



Planning of Public Bicycle (Bike) Sharing System (PBSS): A Case Study of Surat City

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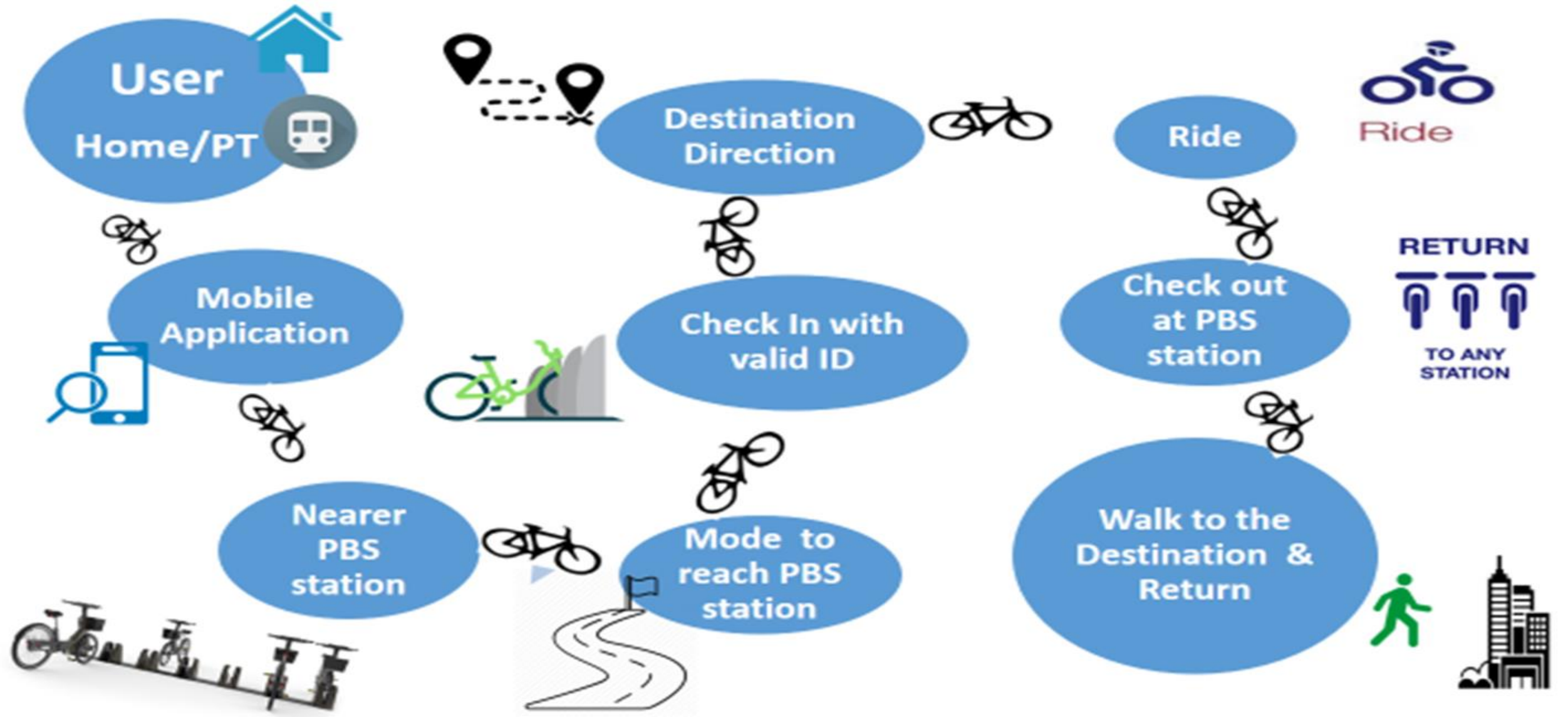
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Presentation Outline

- Concept of PBSS
- Literature review
- Study area characteristics
- Survey Analysis for Central Zone
- Survey Analysis for BRTS corridor
- PBSS system Phasing criteria
- Station Locations : I – CBD, II- BRTS
- Conclusion
- Suggestion and Discussions
- References

CONCEPT



- Public Bicycle Sharing (PBS) is a **high quality bicycle based public transport system**
 - A user checks-out the bicycle from one location, rides to destination, and drops the bicycle to another location.
 - The operators coordinate the redistribution of bicycles and ensure availability of cycles at locations with the highest demand at any given time.
- Include:
 - Bicycles;
 - Key locations;
 - Closely spaced network of stations;
 - Tracking of bicycles;
 - Allows short-term shared use of bicycles.

LITERATURE REVIEW



- The methodological guide to designed bicycle-sharing in Spain differentiates based on the *size of city, density of the city and the type of loan system* (IDAE, 2007).
- Most favourable location tools known as location-allocation models have been implemented in a GIS background by García-Palomares et al., (2012) which may be of enormous apply to locating potential bicycle stations with relation to the *distribution of potential demand*.
- The study by Lin and Yang, (2011) considering the interests of both users and investors.
- Output of the proposed model determine *the number and locations of bike stations, the optimal requirement of bike paths connected between the pair of origins and destinations*.
- Frade and Ribeiro, (2015) attempt planning of PBSS using an optimization method in such that it maximizes the *demand covered and takes the available budget as a constraint*.
- Hub-location inventory model which is popularly known as a Hub-spoke location model, has been enacted by Lin et al., (2013) and the number of cycling stations, places of bicycle stations, bicycle lanes and cycle path between origin and destinations, etc. have been taken as the main design decisions.

GLOBAL SCENARIO OF PBSS

- ✓ Globally around 600 cities have 370 public bike sharing programs operating with over 0.7 million bicycles at 35,698 stations in five continents and 36 countries as on 2018.

CONTINENT	NO. OF PBSS	DOCKING STATION	FLEET SIZE
Africa	1	3	30
America	74	5787	59264
Asia	84	18618	486592
Asia pacific	6	203	7776
Europe	200	11001	124329
Middle east	4	75	2000
North America	1	11	50
total	370	35698	680041

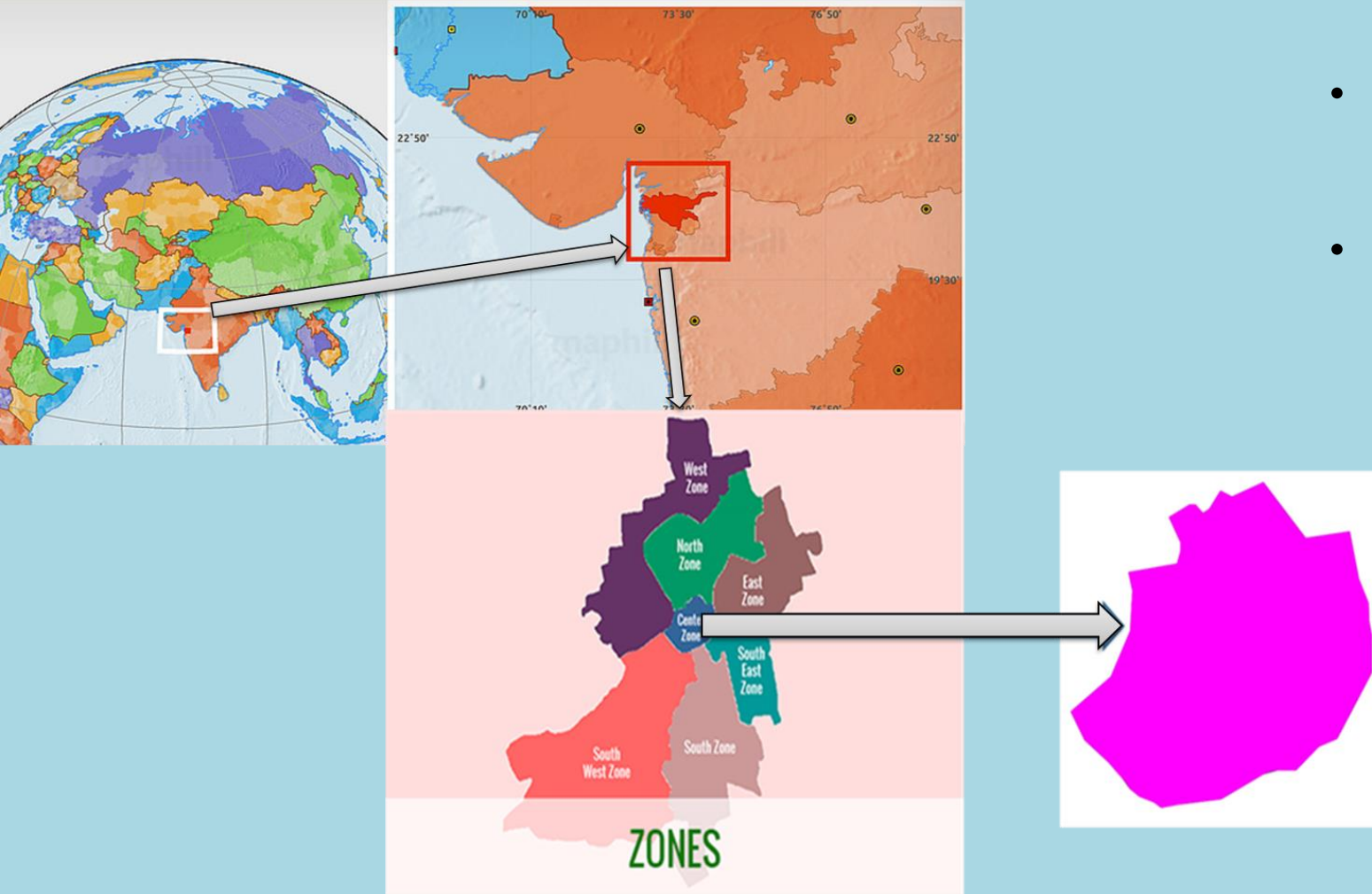
(Source: Author calculation)

PBSS DEVELOPMENT IN INDIA

CITY	FLEET SIZE	DOCKING STATION	RIDERSHIP
Mysore	450	52	2
Bhopal	500	50	1.2
Bangalore	45	9	2.5
Pune	4000	Dock less	2.5
Ranchi	1200	120	5.2

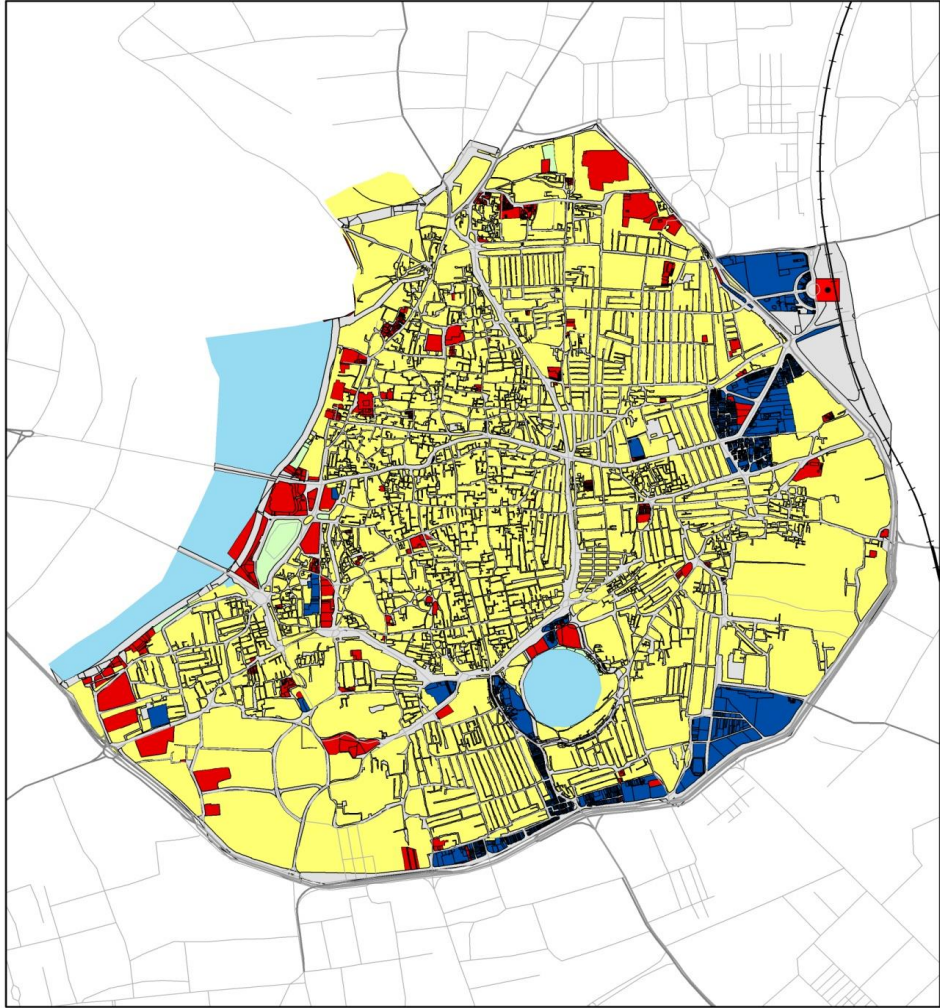
(Source: Author calculation)

STUDY AREA CHARACTERISTICS



About Surat CBD

- Central zone of Surat is the CBD area of Surat; (@ 8.18 Sq Km area), population of 4,467,797 Lacs. Density is 14000 people per sq.km.
- It has varied land-use
 - *Commercial places;*
 - *Manufacturing locations;*
 - *Residential and neighbourhood activities;*
 - *Entertainment and recreation places;*
 - *Institutional and administration offices;*
 - *Public spaces like religious places, libraries and community halls;*
 - *A large number of heritage rich locations with potential tourism attraction;*
 - *Chowk area is having organic growth, having high population density and higher FSI;*
 - *Connecting links passing from within to important locations outside of walled city.*



Land Use of CBD
(Source: Census 2011, SMC)



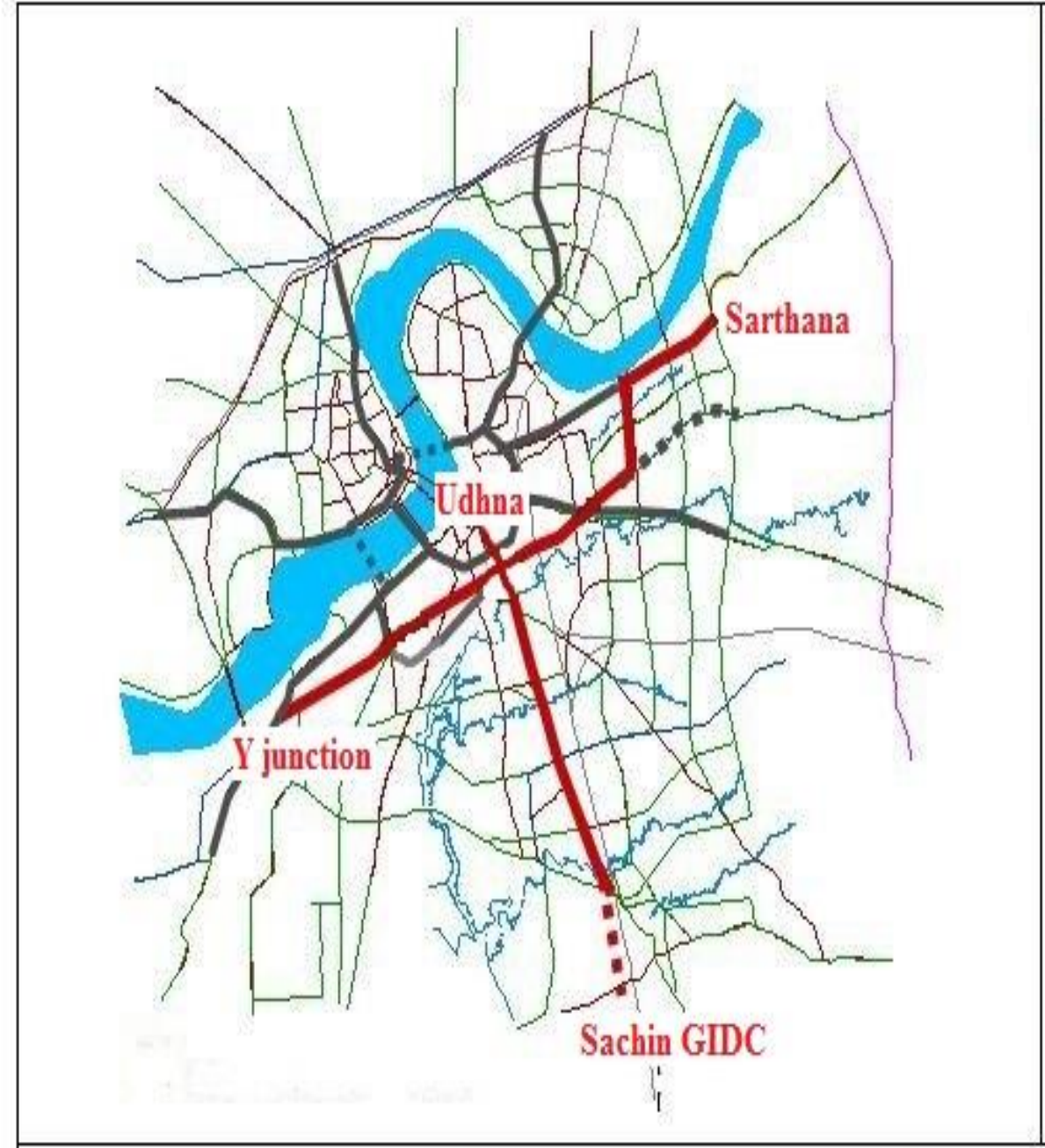
Existing major transportation nodes
(Source: Census 2011, SMC)

BRT system Phase-I consists of two corridors

Corridor 1: Surat Navsari road
[10.2 km]

Corridor 2: Magdalla – Sarthana
Nature Park [20 km]

Note: In these corridors, there are total **54** stations



Travel Behavior Study

- The team of 60 Students in 7 team collected 856 surveys.
- The survey of HH Characteristics, Socio economic character of stakeholders, O-D travel pattern of the study area etc. are analyzed and used for the PBS System Design.

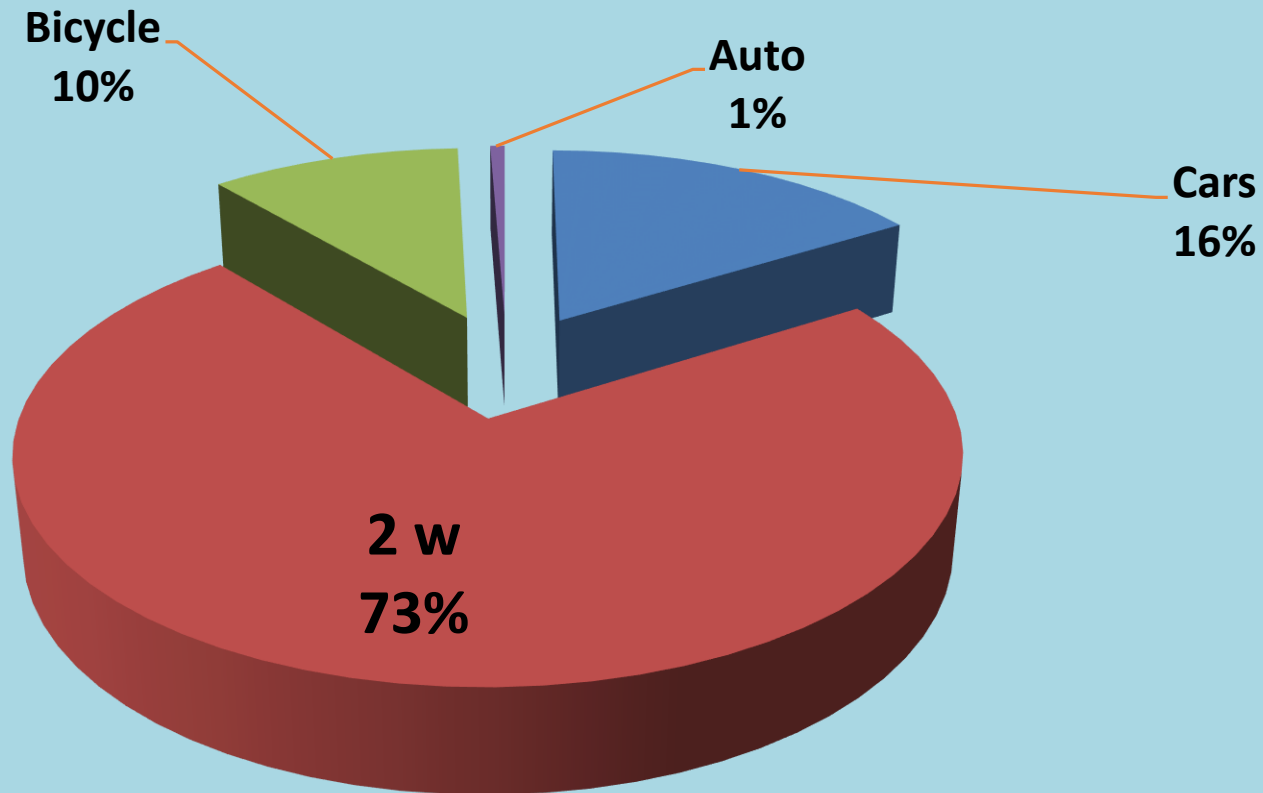
ANALYSIS OF SURVEY FOR CZ

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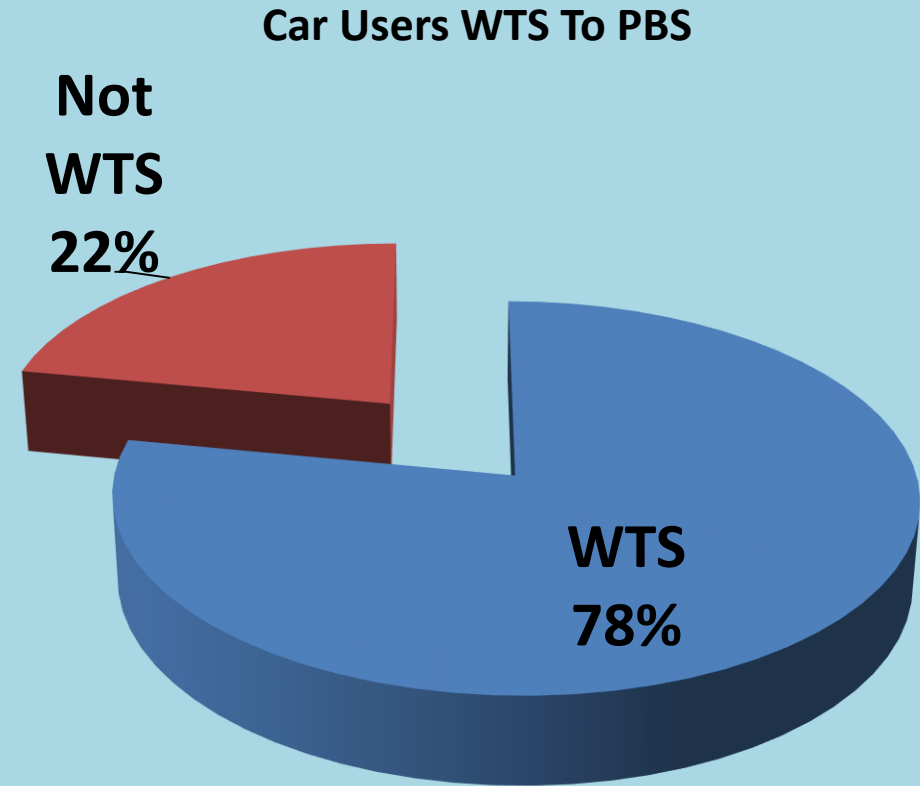
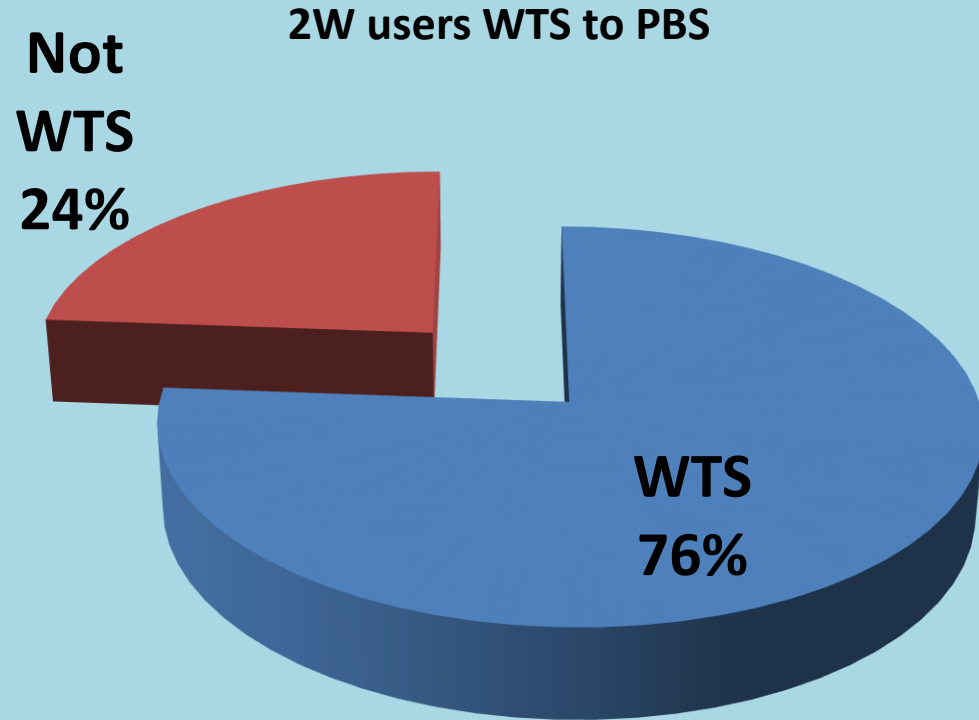


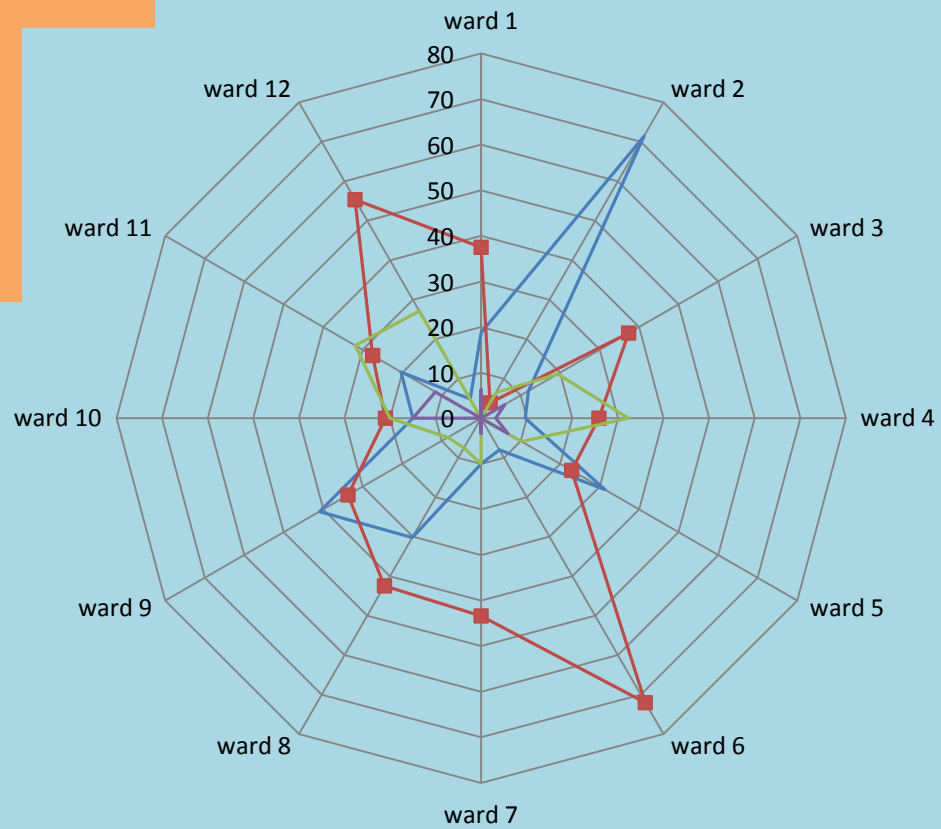
Vehicle ownership per HH

- from this data we can predict the number of different types of vehicle availability per HH in study area & as well as pattern of growth of vehicle individually.



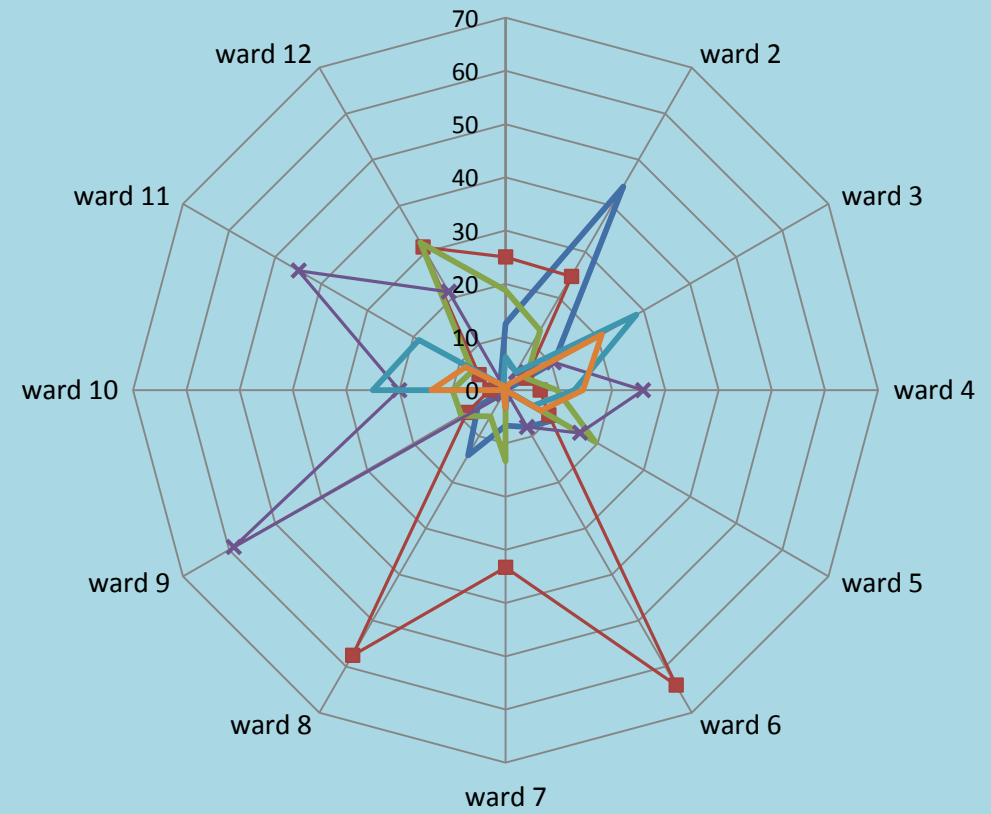
Willingness To Shift (WTS) Analysis





Walking Distance Preferred by users to reach Cycle stand

— <100 m ■ 100 to 200 — 200 to 500 — >500



Trip distance preferred with PBS system by users

— <100 ■ 100 to 500 — 500 to 1.5km × 1.5 km to 2.5km — 2.5 km to 5 km — >5 km

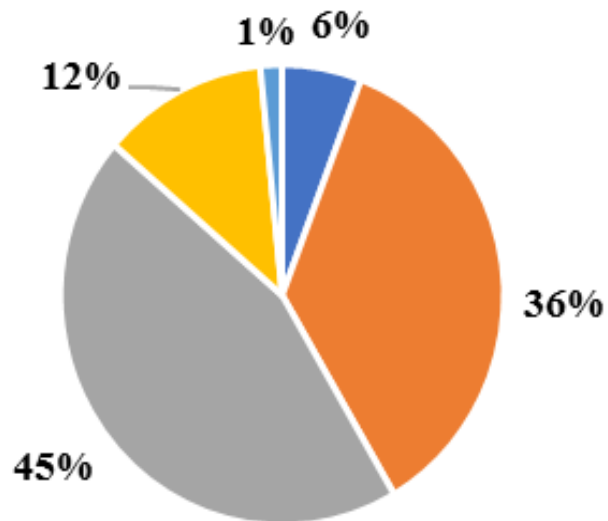
ANALYSIS FOR BRT CORRIDOR

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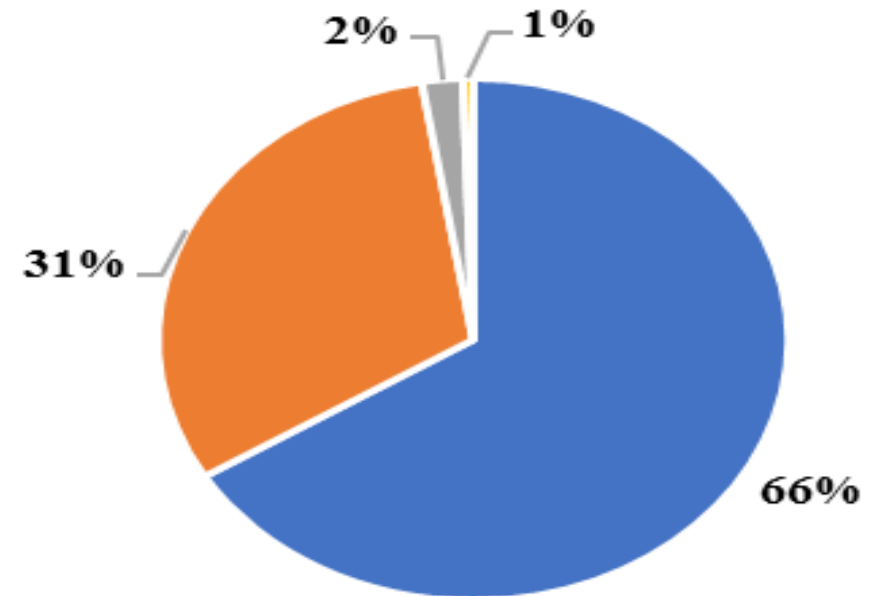
Vehicle ownership per HH

Two wheeler ownership in Respondent's Family



■ 0 two wheelers ■ 1 two wheelers ■ 2 two wheelers
■ 3 two wheelers ■ 4 two wheelers

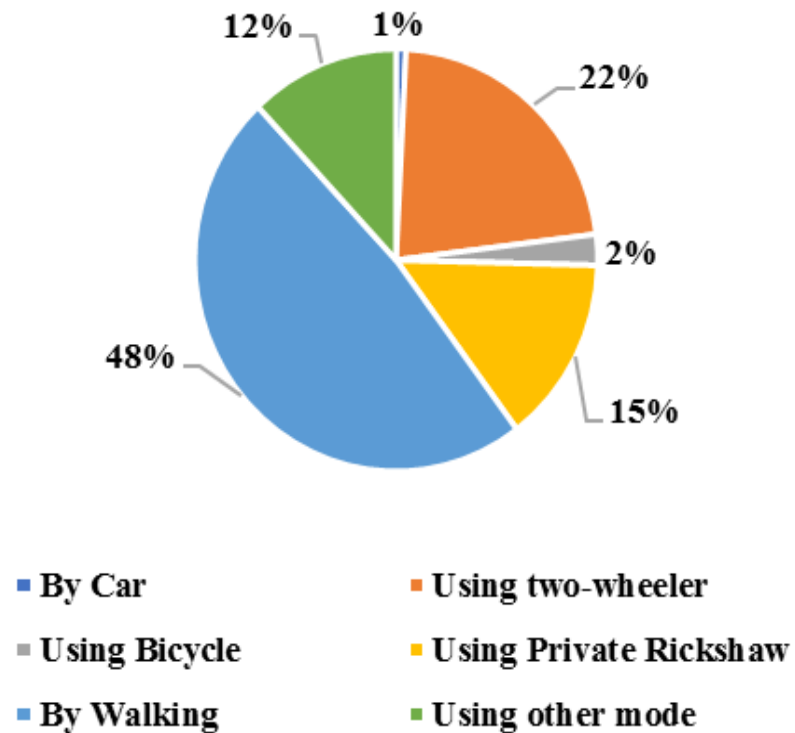
Car ownership in Respondent's Family



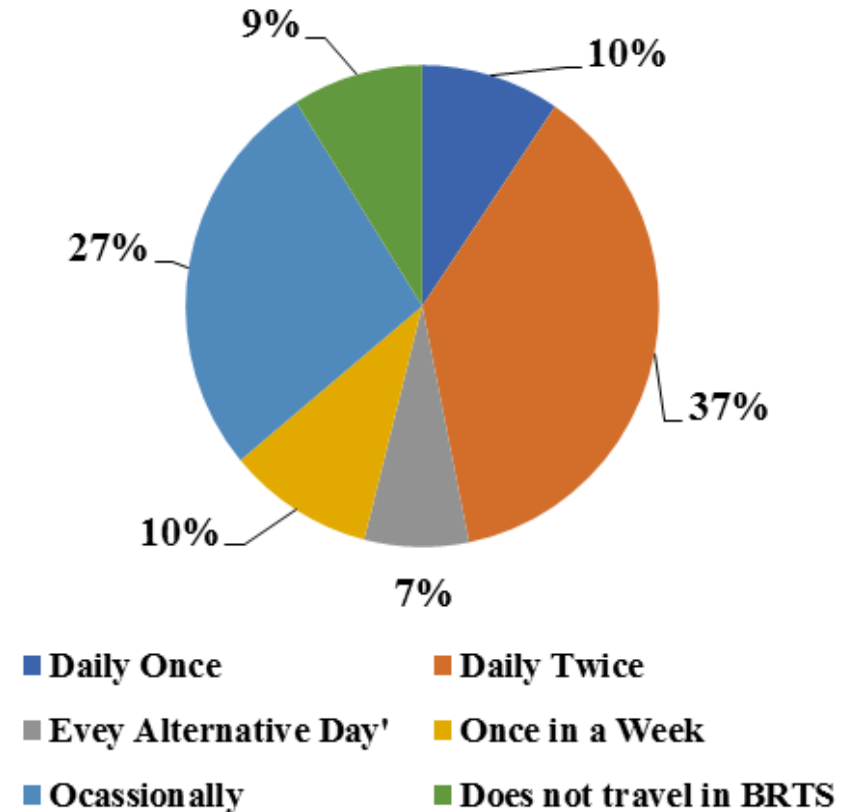
■ 0 cars ■ 1 car ■ 2 cars ■ 3 cars

Utilization of BRTS facility by respondents

Respondent reaching BRTS Station by

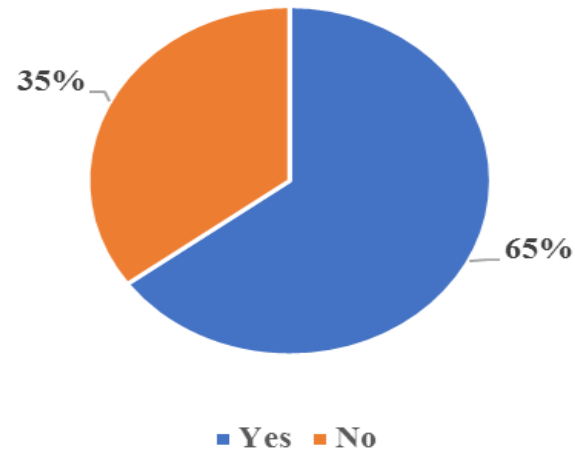


Frequency of travel in BRTS

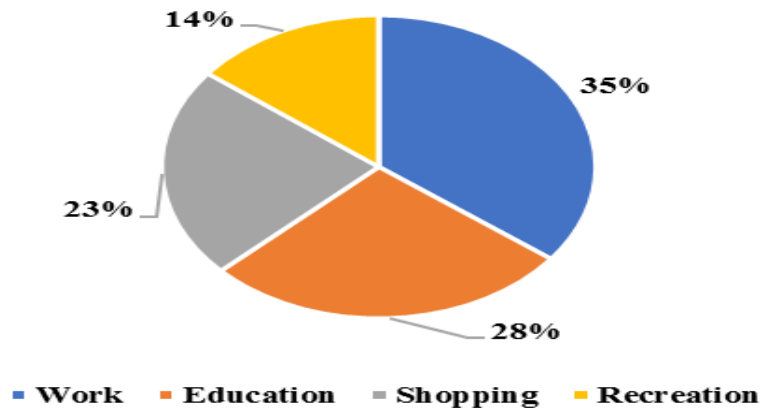


Analysis for Willingness To Use PBS

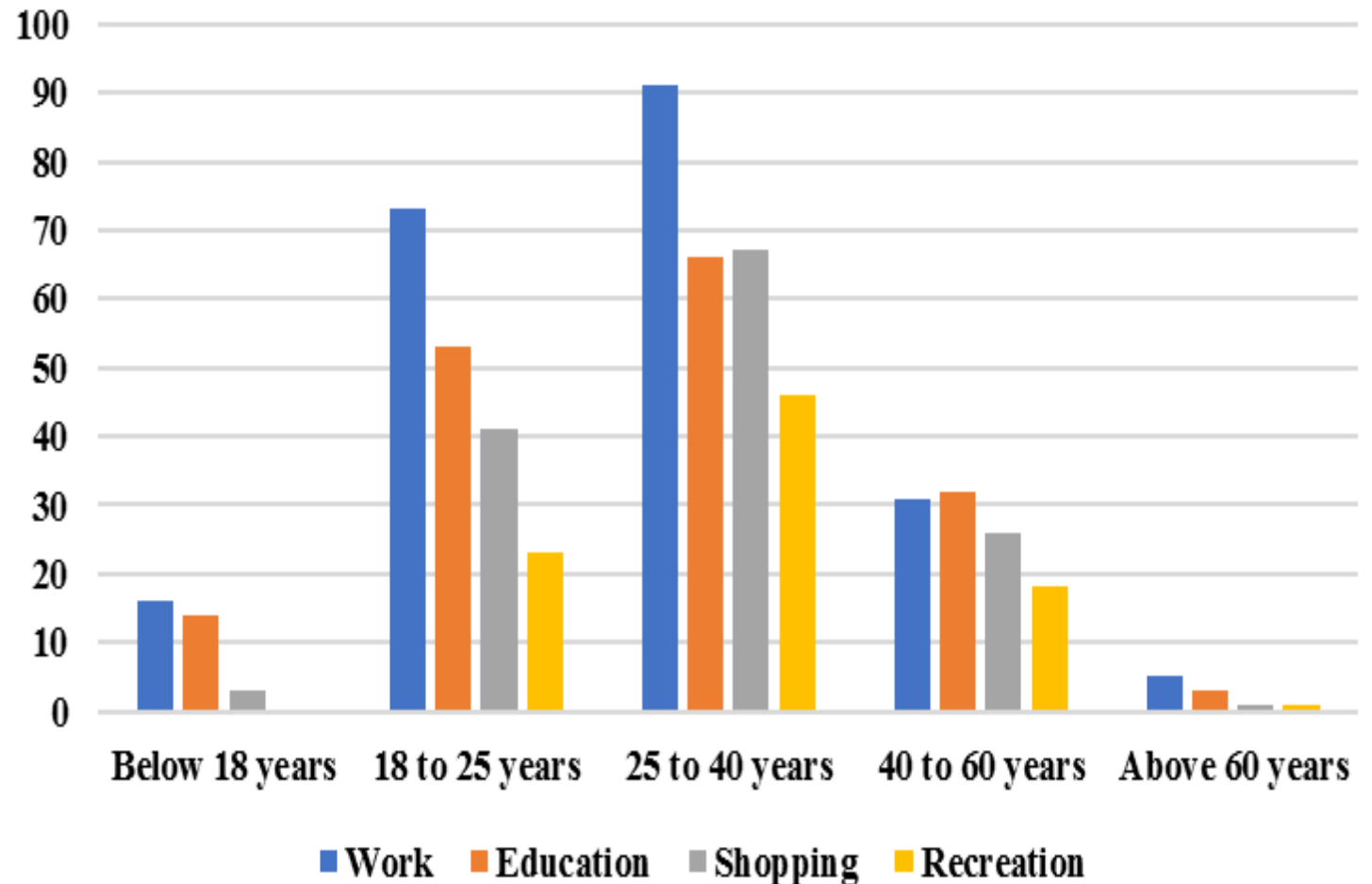
Willingness to use PBS



Williness to use PBS for various purposes



Williness to use PBS for various purposes



Demand Assessment

S.no	Assumption	Estimated Demand
1	Total Daily Trips	2,51,120
2	Total trips made by 2W and Car (90%)	1,75,784
3	Trips from (2) that are shorter than 5km (40%)	70,314
4	Peak hour demand (10% of total daily trips)	7,031
5	Catering to 70% of Full Demand	4920
6	Total Demand For Phase 1	4920

Summary of surveys

- Total 856 valid responses were received out of 1000
- Total 90% Trips are by Two Wheeler and Car
- 78% car users are willing to shift to PBSS while 76% 2-W users WTS to PBSS
- The average distance to walk for stations is 300 m and to drive cycle is 2.5 km

PBS System Phasing

I: For CBD II: For BRTS



I: For CBD

- **Overall delineation** of study area divided into various phases for PBS implementation due to technical or financial reasons.
- The PBS system phasing was derived from the analysis of density of activity nodes. Surat's proposed PBS system is divided into three phases.

Phase I is the Core inner city region, which historically has had the highest number of activity areas and population density.

Phase II includes areas with high potential for growth, mainly the core residential areas in the city

Phase III includes the rest of study area to ensure denser PBS network coverage.

PHASE I Has potential to create maximum PBS trips

Areas: Ring Road, Raj Marg, Nanpura, Railway station Lal Darwaja, Gopi Talav

POPULATION DENSITY	Very High population density. Largely covering areas with more than and equal to 600ppha
LAND USE	Includes residential population, major administrative offices like- SMC building, Main office , post office, commercial areas, market places, recreational places, educational institutes
ROAD NETWORK	Includes the Ring Road, Raj Marg , Kotsafil Road and other arterial roads along railway and bus station and within the old city.
TRAFFIC GENERATING ACTIVITY	Dense number of PT and IPT stops. Existing railway station, bus station High density of commercial, recreational, public, religious places and schools colleges & other institutions Includes Chauta pull, Gopi talav, Chowk, Bhagal, Mahidhar Pura etc.
PT & IPT	Existing PT and IPT service available High demand of ridership
Availability of Open Land for Docking Stations	Readily available Open Space, Land Under control of SMC. Multilevel Parking, below flyover.

PHASE II ➡ Include areas with high growth potential

Areas: Begaumpura, Slabatpura, Mahidharpura, Nanavat

POPULATION DENSITY	High population density. Largely covering areas with more than or equal to 500-600ppha
LAND USE	Includes largely residential areas and some industrial areas . Residential growth is observed along the major roads of Mahidharpura,
ROAD NETWORK	The major arterials like Navsari bazaar, and road towrdes city centre .
TRAFFIC GENERATING ACTIVITY	Moderate number of PT and IPT stops Moderate density of commercial, recreational, public, religious places and schools colleges & other institutions.
PT & IPT	Existing PT and IPT service available Moderate demand of ridership Includes part of proposed phase I BRTS network
Availability of Open Land for Docking Stations	Ward offices, Govt Building Schools , Urban Health Centres

PHASE III  Geographical limit, Include areas with growth potential near core residential areas of city

Areas: Rampura, Sagrampura, Timaliyawad,

POPULATION DENSITY	Moderate population density. Largely covering areas with less than 500ppha.
LAND USE	Includes mostly core residential areas and the areas not on the major arterial and sub arterial roads.
ROAD NETWORK	Other arterial roads and collector roads .
TRAFFIC GENERATING ACTIVITY	Sparse number of PT and IPT stops Low density of commercial, religious places and moderate schools colleges & other institutions .
PT & IPT	Existing PT and IPT service available Low demand of ridership Includes proposed Phase I and IIBRTS network .
Availability of Open Land for Docking Stations	Land Under control of SMC but under encroachment, privet land which need to be acquired .

PBS system coverage of all the phases

S. No	Phase	Coverage Area (Sq.km)	% Area Covered	No of Stations
1	1	4.0	49%	40
2	2	3.0	36%	11
3	3	1.18	15%	30
	Total	8.18	100%	81

PBS guidelines as per guidance document

S. No	Guidelines as per PBS Guidance Document (GD)	
1	10 to 15 stations per square km of PBS influence area	
2	Number of bicycles in Small Stations	15
3	Number of bicycles in Medium Stations	20
4	Number of bicycles in Large Stations	40

PBS system size estimation

S. No	Phase	Coverage Area (Sq.km)	No of Stations	No of Bicycles
1	1	4.0	40	1160
2	2	1.18	11	210
3	3	3.0	30	550
Total		8.18	81	1920

STATION LOCATION

The criteria followed in locating stations are as follows

1. Station distance is kept **between 200- 400m** to ensure mostly dense and uniform coverage in high demand area. Minimum coverage includes **10 PBS stations per sq km**.
2. Stations location will be **near mass transit stations or transit stops and near bicycle lanes/tracks**, if present.
3. Stations should be located preferably near or on SMC/ Government property, Multi Level Parking, Below Flyover, On major arterials like Ring Road , Rajamrg, and kotsafil Road and places along the street that are safe to access by bicyclists.
4. Stations should be located **inside residential cores and near important public institutions** or places like, school, colleges, parks, markets, commercial areas and other activity nodes.

Population Density

Land Use

Road Network

Traffic Generating Activity

PT & IPT

Availability of Open Land for Docking Stations

Station Location for PBS Phase I CZ.

PBS system size estimation for Phase I

Total No. of Stations	40
Large stations	16
Medium stations	11
Small stations	13
No. of Bicycles	1055
Spares (10%)	105
Bicycles to be deployed	1160

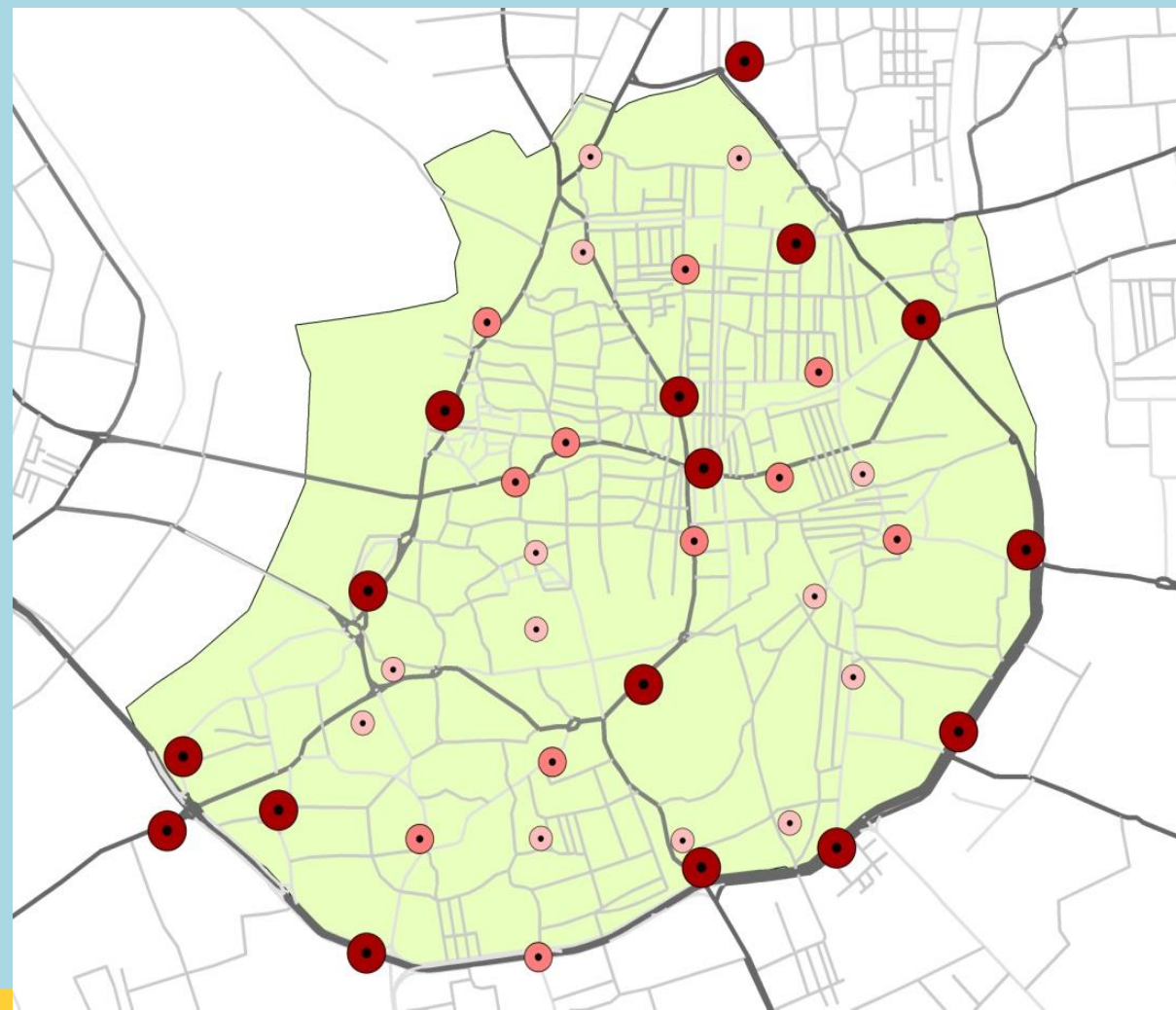
Large stations



Medium stations

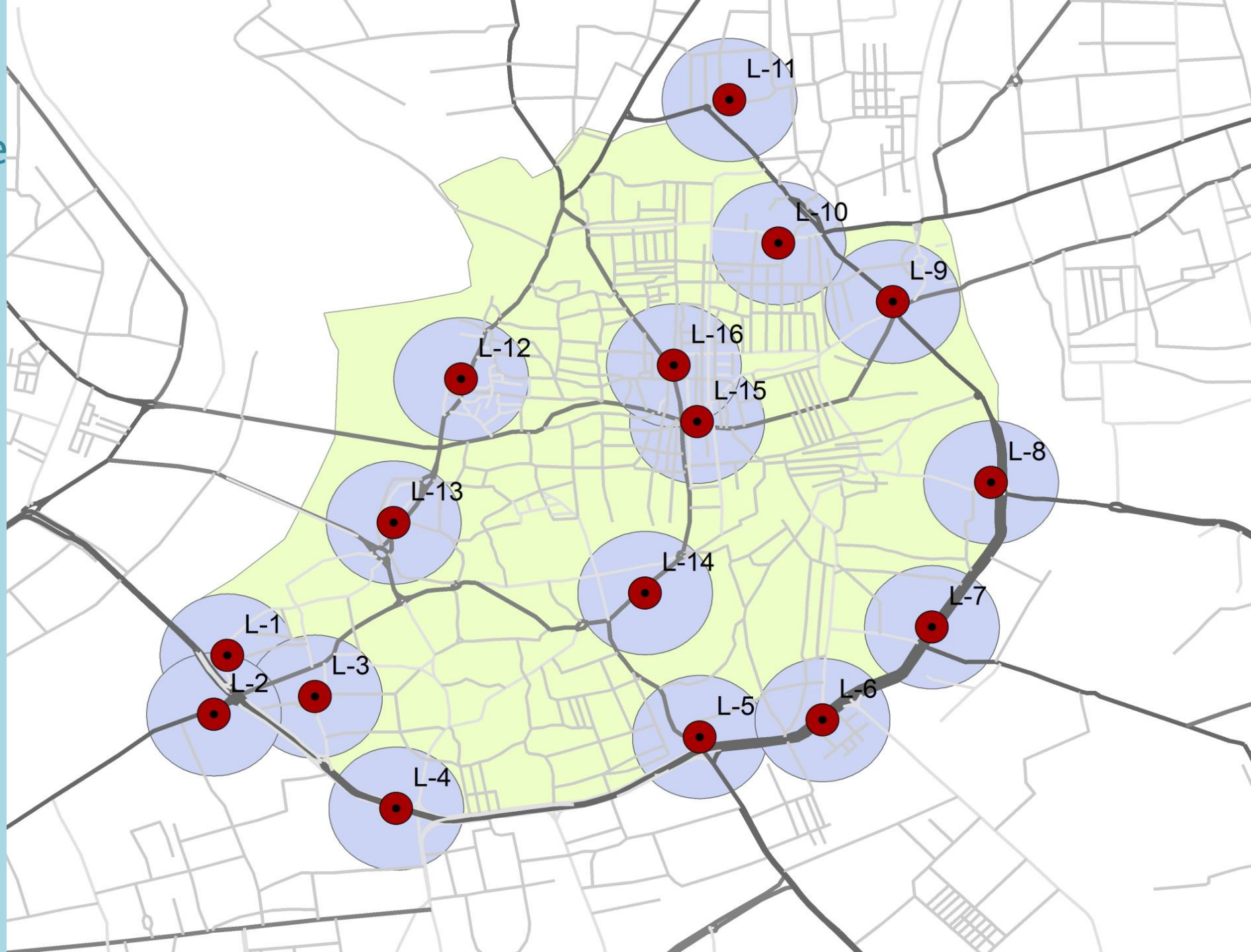


Small stations



Phase I Large Stations Coverage

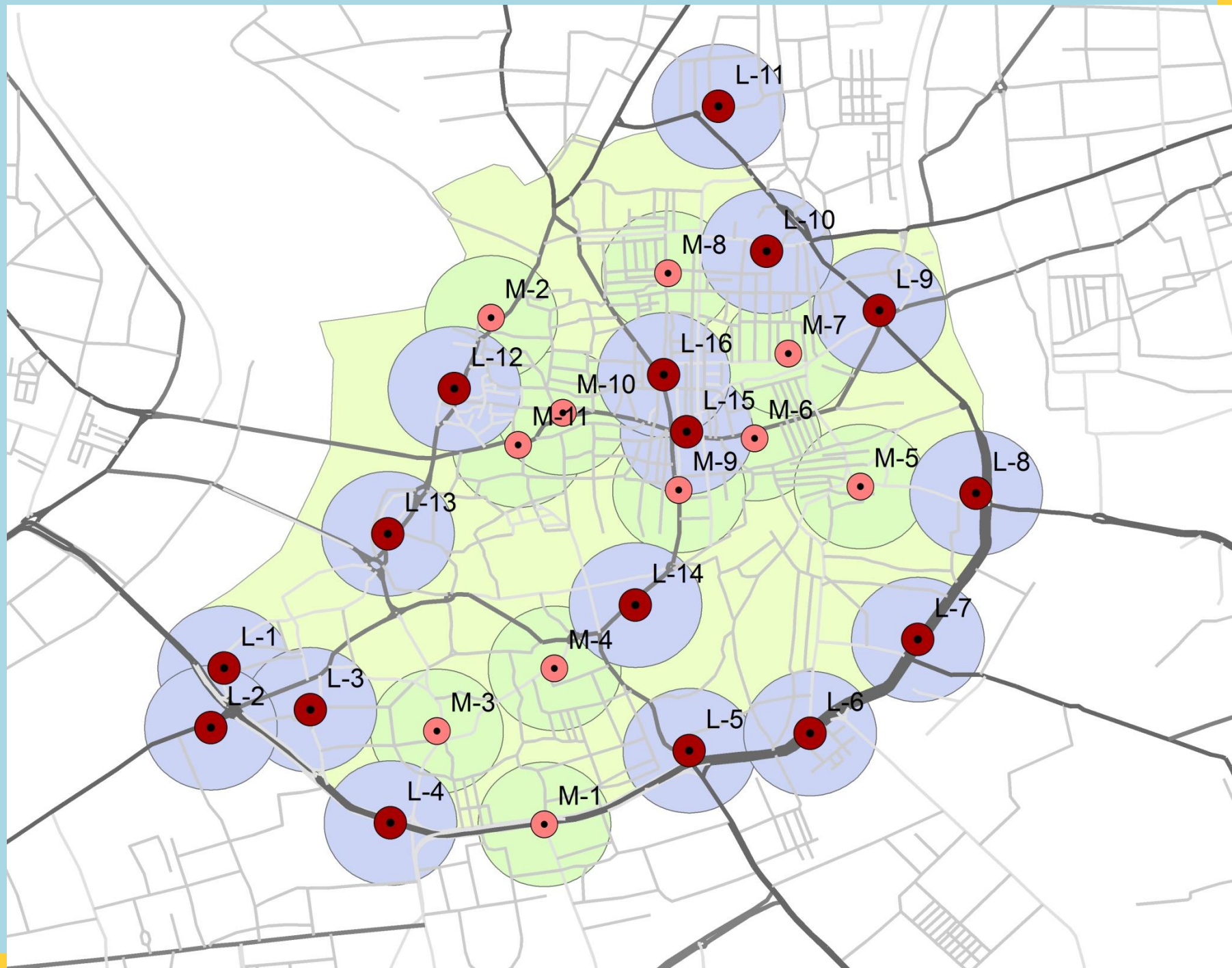
- **Maximum Station to Station distance 1km**
- **300m from major activity centre**



Phase I

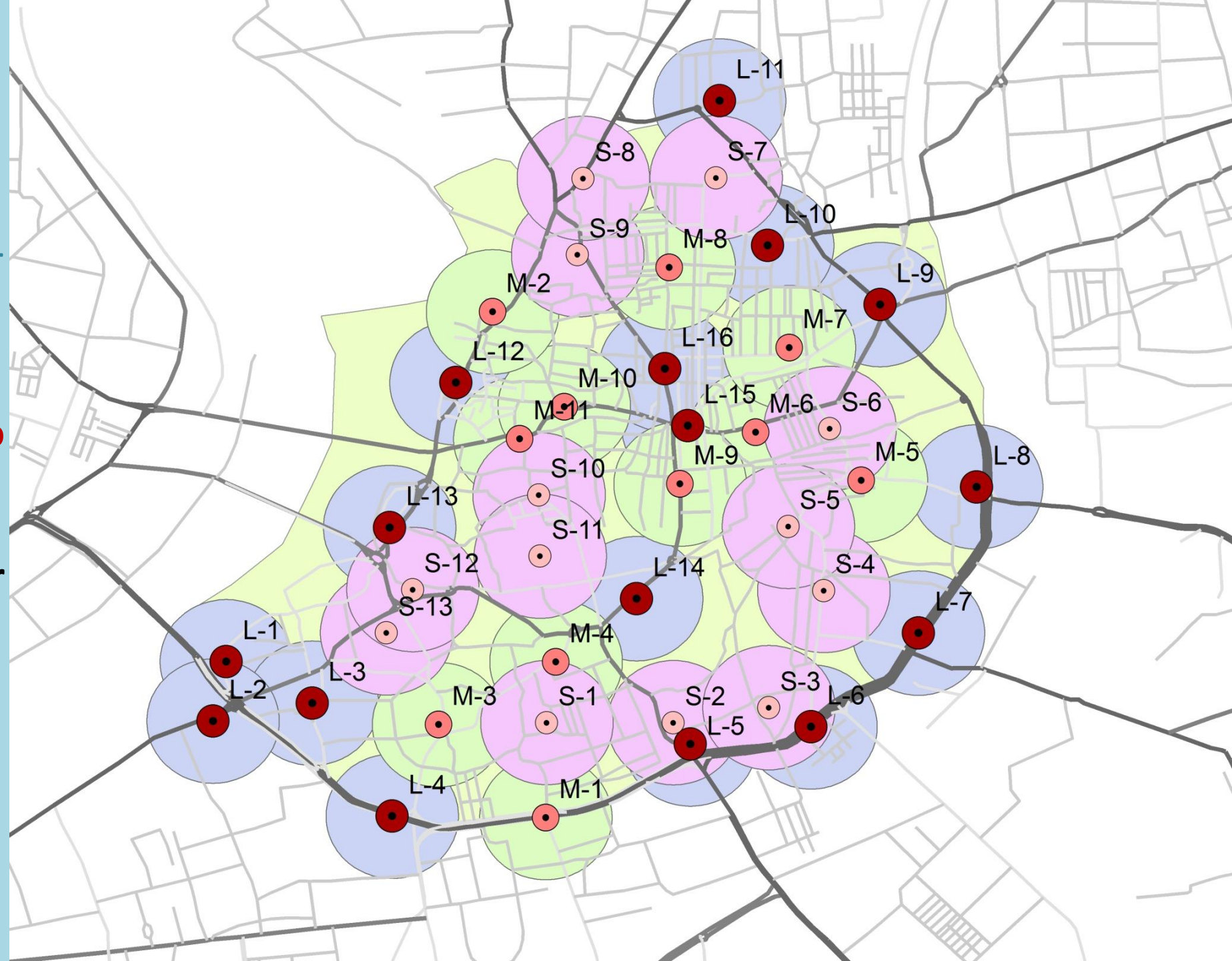
Large + Medium
Stations Coverage

- **Maximum Station to Station distance 700 m**
- **300m from major activity centre**



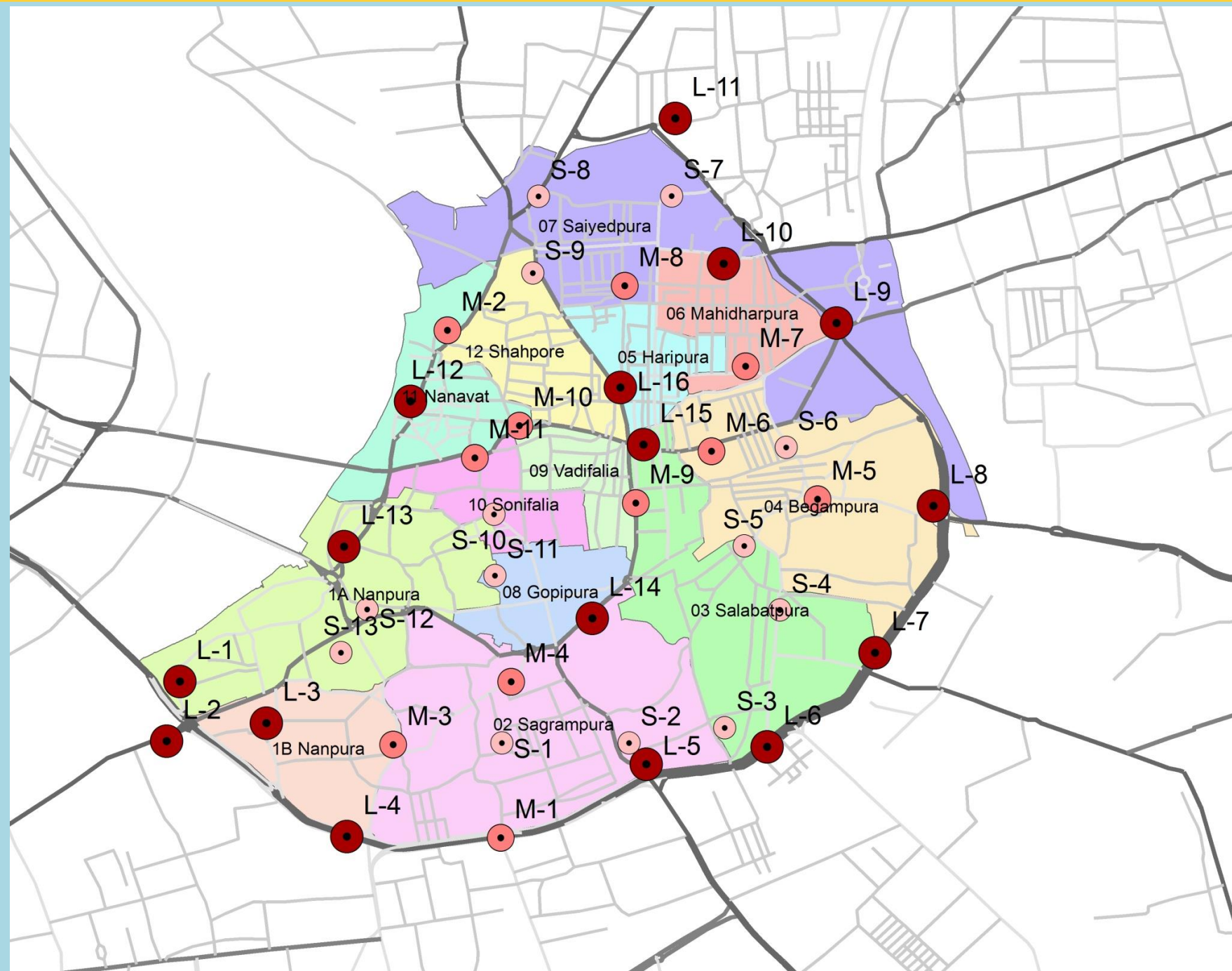
Large + Medium +
Small Station Coverage

- **Maximum Station to
Station distance 700m**
- **300m from major
activity centre**



Phase I

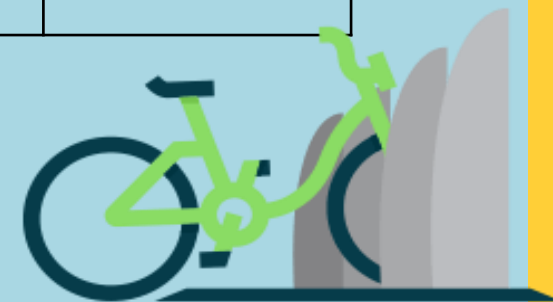
Ward Wise PBS
Location for CZ



II: For BRTS

BRTS PBS system size estimation

S. No	Item	Unit	Total Stations	Total Cycles
1	Total Docking stations			
	Stations with 15 cycles	Nos.	32	480
	Stations with 30 cycles	Nos.	42	1260
	Stations with 50 cycles	Nos.	37	1850
	Total Corridor 1 & 2	Nos.	111	3590



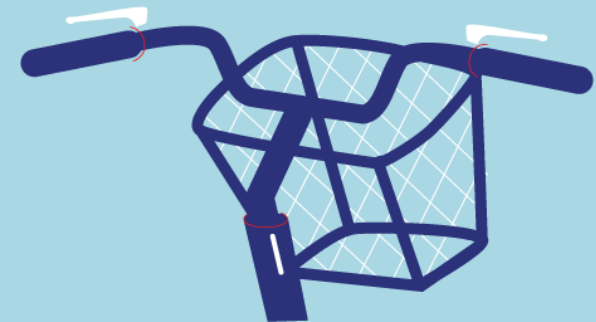
Corridor 1 Udhna-Sachin Corridor

Sr.	Item	Unit	Total Stations	Total Cycles
1	Docking stations			
	Stations with 15 cycles	Nos.	18	270
	Stations with 30 cycles	Nos.	12	360
	Stations with 50 cycles	Nos.	20	1000
	Total	Nos	50	1630

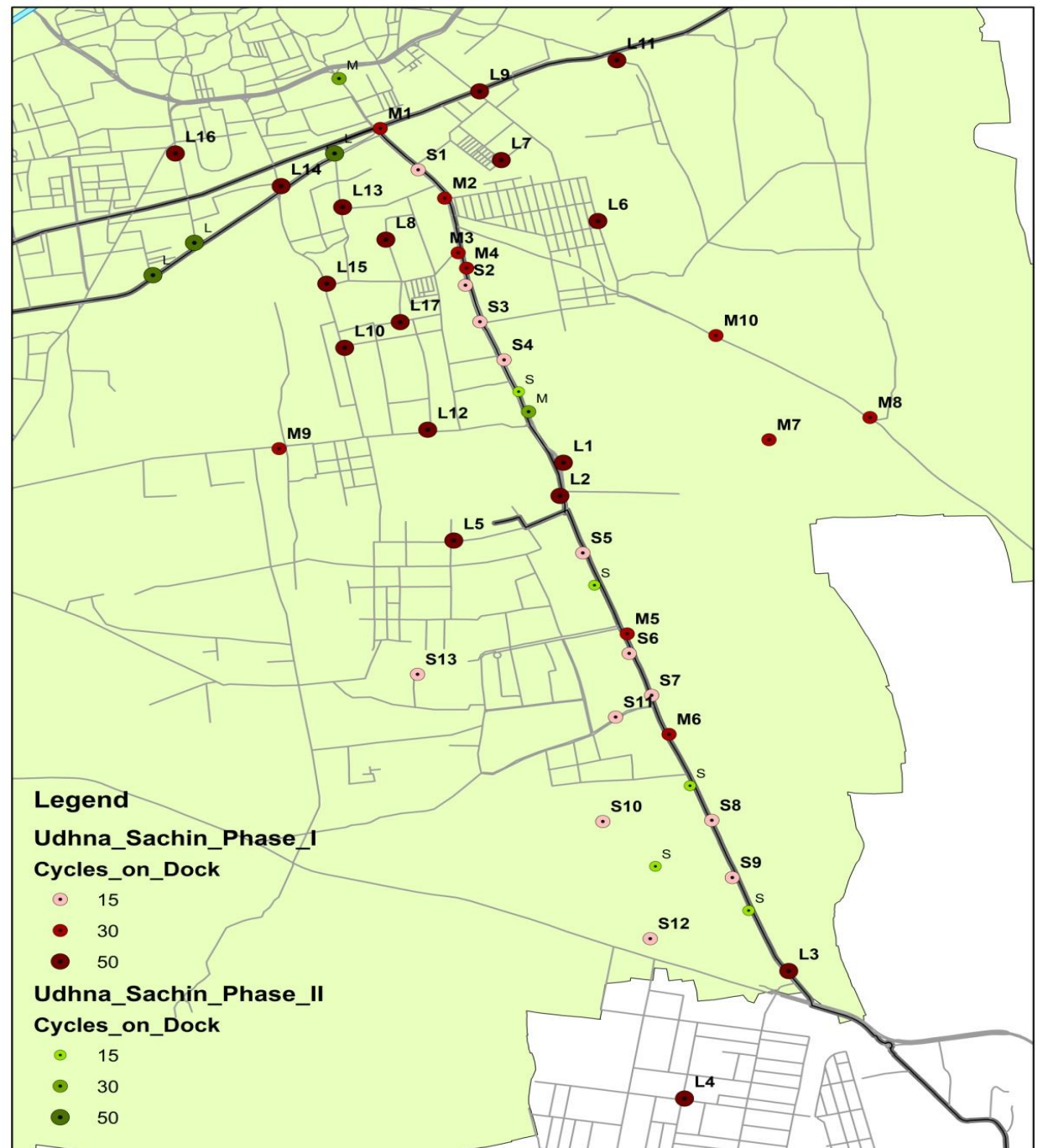
Corridor 2 Magdalla-Sarthana Corridor

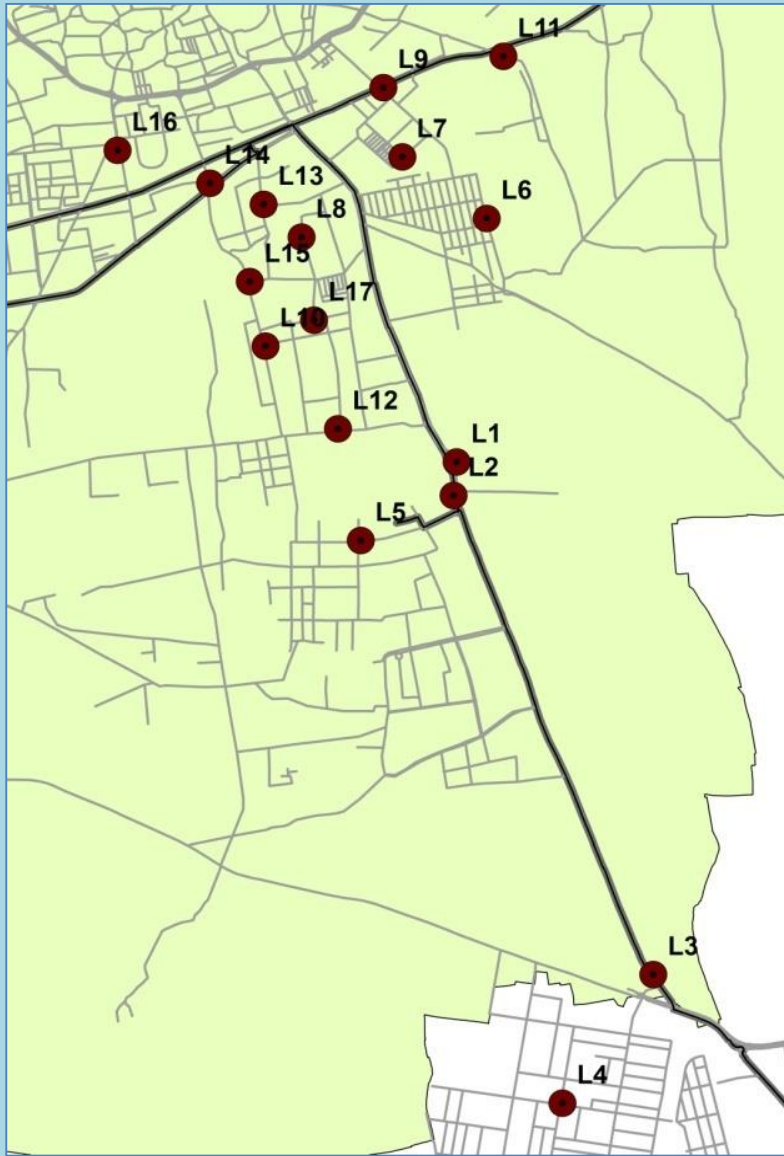
Sr.	Item	Unit	Total Stations	Total Cycles
1	Docking stations			
	Stations with 15 cycles	Nos.	14	210
	Stations with 30 cycles	Nos.	30	900
	Stations with 50 cycles	Nos.	17	850
	Total	Nos	62	1960

UDHNA TO SACHIN BRTS DOCKING STATION

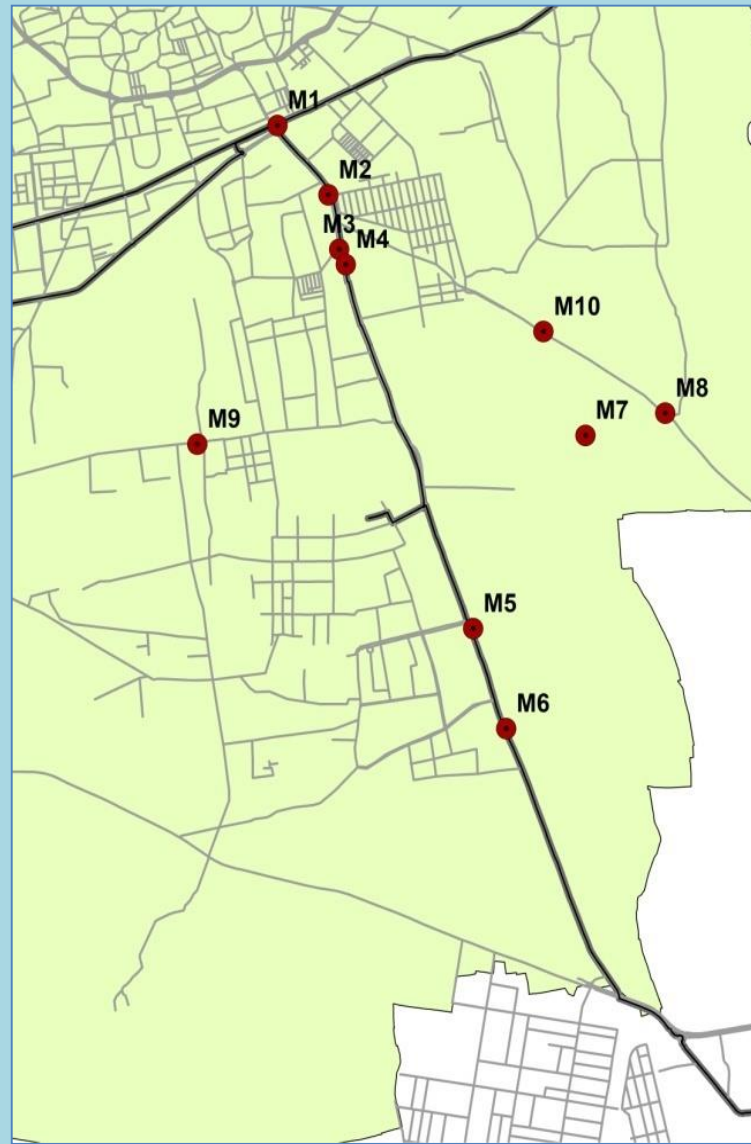


Phase 1 & 2 Docking station

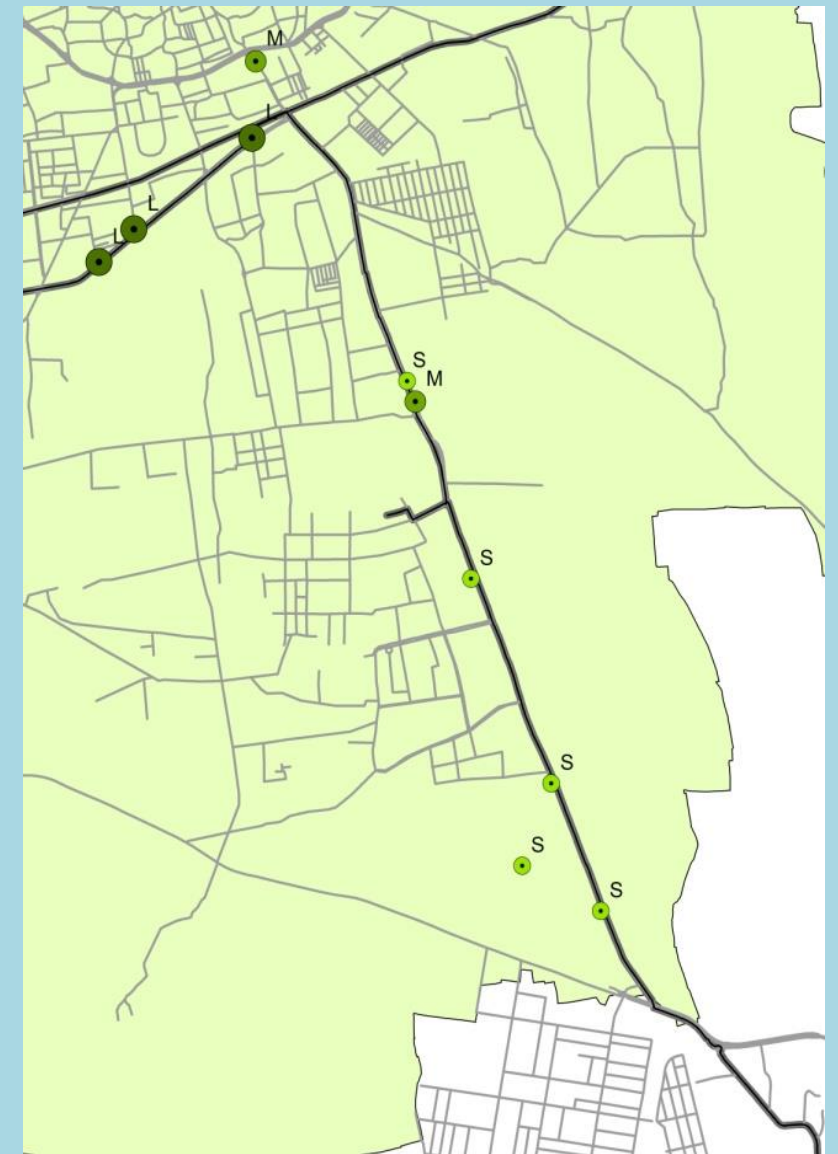




Large Station(Phase I)

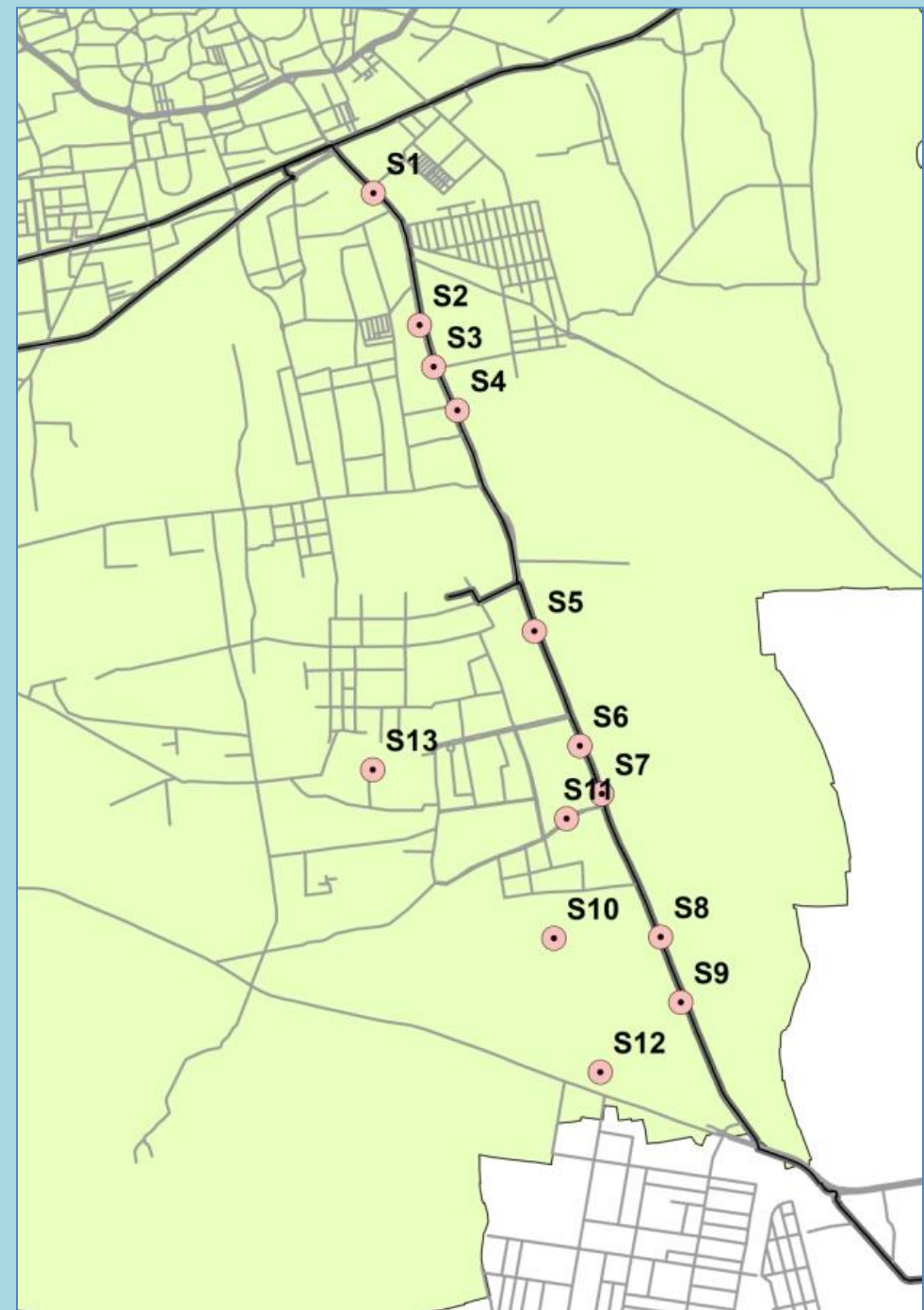


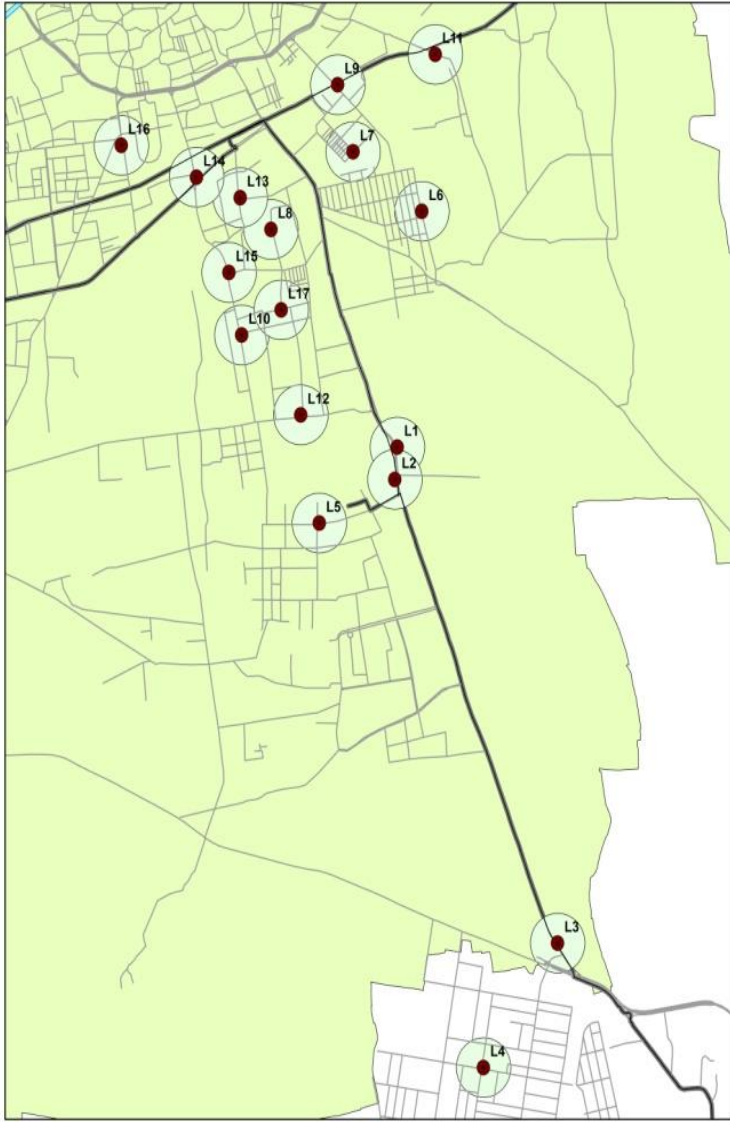
Medium Station (Phase I)



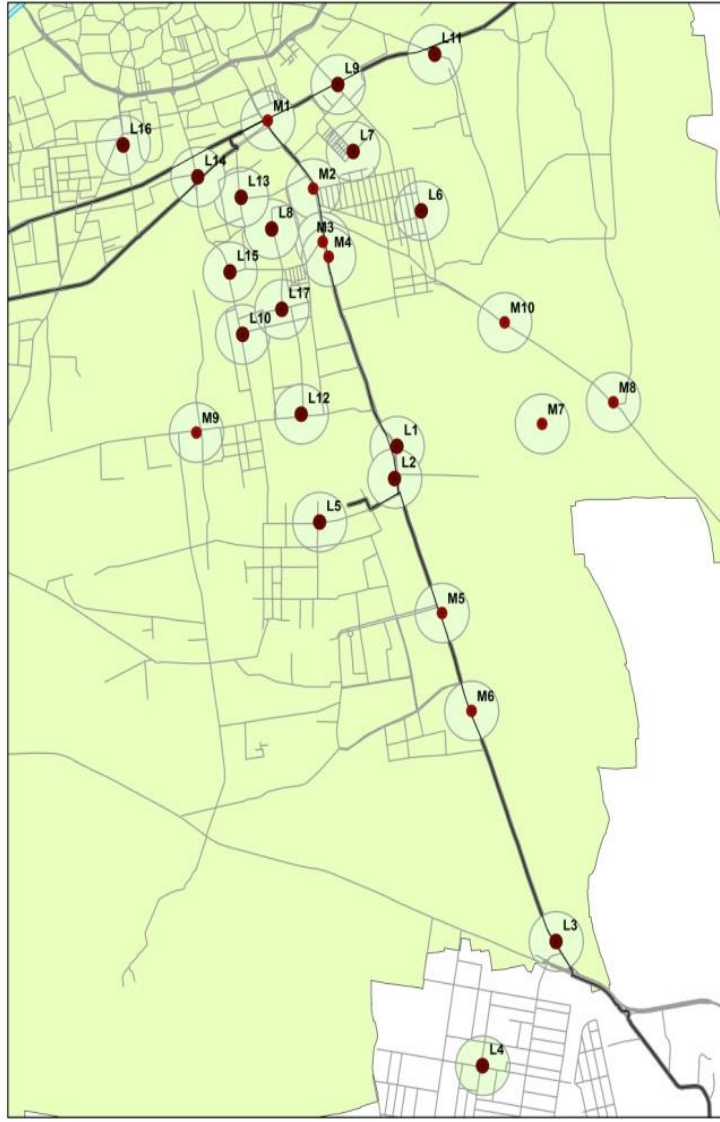
Small Station (Phase I)

Phase II Docking Location

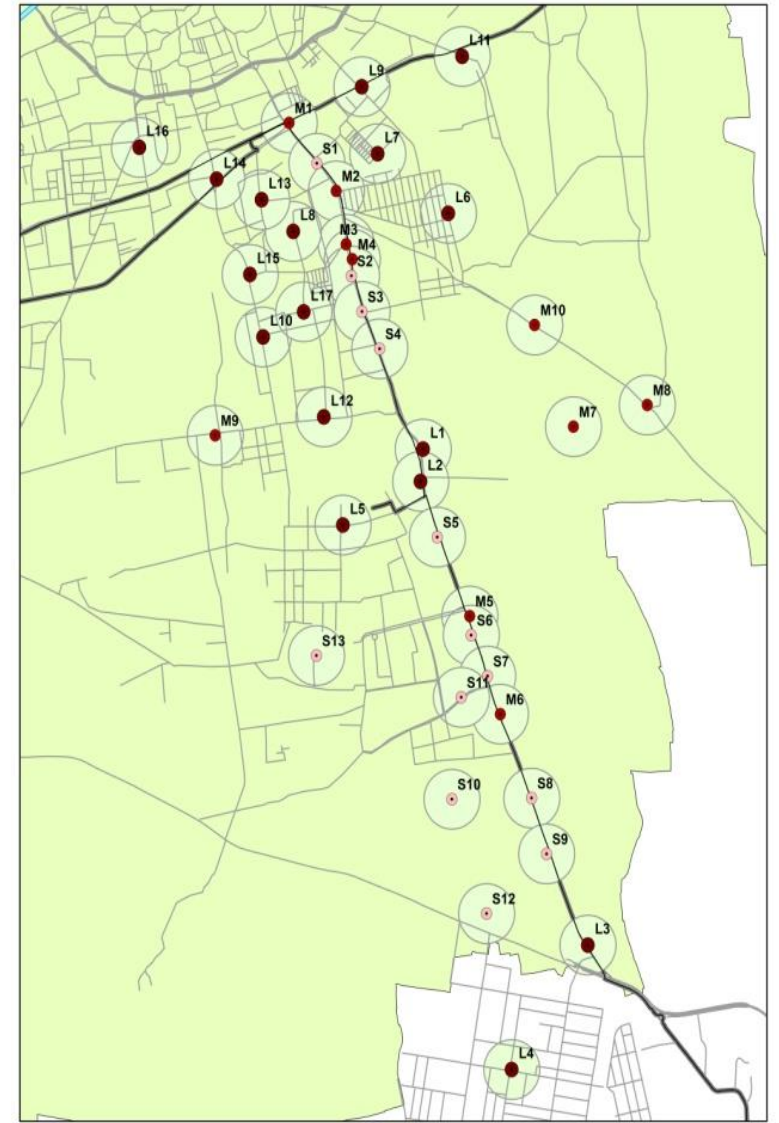




Area Coverage by Large station

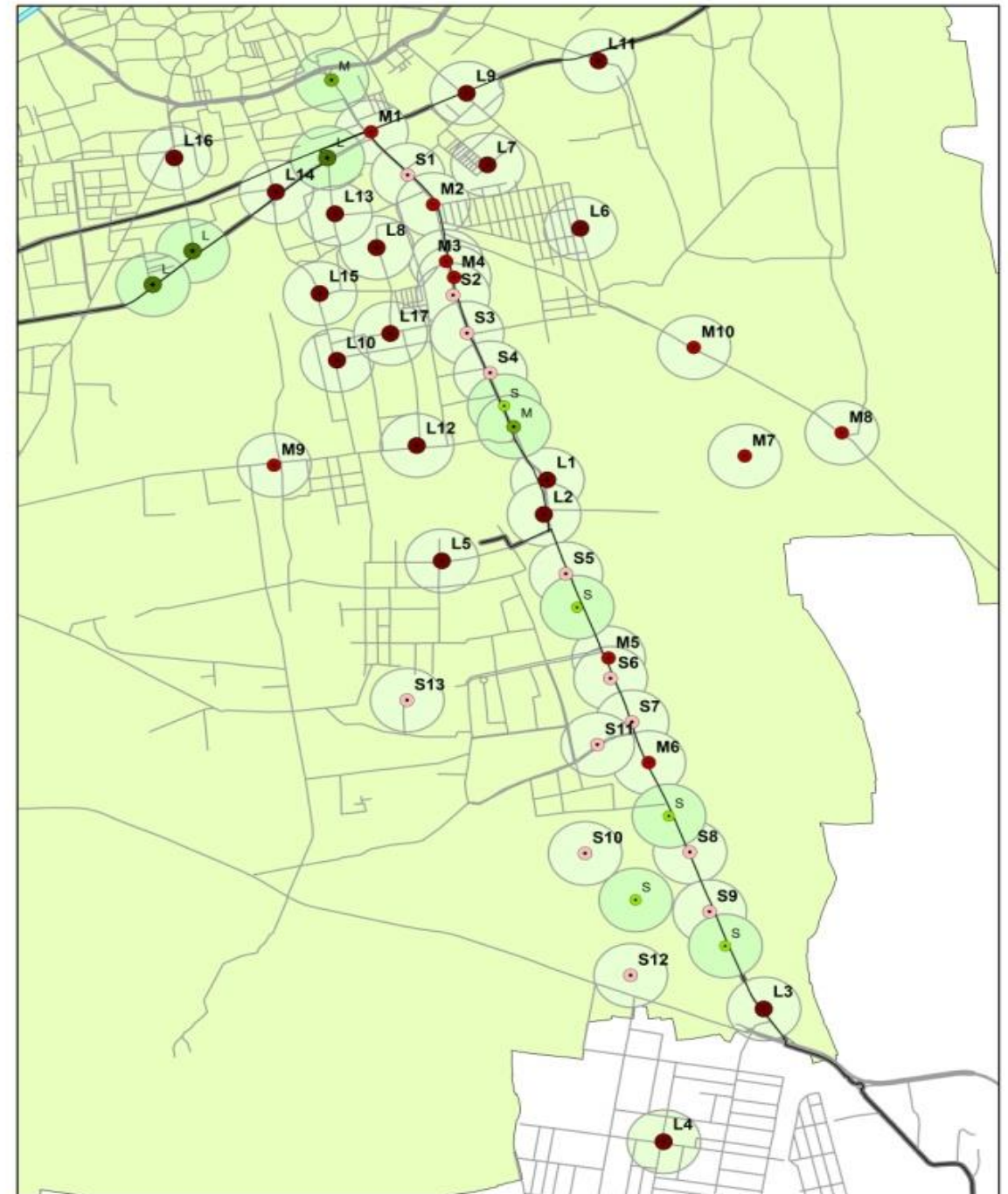


Area Coverage by Large & Medium station
(Phase II)

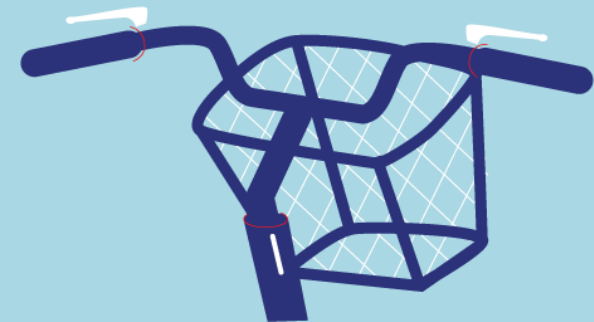


Area Coverage by Large, Medium
& Small station
(Phase I)

Area Coverage By Phase I & Phase II

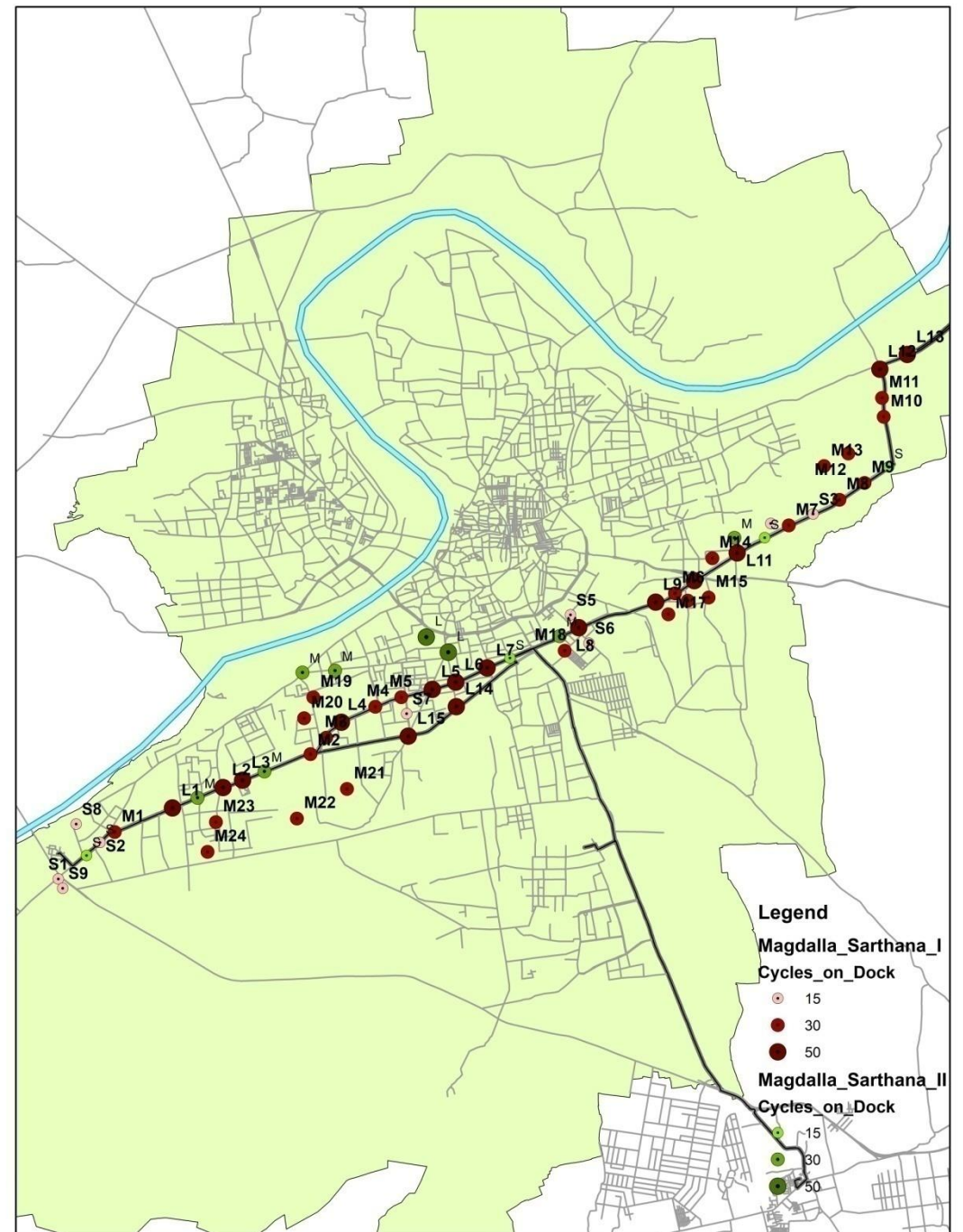


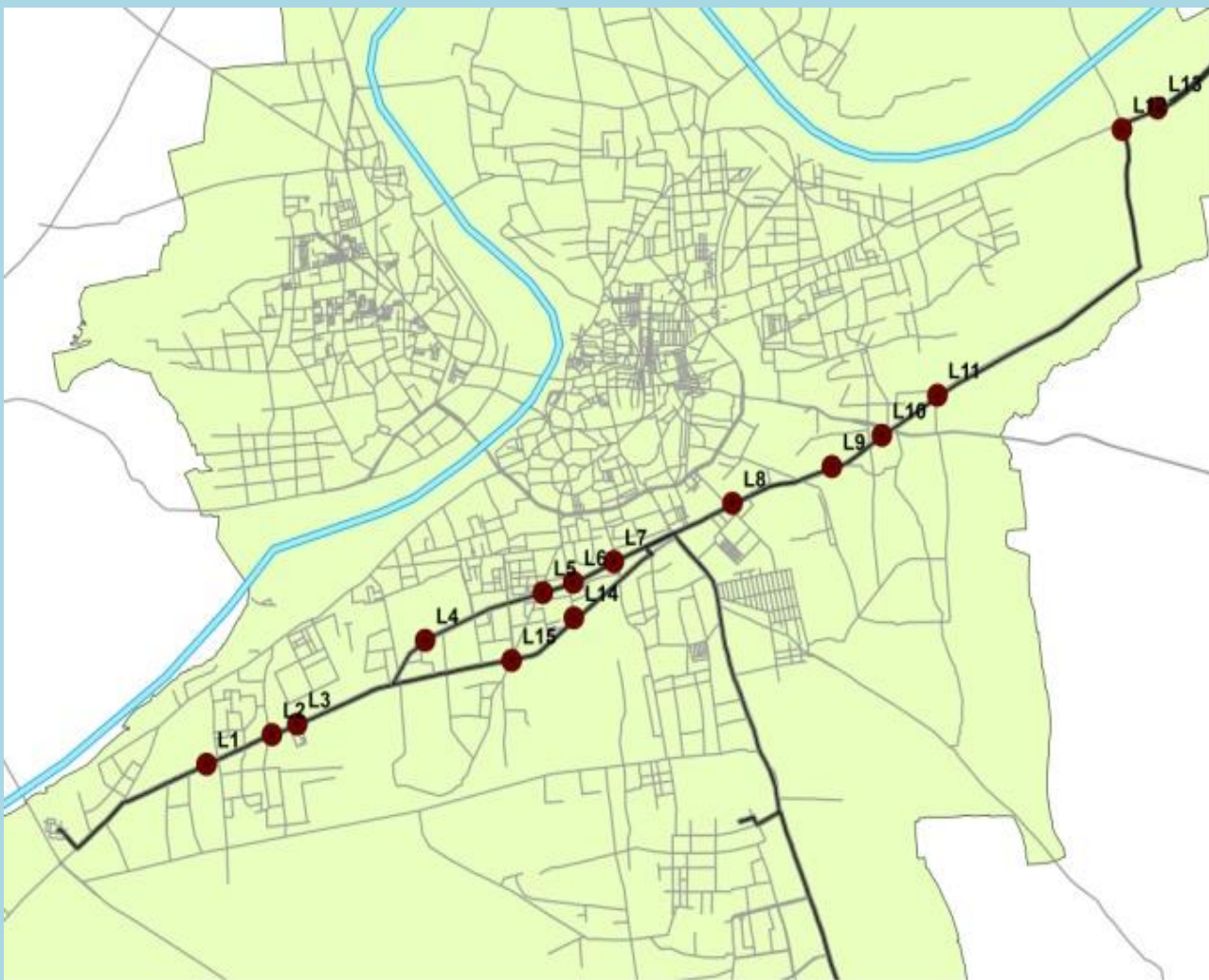
MAGDALLA TO SARTHANA JAKATNAKA BRTS DOCKING STATION



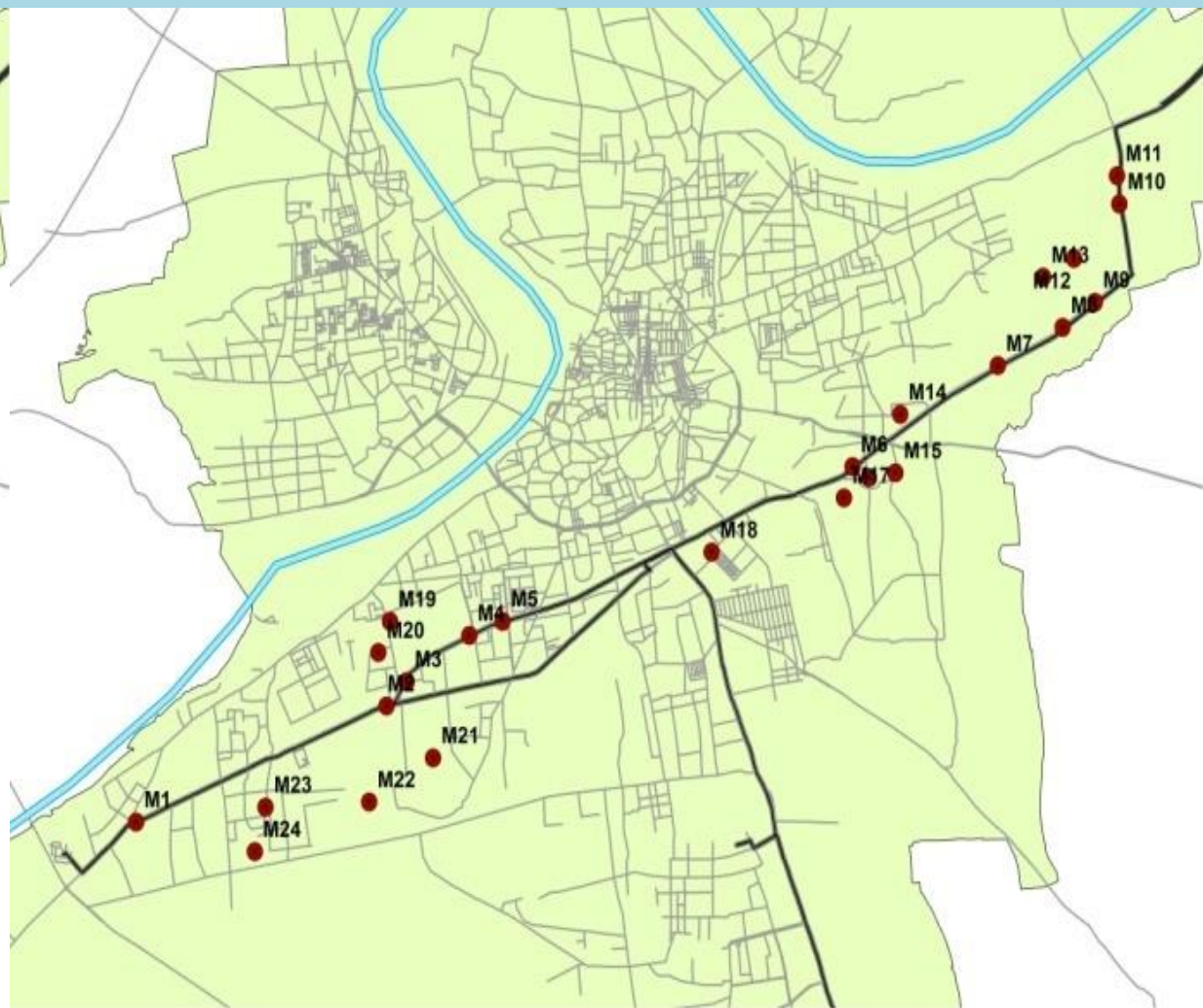
Phase 1 & 2

Docking station

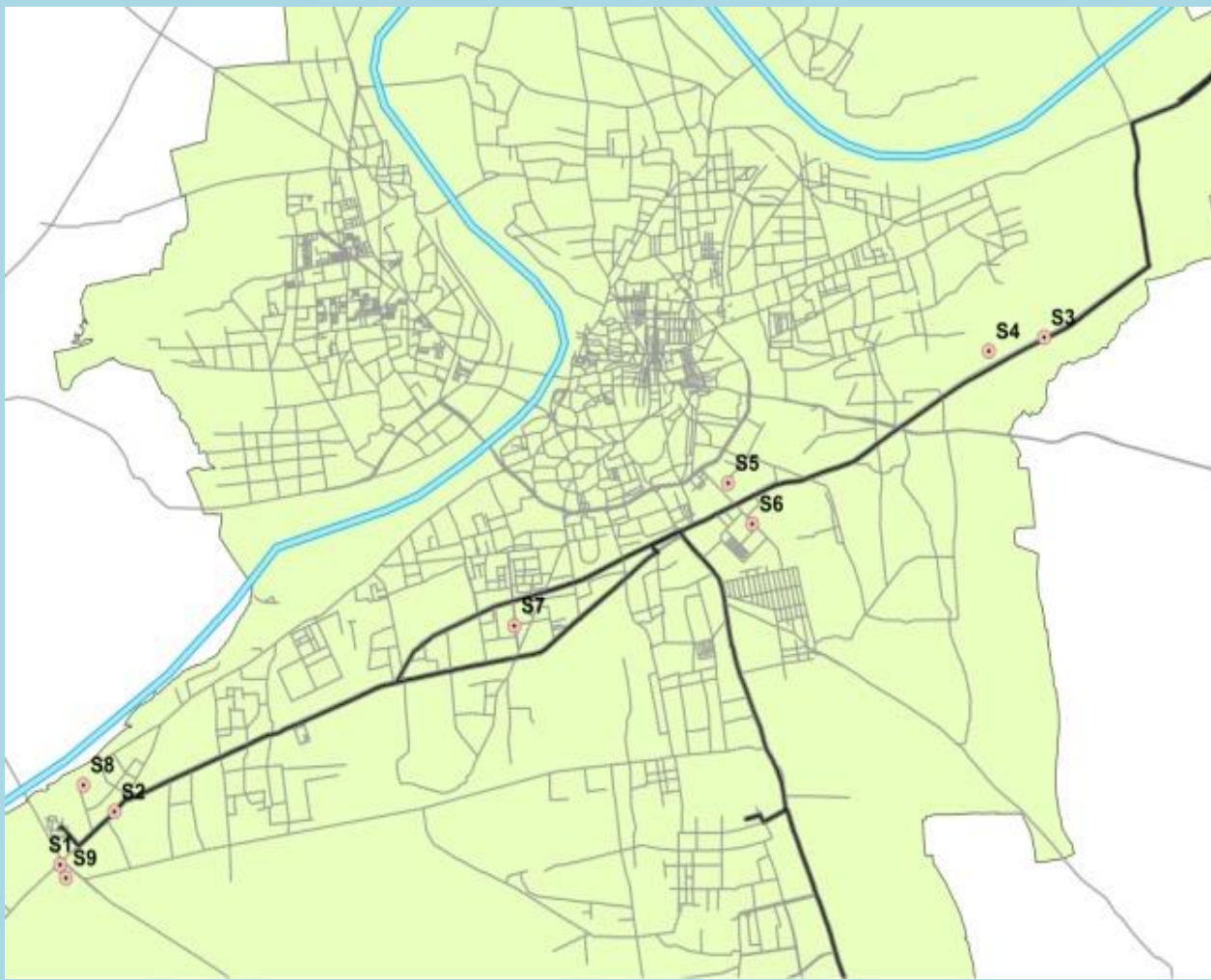




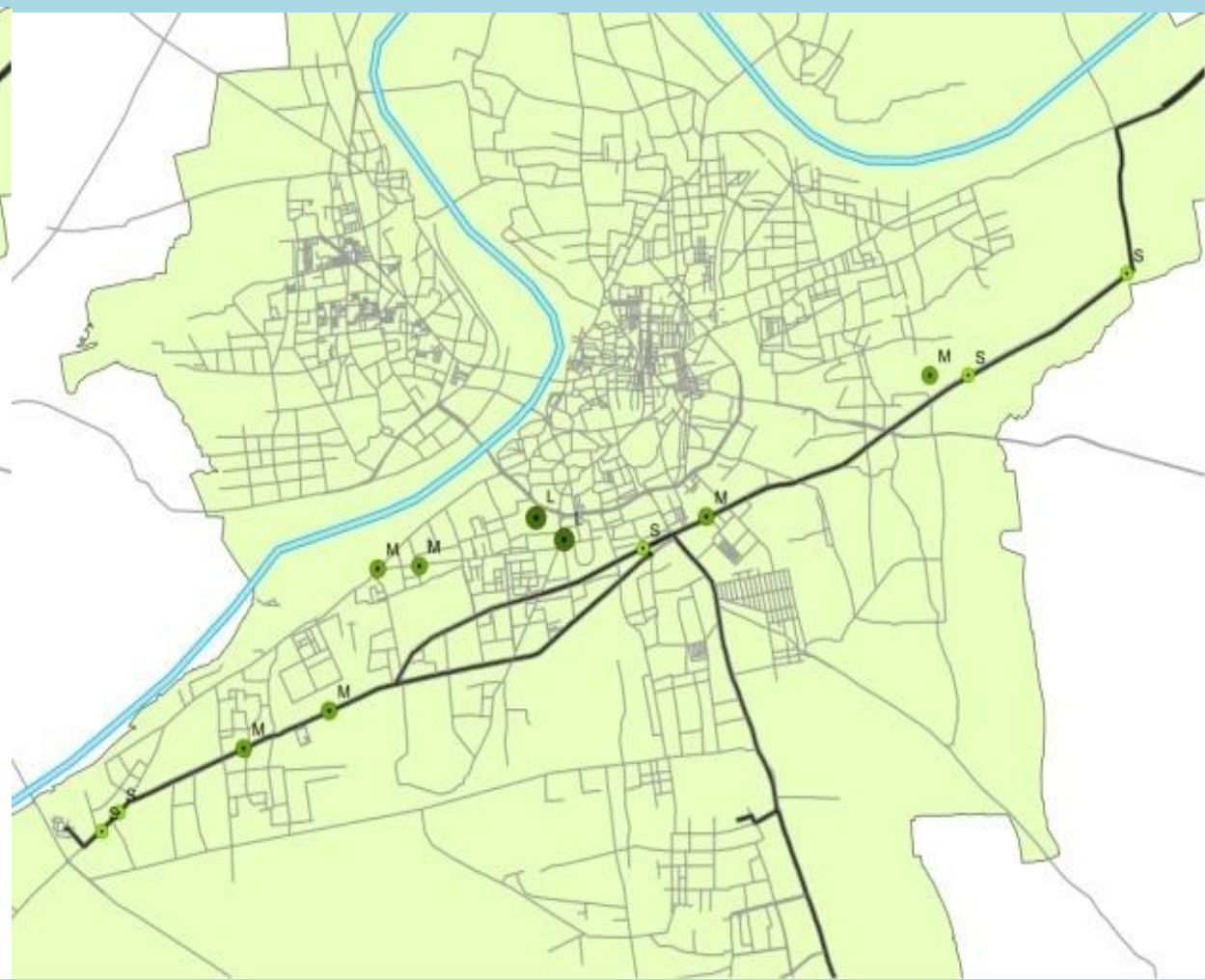
Large Station (Phase I)



Medium Station (Phase I)

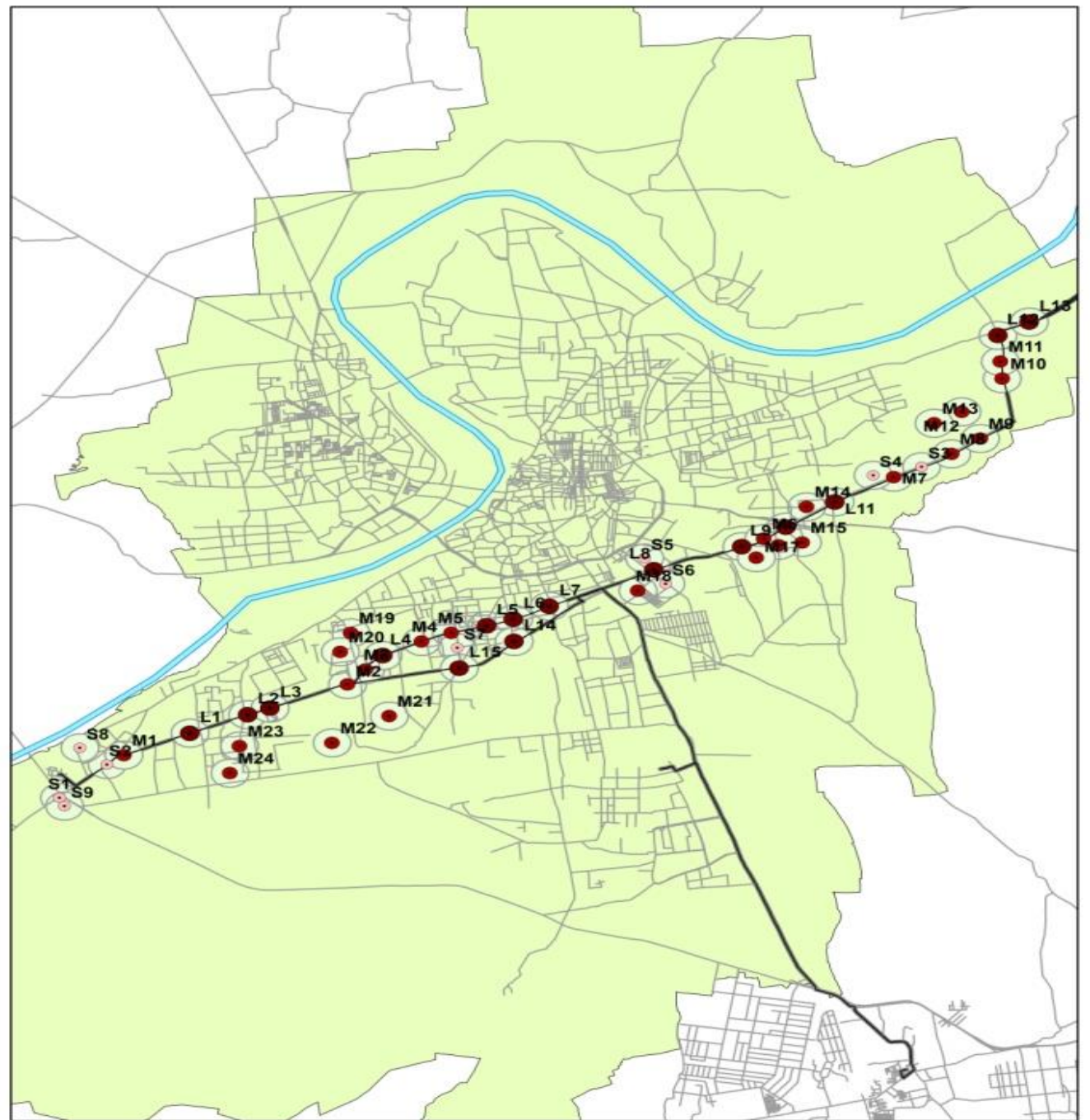


Small Station (Phase I)

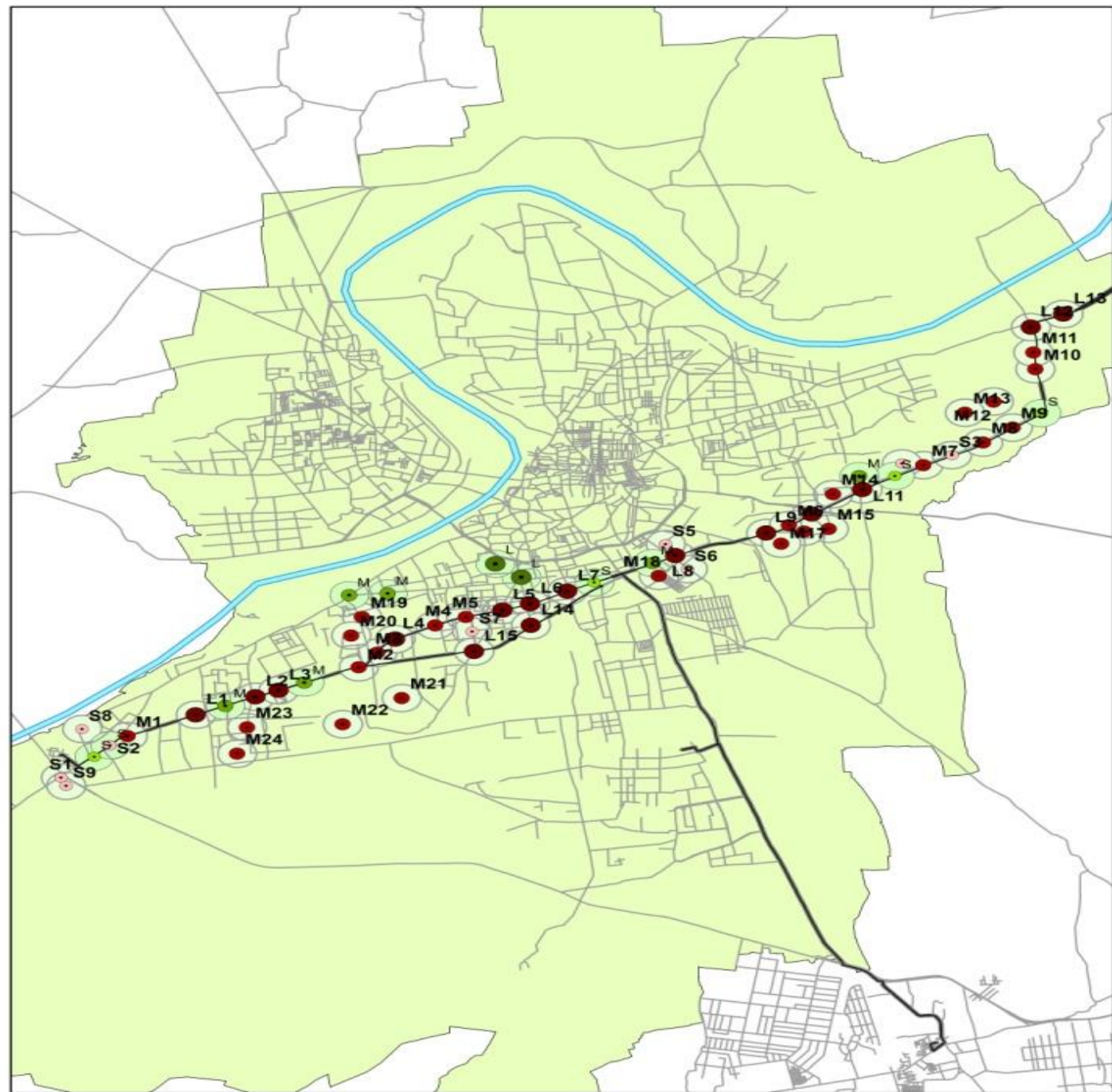


Small Station (Phase II)

Area coverage by Phase I



Area coverage by Phase I & phase II

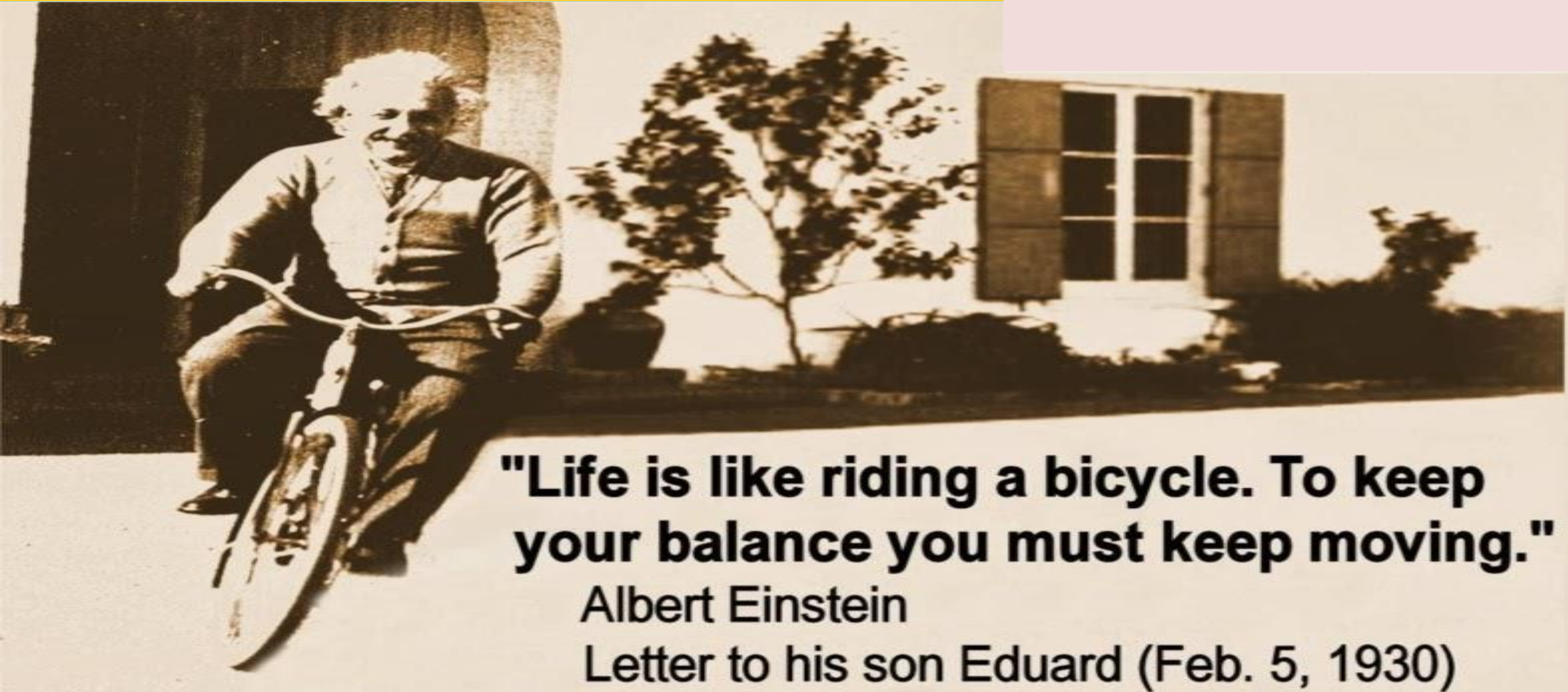


CONCLUSION

- Planning based on users perception will help to locate the stations.
- The different maps like density, major junction , traffic generating activity and land use will help to integrate the PBS with other models
- The willingness to shift analysis will bring more realistic demand to plan numbers of bicycle in each locations.
- Phase wise planning will help to the authority to plan according to the budget and demand.

Suggestions & Discussions

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"Life is like riding a bicycle. To keep your balance you must keep moving."

Albert Einstein

Letter to his son Eduard (Feb. 5, 1930)