17215	1	1	1	1	2	6	Low
17223	3	2	2	1	1	9	Moderate
17227	3	2	3	1	2	11	Moderate
17228	3	2	1	1	2	9	Moderate
17301	3	2	2	2	3	12	Moderate
17302	3	2	3	2	3	13	High

TAZ	Population density	Trip production	Trip attraction	Traffic generating activities	Proximity to metro	Sum	Category
17303	3	2	2	1	1	9	Moderate
17304	3	2	2	1	2	10	Moderate
17305	3	1	1	1	1	7	Low
17306	3	2	2	1	1	9	Moderate
17307	3	2	2	1	2	10	Moderate
17308	3	2	2	1	2	10	Moderate
17309	1	1	1	2	3	8	Low
17310	1	1	1	2	3	8	Low
17311	3	3	2	3	2	13	High
17312	1	1	1	1	1	5	Low
17313	3	1	1	1	2	8	Low
17314	3	1	1	1	1	7	Low
17401	3	2	2	1	3	11	Moderate
17402	3	1	1	1	3	9	Moderate
17403	3	1	1	1	3	9	Moderate
17404	3	2	2	1	3	11	Moderate
17405	3	2	3	1	3	12	Moderate
17406	3	2	3	1	3	12	Moderate
17407	3	2	1	1	3	10	Moderate
17408	3	2	2	1	3	11	Moderate
17409	3	2	2	1	3	11	Moderate
17410	3	2	2	1	3	11	Moderate
17411	3	2	3	2	3	13	High
17412	3	2	2	1	3	11	Moderate
17413	3	2	1	2	3	11	Moderate
17414	3	2	2	1	3	11	Moderate
17415	3	2	1	1	3	10	Moderate
17416	1	1	1	2	3	8	Low
17417	3	1	1	1	2	8	Low
17418	3	1	1	1	2	8	Low
17419	1	1	1	1	3	7	Low
17420	1	1	1	1	3	7	Low
17421	3	2	1	1	2	9	Moderate
17422	1	1	1	1	3	7	Low
17423	3	3	2	2	3	13	High
18101	3	3	2	1	2	11	Moderate
18103	3	1	1	3	2	10	Moderate
18104	3	3	3	3	1	13	High
18401	3	3	3	1	2	12	Moderate
18402	3	2	2	1	2	10	Moderate
18403	3	2	2	2	2	11	Moderate
18404	3	2	3	1	2	11	Moderate
18405	3	2	2	2	2	11	Moderate
18406	3	1	2	1	2	9	Moderate
18407	3	2	3	2	2	12	Moderate
18408	3	2	2	3	2	12	Moderate
18901	3	1	1	2	2	9	Moderate
18902	3	1	1	2	2	9	Moderate
18903	1	1	1	1	2	6	Low
18904	3	3	2	1	2	11	Moderate
18905	1	1	1	1	2	6	Low
18906	3	1	1	2	2	9	Moderate
18907	3	1	1	2	2	9	Moderate

TAZ	Population density	Trip production	Trip attraction	Traffic generating activities	Proximity to metro	Sum	Category
19101	3	2	2	1	3	11	Moderate
19102	1	1	1	1	2	6	Low
19103	1	1	1	1	2	6	Low
19104	3	2	2	2	2	11	Moderate
19105	3	3	2	1	2	11	Moderate
19106	1	1	1	2	2	7	Low
19107	3	1	1	2	2	9	Moderate
19108	3	1	1	2	2	9	Moderate
19109	3	2	2	2	3	12	Moderate
19110	3	3	3	2	3	14	High
19111	3	1	2	2	3	11	Moderate
19112	1	1	1	2	3	8	Low
19113	3	2	2	1	2	10	Moderate
19114	1	1	1	3	2	8	Low
19115	3	2	2	2	3	12	Moderate
19201	3	2	2	2	3	12	Moderate
19202	3	3	3	3	3	15	High
19203	3	2	3	3	3	14	High
19204	3	2	2	2	3	12	Moderate
19205	3	1	1	2	3	10	Moderate
19206	1	1	1	1	3	7	Low
19207	3	2	2	1	3	11	Moderate
19208	3	2	2	1	3	11	Moderate
19209	3	1	1	1	3	9	Moderate
19210	1	1	1	2	3	8	Low