PUNE MUNICIPAL CORPORATION
PUNE, MAHARASHTRA, INDIA

PREPARATORY SURVEY ON THE URBAN RAILWAY PROJECT IN PUNE CITY

FINAL REPORT

JUNE 2013

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
TOSHIBA CORPORATION
INTERNATIONAL DEVELOPMENT CENTER OF JAPAN INC.

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BRT	Bus Rapid Transit
CMP	Comprehensive Mobility Plan
DDA	Delhi Development Authority
DPR	Detailed Project Report
EIA	Environmental Impact Assessment
EIRR	Equity Internal Rate of Return
E&M	Electrical & Mechanical System
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EV	Electric Vehicle
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
F/S	Feasibility Study
GOI	Government of India
GOJ	Government of Japan
HIA	Hinjewadi Industries Association
IEE	Initial Environmental Examination
IR	Indian Railways
IRR	Internal Rate of Return
IT	Information Technology
ITS	Intelligent Transport System
JBIC	Japan Bank for International Cooperation
JICA	apan International Cooperation Agency
LARAP	Land Acquisition and Resettlement Action Plan
LEP	Law on Environmental Protection
LRT	Light Rail Transit
LRV	Light Rail Vehicle
MIDC	Maharashtra Industrial Development Corporation
MoEF	Ministry of Environment and Forest Government of India
MoR	Ministry of Railway
MoUD	Ministry of Urban Development
MPCB	Maharashtra Pollution Control Board
MRT	Mass Rapid Transit
MSEDCL	Maharashtra State Electricity Distribution Co., Ltd.
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
O&M	Operation & Maintenance

PFI	Private Finance Initiative
PMC	Pune Municipal Corporation
PCMC	Pimpri Chinchwad Municipal Corporation
PHPDT	Peak Hour Peak Direction Traffic
PPHPD	Passengers per hour per Direction
PMPML	Pune Mahanagar (Municipal) Parivahan (Transportation) Mahamandal (Corporation) Limited
PPP	Public Private Partnership
RAP	Resettlement Action Plan
ROE	Return on Equity
ROI	Return on Investment
ROW	Right-of-way
SIA	Social Impact Assessment
SPC	Special Purpose Company
SPV	Special Purpose Vehicle
TOD	Transit Oriented Development
TOR	Terms of Reference
VGF	Viability Gap Funding

Chapter 1 Implementation Policy

1.1 Basic Policy of the Study

1.1.1 Background of the Study

The rate of Indian economic growth in 2007 was 9%, which was second in the world. The GDP is estimated at about 120 trillion yen and the economy is the twelfth largest in the world.

The Indian economy is rich in diversity, for example, agriculture, handicraft industry, textile industry and a wide variety of services. While two-thirds of the labor force makes a living through agriculture directly or indirectly, the service sector has been growing rapidly and it has a large role in the economy. However, the construction of infrastructure is not adequate to cover the demand. This has caused serious traffic congestion, which inhibits the efficiency of economic and social activities. Comprehensive improvement and reform of the entire urban transportation system is required.

The population of Pune city, which is located southeast of Mumbai, is currently 3.12 million people (2011). However, the population is expected to increase to 4.4 million in 2021 and 5.63 million in 2031 considering the advancement of urbanization in Pune. The transport sector of the city has many problems that are worsening including traffic congestion, degradation of traffic safety, lowering of public transportation services, inconsistency in traffic compliance by road users, lack of transportation operations management and a lack of transportation infrastructure. Major factors in traffic congestion are the inconsistency in traffic compliance by road users, lack of transportation operations management, and the lack of transportation infrastructure.

Considering these issues, Pune city proposed a concept for the future to be completed by 2031 called the Final Report, Comprehensive Mobility Plan for Pune city (Hereinafter called CMP). This report indicated urban transport demand forecast, a proposal of urban transport policies and strategies with the goal of 2031, and future frames of transportation planning and a transportation investment plan. The report is a guideline indicating the problems related to urban development and strategies to mitigate the issues. In CMP, four alternative scenarios are considered: 1. Augment PMPML (Pune Mahanagar Parivahan Mahamandal Limited), 2. PMPML Bus System＋BRT (Bus Rapid Transit), 3. PMPML Bus System＋BRT＋Ring Corridors, and 4. MPML Bus System＋BRT＋Ring Corridors＋High Capacity System (LRT/Metro/Monorail, etc.). The number of trips of two wheeled vehicles and cars are investigated using those four scenarios. In addition, in Pune, the introduction of medium-capacity rail and mass public transportation systems is considered. Regarding the latter, the detailed design of the metro has already been implemented. On the other hand, studies of the other systems have not yet been done.

The Japanese government and JICA have continued to support the urban transportation plan in India. Improvement of urban transportation is related to the concept of the Master Plan; therefore, upgrading of the public transportation system is one of the important measures.

Previous Major Projects

ODA Loan: "Delhi Mass Rapid Transport System Project" (1996, agreement 2005)

ODA Loan: "Hyderabad Outer Ring Road Construction Project" (2007, agreement 2008)

ODA Loan: "Chennai Metro Project" (2008, agreement 2009)

ODA Loan: "Kolkata East-West Metro Project" (2007, agreement 2009)

ODA Loan: "Bangalore Metro Rail Project" (2005, agreement 2011)

Total Agreement Cost of Transportation Sector: 777,161 million yen

Technical Cooperation for Initiation of ODA Loan

Technical Cooperation Project: "Capacity Development Project on Sustainable Development of Expressways" (2007～2011)

Technical Cooperation Project: "Expressway/Highway Planning, Construction, Operation and Maintenance" (2004～2006)

This Study is to plan improvement of the urban transport system that will result in development of an eco-friendly city. This Study is consistent with Japanese and JICA's key indicators.

1.1.2 Purpose of this Study

This Study is to plan improvement of the urban transport system that will result in development of an eco-friendly city in Pune, Maharashtra district. It will contribute to the improvement of residents' living and sanitary environment, environmental conservation and reduction of GHG (greenhouse gases).

In this Study, the Basic Project Plan is instituted for implementation of this Project under an ODA Loan. Further, the Project cost summary is calculated based on the Basic Project Plan considering the trends and opinions of the related entities in India. Also, we will consider the Project scheme, such as the classification and burden of private and public portions. Project adequacy and efficiency utilizing private investment are evaluated and a comprehensive evaluation is conducted in accordance with the results of researching the Project risks.

1.1.3 Approach to Conducting the Study

The joint venture of Oriental Consultants Co., Ltd. (hereinafter referred to as OC), Toshiba Corporation (hereinafter referred to as Toshiba) and the International Development Center of Japan Inc. (hereinafter referred to as IDCJ) will conduct the Study with the following approach for technical aspects on the basis of the background of the Study, purpose of the Study and points to note for conducting the Study that are mentioned in the terms of reference as well as the ascertainment of the current status and issues in the target area of the Study.

1) Approach for Technical Aspects

(1) Commercialization as Public-Private Partnership (PPP) Project

It is expected that this Project will be successfully implemented as a PPP project in the future. Therefore, comprehensive risk analysis (political and social risk, economic and market risk, etc.) must be completed and measures for these risks must be conducted to increase the feasibility of PPP project implementation. In particular, consistency with acts and regulations related to PPP in India will be carefully studied.

There are many institutions, such as the India Infrastructure Project Development Fund (IIPDF), Transaction Advisor Panel, Viability Gap Funding (VGF), India Infrastructure Finance Corporation Ltd. (IIFCL), etc., promoting PPP projects in India. Through use of these legal institutions, the Study will be carried out smoothly. Close contact with JICA will be maintained, and information sharing and exchange of opinions will be performed during the Study.

While a comprehensive PPP infrastructure framework has been prepared in the State of Maharashtra, PPP projects have been developed individually (Basic Information Collection Study promoting foreign direct investment on the PPP infrastructure projects in India, November 2011). Taking this environment into consideration, the Study Team will share and exchange information with the relevant organizations. It will also conduct, during its initial period, its review on the possible application of PPP laws and regulations, an assessment of the implementation capacity, experience of the executing agency as well as PPP procedures. Through these exercises, it will confirm that the introduction of JICA overseas investment and lending will not cause trouble for the implementation of the Project.

(2) Consideration for the Appropriateness and Relevance of the Project Scale

Economic and financial analyses in the Study on the urban transport system will be carried out on the basis of population scale, city form and ease of train operation & maintenance. Transport capacity and scale of railway facilities will be proposed in consideration of traffic demand between the railway route to be proposed and relevant roads on the basis of appropriateness of Project scale and some forecasts such as population for the target year, economic growth rate and the percentage of houses with a car. An optimum transport system and construction method will be studied, and capacity building of the executive authority that develops the fare system and safety standards and manuals also will be proposed. Railway alignment will be studied not only on existing roads, but also on elevated and underground structures in some cases.

The most important point for the Study is not to create a long-term ideal vision but to study the most rational and optimum investment schedule. The main factor affecting the Project is demand, but Project cost is also important. Therefore, capacities for finance, finance procurement and debt obligations for the Central Government of India, the Government of Maharashtra State, and city governments (Pune and Pimpri Chinchwad) will be estimated. After the estimation proposals for feasible scope, instructions and direction for private firms and appropriate project scale will be given.

(3) Environmental and Social Considerations

Since the proposed route will be on existing roads and a small-scale car depot will be constructed, it is expected that the number of houses for resettlement caused by the Project will be less than 30. To avoid undue impacts, if land other than the road is used, the plan should be considered to ensure minimal land acquisition. The environmental and social aspects will be carefully considered on the assumption that the Project may be categorized as an ‘A’ level project in the JICA Guidelines for Environmental and Social Considerations as this is the first study. The design of the urban transport system must consider the topography, soil conditions, air pollution, waste, noise, vibration and accidents during construction, and noise and vibration after opening the urban transport system, especially for the underground section to be proposed in central Pune. The planning of Project implementation and design will be carefully carried out so that the Project is acceptable from environmental and social aspects. The schedule of environmental acquisition approval and licensing, which is needed when the construction is implemented, has been confirmed.

Technical Support for EIA Study

The main objective of this EIA-related environmental study of the proposed Urban Transport System Project is to carry out relevant technical assistance for the successful EIA application process, which is to be implemented by Indian C/P. In particular, technical support regarding the official EIA application process abiding to both JICA Guidelines for Environmental and Social Considerations (2004, revised 2010) and relevant Indian environmental regulations is important. Also, technical assistance on appropriate public involvement processes, such as stakeholder meetings and relevant information disclosure, is critical for successful implementation of the entire Project. The following are major environmental sub-tasks, to be supported by the Study Team.

1. To conduct preliminary environmental screening and scoping studies based on both JICA Guidelines and relevant Indian environmental laws.

2. To provide technical assistance for the successful EIA application process such as TOR development for the official EIA study. It is noted that the official EIA study required for this proposed Urban Transport System Project is to be conducted by Indian C/P.

3. The EIA schedule covering the period from official registration to license approval is to be prepared based on the Study results obtained from Steps 1 and 2 mentioned above .

4. To provide technical assistance for the selection of the EIA consulting firm required for the EIA study mentioned above. After this process, relevant follow-up studies, such as supervising the progress of the EIA study as well as the coordination/or meetings with relevant agencies, are to be done in collaboration with Indian C/P.

5. To provide technical assistance for the stakeholder meetings.
6. To provide technical assistance for the preparation of an EIA report (RAP included).
7. After submitting the EIA report, follow-up for meetings with related ministries are to be conducted in order to acquire the environmental approval and license.

It is noted that the relevant RAP study, mentioned in Step 2, is to be conducted based on the engineering study results of the proposed Urban Transport System Project.

Since some automobile users will become railway users, reduction of greenhouse gas (GHG) emissions is expected after opening the urban transport system. For this reason, positive effects, such as a reduction in air pollution, an effect on regional economy because of time saving, and obtaining credit for emission rights are expected. Solving the serious environmental issues in India is a high priority in government policy. Since it is also expected that the Project will be able to introduce a Clean Development Mechanism (CDM) program, the amount of GHG emission reduction arising from the introduction of the urban transport system will be estimated.

(4) Review of Existing Studies

The future framework of Pune city for the target year 2031 is proposed in the Final Report, the Comprehensive Mobility Plan for Pune city (CMP) dated November 2008. The following contents are included in the report and these are positioned as guides for the long-term prospects for urban development issues of Pune city and strategies to solve the issues.

1) Future framework of development and growth for Pune city
2) Issues of existing urban transport systems
3) Existing studies
4) Various transport systems and traffic demand forecasts for the cases in which these systems are adopted
5) Proposal of urban transport policy and strategy for the target year 2031
6) Future framework of the traffic plan
7) Future framework of the traffic investment plan

The above CMP will be reviewed during the Study. The following existing studies will also be reviewed and discussions with relevant government agencies will be held on related matters.

- DPR Pune Metro Project (July 2009)
- Comprehensive Mobility Plan for PCMC (November 2008)
- Bus-based Rapid Transport System, PCMC (March 2008)
- Master Plan for Bus Rapid Transit System, CIRT (March 2008)
- DPR for Metro Rail in Pune Metropolitan Area, DMRC (February 2008)
- DPR on Tramways, Consult Team Bremen (2007)
- Detailed Project Report – Sky bus, Konkan Railway Corporation (July 2004)

- Comprehensive Study of Integrated Traffic Dispersal System for PCMC & PMC, CES (July 2004)
- Comprehensive Traffic & Transportation Study, Span Consultants (2003)
- Mass Rapid Transit System for Pune Metropolitan Area, RITES LTD (January 2001)

1. Review of CMP: 1) Gap between the proposed scope of works and reality. 2) Changes in the economic and social scene after development of the CMP. 3) The actual conditions of urban development. 4) Progress status of creating a legal framework. 5) Looking into the status of projects by other donors. 6) Other considerable matters.
2. High Speed Rail project from Pune to Ahmedabad via Mumbai, BRT project in Pimpri Chinchwad and Metro No.1 & 2 projects in Pune: The Study Team will have a meeting with the consultants who conducted these studies to obtain information on qualitative and quantitative conditions for the studies as necessary. Moreover, they will grasp the status of the scenario for Project implementation and the assistance policy.
3. To get information on policy for public works and on the construction of the urban transport system in Pune district from relevant ministries and government offices, the state government and city governments.

In addition to the above, the Study Team will research the preceding railway projects under PPP schemes, sort out useful implications, and review possible and necessary applications to this Project.

(5) Survey for Traffic Demand Analysis

Since the traffic demand forecast of CMP is based on the status as of 2008, the data must be updated. To improve the reliability of the data, a simple survey, such as an SP survey, will be conducted. When the survey items of the SP survey are considered, the differences of routing probability among the public transportation systems should be noted. In addition, regarding the urban development plan in Pune city, the future development plan along with the industrial park and Transit Oriented Development (TOD), information on the current development status and future development plans is to be obtained from PMC and MIDC. This information is to be reflected in the social framework of the demand forecast.

(6) Planning Issues to Propose an Integrated Urban Development Model

One of the main reasons why major cities in Japan can be effectively urbanized with high-mobility is that urban development is promoted through integration of a railway-based urban mass transport system. In this context, it is proposed that an environmentally friendly compact city with a mass transport system be formulated in Pune city. Making Pune city an eco-city is the basic strategy. Furthermore, integrated urban development is also a major strategy to acquire more passengers for the railway operator. Once the operator acquires profits from high-density urban development, it will contribute to the financial reform of the railway business. In this context, it will be important to provide development rights for the areas surrounding major stations to attract private sector participation.

In this Project, an integrated development plan with stations, station plazas, and intermodal facilities will be formulated.

1.1.4 Study Methodology

Understanding the Study background, objectives, approach, scope of work and work schedule, the Team developed a comprehensive work program to accomplish all the mission items in such a way that the inter-relationship between work period, sequence, coordination, and submission of deliverables can be seen in one flowchart (see Figure 1.1.1).

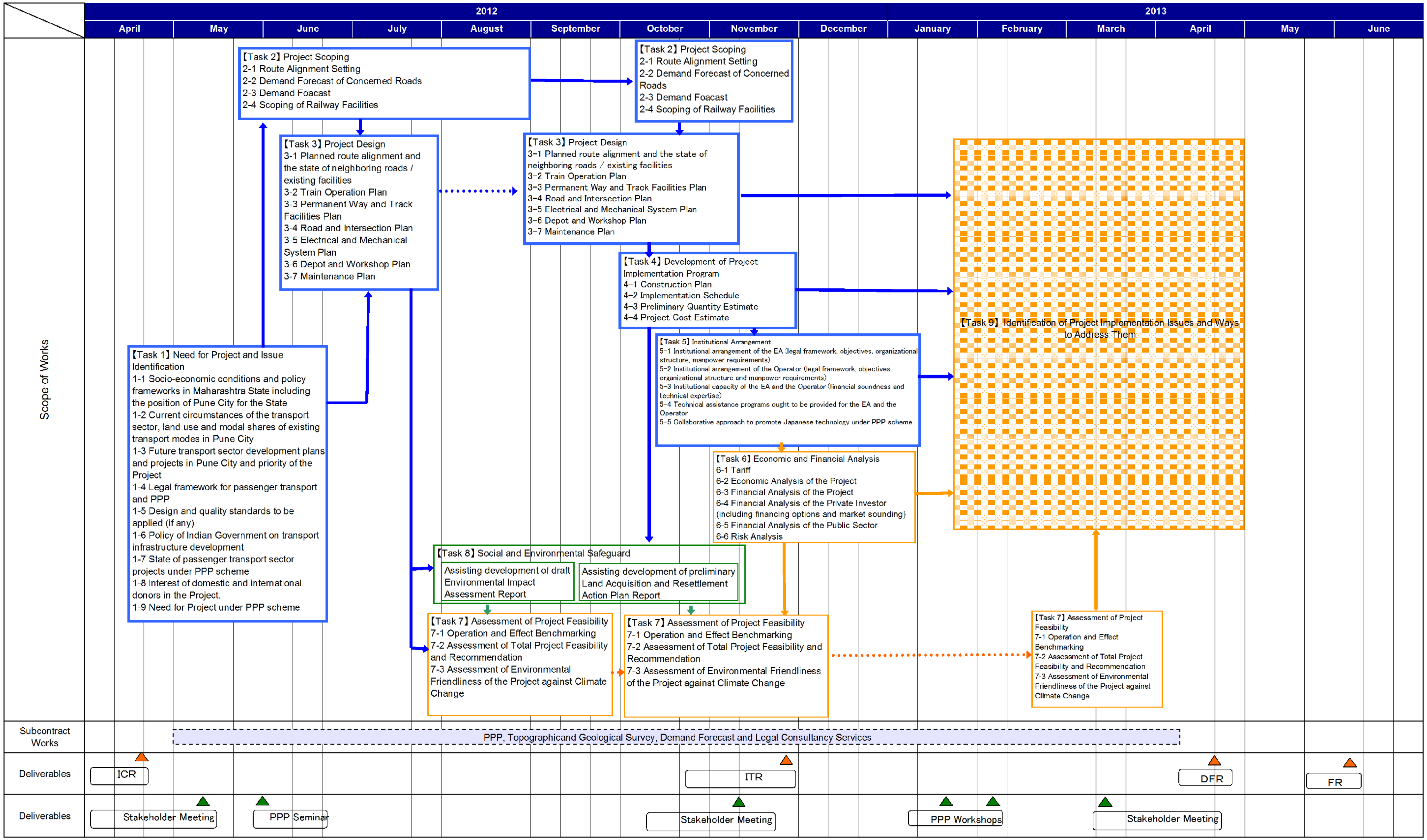


Figure 1.1.1 Work Flowchart

1.1.5 Selection of Study Team Members and Schedule

The Team members were carefully selected, ensuring that they can accomplish all the tasks within the Study period. The criteria for the member selection included the following items (each member satisfies at least one of these requirements):

- Experience in urban railway projects
- Experience in performing similar assignments
- Experience in planning city redevelopments
- Experience in planning the construction of urban railways
- Residing in India, having a good understanding of the local conditions
- Experience in working on projects in India
- Having good communication skills and being able to coordinate with International Donor Agencies and government entities in India

Our members have the experience noted above. Also they are elected in light of their professional abilities. The survey period in India and Japan has been planned.

Experts stay on top of the work which they are in charge of doing in this project and perform their activities responsibly. They cooperate well together in consideration that their specialties are closely related to one another and assist other works flexibly as needed.

Implementing agencies of the Indian side are Pune city (PMC), Pimpri Chinchwad city (PCMC) and Maharashtra Industrial Development Corporation (MIDC). There is Hinjewadi Industries Association (HIA) in Hinjewadi IT Park. It is required to interact with 4 agencies and investigate smoothly.

Collecting data from interviews with related organizations and counterparts (refer to Table 1.1.1) is conducted to facilitate this project. We will address consensus-building on major matters by "Stakeholders Meetings" (see Table 1.1.2). Stakeholder meetings are held a total of three times, the PPP seminar is once and PPP workshop is also once.

Counterparts and stakeholders are as follows.

Table 1.1.1 Counterparts

Department	PMC	PCMC	MIDC
Urban Planning	Mr.Prashart M. Waghmare	Mr. M T Kamble	Mr.S.B. Patil
Civil Work	Mr.Shrinivas Bonala	Mr. S.S. Savane	Mr. Ulhas Kulkarni
E and M Work	Mr.Shrinivas Kandul	Mr. Milind Kapile	Mr. R.K Bhorkade
Environment	Mr.Mangesh Dighe	Mr. Nikam	Mr. P.G.Deogiri
PPP	Mr.Prashant Waghmare Mrs.Kalaskar	Mr. Deepak Shirke	Regional Officer Mr. Relekar
Operation	Mr. Satish Kulkarni	Mr. Gaikwad	Mr. S.B. Patil

Table 1.1.2 Stakeholders

Position	Name	Department
Chairman	Mr. Mahesh Pathak	PMC Commissioner
Vice-chairman	Mr. Anup Yadav	PCMC Acting Commissioner
Member	Mr. Bonala Srinivas	PMC Additional City Engineer
Member	Mr. Prashant Wagmare	PMC
Member	Mr. Sanjey Kulkarni	PMC
Member	Mr.M.T. Kamble	PCMC Joint City Engineer
Member	Mr.B.Gaikwad	PCMC Junior Engineer
Member	Mr.Ulhas Kulkarni	MIDC Executive Engineer
Member	Mr.Relekar	MIDC Regional Officer
Member	Mr. Snil Pailwan	HIA Infosys

The Team is confident that each Team member fully understands their work responsibilities and will perform their scope of works in a professional way, ensuring collaboration and teamwork. Figure 1.1.2 indicates the Study Team Organization.

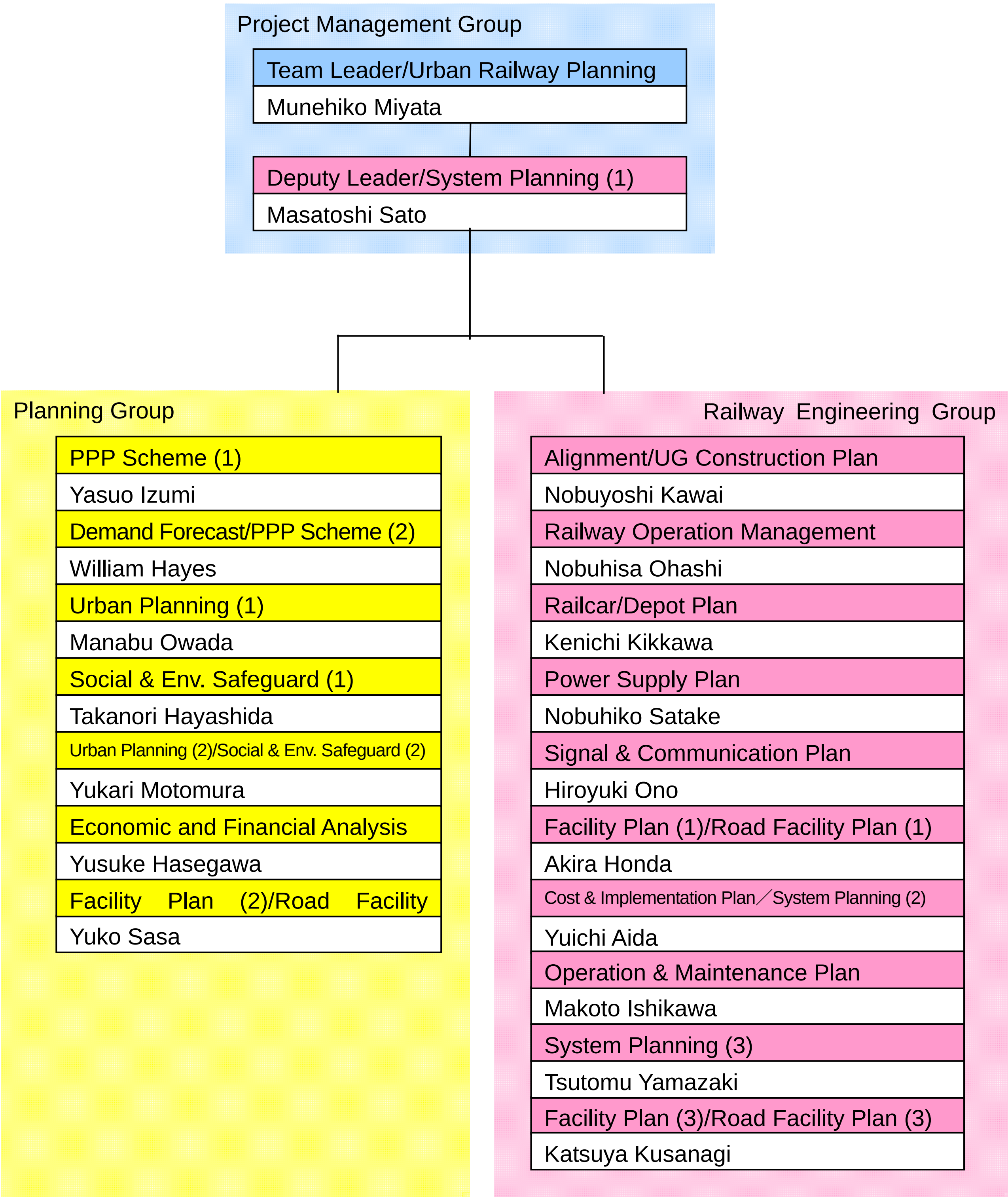


Figure 1.1.2 Study Team Organization

1.2 Target Area of this Study

1.2.1 Planned Urban Transport System Routes

Pune, Maharashtra, India

The 21.6 km between the center of Pune city and northwest Hinjewadi IT Park.

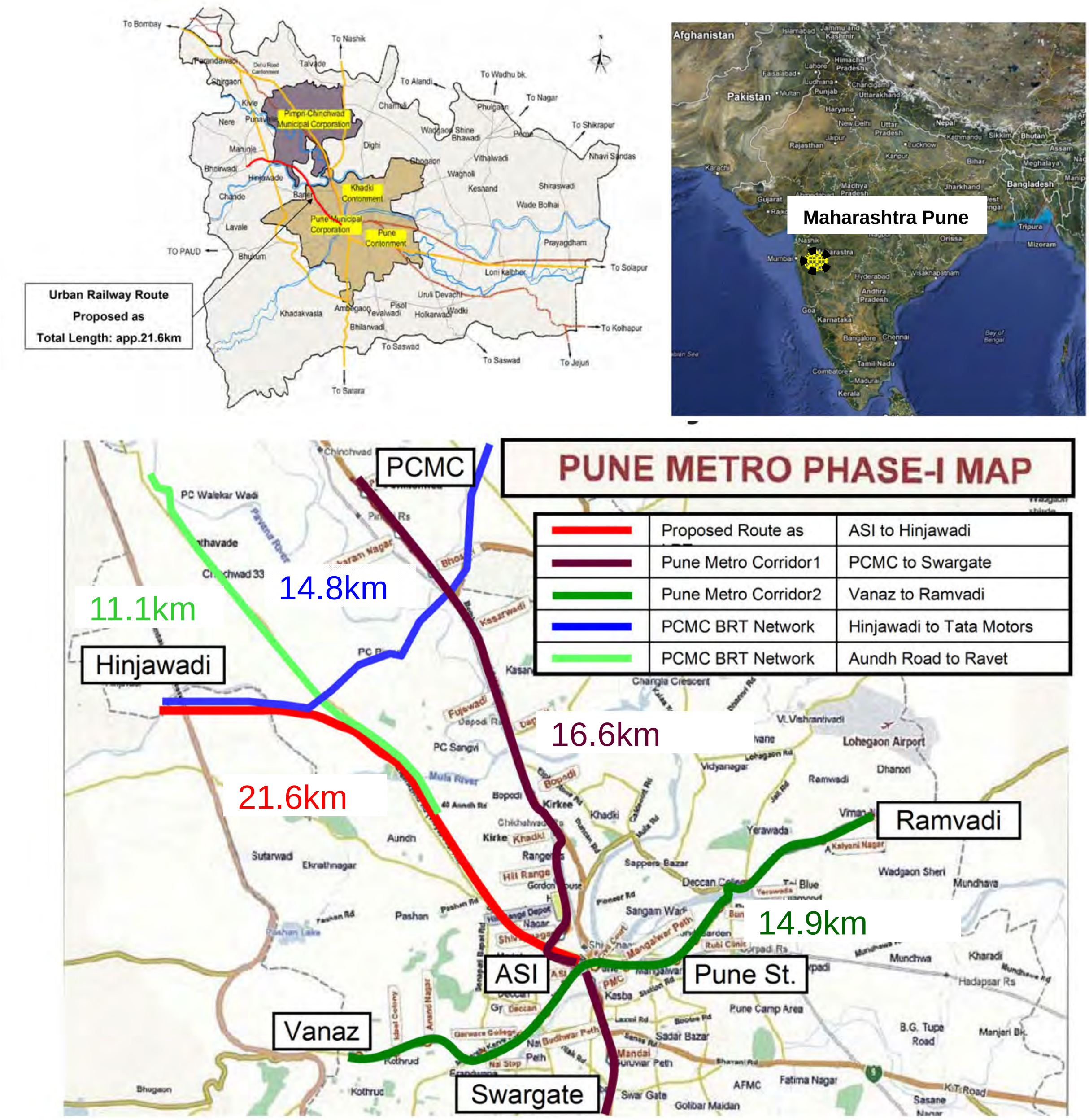


Figure 1.2.1 Planned Urban Transport System Routes of Pune

1.2.2 Basic specifications for Pune - Hinjawadi urban railway

Basic specifications for Pune - Hinjawadi urban railway are shown in Table 1.2.1.

Table 1.2.1 Basic Specifications for Pune-Hinjawadi Urban Railway

Item	Basic Conditions
Route Length	Phase 1： App. 14.6 km Phase 2： App. 6.75 km Total route length： App. 21.35 km
Structure Type of Route	Viaduct and at-grade structures
The Number of Stations	Elevated Station： 20 At-grade Station： 3 Total： 23
Maximum Section Ridership （per hour per direction）	The year 2018： 6,978 persons The year 2028： 10,865 persons The year 2038： 15,102 persons
Daily LRT Passenger Flows for Partially Elevated LRT	The year 2018： 159,347 persons The year 2028： 337,740 persons The year 2038： 655,183 persons
Rolling Stock	Battery driven LRT Vehicle（low-floor）
Train Configuration	3 cars for 1 unit x 2
Minimum Headway	The year 2018： 5 minutes The year 2028： 3.3 minutes The year 2038： 2 minutes
Design Maximum Speed	80 km/h
Gauge	1,435 mm
Maximum Acceleration	4.0 km/h/s
Deceleration	5..5 km/h/s（normal time） 6.0 km/h/s（emergency）
Axle Load	12 t
Rail	Equivalent to UIC 54 kg/m
Maximum Gradient	70 ‰
Minimum Radius	20 m
Recharge Voltage	DC 600 V
Feeding System	Using pantograph at stations
Signalling System	At-grade： Track circuit, Time interval safety operation system, Track signal Elevated：Track circuit, Automatic block system, Color light signal
Communication Equipment	Key Data Transmission System： Optical Fiber Cable
Fare Collection System	Ticket gate system using contactless IC token and card

1.2.3 The focus of this project

- This project is an LRT development project that connects the center of Pune city and the IT Park. It's necessary to consider the connection between this LRT project and metro line 1 and 2 projects which PMC is working on. A comprehensive urban transport in Pune district is required. As part of that, a smart community will be made into a reality.
- In consideration of the environment in Pune, an LRT system which has no overhead line will be introduced. At the place where serious road congestions occur, an elevated route is adopted. If we can secure enough land on the road, At-grade is thought to be best. Electricity is sometimes cut off in Pune, therefore the storage battery is adopted as the power supply system in such area.
- Construction of the bus terminal in the center of Pune, redevelopment in front of the station of Indian Railways and the buildings in the depot are proposed to attract investors.

1) Formation the transportation network and development the urban railway by construction of an LRT

1. The IT Park which is expected to progress in development, 2. PCMC area where the development expands and many residential apartment blocks are located. 3. The center of Pune city (the connection point with the metro lines 1 and 2)

An LRT which connects from 1 to 3 is planned.

Pune city's concept is a Green City. The introduction of an LRT system without overhead wire is expected, because it's friendly to the environment to suit Pune city. Metro Lines 1 and 2 have already been approved by the state government. At JM Temple station, which is the starting station of the LRT, we can transfer from the LRT to Metro Lines 1 and 2. This connecting station will improve the convenience for passengers who ride the LRT and Metro. Also because of the transportation network including LRT and Metro, the area of movement of the passengers is broadened and it is possible to increase the convenience of access to destinations around the LRT and Metro stations. In addition to this, the ability to pull in more customers is expected in the surrounding area.

2) The introduction of a railway system that is environmentally friendly

The power supply system that has no overhead wires that is eco-friendly is a storage system. If we introduce the power storage system, it's possible to operate the railway in case of power outage. Also, the LRT is able to turn through a small radius of curvature and on narrow roads. By introducing this new type of urban railway, Pune district will enhance its role as the core area of India, and the IT Park, PCMC and PMC will be highly socially connected.

3) Improving the quality of maintenance and reducing the costs of public facilities

At the parts of the elevated structure, an elevated access way or concourse under the walkway are to be installed. Service facilities are also to be introduced to enhance the convenience of passengers. At the parts of the at-grade structure, a limited LRT lane is constructed to gain labor-saving and efficiency of the LRT system's maintenance, and improvement of cost reduction and the safety of passengers. Earnings from private investment facilities which are constructed in the depot form a part of the budget of the construction cost of LRT to relieve the burden of expenses from the central, state and local governments.

Chapter 2 Current Condition, Issues and Development Policy in Pune Region

2.1 Policy and Legislative System in Maharashtra State

2.1.1 Outline of Maharashtra State

1) Geography and Climate

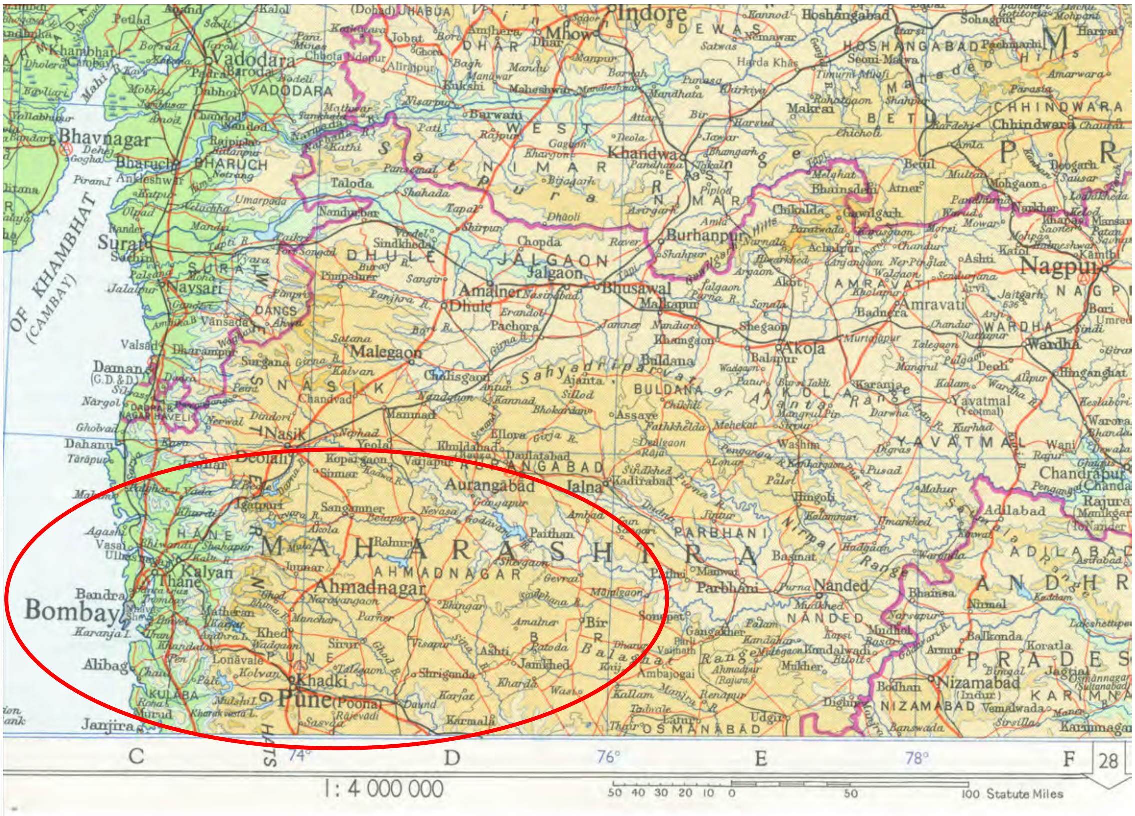


Figure 2.1.1 Topographic Map of Maharashtra State (Mumbai- Pune)

Source: The Times ATRAS OF THE WORLD

Table 2.1.1 Temperature (°C) and Rainfall (mm) in Pune Region

By Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum Temperature (°C)	30.8	32.8	36	38.1	37.2	32.1	28.3	27.5	29.3	31.8	30.5	29.6
Average Minimum Temperature (°C)	11.4	12.7	16.5	20.7	22.5	22.9	22	21.4	20.7	18.8	14.7	12
Rainfall (mm)	0	0.5	5.3	16.6	40.6	116.1	187.2	122.3	120.1	77.9	30.2	4.8
Rainfall Days	0	0.1	0	1.1	2.8	7.5	12.8	10.6	7.4	4.6	2	0.4

Source: Data from World Meteorological Organization

Maharashtra State encompasses an area of 307,713 km², and is the third largest state in India. The State is located in western India. It is bordered by the state of Goa and Karnataka to the south, Andhra Pradesh to the Southeast, Gujarat and Madhya Pradesh to the north, and Chattisgarh to the east. There is the Arabian Sea to the west of Maharashtra state. The Deccan Plateau is located in a north-south direction in Maharashtra state. There are summer resorts using the elevation difference. From June until October, it is rainy season because of the monsoon. The temperature of Mumbai city, the capital of Maharashtra state is between about 16 – 33 ^{0}C.

2) Socio-economic Condition

The population of Maharashtra state is approximately 112 millions. In the past, Mumbai city was the largest city. However, the Mumbai metropolitan area has been expanded in recent years. The population of the old city has been reduced. In 2011, the Thane district next to Mumbai city was the largest district in Maharashtra state. On the other hand, the population density of Mumbai city is still high and it covers 20 thousand / km^2. The population of the Pune district is 9.4 million. The population growth rate is approximately 2.7% / year.

Table 2.1.2 District wise population, population density and population growth rate in 2011

District	Population (Thousand Person)	Population Density (Person/km^2)	Growth Rate (%)	District	Population (Thousand Person)	Population Density (Person/km^2)	Growth Rate (%)
Nandurbar	1,646	276	2.3	Aurangabad	3,696	365	2.4
Dhule	2,049	285	1.8	Nashik	6,109	393	2.0
Jalgaon	4,224	359	1.4	Thane	11,054	1,157	3.1
Buldana	2,588	268	1.5	Mumbai (Suburban)	9,332	20,925	0.8
Akola	1,819	321	1.1	Mumbai	3,146	20,038	-0.6
Washim	1,197	244	1.6	Raigarh	2,635	368	1.8
Amravati	2,888	237	1.0	Pune	9,427	603	2.7
Wardha	1,296	205	0.5	Ahmadnagar	4,543	266	1.2
Nagpur	4,653	470	1.4	Bid	2,586	242	1.8
Bhandara	1,199	293	0.5	Latur	2,456	343	1.7
Gondiya	1,322	253	1.0	Osmanabad	1,660	219	1.1
Gadchiroli	1,072	74	1.0	Solapur	4,316	290	1.1
Chandrapur	2,194	192	0.6	Satara	3,004	287	0.7
Yavatmal	2,775	204	1.2	Ratnagiri	1,613	196	-0.5
Nanded	3,357	319	1.6	Sindhudurg	849	163	-0.2
Hingoli	1,179	244	1.8	Kolhapur	3,874	504	1.0
Parbhani	1,836	295	1.9	Sangli	2,821	329	0.9
Jalna	1,958	255	2.0				

Source: Population Census 2011

Maharashtra State is the most rapidly growing state in India. The GSDP of Maharashtra State at 2004 prices in 2011 was approximately 8 trillion, contributing approximately 15% of India's GDP. The annual growth rate was 8.54% in 2011, beyond the average growth rate of India. The GSDP of Mumbai is the highest in Maharashtra state. Second highest district is the Thane district next to Mumbai. Third highest district is the Pune district, the study area.

Table 2.1.3 District wise GDDP at 2004 prices in 2010

Unit: Trillion Rupee

District	GDDP	District	GDDP	District	GDDP
Mumbai	1,690	Sangli	153	Akola	81
Thane	997	Solapur	223	Washim	37
Raigad	189	Kolhapur	254	Amravati	128
Ratnagiri	98	Aurangabad	225	Yavatmal	107
Sindhudurg	48	Jalna	66	Wardha	65
Nashik	372	Parbhani	63	Nagpur	367
Dhule	85	Hingoli	31	Bhandara	52
Nandurbar	41	Beed	83	Gondia	48
Jalgaon	218	Nanded	106	Chandrapur	124
Ahmednagar	207	Osmanabad	54	Gadchiroli	29
Pune	852	Latur	86		
Satara	155	Buldhana	83		

Source: Maharashtra Economic Survey in Maharashtra 2011-2012

2.1.2 Legislative system

1) Government Structure on Urban Development

Based on the Constitution of India in 1950, the legislative power has been split into the central government and state government. The local administration had made state governments play a central role. Based on the Five - Year Plans of India, the central government makes the policy for the urban development that is conducted by the state government and supports it financially. However, the transfer of authority and resources to municipalities hasn't occurred. Therefore, the constitution was amended in 1992, the 74th Amendment. The main authority concerning urban policy (land use regulation, urban planning, economic development, sewage, local road development and so on) has been transferred from state government to the municipalities. With the constitutional amendment, municipalities were divided into urban areas and rural areas. It was specified in the constitution that the urban municipalities develop the urban plan, land use regulation and local roads in their jurisdiction and state governments regulate the development in rural areas

Table 2.1.4 Performance of functions of state governments and local governments

<table>
<tr><th colspan="2">State Government</th></tr>
<tr><td colspan="2">1. Public Order 2. Public health and sanitation 3. Relief of the disabled and unemployed 4. Transportation infrastructure development 5. Agriculture, including agricultural education 6.Preservation of stock 7. Water supply 8. Land preservation 9. Fisheries 10. Regulation of mine and mineral development 11. Industry conservation 12. Gas and gas-works 13. Trade and commerce within the State 14.Production, supply and distribution of goods 15. Incorporation 16. Management of State owned factory buildings and areas</td></tr>
<tr><th>Urban Municipality</th><th>Village</th></tr>
<tr><td>1. Urban planning including town planning.
2. Regulation of land-use and construction of buildings
3. Planning for economic and social development
4. Roads and Bridges
5. Water supply for domestic, industrial and commercial purposes
6. Public health, sanitation conservancy and solid waste management
7. Fire Services
8. Urban forestry, protection of the environment and promotion of ecological aspects
9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded
10. Slum improvement and up grading
11. Urban poverty alleviation
12. Provision of urban amenities and facilities such as parks, gardens, playgrounds
13. Promotion of cultural, educational and aesthetic aspects
14. Burials and burial grounds; cremations, cremation grounds; and electric crematoriums
15. Cattle pounds; prevention of cruelty to animals
16. Vital statistics including registration of births and deaths.
17. Public amenities including street lighting, parking lots, bus stops and public conveniences
18. Regulation of slaughter houses and tanneries.</td><td>1. Agriculture, including agricultural extension
2. Land improvement, implementation of land reforms, land consolidation and soil conservation
3. Minor irrigation, water management and watershed development
4. Animal husbandry, dairying and poultry
5. Fisheries
6. Social forestry and farm forestry
7. Minor forest produce
8. Small scale industries, including food processing industries
9. Textile industry, village and cottage industries
10. Rural Housing
11. Drinking Water
12. Fuel and fodder
13. Roads, culverts, bridges, ferries, waterways and other means of communication.
14. Rural electrification, including distribution of electricity
15. Non-conventional energy sources
16. Poverty alleviation program
17. Education, including primary and secondary schools
18. Technical training and vocational education
19. Adult and non-formal education
20. Libraries
21. Cultural activities
22. Markets and fairs
23. Health and sanitation, including hospitals, primary health centers and dispensaries
24. Family welfare
25. Women and child development
26. Social welfare, including welfare of the handicapped and mentally retarded
27. Welfare of the weaker sections, and in particular, of the Scheduled Castes and the Scheduled Tribes
28. Public distribution system
29. Maintenance of community assets</td></tr>
</table>

Source: The constitution of India

2) Urban Land Ceiling and Regulation Act: ULCRA

To prevent land speculation and monopoly in urban areas, the urban land ceiling and regulation act was enacted in 1976 in India. Land transactions even for housing developments up to 500 – 2,000 square meters are regulated by the law. This caused many people to avoid land transactions, which led to the development of slums. Regarding the issues, some states repealed the ULCRA beginning in 1999. To apply for projects based on the JNNURM scheme, repealing the ULCRA is required for the state.

3) Maharashtra Regional and Town Planning Act: MRTPA

A development plan which is created by a municipality has legal force based on state law. In the MRTPA, it is specified that urban planning should be conducted based on 3 processes, regional planning, the municipal development plan and urban planning. It is also specified that the development plan which is created by the municipality should include a land use plan and transportation infrastructure development plan. A survey of existing land use and public involvement are required in the process of developing the plan. Final approval of the Maharashtra state government is also required.

2.1.3 Urban Development and Transportation Policy

1) National Urban Transportation Policy: NUTP

Considering the recent rapid population growth in urban areas and the degradation of the transportation environment, the ministry of urban development enacted the NUTP in 2006. To improve the transportation environment, it is specified in the NUTP to integrate land use plans and transportation policy, preferential use of public transport and develop seamless transfer facilities between public modes of transport. Furthermore, to improve the atmospheric environment in urban areas, it is also specified that the necessity to promote bicycle use and introduce electric cars.

2) JNNURM (Jawahalal Nehru National Urban Renewal Mission)

The JNNURM is the project scheme regarding transportation and urban development founded by the ministry of urban development. Based on the 74th Amendment, the municipality is responsible for urban planning. The central government approves and supports financially only the urban development projects which are in concurrence with the national policy.

The characteristics of the scheme are as follows;

- Huge amount of budget
- Target only for major cities
- Based on the 74th amendment, public involvement is required
- There are two programs, urban infrastructure and governance and basic Services for Urban Poor

To be approved, the following things are required for the municipality;

- Development of a middle term city development plan, CDP, and involvement of public comment
- Development of project lists based on the CDP
- Development of an implementation plan

2.2 Current Condition and Issues in Pune Region

2.2.1 Current Condition and Issues in Pune Metropolitan Region

1) Development Plan for Pune Metropolitan Region

(1) Outline

In 1967, the Maharashtra State started to develop the regional plan for the Pune metropolitan region, including the PMC, PCMC and more than 100 surrounding villages covering approximately 1,610 square kilometers. The first regional plan was targeted for 1979 to 1991. The second plan targeted 1990 to 2011. At present, there is no regional plan other than the second plan.

Establishment of the Pune metropolitan regional development authority is still under consideration. Therefore, the chief secretary of the Pune district manages the regional plan for the Pune metropolitan region and the city planning department of the Maharashtra state supports it.

(2) Development Policy

To alleviate traffic congestion and slum areas growing in urban areas, the multi-polar urban structure was proposed in the regional plan to prevent over concentration in Pune as of 1990. Seuru, Kanapur , Hinjawadi, Moshi, Waguholi are specified as new developing cores in addition to PMC, PCMC, the existing cities.

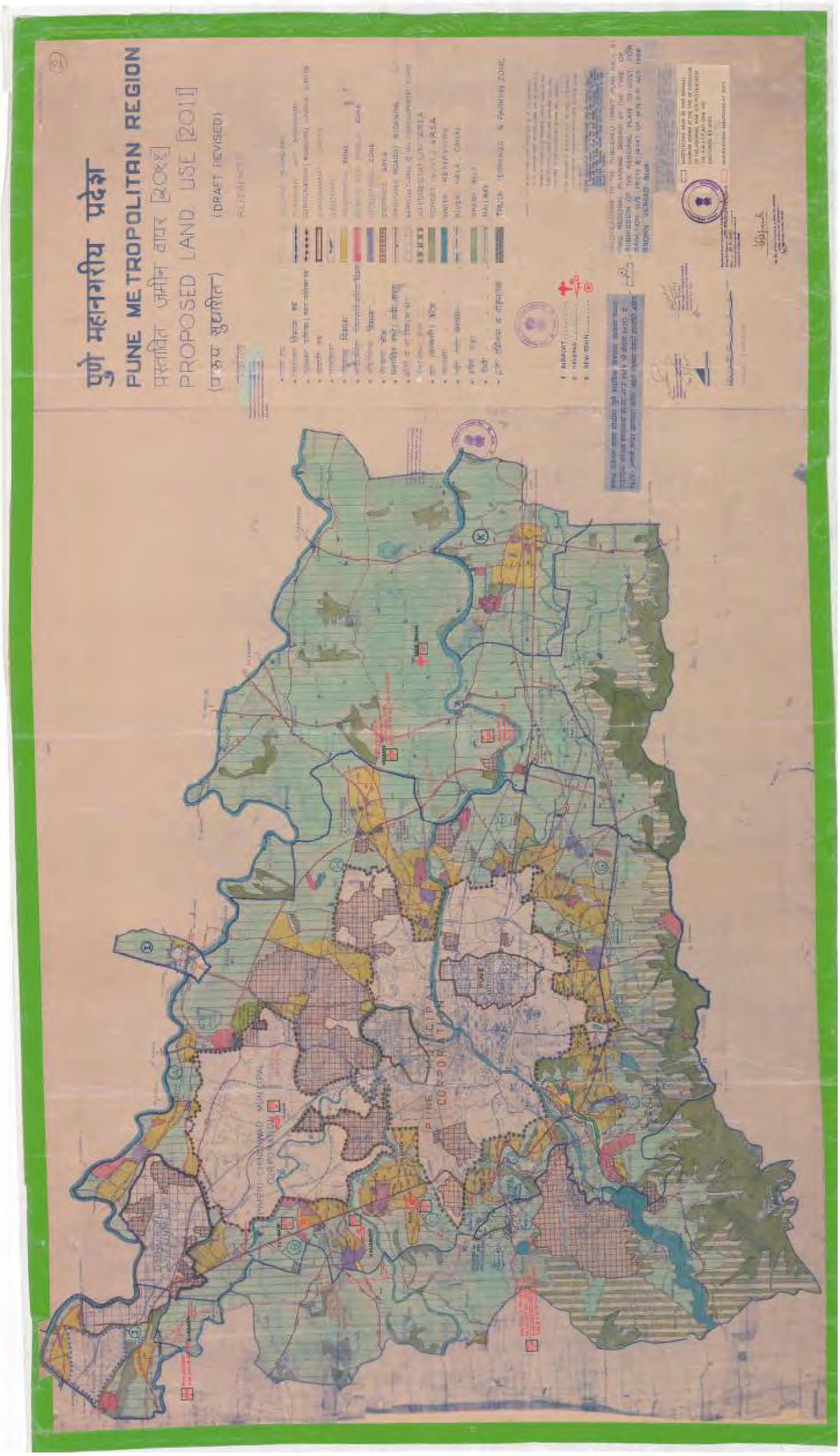


Figure 2.2.1 Development Plan for Pune Metropolitan Region

Source: Development Plan for Pune Metropolitan Region

2) Population

The population of the Pune Metropolitan Region in 2001 was approximately 4.3 million. The population of the metropolitan region has been growing. In particular, the proportion of the population of the Pimpri – Chichwad City has been increasing.

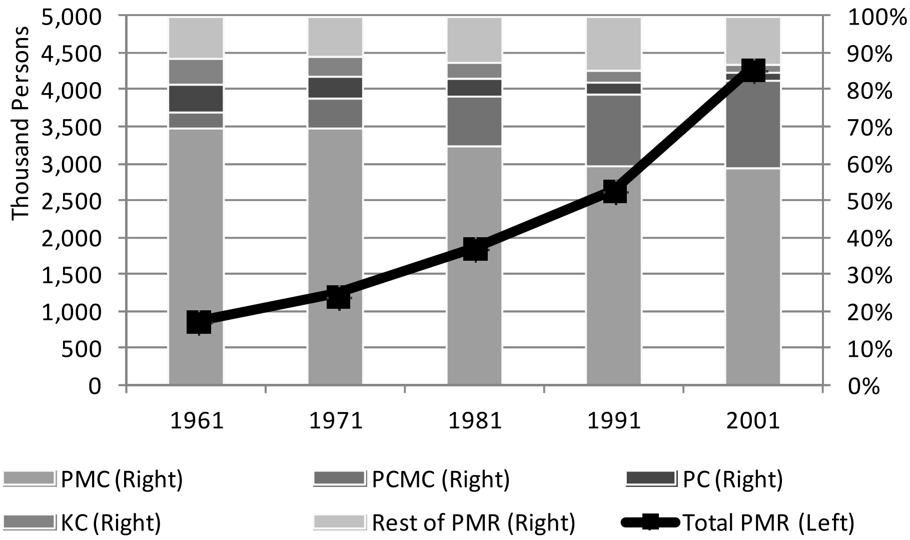


Figure 2.2.2 Trend of the population of Pune Metropolitan Region

Source: Estimated by JICA Study Team based on the Population Census

3) Industrial Development

To develop a multi-polar urban structure, an industrial area has been developed by MIDC in the suburban area of the Pune metropolitan area. IT parks are over represented in the industrial development. Particularly, the Rajiv Gandhi InfoTech Park Area, RGIP, is a large scale industrial area. The industrial area in Pimpri Chinchwada, for the auto industry, is sold out. There is TATA motors in the industrial area.

Table 2.2.1 Industrial area in the Pune Metropolitan area

Name	Owner	Area (ha)	Completion Status	Sector	Land Rate (Rp.sqm)
Rajiv Gandhi InfoTech Park Area Phase-1	MIDC	94.62	100%	IT, ITES	2470
Rajiv Gandhi InfoTech Park Area Phase-2	MIDC	236.23	100%	BT	2470
Rajiv Gandhi InfoTech Park Area Phase-3	MIDC	351.17	80%	IT, ITES	2470
Rajiv Gandhi InfoTech Park Area Phase-4	MIDC	464.44	N/A	IT, ITES	N/A
Rajiv Gandhi InfoTech Park Area Phase-5	MIDC	446.59	N/A	N/A	N/A
Rajiv Gandhi InfoTech Park Area Phase-6	MIDC	712.8	N/A	N/A	N/A
Talegaon	MIDC	578.1	N/A	Floriculture	2395
Talawade Software Park	MIDC	75	60%	IT	935
Pimpri Chinchwada	MIDC	1224.12	100%	Auto, Auto Component	9310
Kharadi Knowledge Park	MIDC	30	100%	Software	1000
SP Info city	Private	N/A	N/A	IT	795
Magarpatta CyberCity	Private	N/A	N/A	IT	N/A

Source:JICA study team, based on the document from MIDC

4) Township Development

Huge township developments, such as more than 100 acres, have been developed by private investors in the Pune metropolitan area. With exceptions, most of the townships have been developed in villages next to PMC and PCMC.

Table 2.2.2 Township developments in the Pune Metropolitan Area

Name	Developer	Area (Acre)	Stage	Sector
Balador	Sabio Eagle Realtors Pvt. Ltd.,	45	Under Construction	Commercial and Residence
Amanora Park Town	City Corporation Ltd.,	400	Completed	Commercial and Residence
Lake District	PRT Realty Pvt.Ltd.,	110	Under Construction	Commercial and Residence
Nanded City	Nanded City Development & Construction Company Ltd.,(SPC)	700	Under Construction	Commercial and Residence
Mangarapatta City	Magarpatta Township Development & Construction Company Ltd,	400	Under Construction	Commercial, Residence and Industry
Blue Ridge	Paranjape Schemes (Construction) Ltd.	138	Under Construction	Commercial, Residence and Industry
Kul Ecoloch	Kumar Urban Development Ltd.,	N/A	Under Construction	N/A
Life Republic	Kolte-Patil Developers Ltd.,	400	Under Construction	Commercial and Residence
Megapolis	Pegasus Properties Pvt. Ltd.,	150	Under Construction	Residence

Source: JICA study team, based on brochures of each developer

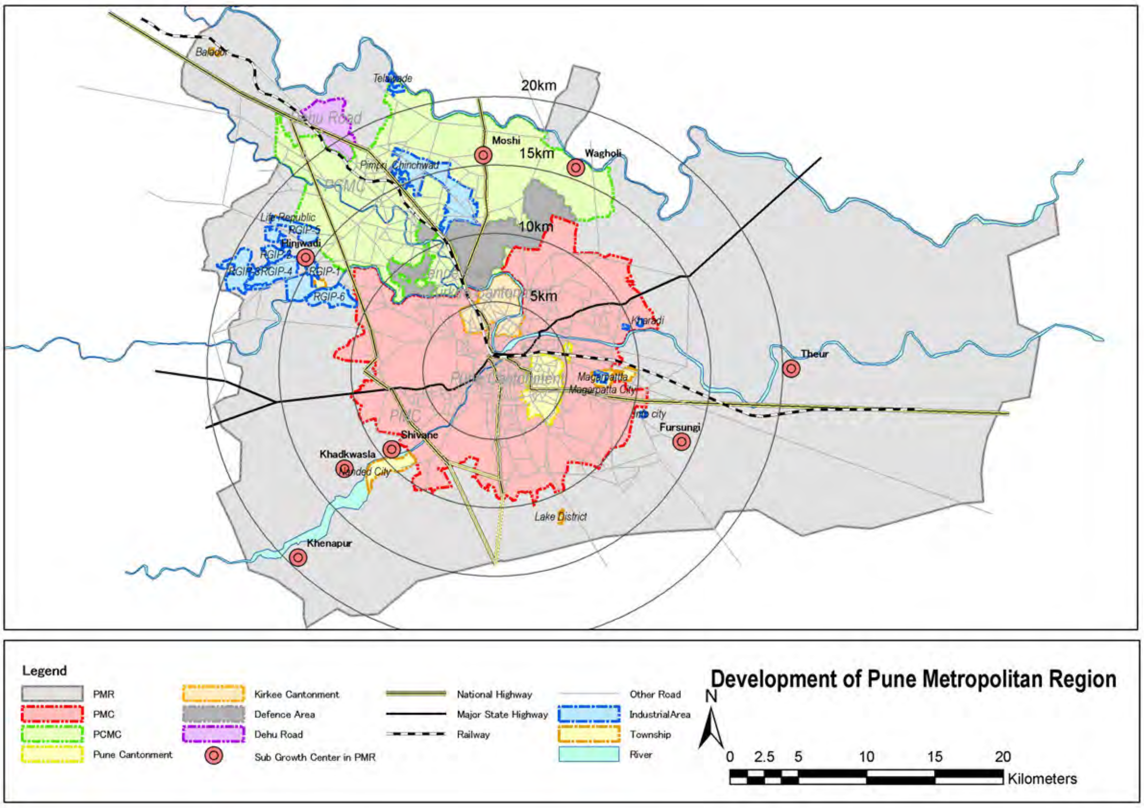


Figure 2.2.3 Development direction and trend in the Pune metropolitan region

Source: JICA study team, based on the regional plan for the Pune metropolitan region

5) Issues in the Pune metropolitan region

Based on the policy of Maharashtra state, huge industrial areas have been developed in suburban areas. Furthermore, townships have been developed by private sectors in suburban areas of PMC and PCMC. This has caused an increase in the residential area and increase population.

With the urban sprawl, it is assumed that economic activities will cross the borders of municipalities. Establishment of the Pune metropolitan region development authority is required to manage the economic, urban and transportation issues comprehensively.

2.2.2 Current Condition and Issues in PMC

1) Outline

PMC, urban municipality which was established in 1950, is consisted of 14 wards and 144 sub-wards. There are many educational institutions such as the University of Pune, and research institutes in PMC. Therefore, PMC is called the “Oxford of the East”. There are cantonment areas in the east and north part of PMC. With the urban sprawl, jurisdiction of PMC has also expanded to the outside. The jurisdiction has expanded to 244 square kilometers as of 2012 from 139 square kilometers as of 1961.

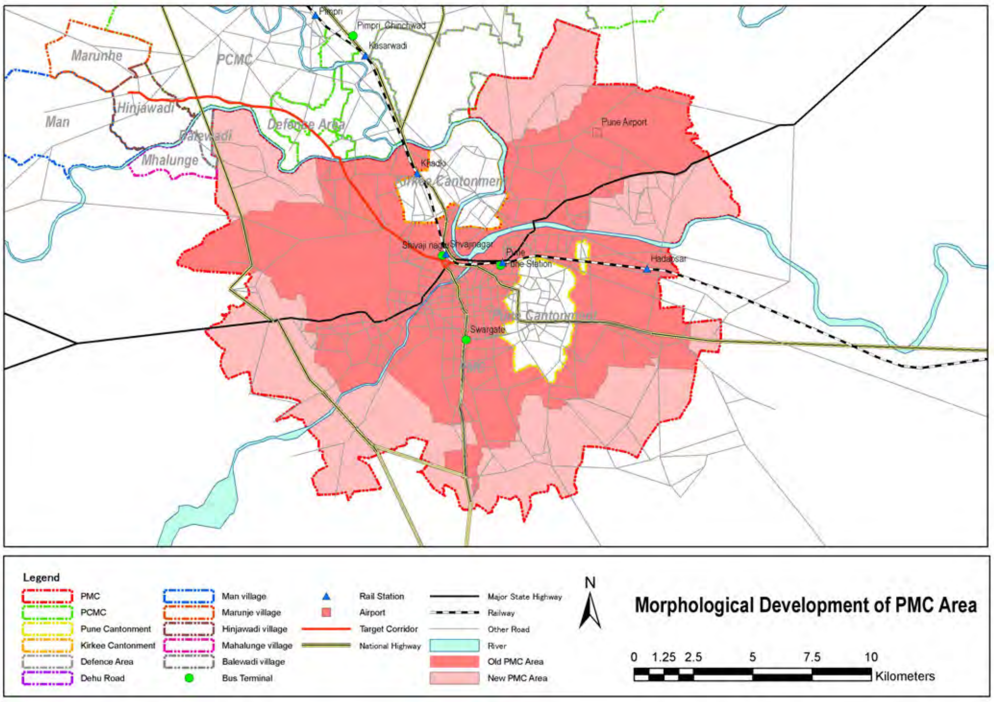


Figure 2.2.4 Morphological development of PMC area

2) Demographics

Pune is the ninth largest municipality in India and the second largest municipality in the Maharashtra state as of 2011. With the expansion of the urban area, population and population density also have been increasing. Population of PMC is approximately 3.12 million. Population density is quite high, 12,775 persons per square kilometer.

Table 2.2.3 Trend of population and population density of PMC

Year	Population (Person)	Area (km2)	Density (Person/km2)
1951	488,419	19.05	256
1961	606,777	138.98	4,366
1971	856,105	138.98	6,160
1981	1,203,363	146.95	8,189
1991	1,566,651	146.11	10,722
2001	2,538,473	243.87	10,409
2011	3,115,431	243.87	12,775

Population density is high in the central area, old city, and low in suburban areas, and the new town in PMC. Along with the target corridor, south of the Ghaneshind Road and the old city, near the Aundh, are high density areas. On the other hand, the area of the University of Pune and Pnachavati hill is low density.

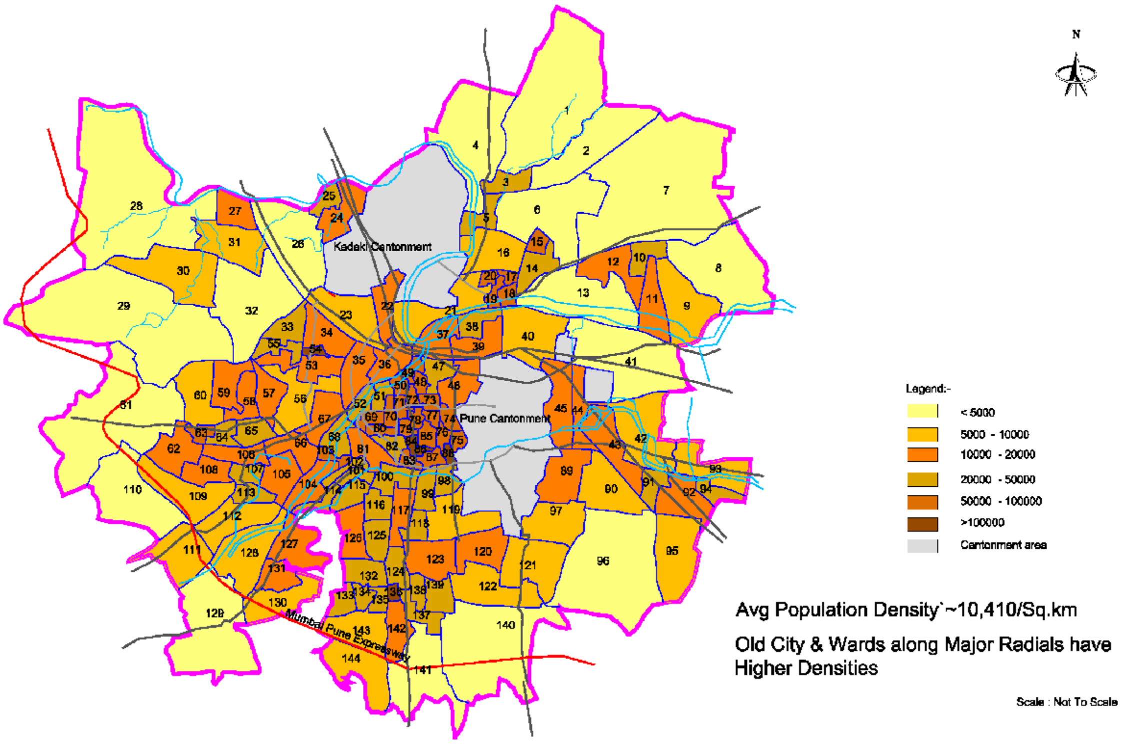


Figure 2.2.5 Population density of PMC in 2001

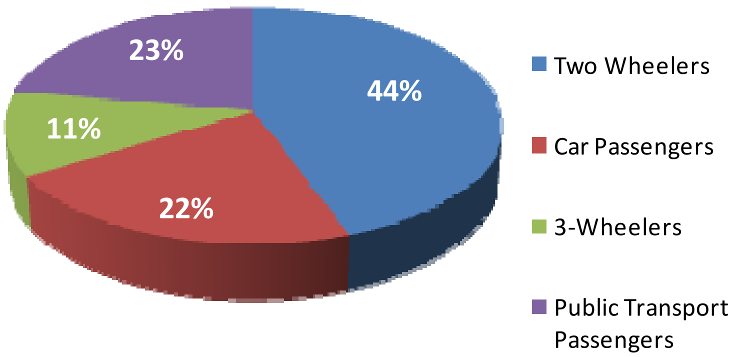
Table 2.2.4 Administration ward wise population in PMC, preliminary figure

Ward Name	Populationin2011
Aundh	180,007
Bhawani Peth	191,514
Bibwewadi	295,246
Dhankawadi	236,284
Dhole Patil Road	155,086
Ghole Road	171,511
Hadapsar	324,104
Kasba Vishrambaugwada	178,079
Kothrud	208,748
Yerwada	238,094
Sahakarnagar	203,031
Sangamwadi	260,935
Tilak Road	240,397
Warje Karvenagar	232,395
Total	3,115,431

Source: JICA study team estimated, based on the document from PMC

3) Transportation

Share of public transportation in PMC is approximately 23%. Compared with other major cities in Asia, the share is relatively high. On the other hand, the number of registered cars and motorcycles has been growing. The number of motorcycle owners in 2007 was 367 motorcycles per thousand persons, 2.7 times higher than the number in 1993. The number of car owners in 2007 was 71 cars per thousand persons, 4.3 times higher than the number in 1993.



Unit: Trips/ Peak Hour, %

Figure 2.2.6 Modal split of inner trips in PMC in 2008[1]

Source: Comprehensive mobility plan for PMC

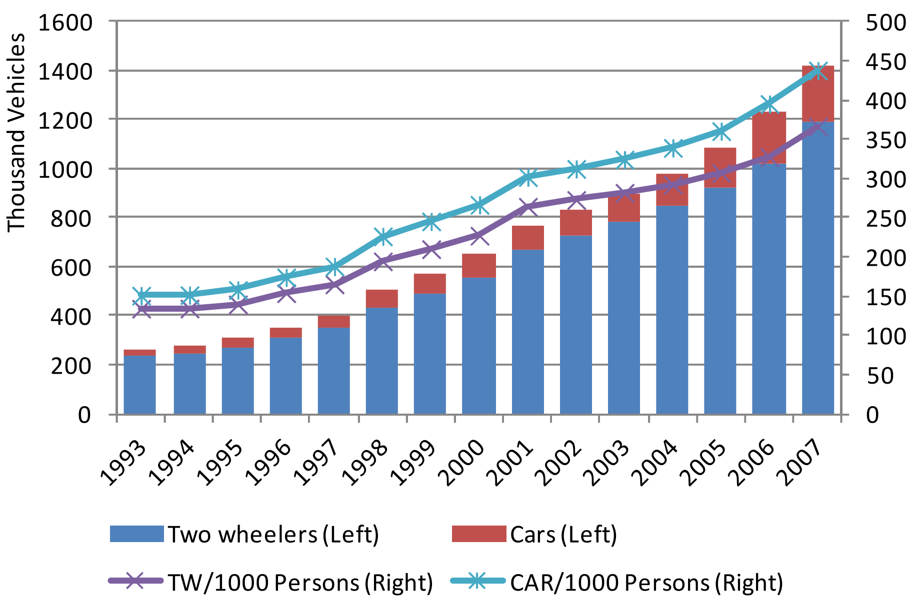


Figure 2.2.7 Trend of car and motorcycle ownership in PMC

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

4) Issues

The population, jurisdiction and population density of PMC has increased. The expansion of jurisdiction increases the average trip distance of people. The increasing population density increases traffic volume. Furthermore, economic growth has caused an increase in car ownership and motorcycle users. It might make worth the environmentl impact caused by traffic in PMC.

[1] The component ratio of the trips between each zone by each transportation mode were estimated by the demand forecast model in the Comprehensive Mobility Plan for PCMC

2.2.3 Current Condition and Issues in PCMC

1) Outline

PCMC, is an urban municipality which was established in 1970, the residential area for refugees from Pakistan which was developed in 1948, consisted of 4 wards. There are cantonment areas in south north part of PCMC. With the urban sprawl, jurisdiction of PCMC has also expanded, like PMC. The jurisdiction has expanded to 170.51 square kilometers as of 2012 from 86.01 square kilometers as of 1970. There is an industrial area which was developed by MIDC in the center of PCMC. The PMCM is next to the Hinjawadi in area.

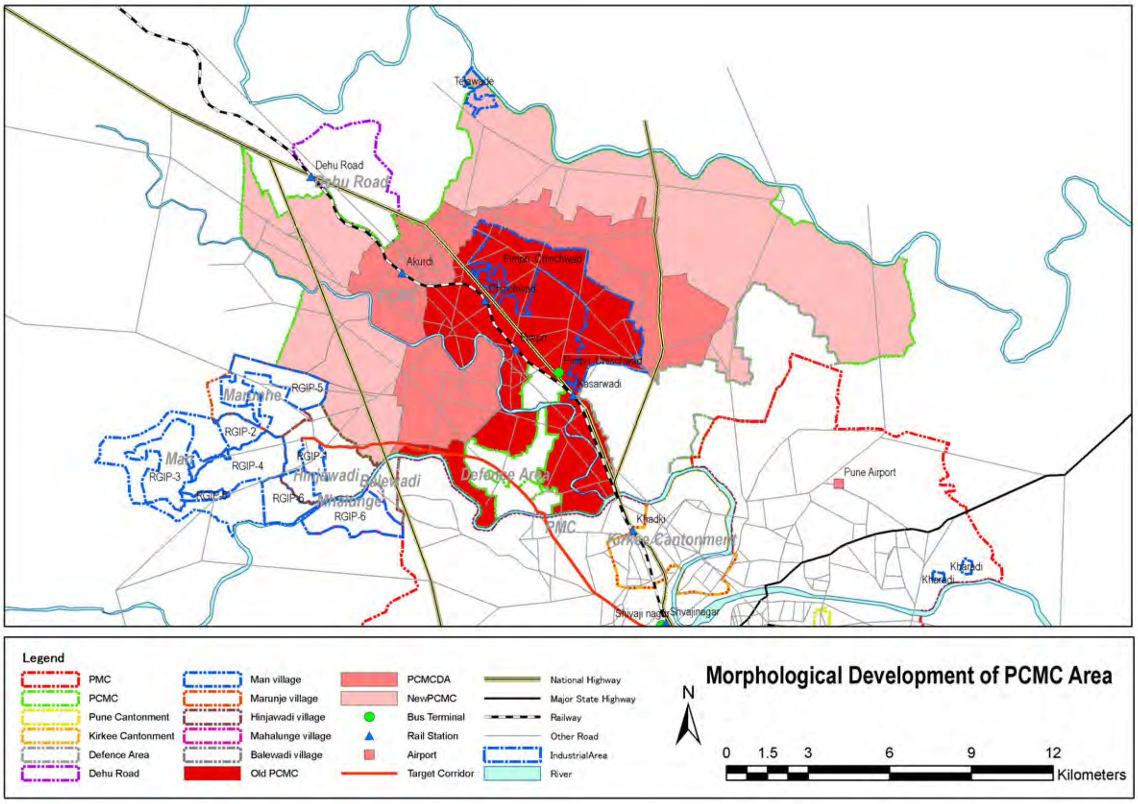


Figure 2.2.8 Morphological development of PCMC area

2) Demographic

With the expansion of urban areas, population and population density also have been increasing rapidly. Population of PCMC is approximately 1.73 million. Population density is quite high, 10,142 persons per square kilometer.

Table 2.2.5 Trend of population and population density of PCMC

Year	Population (Person)	Area (km2)	Density (Person/km2)
1981	251,769	86.01	2,927
1991	520,639	86.01	6,053
2001	1,006,417	170.51	5,902
2011	1,729,359	170.51	10,142

Population density is high in the central area, old city, and low in suburban areas and the new town in PMC. The area along the target corridor is a quite low density area.

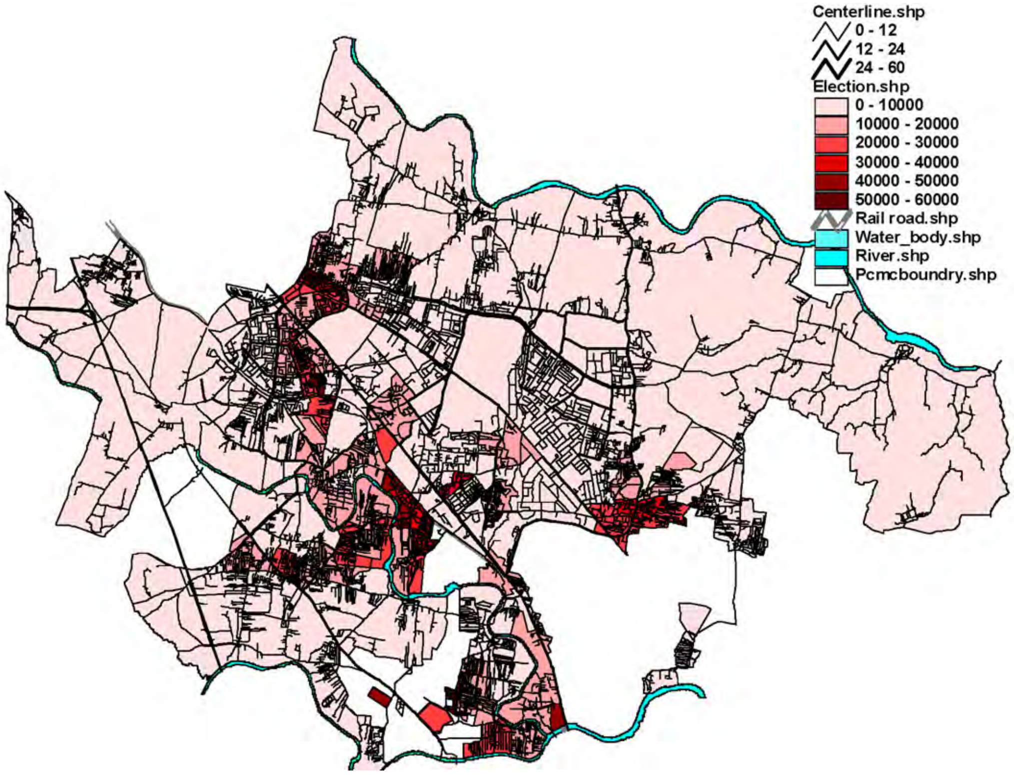


Figure 2.2.9 Population Density of PCMC in 2001

Table 2.2.6 Administration ward wise population in PCMC, preliminary figure

Ward Name	Populationin2011
A	413,588
B	340,943
C	444,693
D	530,135
Total	1,729,359

Source: JICA study team estimated, based on the document from PCMC

3) Transportation

Share of public transportation in PCMC is quite low, approximately 3%. The number of registered cars and motorcycles has been growing. The number of motorcycle owners in 2007 was 250 motorcycles per thousand persons, 3.8 times higher than the number in 1993. The number of car owners in 2007 was 37 cars per thousand persons, 7.4 times higher than the number in 1993.

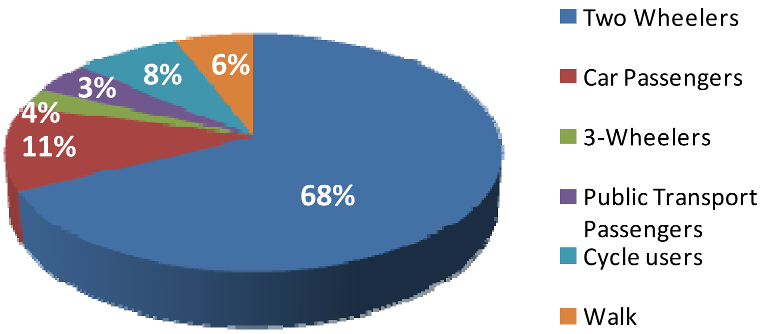


Figure 2.2.10 Modal split of inner trip in PCMC in 2008

Source: Comprehensive mobility plan for PCMC

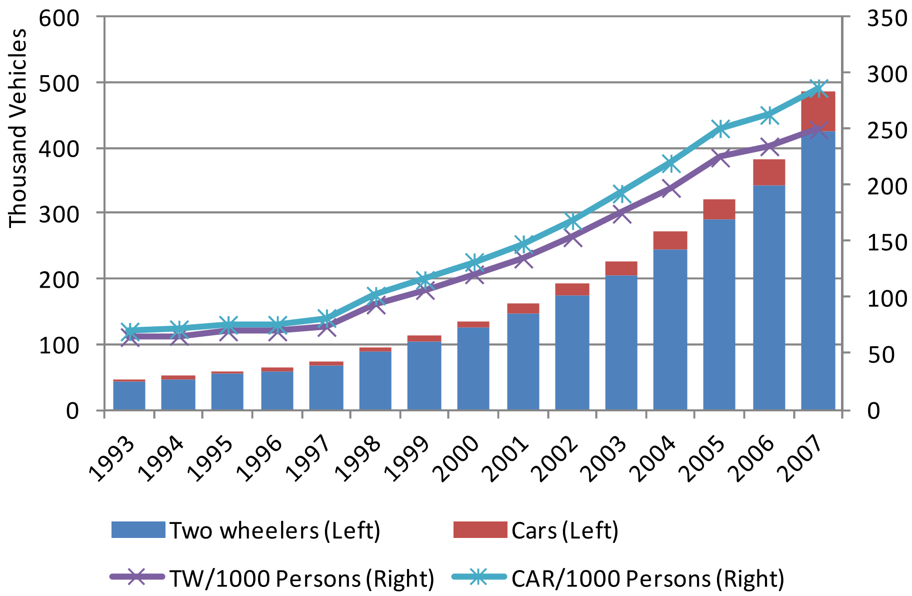


Figure 2.2.11 Trend of car and motorcycle ownership in PCM

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

4) Issues

The population, jurisdiction and population density of PMC has increased rapidly. The increase in car ownership and motorcycle users makes worth the environmental impact caused by traffic in PCMC.

2.2.4 Current Condition and Issues in Hinjwaadi Industrial area

1) Outline

The Hinjawadi Industrial area, the Rajiv Gandhi I.T. Park (RGIP) at Hinjawadi, spreads across 4 villages, Hinjwadi, Man, Marunje and Mahalunge. MIDC has conducted land acquisition, development, management and selling lots. The development plan is divided into 6 phases. Total development area is approximately 2,300 hectares. At present, phases 1 and 2 areas are sold out. The phase 3 area has been under construction and sold gradually. The phase 4 area was approvaled. However, the land acquisition has bogged down. The phase 5 and 6 area isn't notified. The outside of the industrial area is jurisdiction of the Pune district.

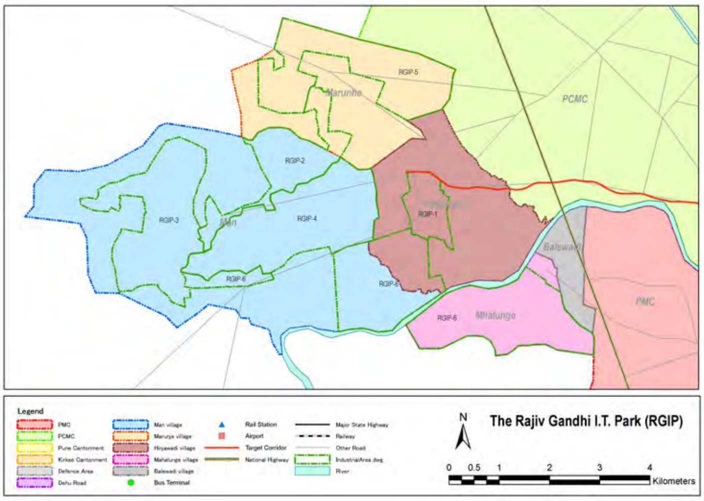


Figure 2.2.12 Development plan of Hinjawadi industrial area

Table 2.2.7 Development plan of Hinjawadi industrial area

Rajeev Gandhi InfoTech Park	Village wise break up RGIP (Ha)				Total Area (Ha)	Status of Acquisition
	Man	Marunje	Hinjawadi	Mahalunge		
Phase I			96.42		96.42	Land Acquired
Phase II	236.23				236.23	Land Acquired
Phase III	351.17				351.17	Land Acquired
Phase IV	464.44				464.44	Land Notified but not acquired
Phase V		446.59			446.59	Not Acquired
Phase VI	402.8			310	712.80	Not Acquired
TOTAL	1454.64	446.59	96.42	310	2307.66	

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

2) Employment

Approximately 78 thousand people worked in Hinjawadi industrial area in 2011, based on the interview survey for HIA. Some companies are running shift-work systems because of a business tie-up with foreign companies.

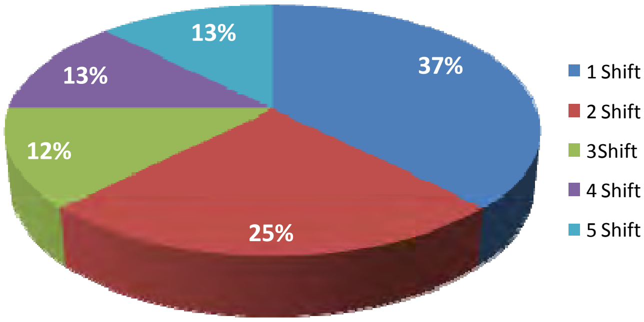


Figure 2.2.13 Shift-work system in Hinjawadi industrial area in 2008, based on sample survey

Source: JICA study team, based on the document from HIA

3) Transportation

The 32 % of the total trips concerning Hinjawadi industrial area are trips to / from PCMC, 14% are trips to / from PMC and 27% are trips to / from the southeast area of PMC. The 73% of trips for the Hinjawadi industrial area are trips via PMC or PCMC area. The modal share of commuter buses which are operated by private companies in the industrial area is 30% of total trips. Since there r not many access roads to the industrial area, some major roads are congested in the peak hour. However, the peak ratio of these roads is approximately 9%, this is not a very high ratio for a road to an industrial area. This might be because of the Shift-work system of companies in the industrial area.

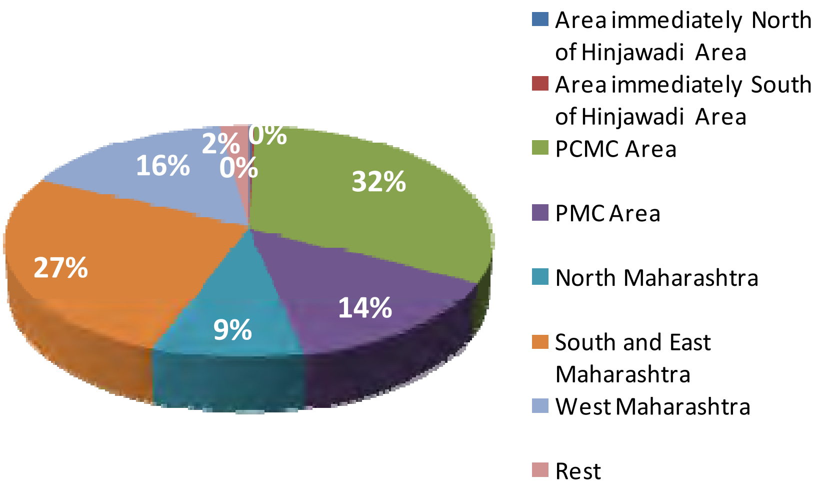


Figure 2.2.14 Origin and destinations of trips concerning Hinjawadi industrial area

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

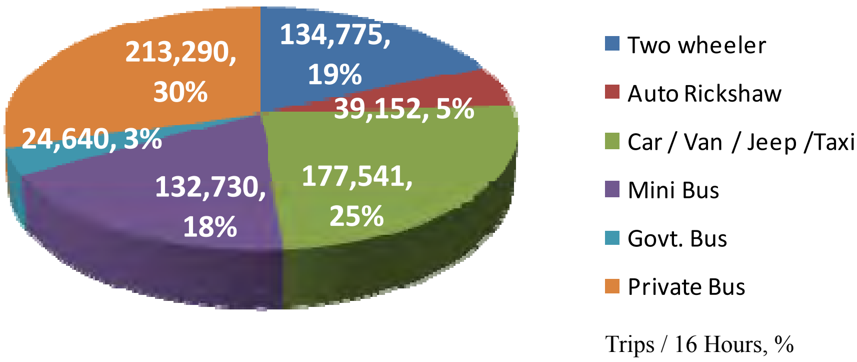


Figure 2.2.15 Modal share in Hinjawadi industrial area in 2008, based on the result of 16 hours survey[2]

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

4) Issues

Since there are not many residential areas in the Hinjwadi industrial area at present, workers commute from PMC and PCMC. On the other hand, some major roads are congested in the peak hour, since there are not many access roads into the industrial area. It seems that the public transportation is effective because the access routes to the industrial area are limited.

2.3 Development Policy of Pune Region

2.3.1 Urban Planning in PMC

1) Outline

Urban planning in PMC is conducted based on the development plan for PMC and the development control regulation for PMC. These land use plans and regulations have legal force based on state law, MRTPA. PMC has been using the JNNURM scheme to develop the infrastructure. To be approved under the JNNURM project, it is required to develop a middle term city development plan with a target for 4 or 5 years. PMC also developed the city development plan target for 2006 to 2012.

2) Development Plan

(1) Outline

The first development plan for PMC was for the central area, 146.11 square kilometers, targets for 1987 to 2007. After that, a new development plan which additionally includes 23 suburban villages, and 97.84 square kilometers, was submitted to the Maharashtra state in 2005. The second

[2] The component ratio of the trips per 16 hours between each zone by each transportation mode was estimated by the demand forecast model in the Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune

development plan is targeted for 20 years from 2005. At present, the development plan for the central area is under reconsideration.

(2) Land Use Plan

Table 2.3.1 shows the categorized land use plan in the development plan for PMC. The share of residential and public areas is high in the central area and the old city. The share of residential, reserved forest and agriculture areas is high in the suburban areas and the new city. However, only 30% has been realized at present.

Table 2.3.1 Land use plan in the development plan of PMC

Land use Category	1987 DP	2001 DP	Total	1987 DP	2001 DP	Total
	Sq. km.	Sq. km.	Sq. km.	%	%	%
Residential	50.58	53.16	103.74	36.56	50.35	42.53
Commercial	2.35	1.57	3.92	1.7	1.49	1.61
Industrial	7.26	2.62	9.88	5.25	2.48	4.05
Public and Semi-public	15.22	1.45	16.67	11	1.37	6.83
Public Utilities	1.38	-	1.38	1	-	0.57
Transport	22	9.81	31.81	15.9	9.29	13.04
Reserved Forest and Agriculture	2.35	26.7	29.05	1.7	25.29	11.91
Water Bodies	12.04	2.48	14.52	8.7	2.35	5.95
Hills and Hill Slopes	12.45	-	12.45	9	-	5.1
Recreational	12.73	7.79	20.52	9.2	7.38	8.41
Total	138.36	105.58	243.94	100	100	100

Source: Development plan for PMC

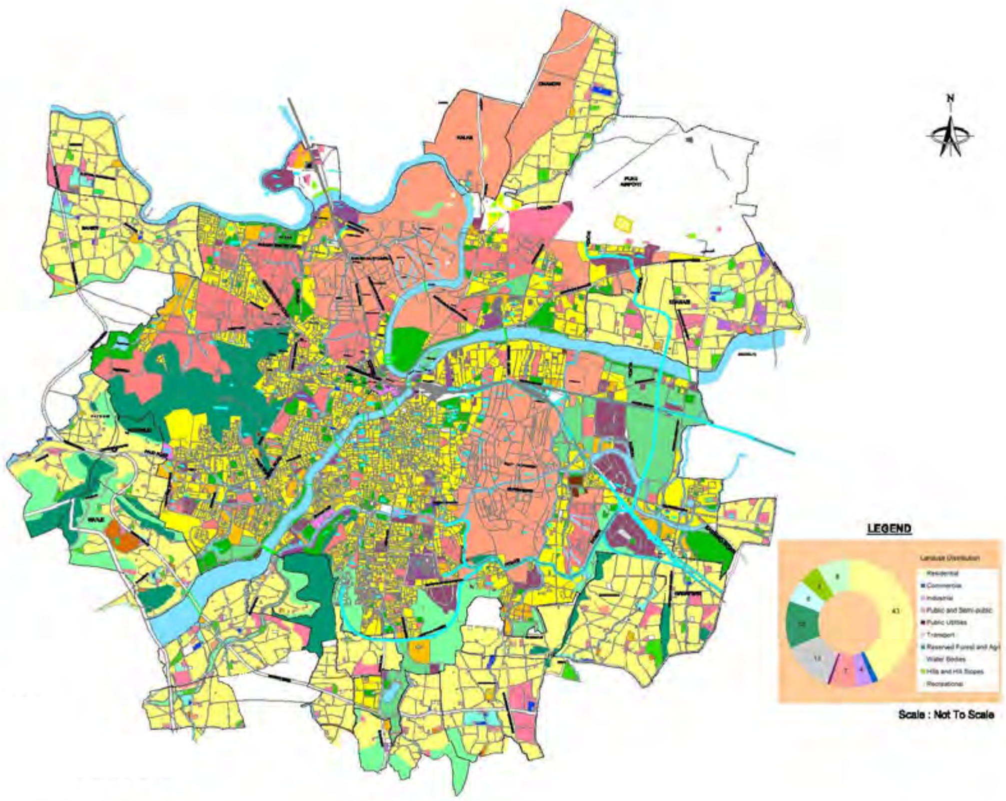


Figure 2.3.1 Land use plan in PMC

Source: Development plan for PMC

(3) Development of the Multi-polar Urban Structure

To alleviate the over concentration in Pune, new development centers were planned in the development plan for PMC. Furthermore, to implement the land use plan, the land use plan in the center of PMC and the old city, has been under reconsideration and regulations for illegal construction have been strengthened.

2.3.2 Urban Planning in PCMC

1) Outline

Urban planning in PCMC is also conducted based on the development plan for PCMC and the development control regulations for PCMC, as the case of PMC. PCMC developed the city development plan targeted for 2006 to 2012.

2) Development Plan

(1) Outline

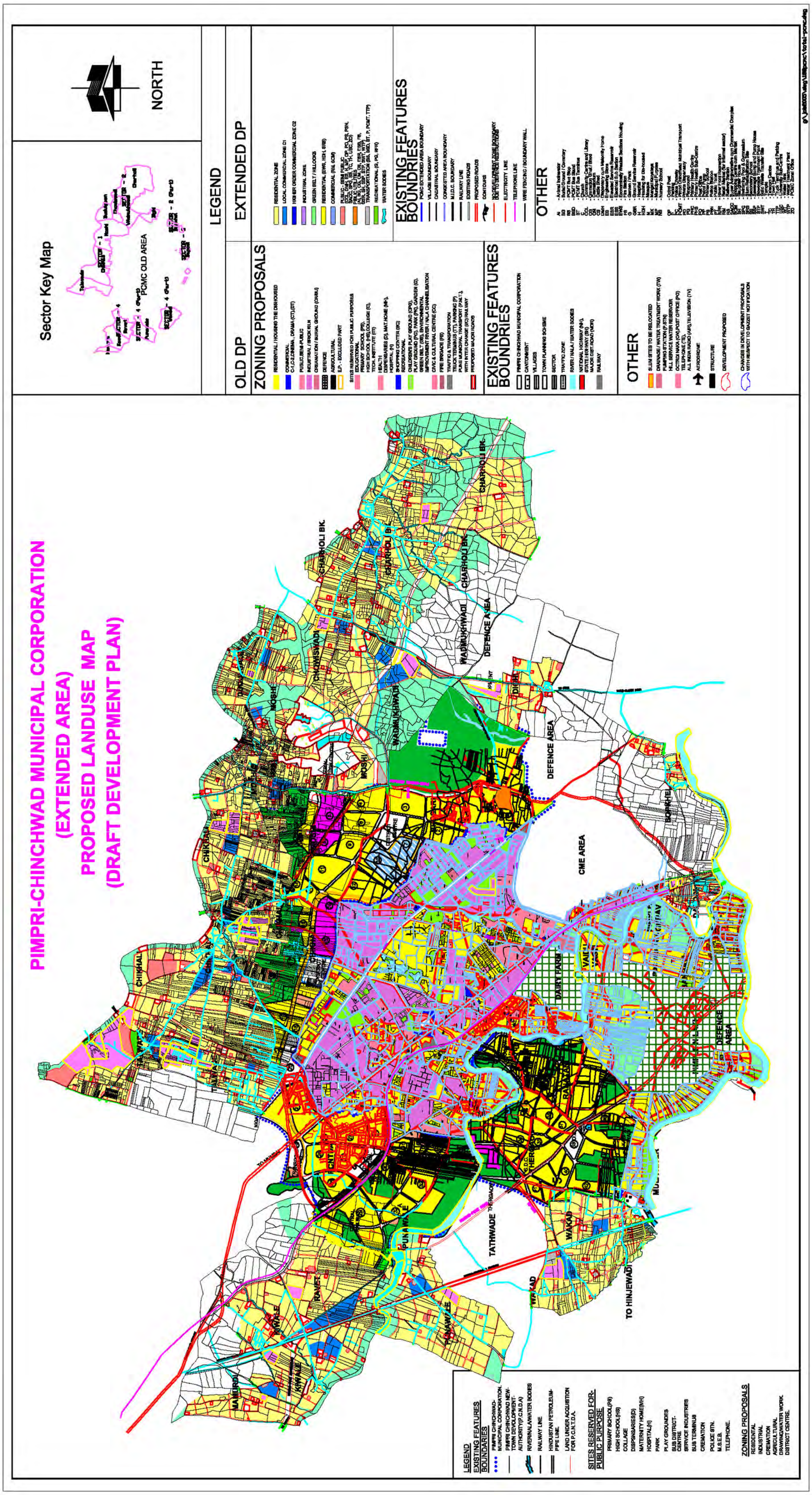
The first development plan for PCMC was created for the central area, 86.01 square kilometers, in 1986. In 1995, the plan was approved by the Maharashtra state and enacted. In 1997, the area developed by PCNDTA has been incorporated into the development area of PCMC. In 2007, surrounding area of 84.53 square kilometers was added to the development area.

(2) Land Use Plan

Table 2.3.2 shows the categorized land use plan in the development plan for PCMC. The share of industrial area is high in the central area and the old city, since there is a large industrial area by MIDC. The share of residential areas is high in the additional suburban areas.

Table 2.3.2 Land use plan in the development plan of PCMC

Land use Category	Old DP	New DP	Total	Old DP	New DP	Total
	Sq. km.	Sq. km.	Sq. km.	%	%	%
Residential	36.94	47.28	84.22	57.73	55.93	49.38
Commercial	0.29	2.68	2.97	0.45	3.17	1.74
Industrial	15.61	3.22	18.83	24.39	3.81	11.04
Public Utilities	0.77	0.97	1.74	1.21	1.15	1.02
Public & Semi- public	3.14	2.66	5.8	4.9	3.15	3.40
Transportation/ Circulation	5.48	10.94	16.42	8.56	12.94	9.63
Open Spaces/ Recreation	1.76	2.56	4.32	2.75	3.03	2.53
Water Bodies	3.63	1.33	4.96	0	1.57	2.91
Agriculture & Reserve Forest	18.39	12.89	31.28	0	15.25	18.34
Total	86.01	84.53	170.54	100	100	100



Source: Development plan for PCMC

Figure 2.3.2 Land use plan in PCMC

2.3.3 Development Plan in Hinjawadi Area

1) Outline

Development plan and regulations for Hinjawadi area were developed by MIDC.

(1) Phase 1

The phase 1 area, 96.42 hectares, was already acquired and developed. The developed land has been sold. There are IT companies, such as Wipro and Infosys, in the area. There are educational institutions and accommodations, like the Lemon tree hotel.

(2) Phase 2

The phase 2 area, 236.23 hectares, was already acquired and developed. A total of 85% of the developed land has been sold as of 2010. There are IT companies, such as Wipro and Infosys.

(3) Phase 3

The phase 3 area, 351.17 hectares, was certificated as SEZ. The area has already been acquired. A total of 10 % of the area has been developed and sold as of 2010. There are IT companies, such as Tech Mahindra.

(4) Phase 4～6

The development area of phases 4, 5 and 6 is 464 ha, 446 ha and 713 ha, respectively. The land acquisition for phase 4 area was approvaled. However, the land acquisition has bogged down. The phase 5 and 6 areas haven't been pending approval officially.

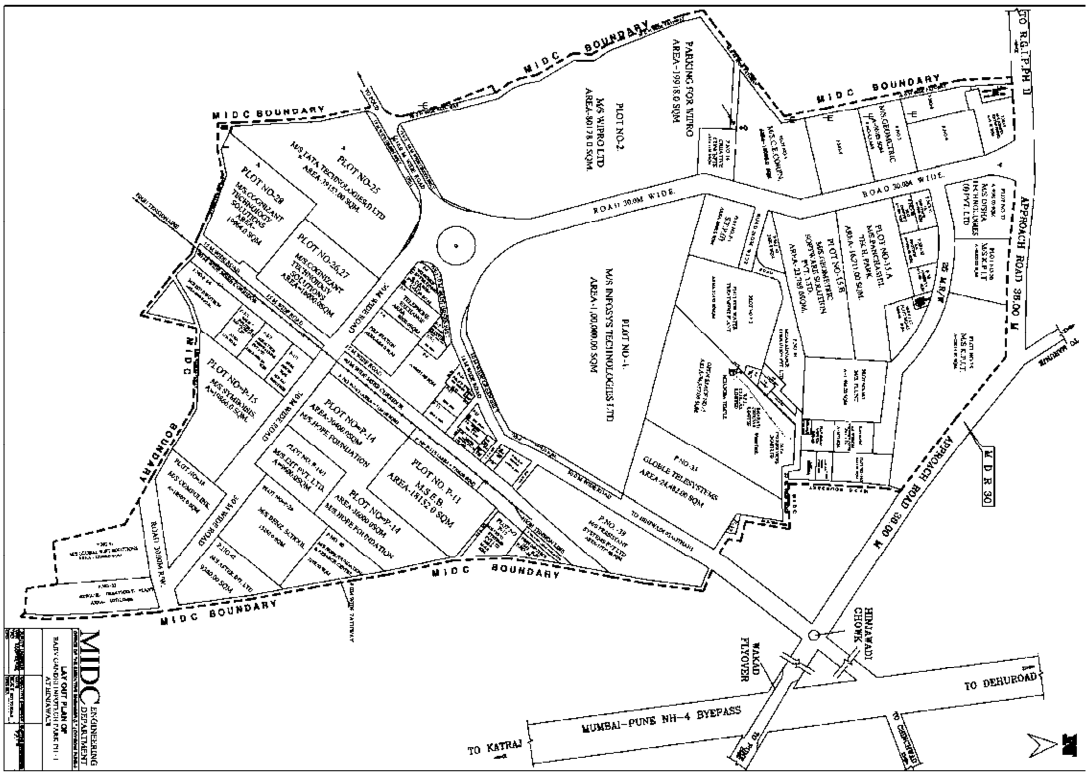


Figure 2.3.3 Phase 1 Layout Plan

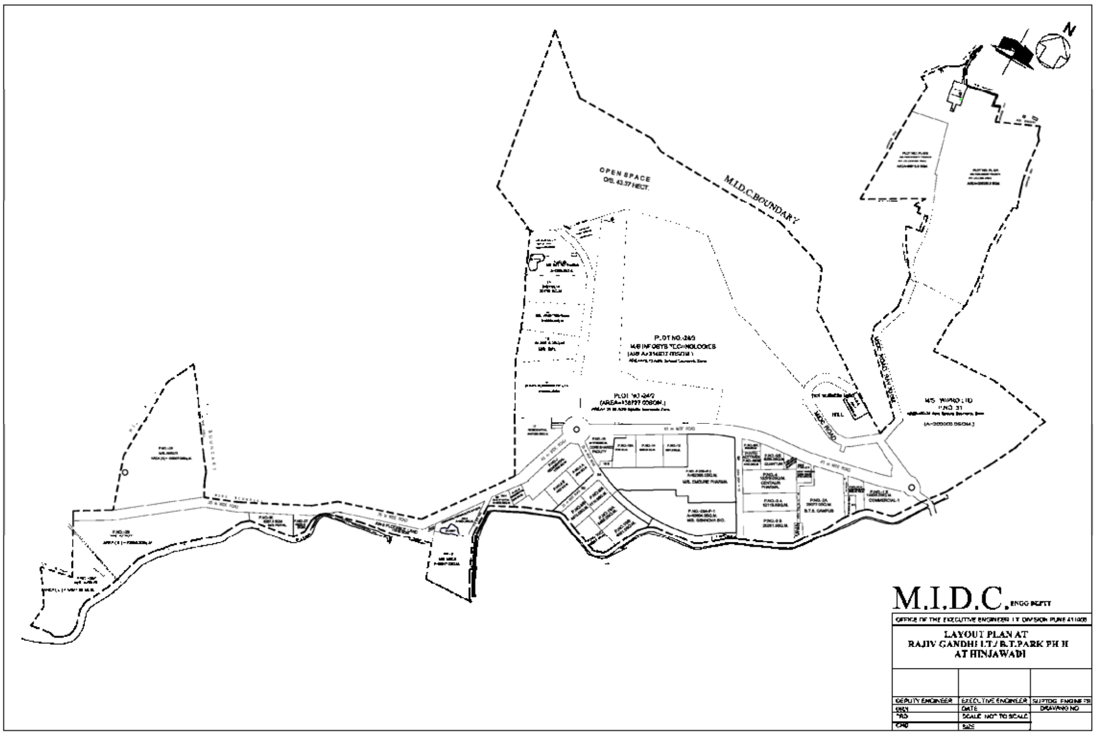


Figure 2.3.4 Phase 2 Layout Plan

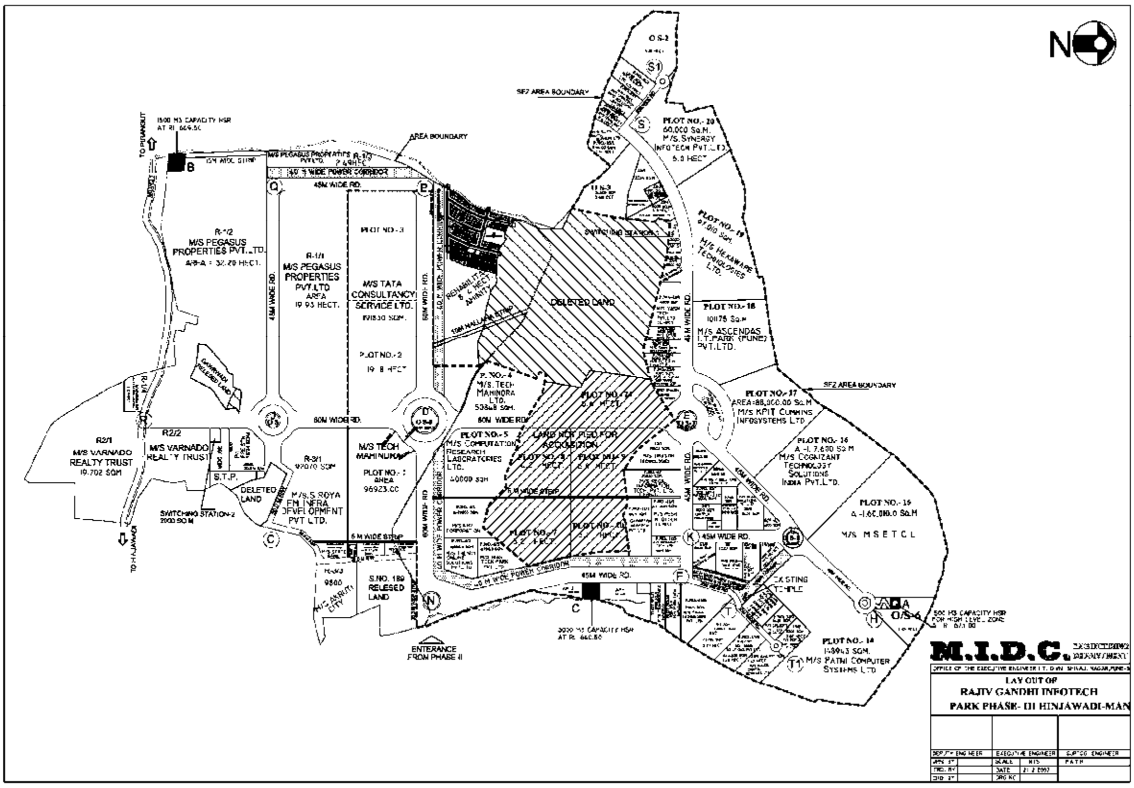


Figure 2.3.5 Phase 3 Layout Plan

2.3.4 Comprehensive Mobility Plan for PMC

1) Outline

The study for a comprehensive mobility plan for PMC has been conducted by Wilbur Smith and IL&FS. In this study, future traffic demand targets for 2011, 2021 and 2031 were estimated based on transportation surveys and future land use plans. A public transportation plan was developed for the main corridors in PMC.

In the mobility plan, the following has been proposed;

- BRT for most of the main corridor in the PMC area in 2011
- Outer ring monorail and MRT along with the national highway 48 for the north-south direction
- Monorail between Nagar Road and Karve Road, Zaneshkhind Road to Hinjawadi area.

2) Demand Forecast

The demand forecast for the Pune metropolitan area was conducted for a target of 2031 based on a basic four step model. The existing OD table was developed based on a home interview survey, cordon line survey and screen line survey. The home interview survey was conducted for only 5,000 households to estimate the demand for the 3 million population city.

3) Development Plan for Target Corridor

There is a plan to develop BRT in the target corridor, the section between Ganeshkhind Road to Hinjawadi, in 2011. There is a plan to upgrade the BRT to monorail in 2031. There is a plan to develop the bicycle lane to the corridor and pedestrian under pass at the intersection of University Road and Aundh Road. There are plans to develop the terminals at the junction of University Road and Baner Road and the terminal station for MRT at the city center.

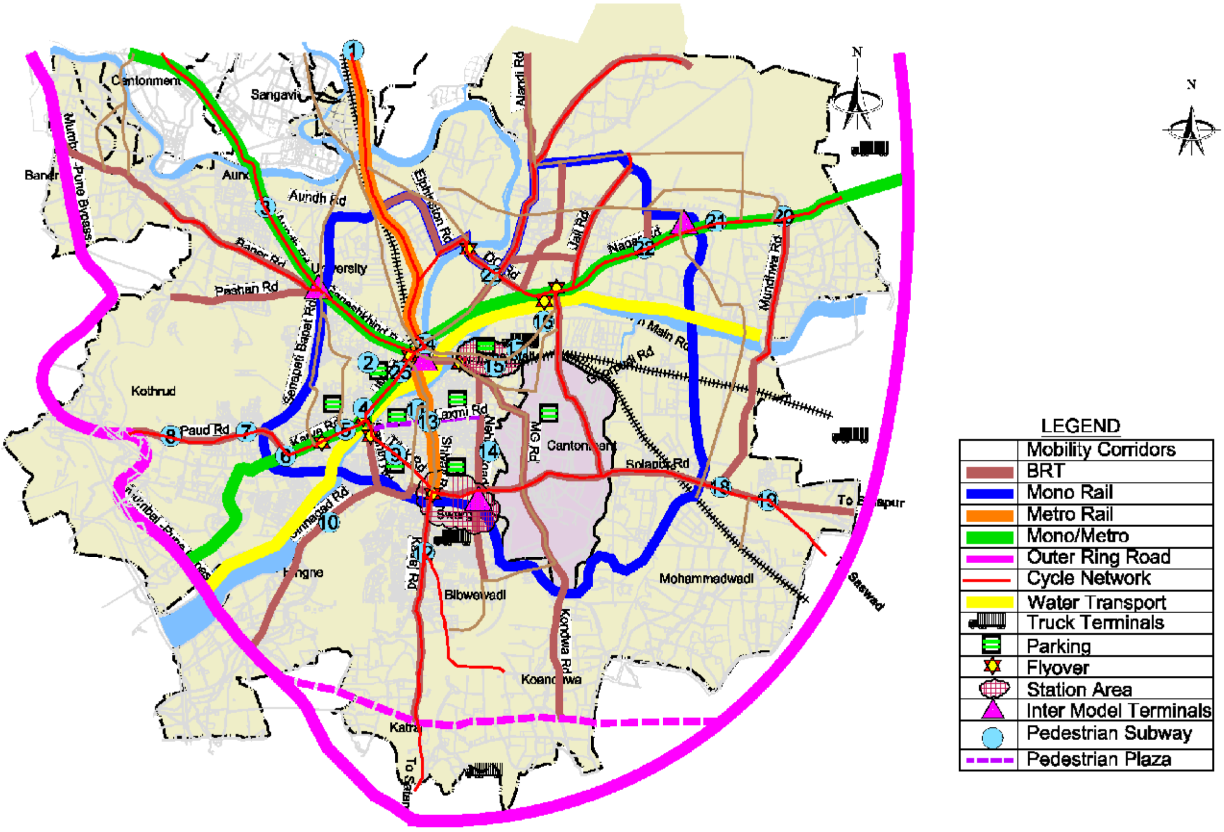


Figure 2.3.6 Comprehensive Mobility Plan for PMC in 2031

Source: Comprehensive mobility plan for PMC

2.3.5 Comprehensive Mobility Plan for PCMC

1) Outline

The study for a comprehensive mobility plan for PCMC has been conducted by Credit Rating and Information Services of India Ltd., CRISIL. In this study, future traffic demand target for 2021 was estimated based on a transportation survey. The BRT plan was developed for the main corridors in PCMC. A total of 10 major BRT lines and 4 branch lines were planned in this study.

2) Demand Forecast

The demand forecast for the PCMC area was conducted with a target of 2021 based on a basic four step model. The existing OD table was developed based on a home interview survey, cordon line survey and screen line survey. The home interview survey was conducted for only 5,000 households.

3) Development Plan for Target Corridor

There is a plan to develop BRT in the target corridor, the section between Karewadi Main road and Hinjawadi Road. Detailed information of the passengers for each station, structure and implementation plan isn't clarified in the report.

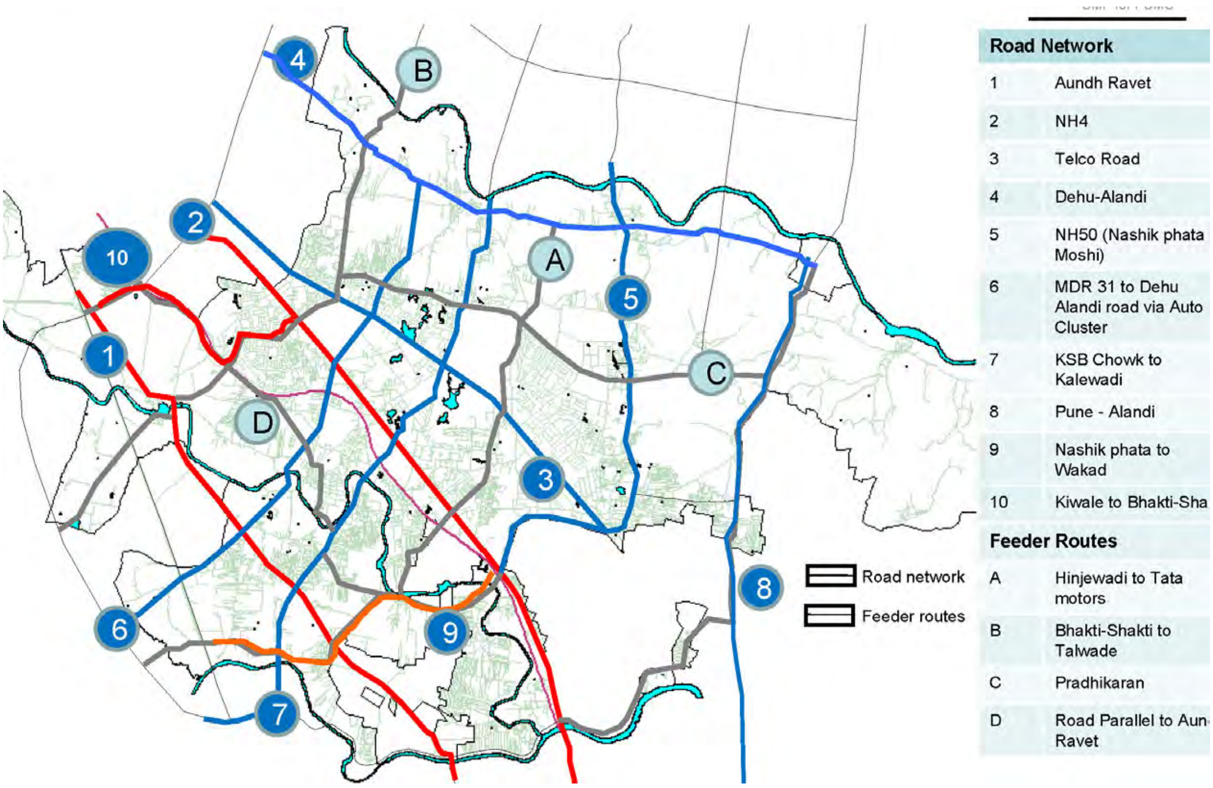


Figure 2.3.7 Comprehensive Mobility Plan for PCMC

Source: Comprehensive Mobility Plan for PCM

2.3.6 Comprehensive Master Plan for Hinjawadi Industrial Area

1) Outline

The study for a comprehensive master plan for Hinjawadi industrial area has been conducted by Consulting Engineering Service (India) Private Limited, CES. In this study, future traffic demand with a target for 2021 was estimated based on a transportation survey. There is a plan to extend the BRT from PCMC to the phase 3 area via Hinhwadi Choke. There is a plan to develop a new road and flyover and widen the existing road.

2) Demand Forecast

The demand forecast for the Hinjawadi area and surrounding area was conducted with a target of 2021 based on a basic four step model. The existing OD table was developed based on a home interview survey, cordon line survey and screen line survey.

3) Development Plan for Target Corridor

There is a plan to expand the Hinjawadi Road to 6 lanes by 2011, develop a flyover above the Hinjawadi Chowk and KPIT Junction by 2015 and develop the MRT to the phase 3 area by 2021. The detail structure of the section of flyover along with MRT wasn't clarified.

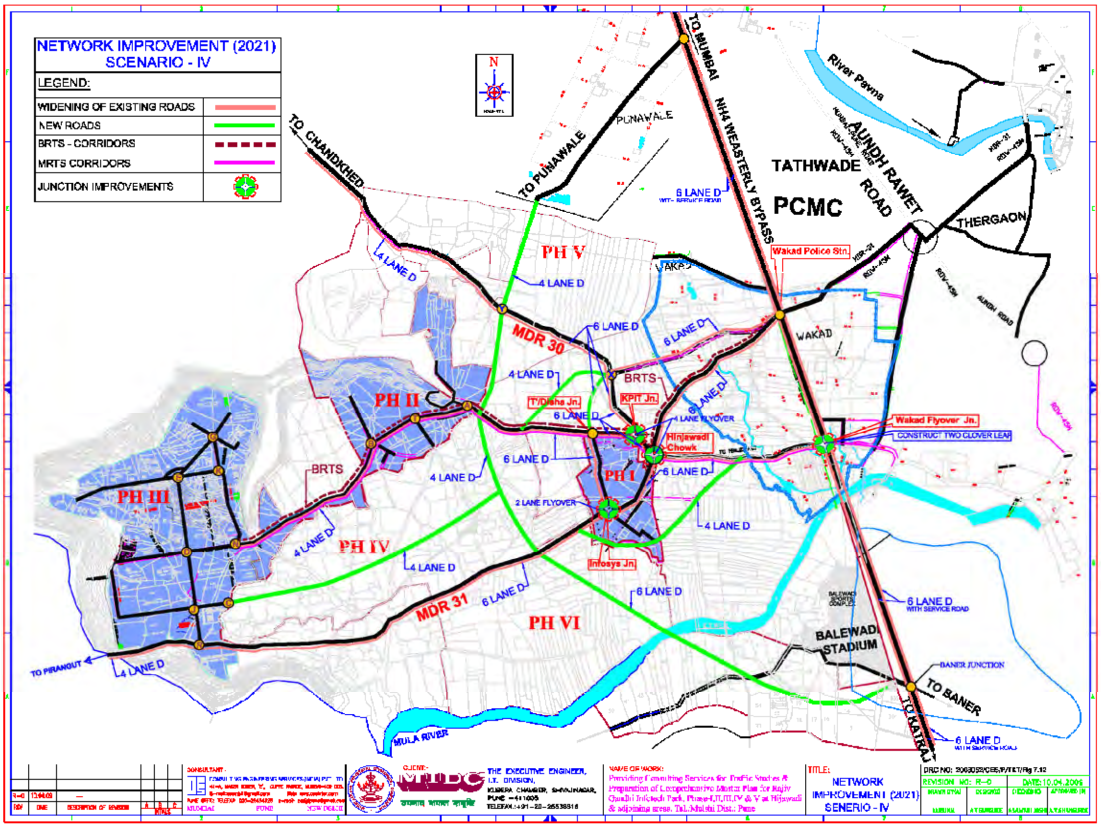


Figure 2.3.8 Comprehensive Master Plan for Hinjawadi Industrial Area and Target Corridor of the Study

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park @ Hinjawadi, Pune and JICA study team

2.3.7 BRT Development Plan

1) JNNURM Project

With the budget from the ministry of urban development and the World Bank Group, BRT has been developed in the PMC and PCMC areas. Table 2.3.3 shows the JNNURM projects concerning transportation infrastructure in the Pune region. To develop the BRT, road improvement projects have been planed and conducted. The BRT pilot project in the south-east Pune area has been conducted and operated. BRT was planned along the target corridor, the sections between Nashik Phata and Wakad. A flyover for the BRT corridor has been constructed. BRT plans for Audh Rawet Road are also approved and a road widening has been conducted.

Table 2.3.3 Project List Concerning Transportation Infrastructure in Pune as of 2012

Sector	Project Title	Approved Cost (Million Rs.)	Date of Project Approval	% of work comple	Date of Complet ion as per latest QPR
Mass Rapid Transport System	BRT Pilot project for Pune city (Katraj Swargate Hadapsar Route 17.00 Km)	10,314	11-Aug-06	Comple ted	Complet ed
	Bus Rapid Transit (Phase I) for Pune city -48.77 Km	47,662	25-Oct-06	90%	Mar-12
	Bus Rapid Transport system (Development of Infrastructure for Commonwealth Youth Games, 2008) -36.00 Km	43,422	5-Mar-07	90%	Mar-12
	BRTS Corridor for Mumbai Pune Highway (8.5 Kms) and Audh Rawet Road (14.5 Kms) Total (23 Kms)	31,214	28-Dec-07	70%	Mar-12
	Improvement and Strengthening of New Alandi Road as BRT corridor for Pune (13.9 Km. from Vikrantwadi to Dighi-Octroi Naka)	3,703	19-Aug-08	73%	Mar-12
	BRTS Corridor-Kalewadi-KSB Chowk to Dehu-Alandi Road (Trunk Route 7)-PCMC -11.20	21,920	21-Nov-08	16%	Dec-13
	BRTS Corridor-Nashik Phata to Wakad (Trunk Route No.9)-PCMC -7.08 Km	20,682	21-Nov-08	71%	Mar-13
Roads / Flyovers / RoB	Subway on Westerly Bypass at Baner junction	726	22-Feb-08	Comple ted	Complet ed
	Approach Road to Sangamwadi bridge	782	22-Feb-08	Comple ted	Complet ed
	Construction of pedestrian subways (3 Nos.) and vehicular underpass (1 No.) at Nagar Road	661	22-Feb-08	90%	Dec-11

Source: Home page of the ministry of urban development

The following 21 corridors were applied as JNNURM BRT project in PMC.

Figure 2.3.9 BRT project corridor by JNNURM

Source: Network Development for BRT for Pune City under the Scheme of JNNURM - Main Report, July 2006

In PCMC area, 10 BRT corridors were proposed and the following 4 corrirors were approved by JNNURM and road widening has been conducted. The Nashil Phata – Wakad corridor was funded by World Bank Group and surveys for LAP and EIA were conducted.

1. Old NH-4 (Mumbai-Pune highway)
2. Aundh Rawet corridor
3. Kalewadi phata to Dehu Alandi road
4. Nashik phata to Wakad

2.3.8 MRT Development Plan

1) Outline

A Detailed Project Report for Pune Metro Project in the PMC and PCMC areas has been developed by DMRC. In the study, traffic demand was forecast for 6 corridors, which were proposed in a previous study, the Mass Rapid Transit System for Pune Metropolitan Area. Two corridors, Line 1: PCMC – Swargate and Line 2: Vanaz – Ramvadi were planned to develop as phase 1 in 2013. Another 2 corridors, Line 3: Deccan – Gymkhana , Line 4: ASI – Hinjawadi and extention of the Line 1: PCMC – Nigdi and Swargate – Katraj, were planned to develop as phase 2 in 2021. The demand forecast for the MRT was conducted with a target of 2031 based on a transportation survey and population forecast. Detailed information for the ridership for each section and structure of MRT is clarified in the report only for the phase 1 projects.

2) Development Plan along the Target Corridor

The aboved mentioned Line 4 is the target corridor. However, the detailed information, such as location of the stations, is not clariffied.

- Total Length: 18km
- Number of stations: N/A
- Interval: N/A
- Fare: Rs. 7 + 0.5 Rs. / km (Same fare structure as Delhi Metro
- Structure: N/A
- Daily passengers: 59 thousand persons per day in 2031
- Maximum cross sectional passengers: 30 thousand persons per direction per peak hour

Figure 2.3.10 MRT Plan and Target Corridor of the Study

Source: Detailed Project Report Pune Metro Project and JICA study Team

2.3.9 High Speed Railway Development Plan

The minsitry of railways in India planned to develop a high speed railway on the section Ahmedabad – Mumbai- Pune. In the pre feasibility study, which was conducted in 2010, ridership of the high speed railway between Mumbai and Pune was forecast at 13.2 million persons per year in 2021. A qualitative evaluation was conducted for the location of the Pune station. There were three altanatives for the Pune station, the station next to the existing Pune station, the station near the college of agriculture and the station near the Moshi. As a result of the evaluation, the station next to the exisiting Pune station was proposed. However, detailed studies concerning the land acquisition and connection with the MRT weren't conducted.

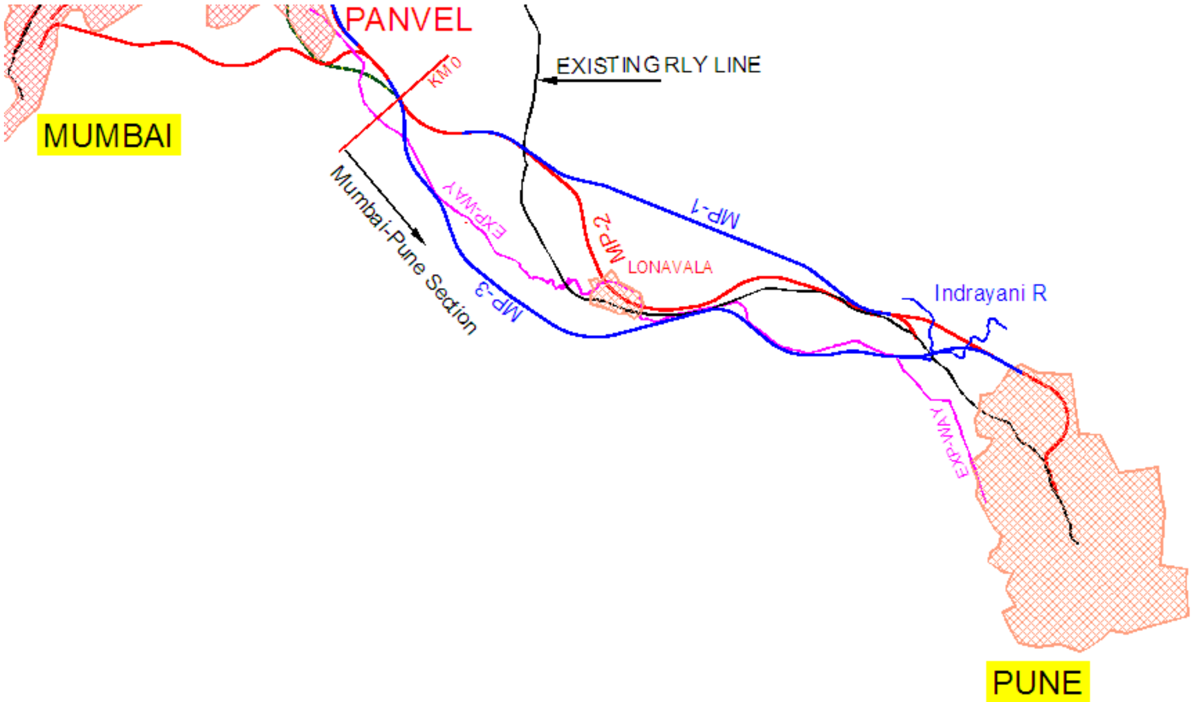


Figure 2.3.11 Alignment Plan of the High Speed Railway for Mumbai - Pune

Source: Pre Feasibility Study Pune – Mumbai – Ahmedabad High Speed Line,2010, SYSTRA, RITES

Chapter 3 Transportation Demand Forecast

3.1 Objective & Background

3.1.1 Objective

Numerous studies on the construction of new infrastructure to alleviate congestion and/or increase the transport capacity of major corridors in Pune Metropolitan Region (PMR) have been carried out over the years. One of those corridors, which are crucial to the future of PMR's continued growth and success, is the corridor connecting central Pune with Hinjawadi IT Park via Ganeshkhind, Aund, and Wakad roads (hereafter referred to as the Pune-Hinjawadi Corridor) and it is therefore taken up. Therefore, the objective of this chapter is to construct a model to determine the demand for Light Rail Transit (LRT) that would improve transport capacity along the heavily-traveled Pune-Hinjawadi Corridor. This would also alleviate road congestion and reduce travel time and vehicle operating cost (VOC), which is used to estimate economic benefits.

3.1.2 Background

PMR has been one of the fastest growing cities in India and this can be seen by its population growth over the past 60 years in two of its most important cities of Pune Municipal Corporation (PMC) and Pimpri-Chinchwad Municipal Corporation (PCMC) in the figures below. In the case of PMC, the compounded annual growth rate (CAGR) has always been greater than 2.0% and during the high growth period of 1991 to 2001 it rose to 4.9% and then declined to 2.1% for the period of 2001 to 2011, which is the lowest in over the past 60 years and approximately the same as that for India overall.

As for PCMC, its CAGR has always been greater than 4.2% and during 1971 to 1981 it was 9.8%, which then decreased steadily over the next three decades to 7.5%, 6.8%, and 5.3%.

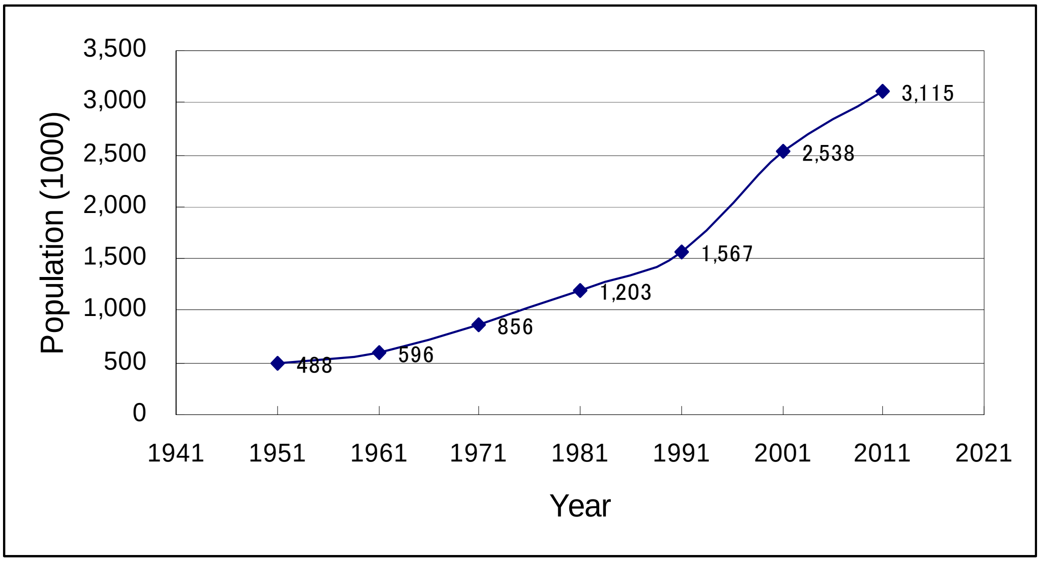


Figure 3.1.1 Trend in Population Growth in Pune Metropolitan Corporation (PMC)

Source: Census of India

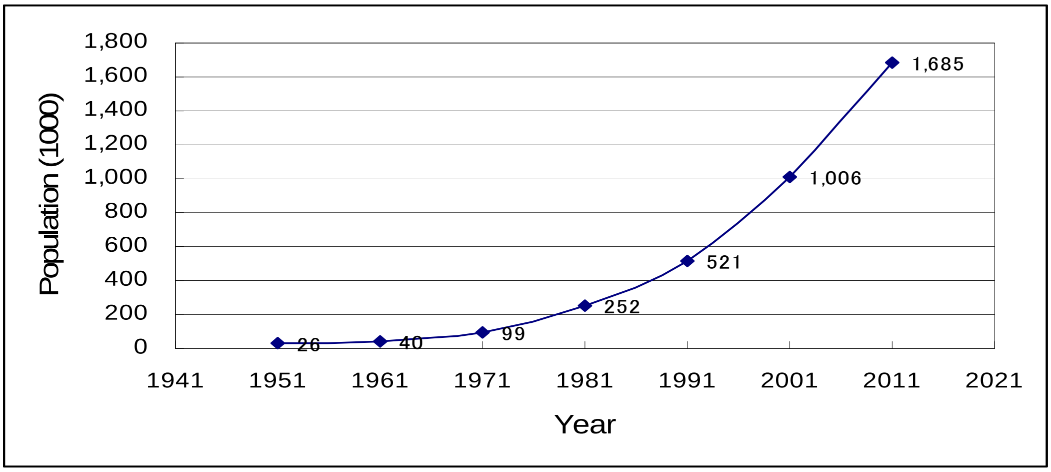


Figure 3.1.2 Trend in Population Growth in Pimpri-Chinchwad Metropolitan Corporation (PCMC)

Source: Census of India

PMR has also experienced great economic growth with GDP expanding until recently by about 15% annually[1], and in 2008 it was the 8th largest city in India in terms of GDP totaling USD 30 billion[2]. This can be attributed to the large number of automotive and IT industries that have located there, including Tata Motors, Mahindra & Mahindra, Mercedes Benz, etc., as well as other businesses such as India's largest engineering conglomerate the Kirloskar Group. Note that Pune is the largest hub for German companies in India with more than 225 German firms.

PMR's economic growth is also reflected in the fast growth in vehicle registration over the years as shown in Figure 3.1.3, which indicates that motor vehicles in PMR grew 2.32 times during the decade of 2001 to 2011, with the total number of vehicles in 2011 exceeding 2 million. This growth can be attributed to the increase in the number of 2-wheelers and cars, which accounted for about 74% and 17%, respectively, of the total vehicles registered in 2011.

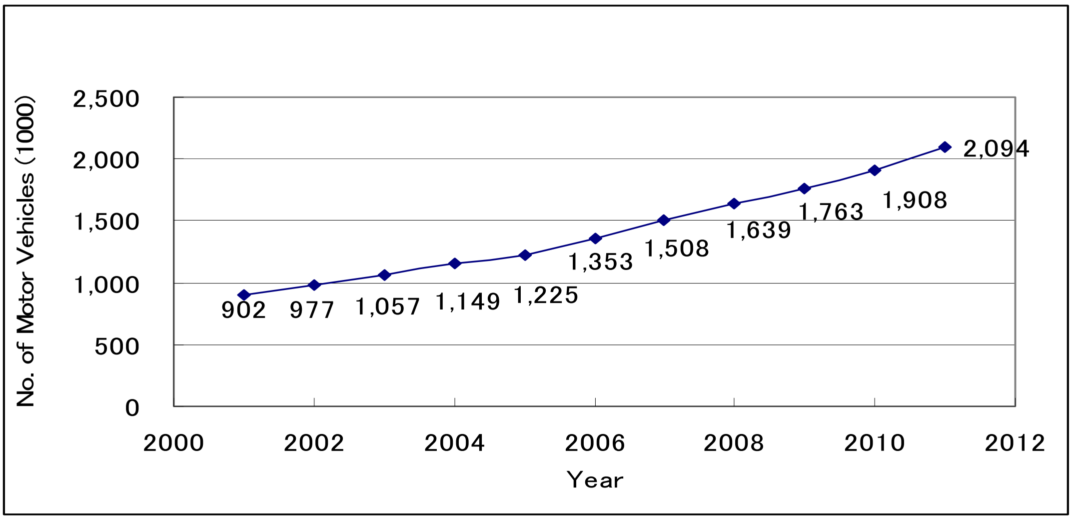


Figure 3.1.3 PMR Motor Vehicle Population Trend

Source: Pune Regional Transport Office

[1] The Institute of Management Consultants of India
[2] http://en.wikipedia.org/wiki/List_of_Indian_states_by_GDP

3.2 About Transport Model

It was decided that updating the existing transport model used to produce the November 2008 "Comprehensive Mobility Plan for Pune City" would be the most suitable method for deriving transport demand for the proposed Pune LRT. The updating work of the 2008 model, which was constructed with the software CUBE, consisted mostly of the following:

- Disaggregation of zoning system along the Pune-Hinjawadi Corridor to model transport demand more accurately for the LRT, as well as other zonal readjustments to model overall PMR demand suitably.
- Supplementing/modifying the existing transportation network as required.
- Carrying out of traffic surveys at strategic locations (including screen and cordon lines) to assess changes in travel demand between 2008 and 2012.
- Updating of population and employment values for 2012 for trip generation and production and the creation of 2012 OD tables.
- Adjustment and validation of the 2012 OD tables via screen and cordon line checks using the traffic survey data of this Study.

The structure of the model for forecasting LRT passenger flows is as indicated below.

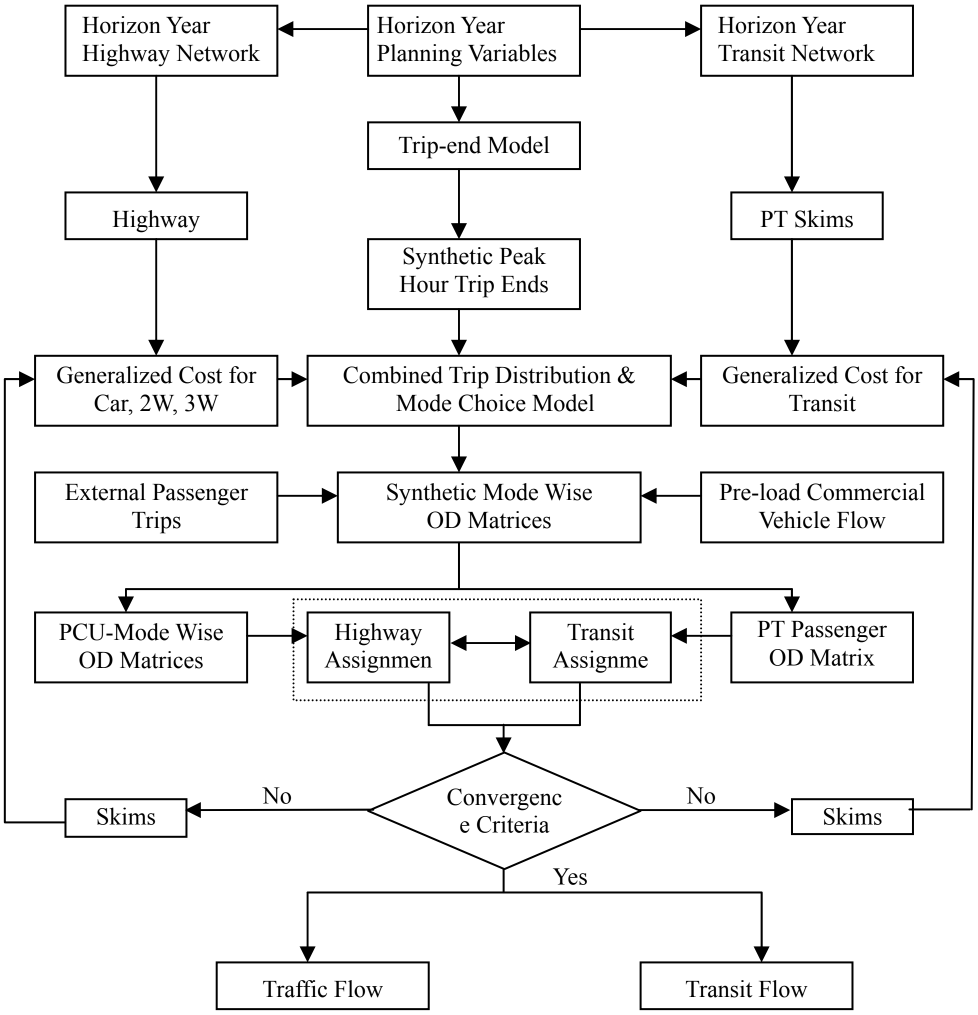


Figure 3.2.1 Transportation Demand Model Flowchart

Source: Study Team

3.3 Transportation Survey

Transportation surveys were executed in order to assess the change in transport demand and are described in Table 3.3.1. Eight different surveys were executed from the third week of June till 10th July 2012, The locations of the surveys are as indicated in Figure 3.3.1. Survey data is analyzed to evaluate the following characteristics of the Study area: 1. Existing transport infrastructure, 2. Public transport /Intermediate public transport Systems, 3. Passenger movement on the proposed LRT Corridor, 4. Use of public transport in the study area, and 5. User's preference on the proposed system and willingness to pay.

Table 3.3.1 Dates & Types of Transportation Surveys Executed by Study Team

Sl. No.	Type of Survey	Duration	Locations/Km	Dates
1	Road Inventory Survey	-	All major roads in the Study area and all roads in the Area of Influence of LRT alignment.	21/6/2012 to 6/7/2012
2	Speed-delay Survey	-	All corridors where traffic volume survey is carried out.	19/6/2012 to 4/7/2012
3	Screen Line Volume Count Survey	05.00-23.00 hrs	9	19/6/2012 to 28/6/2012
5	Cordon Line Volume Count Survey	05.00-23.00 hrs	4	25/6/2012 to 25/6/2012
4	Mid-block Survey	05.00-23.00 hrs	4	28/6/2012 to 4/7/2012
6	Bus Occupancy Survey	Hours of operation	4	22/6/2012 to 4/7/2012
7	Bus Passenger Count Survey	05.00-23.00 hrs	6	3/7/2012
8	OD Survey	05.00-23.00 hrs	4	28/6/2012 to 4/7/2012
9	Stated Preference Survey	3 days	2000 Nos.	5/7/2012 to 10/7/2012

Source: Study Team

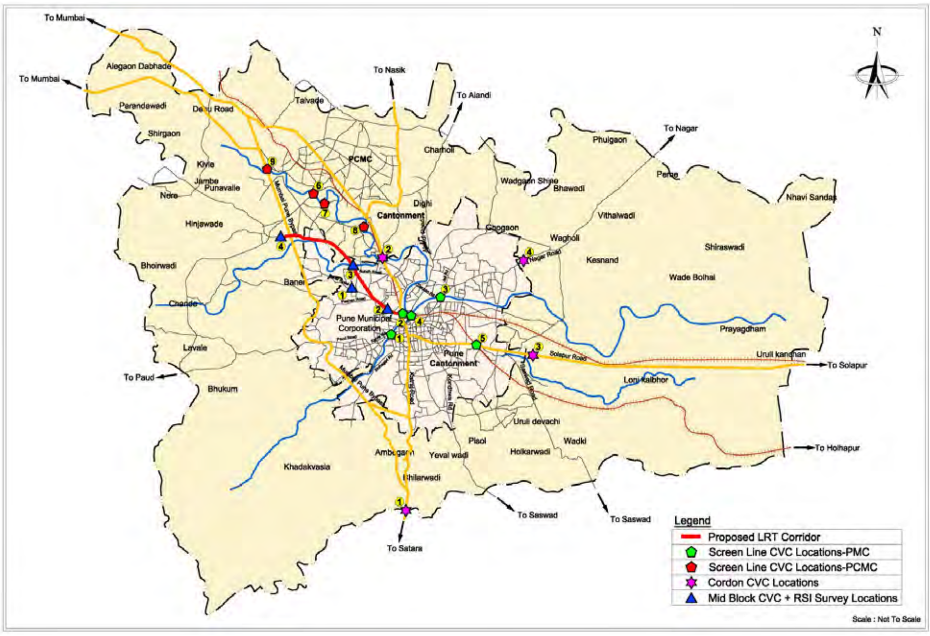


Figure 3.3.1 Locations of Surveys

Source: Study Team

3.4 Results of Transportation Surveys

3.4.1 Road Inventory Survey

The road inventory survey was carried out in the project influence area, or an area within 2 km of the Study corridor, and the results were used to update the road network data of the transport model for PMR, which is as described in the table below.

Table 3.4.1 Road Type & Length in PMR

ID No.	Road Type	Length (km)
1.	Undivided 1-lane road	2.65
2.	Undivided 1.5-lane road (one way)	13.9
3.	Undivided 1.5-lane road	13.8
4.	Undivided 2-lane road (one-way)	1.0
5.	Undivided 2-lane road	702.0
6.	Divided 3-lane road	3.56
7.	4-lane road (one-way)	0.47
8.	Divided 4-lane road	278.0
9.	Divided 6-lane road	28.9
10.	BRT	15.6
Total		1059.88

Source: 1) Comprehensive Mobility Plan for Pune City, Wilbur Smith Assoc & IL&FS, Nov. 2008.
2) Study Team

As the above table shows, 66.2% of the roads in PMR are undivided 2-lane roads and 26.2% are divided 4-lane roads. These two types of road facilities account for 92.4% of the road network. As for the Study area, the composition of road types is as shown in Figure 3.4.1. The figure indicates that most of the roads in the Study area are divided 4-lane facilities (i.e., roads with 2 lanes per direction), meaning that access for feeder services to the proposed LRT should not pose a problem.

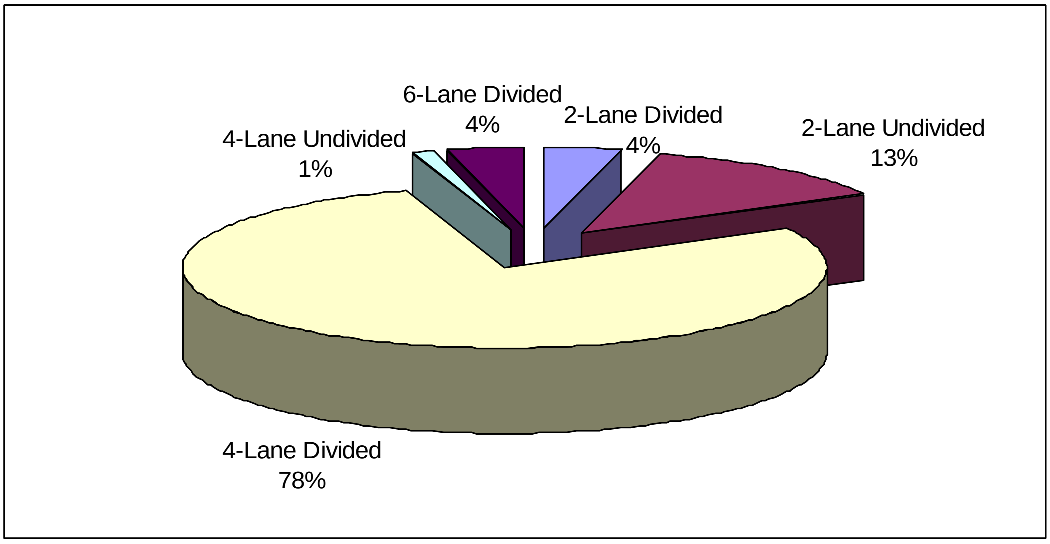


Figure 3.4.1 Types of Road in Study Influence Area

Note: Study influence area is approx. 2km on either side of study corridor

Source: Study Team

3.4.2 Travel Speed Survey

The travel speed survey was carried out on seven major corridors to assess journey speeds (which includes delays & stops at intersections) and running speeds on the road network as shown in Table 3.4.2. Journey speeds on the road links of the Study corridor are given in Figure 3.4.2.

Table 3.4.2 Existing Travel Speeds along 7 Major Corridors

Road Name	From	To	Peak	Time	Delay in Sec.	Distance in Km	Journey Speed (km/h)	Running Speed (km/h)
Aundh Road	Jahangir Hospital	IT Park Phase 3	AM	1:04:48	635	25.34	23.46	28.04
			PM	1:00:00	650		25.34	30.92
Banner Road	University	NH4 Bypass	AM	0:13:36	40	7.56	34.63	35.07
			PM	0:14:00	40		32.40	34.02
Kataraj Road	PMC	Shindevadi	AM	0:54:18	760	19.27	21.29	27.77
			PM	0:56:18	940		20.53	28.45
NH4 Nypass	Shindevadi	NH4	AM	1:09:45	45	42.86	36.87	37.27
			PM	1:08:40	55		37.45	37.96
Nagar Road	Jahangir Hospital	Vagholi	AM	0:37:50	445	13.93	22.09	27.48
			PM	0:38:51	390		21.51	25.84
Solapur Road	MG Road Bus Depot	Laxmi Colony	AM	0:22:00	155	8.24	22.47	25.46
			PM	0:21:00	145		23.54	26.60
NH4	Sancheti Hospital	NH4 Bypass	AM	0:58:35	535	24.80	25.40	29.96
			PM	0:44:00	295		33.82	38.07

Source: Study Team

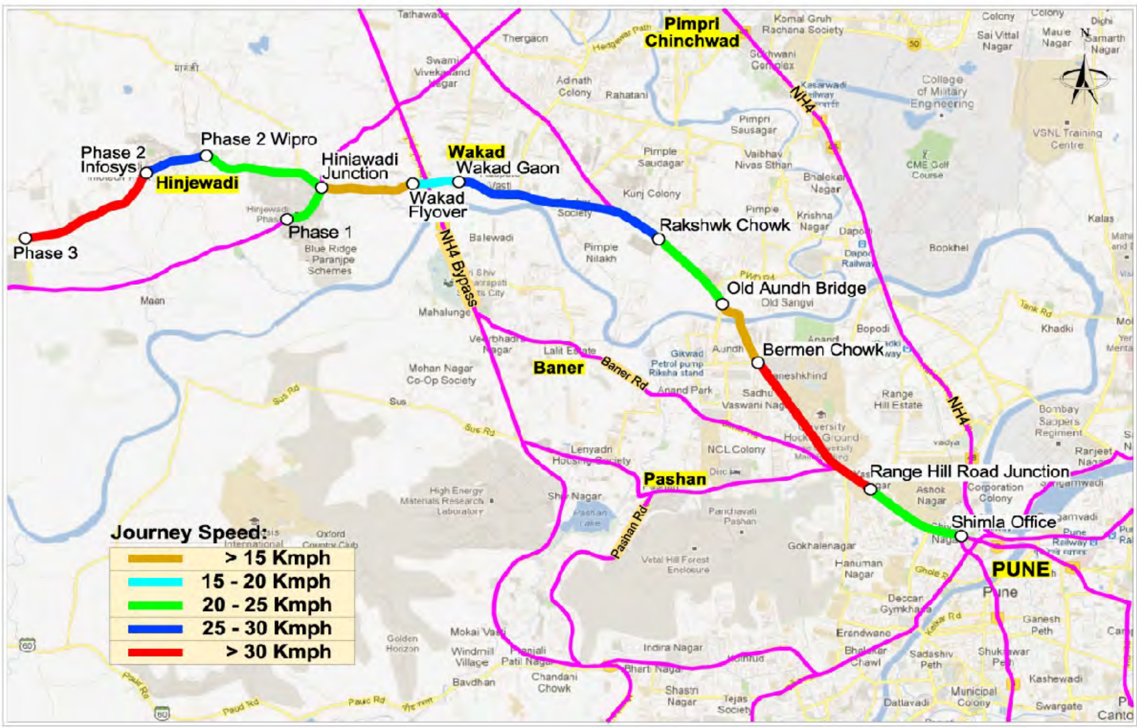


Figure 3.4.2 Existing Journey Speed along Study Corridor

Source: Study Team

Based on the travel speed survey the following can be said:

- Average running speed on the project corridor is 28 km/h and journey speed is 23.46 km/h with a delay of more than 10 minutes in the morning peak
- Journey speed on other major roads in the morning peak ranges from 21 km/hp to 36 km/h, with higher speeds observed in the suburbs.
- The major causes of delays are signals and general road congestion.
- The largest and most significant delay experienced is on Katraj Road, which starts from PMC and passes through the most urbanized parts of the city. Aundh Road, which is part of the Study corridor, experiences the second largest delay.
- The road having the least amount of delay and one of the highest journey speeds is Banner Road.

3.4.3 Screen Line Volume Count Survey

Screen line traffic flows were manually counted over a period of 18 hours (5am-11pm) on typical working days. For modeling purposes, vehicle flows are also converted into passenger car units (PCUs) applying the values in Table 3.4.3, which are based on the code of the Indian Roads Congress.

Table 3.4.3 PCU Values Adopted for Study

Vehicle Type	PCU Values for Urban Areas	
	Up to 5%	>5%
City Bus (20 seater)	1.4	2.0
City Bus (30 seater)	1.4	2.0
Intercity Bus	1.4	2.0
Institutional bus/company bus	1.4	2.0
Car small	1.0	1.0
Car big	1.4	2.0
Taxi small	1.0	1.0
Taxi Big	1.4	2.0
Two wheelers	0.5	0.8
Trucks	2.2	3.7
Cycle	0.4	0.5
Other vehicles	2.0	3.0
Govt. Car Big	1.4	2.0
Govt. Car Small	1.0	1.0

Source: Indian Roads Congress 106-1990

Traffic volumes for the screen lines in PMC and PCMC are described in Tables 3.4.4 and 3.4.5., with the traffic flows in PMC being larger on average than those of PCMC. Vehicle flows for PMC ranged from a maximum of 225,468 to a minimum of 48,253. As for PCMC, vehicle flows ranged form a maximum of 116,669 to a minimum of 35,658. PCU flows for the screen line locations are indicated on Figure 3.4.3.

Table 3.4.4 Traffic Volume (18 hours) at PMC Screen Line Locations

Location	Total	
	Vehicles	PCUs
Deccan Corner Senapati Bridge	48,253	74,126
Shivaji Nagar (ROB)	114,623	115,705
Yerwada Bridge	225,468	234,786
Sangam Bridge	95,565	101,952

Source: Study Team

Table 3.4.5 PCMC Screen Line Traffic (18hours)

Location	Total	
	Vehicles	PCUs
NH9/Sholapur ROB	116,669	120,222
Adithya Birla Hospital Marg.	61,646	64,166
Hegdewar Path Bridge	35,658	31,717
Pimple Gurav Road	19,347	7,893
NH4 Bypass Bridge	37,547	54,637

Source: Study Team

Figure 3.4.3 Daily (18-hour) Flows at Screen Line Locations (PCU)

Source: Study Team

As for peak hour traffic flows, in the case of PMC they represent 7.6% to 9.0% of traffic flows during the 18-hour period of 5am to 11pm in terms of PCUs, while in the case of PCMC peak hour traffic ranges from 7.2% to 12.0% of the total. As for the traffic that comprises peak hour flows, in the case of PMC the vast majority (82% of the total) is private passenger vehicles, with 53% being 2-wheelers and 29% cars. In the case of PCMC, 84% of peak hour traffic consists of 2-wheelers (57%) and cars (27%). See Figures 3.4.4 and 3.4.5.

Table 3.4.6 Peak Hour Traffic at PMC Screen Line Locations

Location	Peak Traffic in PCUs (Veh)	Traffic (18hrs) in PCUs (Veh)	Peak % in PCUs (Veh)
Deccan Corner Senapati Bridge	5,665 (3,519)	74,126 (48,253)	7.6% (7.3%)
Shivaji Nagar (ROB)	10,268 (10,831)	115,705 (114,623)	8.9% (9,5%)
Yerwada Bridge	20,475 (21,251)	234,786 (225,468)	8.7% (9.4%)
Sangam Bridge	9,127 (8,720)	101,952 (95,565)	9.0% (9.1%)

Source: Study Team

Table 3.4.7 Peak Hour Traffic at PCMC Screen Line Locations

Location	Peak Traffic In PCUs (Veh)	Traffic (18hrs) in PCUs (Veh)	Peak % in PCUs (Veh)
NH9/Sholapur ROB	8,941 (9,166)	120,222 (116,669)	7.4% (7.9%)
Adithya Birla Hospital Marg.	4,950 (4,866)	64,166 (61,646)	7.7% (7.9%)
Hegdewar Path Bridge	2,621 (2,981)	31,717 (35,658)	8.3% (8.4%)
Pimple Gurav Road	2,186 (2,577)	17,893 (19,347)	12.2% (13.3%)
NH4 Bypass Bridge	3,915 (2,977)	56,025 (37,547)	7.0% (7.9%)

Source: Study Team

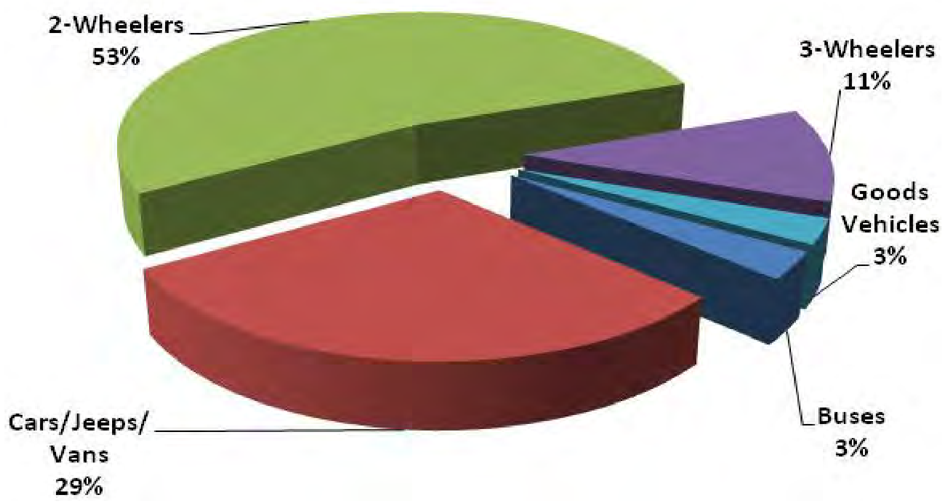


Figure 3.4.4 Peak Hour Traffic Composition for PMC at Screen Line (Veh)

Source: Study Team

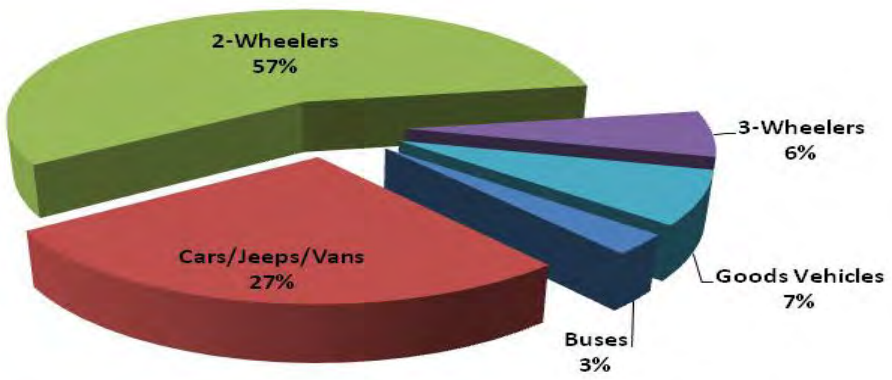


Figure 3.4.5 Peak Hour Traffic Composition for PCMC at Screen Line (Veh)

Source: Study Team

3.4.4 Cordon Line Volume Count Survey

A cordon line survey was carried out to assess movements between the center and outer areas of the Study area over an 18-hour period (5am-11pm) on typical workdays. As Table 3.4.8 indicates, traffic at the cordons ranged from 29,168 vehicles to 135,901 vehicles (both directions). The location and 18-hour traffic volumes at the four cordons are illustrated in Figure 3.4.6.

Table 3.4.8 Traffic Volume (18 hours) at Cordon Locations

Road Name	Outbound Traffic		Inbound Traffic		Total	
	Vehicles	PCUs	Vehicles	PCUs	Vehicles	PCUs
NH4 @ Shivpur	13,039	18,064	16,129	21,603	29,168	39,667
Dapodi Harris Bridge	64,562	59,125	71,339	66,844	135,901	125,969
NH9 @PMC Boundary	23,242	28,893	25,151	31,708	48,393	60,600
Nagar Road near PMC Boundary	27,175	33,549	25,323	34,511	52,498	68,060

Source: Study Team

As for peak-hour traffic flows in terms of PCU, they range from 6.8% to 8.3% of the total and consist mainly of private passenger vehicles (86% of the total), with 57% being 2-wheelers and 29% cars (see Figure 3.4.7). Note the farther the distance from the center of PMC the larger the proportion of trucks. In the case of the screen lines the percentage for PMC was 3%, for PCMC it was 7%, and for the cordons it is 8%.

Table 3.4.9 Peak Hour Traffic at Cordon Locations

Location	Peak Traffic in PCUs (Veh)	Traffic (18hrs) in PCUs (Veh)	Peak % in PCUs (Veh)
NH4 @ Shivpur	2,882 (2,172)	39,667 (29,168)	7.3% (7.5%)
Dapodi Harris Bridge	10,516 (12,044)	125,969 (135,901)	8.3% (8.9%)
NH9 @PMC Boundary	4,148 (3,475)	60,600 (48,393)	6.8% (7.2%)
Nagar Road near PMC Boundary	5,106 (3,932)	68,060 (49,251)	7.5% (8.0%)

Source: Study Team

Figure 3.4.6 Daily (18-hour) Flows at Cordon Locations (PCU)

Source: Study Team

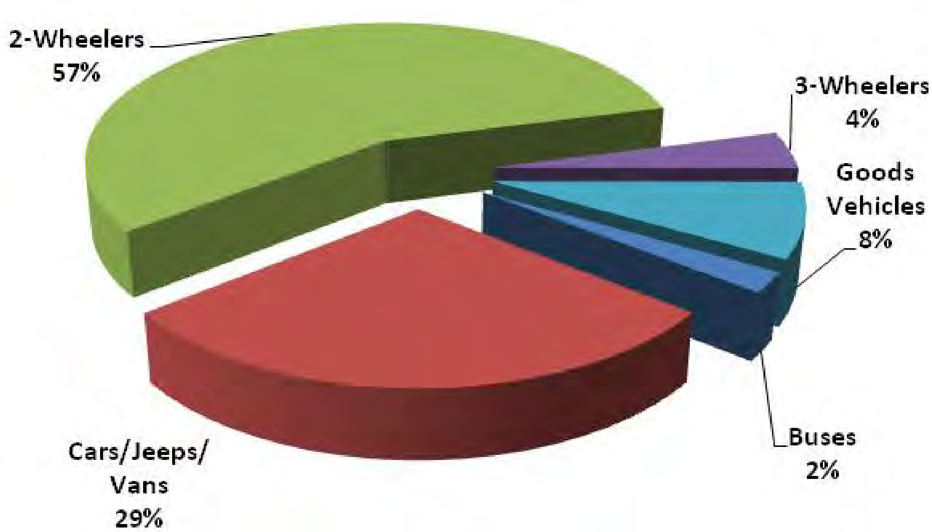


Figure 3.4.7 Peak Hour Traffic Composition at Cordons (Veh)

Source: Study Team

3.4.5 Mid-Block Survey

The mid-block survey was carried out on the Study corridor, with one survey point being on the parallel corridor of Banner Road, in order to assess and compare travel on the Study corridor. As Table 3.4.10 indicates, peak traffic on the Study corridor ranges from 7.1% to 9.0% in terms of PCUs and 10.2% on Banner Road. On the other hand, the largest daily (18-hour) traffic is on Ganeshkhind Road in central PMC at 130,809 PCUs and then on Aundh Road and Hinjawadi Road at approximately 79,000 and 82,000 PCUS, while traffic on Banner Road was the lowest of the mid-block survey points at 70,243, indicting that the Study Corridor in terms of traffic of a higher priority.

As for the composition of the peak hour traffic, private passenger vehicles account for the vast majority at 89%, with 2-wheelers at 57% and cars at 32%. Buses and 3-wheelers only accounted for 2% and 6%, respectively, of the total.

Table 3.4.10 Observed Traffic at Mid-block Locations

Location	Peak Traffic in PCUs (Veh)	Traffic (18hrs) in PCUs (Veh)	Peak % in PCUs (Veh)
Banner Road	7,131 (7,401)	70,243 (70,698)	10.2% (10.5%)
Ganeshkhind Road	9,725 (10,294)	130,809 (129,330)	7.4% (8.0%)
Aundh Road	7,088 (7,873)	79,158 (81,604)	9.0% (9.6%)
Hinjewadi	5,823 (6,051)	82,043 (83,065)	7.1% (7.3%)

Source: Study Team

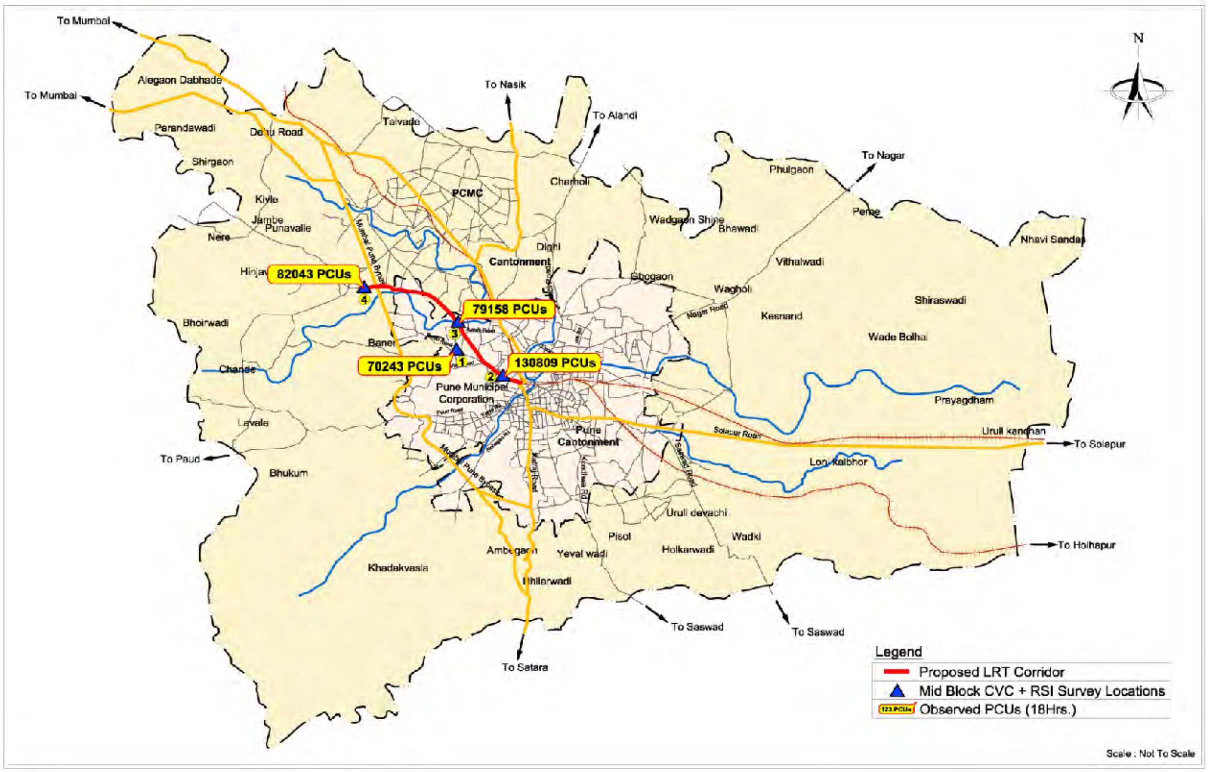


Figure 3.4.8 Daily (18-hour) Flows on & Near Project Corridor (PCU)

Source: Study Team

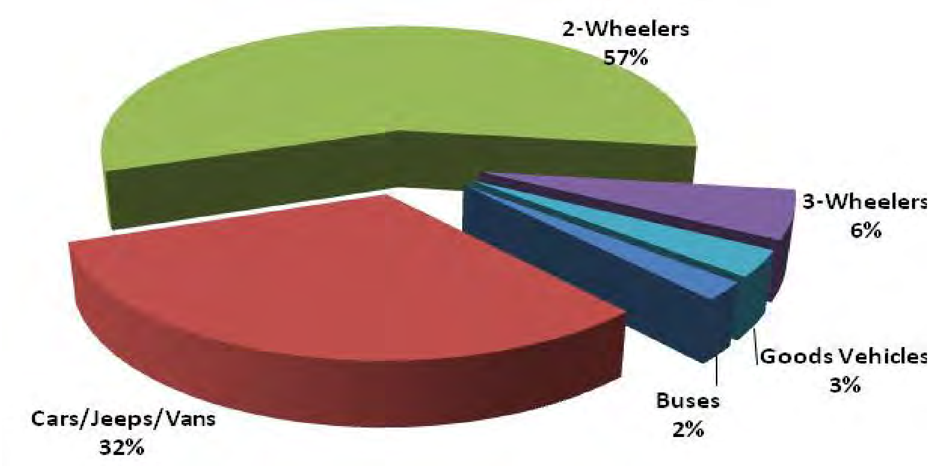


Figure 3.4.9 Peak Hour Traffic Composition on & Near Project Road (Veh)

Source: Study Team

3.4.6 Bus Occupancy Survey

The bus occupancy survey was carried out at 3 mid-block locations via a manual count along the Study corridor to assess the number of passengers using public transit. As Table 3.4.11 indicates, the average number of passengers riding on buses during the hours of bus operation ranged from 41 to 53.。

Table 3.4.11 Average Bus Occupancy

Location of Road Section	Average Occupancy (No. of Passengers)
Ganeshkhind Road	53
Aundh Road	47
Hinjawadi Road	41

Source: Study Team

3.4.7 Bus Boarding/Alighting Survey

The bus boarding/alighting survey was carried out at six major bus stops along the Study corridor during the operational hours of buses on a normal working day. The total number of passengers boarding/alighting ranged from a minimum of 1,275 at Wakad Road bus stop to a maximum of 15,901 at the Ganeshkhind Road bus stop. The Pune University bus stop had the second largest number with 8,978 passengers and the Aundh Road bus stop had the third largest with 6,781 passengers.

Table 3.4.12 Hourly Distribution of Boarding & Alighting for Buses along the Study Corridor

Time	Aundh Road		Ganeshkhind Road		Infosys Phase 1		Infosys Phase 2		Pune University		Vishal Nagar (Wakad)	
	BRG	ALG	BRG	ALG	BRG	ALG	BRG	ALG	BRG	ALG	BRG	ALG
5.00-6.00	166	57	33	49	5	6	11	12	29	23	12	12
6.00-7.00	67	77	77	78	16	12	32	24	49	35	27	17
7.00-8.00	153	146	303	166	78	103	105	157	297	296	91	108
8.00-9.00	260	181	586	340	47	60	29	108	308	402	74	8
9.00-10.00	213	138	376	183	59	106	39	135	306	305	64	19
10.00-11.00	291	239	641	526	63	140	13	145	298	312	51	11
11.00-12.00	325	388	300	124	38	124	57	217	431	313	64	25
12.00-13.00	249	328	565	286	22	74	43	120	567	301	26	25
13.00-14.00	116	141	754	455	31	37	27	83	221	100	25	20
14.00-15.00	213	200	663	429	34	44	49	92	377	146	28	33
15.00-16.00	155	212	327	290	34	59	91	41	456	168	12	30
16.00-17.00	251	195	605	432	66	51	99	39	418	155	26	32
17.00-18.00	138	267	1150	599	58	33	129	73	584	149	25	56
18.00-19.00	348	182	893	452	82	35	124	27	593	181	11	37
19.00-20.00	349	196	956	334	86	45	206	15	400	133	21	103
20.00-21.00	208	157	872	485	67	45	84	21	262	76	25	104
21.00-22.00	60	60	418	412	25	25	15	19	106	84	8	24
22.00-23.00	27	28	372	370	5	8	8	5	53	44	8	13
Total	3,589	3,192	9,891	6,010	816	1,007	1,161	1,333	5,755	3,223	598	677

Source: Study Team

3.4.8 OD Survey

The OD survey was carried out at 3 locations along the Study corridor and on the parallel Banner Road to assess trip-making behavior. The sampling rate by vehicle type is as indicated in Table 3.4.13, ranging from 3.4% to 4.5% for cars, 1.8% to 7.5% for 3-wheelers, and 2.5% to 4.1% for 2-wheelers.

Table 3.4.13 OD Sample Size

Vehicle Type	Sample Size			
	Banner Road	Ganeshkhind Road	Aundh Road	Hijawadi Road
2-Wheeler	4.0%	2.5%	4.1%	2.5%
3-Wheeler	5.5%	1.8%	5.4%	7.5%
Car	4.0%	3.9%	4.5%	3.4%

Source: Study Team

Based on the OD survey it was understood that 85%, 69%, 78%, and 73%, respectively, of the 2-wheeler, 3-wheeler, car, and taxi riders interviewed make a daily trip using the Study corridor. It was further understood that 8%, 14%, 11%, and 14% of those interviewed for the same modes make multiple trips in a day (see Figure 3.4.13). The vast majority of trip making was for work with 87%, 88%, 94%, and 95%, respectively, of the 2-wheeler, 3-wheeler, car, and taxi riders interviewed making trips for that purpose (see Table 3.4.15). The average number of occupants by vehicle type is 1.4, 2.1, 2.0, 3.4, respectively, for 2-wheelers, 3-wheelers, car, and taxis.(see Table 3.4.15) Finally, 98.0% and 92.5%of those interviewed on the Study corridor and Banner Road, respectively, make their trips within PMR (see Table 3.4.16). The trip desire line figures for 2-wheelers, cars, and 3-wheelers are as shown in Figure 3.4.10, 3.4.11, and 3.4.12.

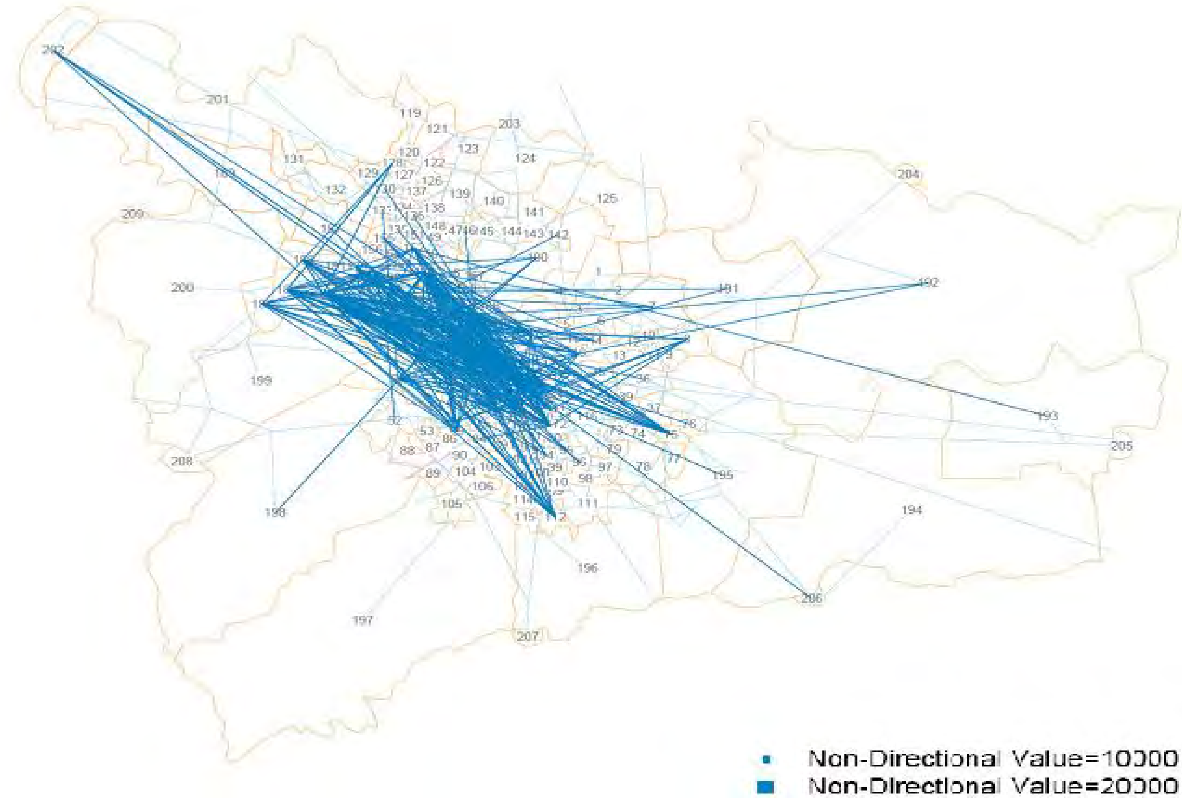


Figure 3.4.10 Desire Lines for 2-wheelers (Peak Hour)

Source: Study Team

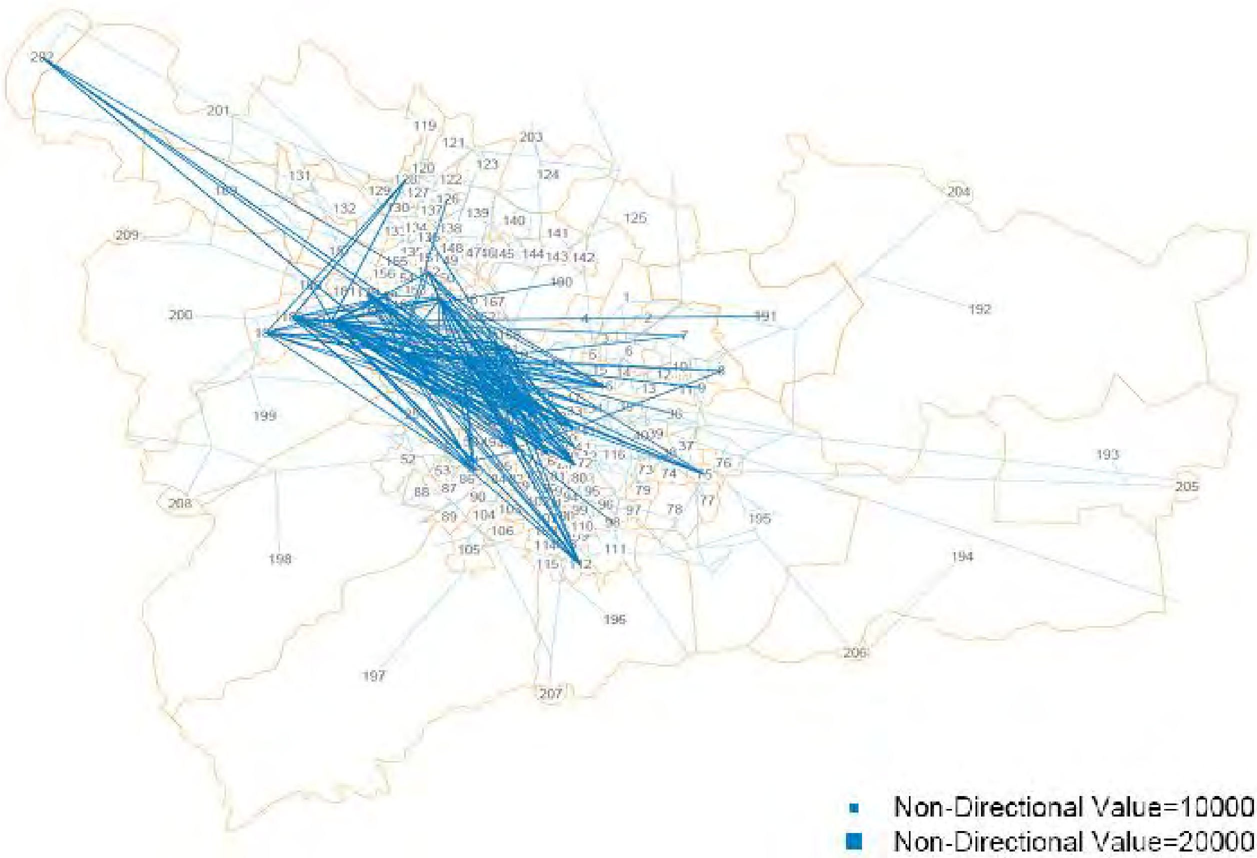


Figure 3.4.11 Desire Lines for Cars (Peak Hour)

Source: Study Team

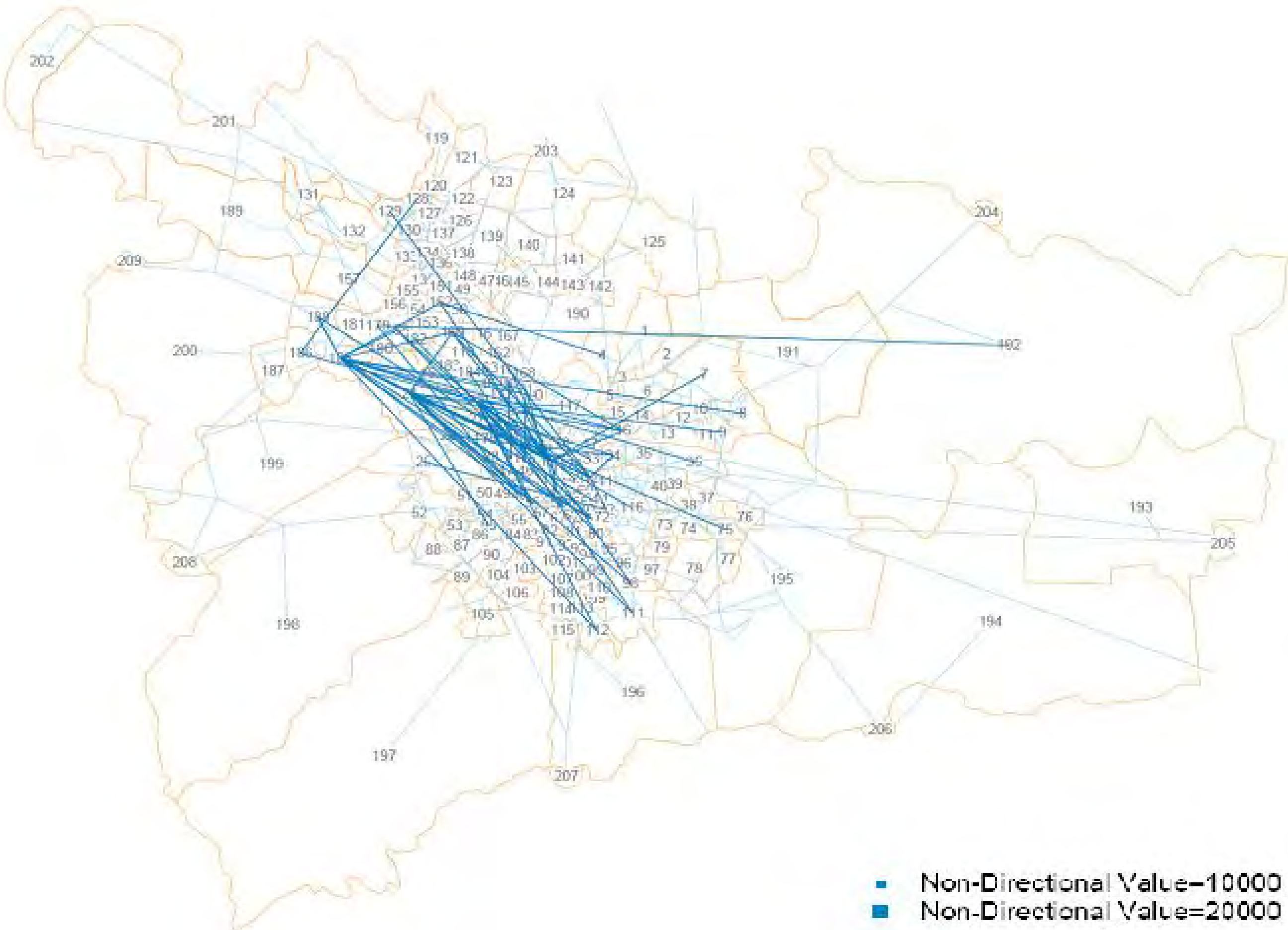


Figure 3.4.12 Desire Lines for 3-wheelers (Peak Hour)

Source: Study Team

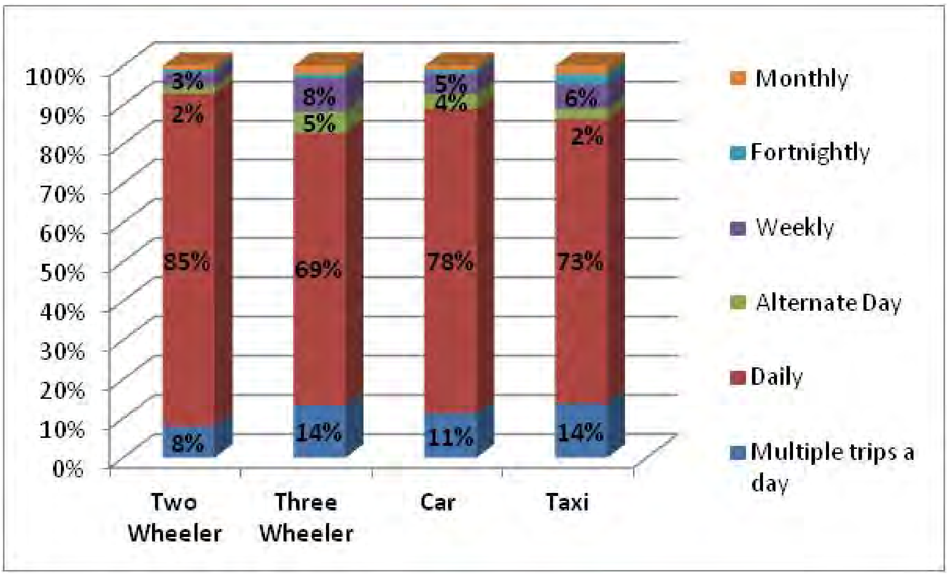


Figure 3.4.13 Travel Frequency along Study Corridor

Source: Study Team

Table 3.4.14 Trip Purpose on Study Corridor

Vehicle Type	Work	Education	Social	Tourism & Recreation	Others	Total
2-Wheeler	87%	7%	3%	1%	2%	100%
3-Wheeler	88%	5%	3%	1%	3%	100%
Car	94%	3%	2%	1%	1%	100%
Taxi	95%	1%	1%	1%	1%	100%

Source: Study Team

Table 3.4.15 Average Vehicle Occupancy on Study Corridor

Vehicle Type	Banner Road	Ganeshkhind Road	Aundh Road	Hinjawadi Road	
Two-Wheeler	1.4	1.4	1.4	1.5	1.4
Three-Wheeler	1.9	1.4	2.6	2.4	2.1
Car/Van	1.9	1.8	2.4	1.8	2.0
Taxi	3.3	2.3	3.3	4.7	3.4

Source: Study Team

Table 3.4.16 Travel Pattern on Study Corridor

Location	Passenger Vehicles		
	I-I	E-I &I-E	E-E
Study Corridor	98.0%	2.0%	0.0%
Banner Road	92.5%	7.4%	0.1%

Source: Study Team

Note: 'I' means within PMR and 'E' means outside of PMR.

Another important piece of information gathered from the OD survey was the preference for public transit, with 77%, 66%, 86%, and 79%, respectively, of 2-wheeler, 3-wheeler, car, and taxi users preferring not to use bus (see Figure 3.4.14). Only 23% of private vehicle users on average prefer to use the bus and the majority of these people do not own their own vehicle. The reason for not preferring to use bus transport is the poor condition of buses, insufficient frequency, lateness, and overcrowding.

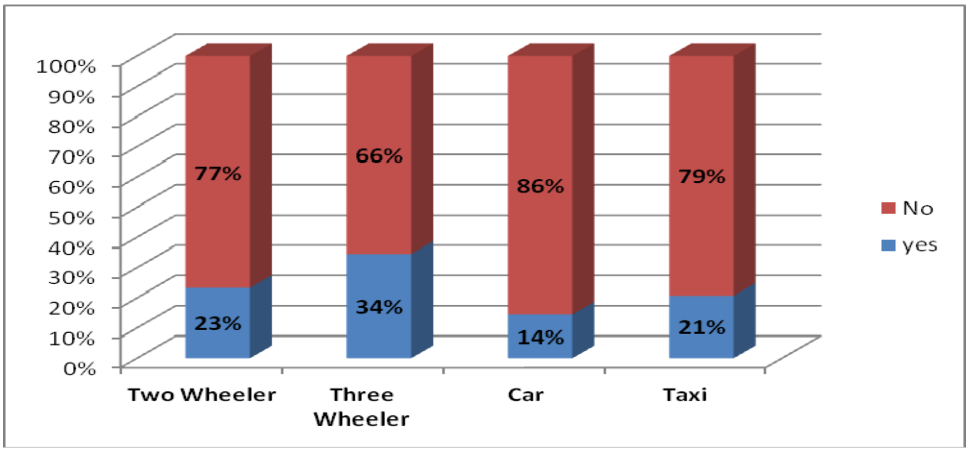


Figure 3.4.14 Preference for Use of Public Transit

Source: Study Team

3.4.9 Stated Preference Survey

The stated preference (SP) survey was carried out at three locations on the Study corridor (i.e., the Pune bus terminal, Shivaji Nagar bus stop, & Hinjawadi IT Park), and 2000 samples were collected from car, 2-wheeler,3-wheeler, and bus users to asses willingness to pay for the proposed LRT. The fare that was considered is as shown in Table 3.4.17. Fare Level-1 is based on the fares of the Delhi Metro and Fare Level-4 is based on the fares for the Delhi Airport Line. As for Fare Level-2 and Fare Level-3, it is multiples of Fare Level-1 (i.e., 1.5 & 2.0 times its fare).

Table 3.4.17 Fare Levels for LRT

Distance in Km	Fare in Rupees			
	Level-1	Level-2	Level-3	Level-4
<=3	8	12	16	20
3-6	11	17	22	26
6-9	14	21	28	39
9-12	17	26	34	52
12-15	21	32	42	65
15-18	24	36	48	75
18-21	27	41	54	87
21-24	30	46	60	98

Note: Fares are by distance interval.
Source: Study Team

The average income of 72% of the SP survey respondents is less than Rs. 30,000 per month, with 15% of those making less than Rs. 10,000. Twenty percent of respondents earn between Rs. 30,000 and 50,000 and only 8% earn more than Rs. 50,000 (see Figure 3.4.15). The dominant mode most used by respondents is bus (52%), with 2 wheelers and car coming next at 19% and 18%, respectively (see Figure 3.4.16). Further, the vast majority of trips are for work, with more than 90% of all respondents for all modes traveling for that purpose (see Figure 3.4.17). On the other hand, of those interviewed only 30% receive a commutation allowance. Finally, willingness to pay by mode, which is obtained by the sum product of response percentages and fare levels, is shown in Figure 3.4.18. As that figure indicates most respondents would be willing to pay approximately Fare Level-2 to ride the LRT.

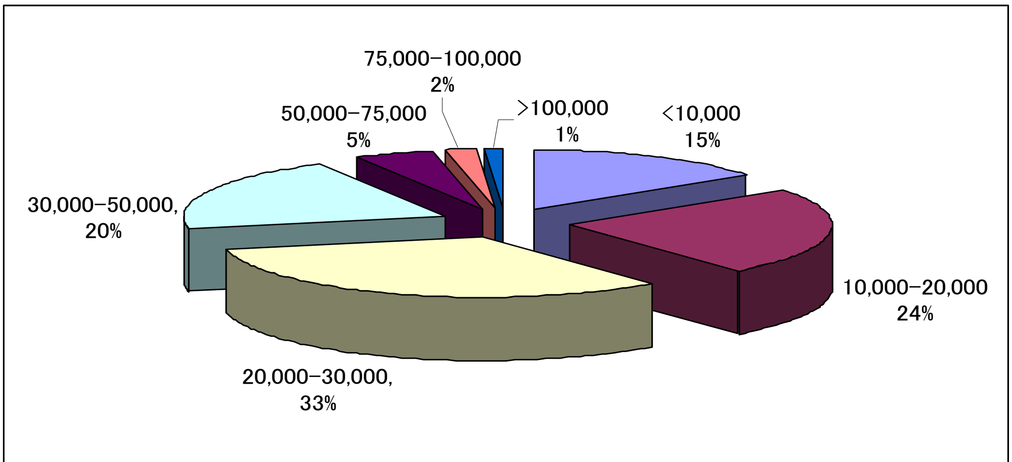


Figure 3.4.15 SP Survey Respondents by Income

Source: Study Team

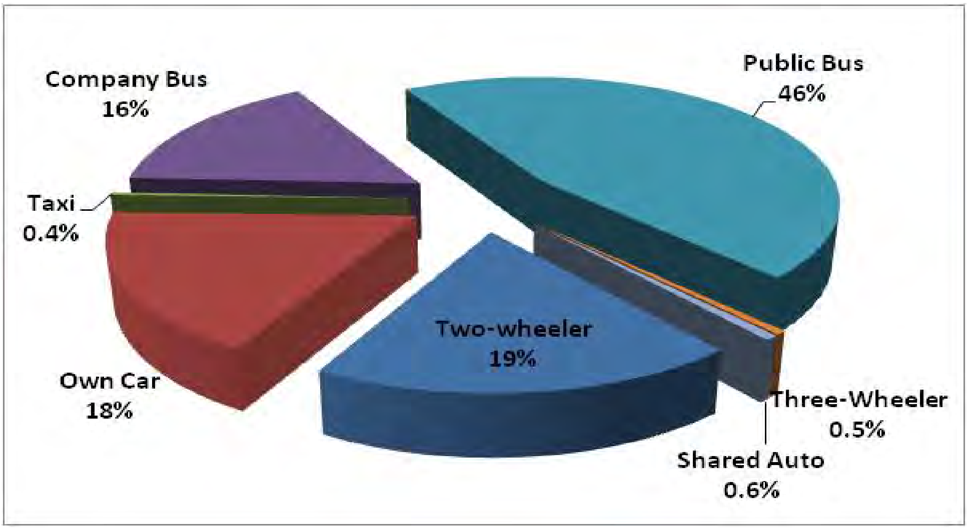


Figure 3.4.16 Dominant Mode of Travel for SP Survey Respondents

Source: Study Team

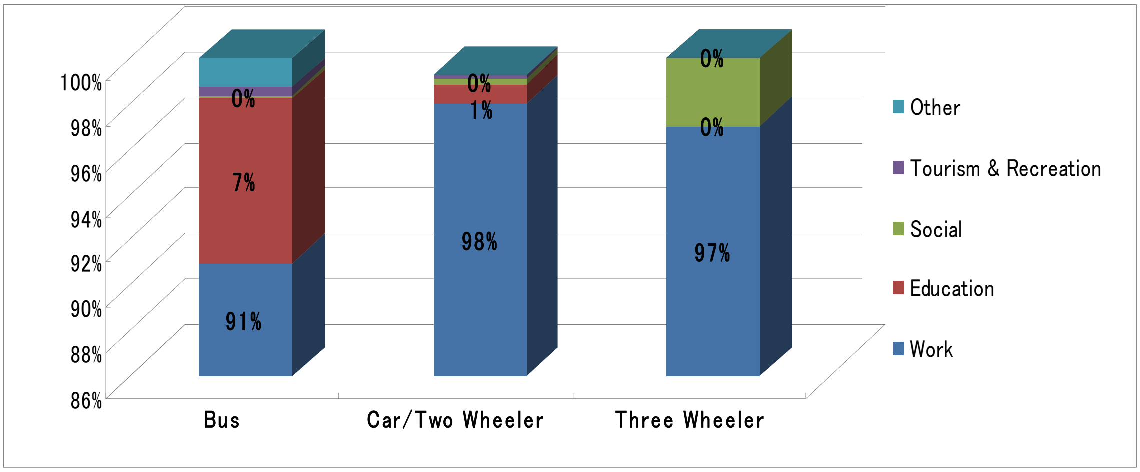


Figure 3.4.17 Purpose of Journey by Mode

Source: Study Team

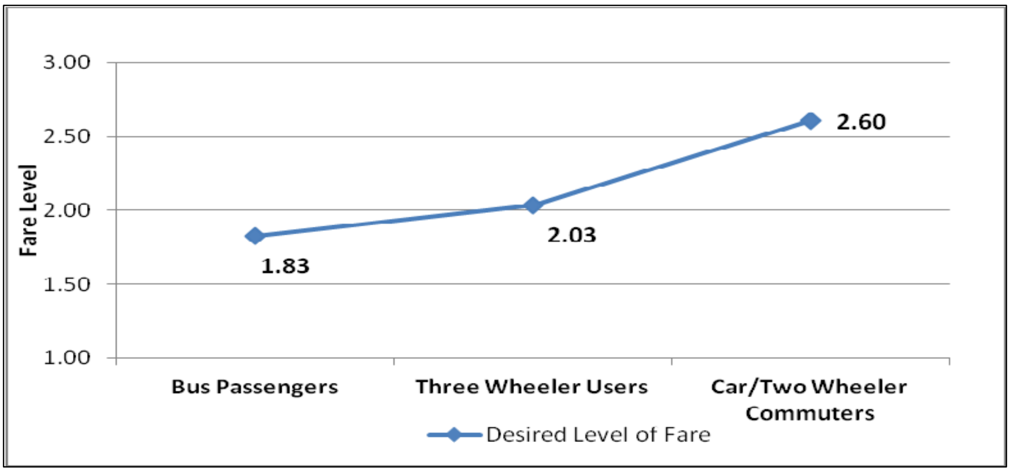


Figure 3.4.18 Willingness to Pay of SP Survey Respondents

Source: Study Team

3.5 Updating & Validation of Model

The transport model used for the 2008 “Comprehensive Mobility Plan” was updated applying data from the transportation surveys and on adjusting population and employment data using control totals for the areas of PMR. Below, the model specifications for the trip generation, trip attraction, and trip distribution/mode choice models are given.

Table 3.5.1 Trip Generation Models (Peak Hour)

Area	Equation	T Value	F Value	R^2
PMC & PCMC	0.088*Population+276.88	11.46	131.32	0.51
Rest of PMR	0.061*Population+1020.57	14.37	206.44	0.95

Source: Study Team

Table 3.5.2 Trip Attraction Models (Peak Hour)

Area	Equation	T Value	F Value	R^2
PMC & PCMC	0.197*Employment+436.048	19.70	388.19	0.76
Rest of PMR	0.220*Employment+15.369	44.28	1960.82	0.99

Source: Study Team

The combined trip distribution/mode choice model is as described below.

$$\mathbf{T_{ijm} = r_i\, G_i\, s_j\, A_j\, F_{ijm}}$$

T = number of inter zonal trips between zone i & j and by mode m

G = Total generation trip ends by zone

A = Total attraction trip ends by zone

i = Generation zone

j = Attraction Zzone

r,s = Balancing factors (constants)

F_{ijm} = Deterrence function for mode m

$$\mathbf{F_{ijm} = K_m\, e^{-\beta cijm} \quad C_{ijm}{}^{\alpha}}$$

K = Constant factor

C = Generalized cost

B = Calibration constant–exponential function

α = Calibration constant-power function

The parameters obtained via calibration for each mode is given in the table below.

Table 3.5.3 Calibrated Deterrence Functions

Mode	Peak Hour		
	K	ALPHA	BETA
2-wheeler	2.5	-0.2	52.8
Car	1.2	0.8	12.0
3-wheeler	4.6	-0.1	24.8
Public Transport	3.0	0.2	59.4

Source: Study Team

The outline of the network of the updated model is as described in Table 3.5.4.

Table 3.5.4 Details of Network of Updated Model

Highway Network	Public Transit Network
No. of Links: 3,972 No. of Nodes: 3,397 No. of Zones: 190	No. of Bus Routes: 308 No. of BRT Routes: 1

Source: Study Team

The zoning system was revised from 169 to 190 zones (182 internal & 8 external), with the zones around the LRT corridor made smaller to increase the accuracy for estimating LRT trips in the future (see Figure 3.5.1).

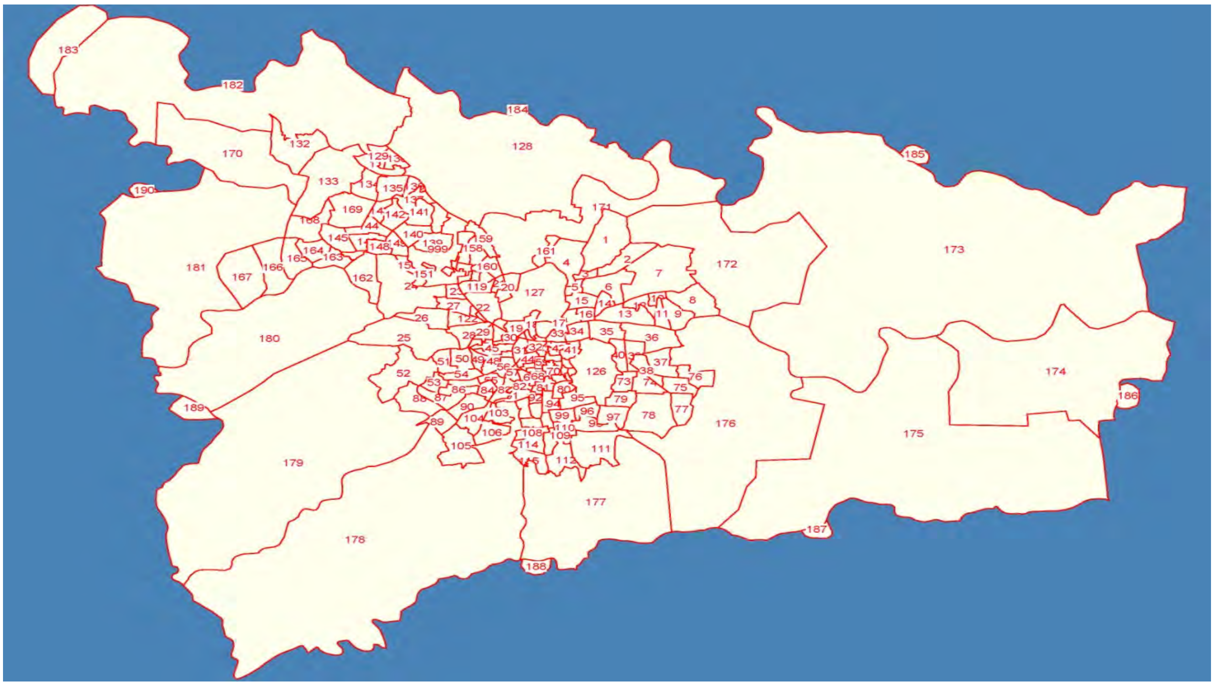


Figure 3.5.1 Zoning System for Updated Model

Source: Study Team

The updated model was validated by comparing observed and modeled traffic at the screen lines, the cordons, and on the Study corridor, as well as journey speeds on 7 major corridors. From these comparisons, it can be seen that the percentage difference between observed and modeled values does not exceed 15%, which is within the level of tolerance for a valid model. Based on this, the updated model can be considered to valid.

Table 3.5.5 Observed Traffic vs. Modeled Traffic at Screen Line-1

Modes	Screen Line-1	Towards Mumbai	Towards Solapur
2-Wheelers	Modeled	12,673	10,853
	Observed	13,730	12,069
	% Difference	8%	11%
Car	Modeled	4201	4,701
	Observed	4271	4,662
	% Difference	12%	-1%
3-Wheelers	Modeled	3398	2,380
	Observed	3893	2544
	% Difference	15%	7%

Source: Study Team

Table 3.5.6 Observed Traffic vs. Modeled Traffic at Screen Line-2

Modes	Screen Line-1	Towards Mumbai	Towards Solapur
2-Wheelers	Modeled	3,670	4,690
	Observed	4,106	3,466
	% Difference	12%	13%
Car	Modeled	2,550	3,020
	Observed	2,835	3466
	% Difference	11%	15%
3-Wheelers	Modeled	479	488
	Observed	509	546
	% Difference	6%	12%

Source: Study Team

Table 3.5.7 Observed Traffic vs. Modeled Traffic at Cordon Line

Modes	Screen Line-1	Towards Mumbai	Towards Solapur
2-Wheelers	Modeled	11,375	10,438
	Observed	12,859	9,797
	% Difference	13%	-6%
Car	Modeled	6,051	7,094
	Observed	6,965	7,322
	% Difference	15%	3%
3-Wheelers	Modeled	1,439	1,123
	Observed	1,620	1,168
	% Difference	13%	4%

Source: Study Team

Table 3.5.8 Observed Traffic vs. Modeled Traffic along Study Corridor

Location	Towards City			Towards Hinjawadi		
	Modeled	Observed	% Difference	Modeled	Observed	% Difference
Ganeshkhind	5,614	5,949	6%	3,694	3,344	-9%
Aundh	3,811	3,752	-2%	2,667	2,316	-13%
Hinjawadi	1,202	1,057	-12%	4,621	4,200	-9%

Source: Study Team

Table 3.5.9 Observed & Modeled Journey Speeds along Seven Major Corridors

Road Name	Speed Observed (km/h)	Speed Modeled (km/h)	% Difference
Aundh Road	23.5	21.8	7.2%
Banner Road	34.6	30.1	13.0%
Katraj Raod	21.3	20.0	6.1%
NH4 Bypass	36.9	32.2	12.7%
Nagar Road	22.1	19.9	9.9%
Sholapur Road	22.5	25.2	-12.0
NH4	25.4	23.9	5.9%

Source: Study Team

3.6 Future Socioeconomic Frame for PMR

After revising the zoning system, updating the road network, and validating the model by applying the data of the transportation surveys, it was necessary to forecast population and employment into the future, as these values are responsible for trip production and attraction. After examining the trends in population growth over the past 60 years from the Census of India, referring to a master plan for Hinjawadi[3], and meeting with the Hinjawadi Industrial Association, forecasts for 2018, 2028, and 2038 were carried out (see Table 3.6.1).

Population growth for the entirety of PMR is expected to be 3.2%, 2.8%, and 2.4%, respectively, for the periods of 2012-2018, 2018-2028, and 2028-2038 (see Table 3.6.2). Depending on the area of PMR, population growth varies, with PMC and PCMC gradually declining as these areas are becoming more settled. On the other hand, it is expected that the rest of PMR (i.e., the suburbs) will experience an increase in growth, exclusive of the cantonments whose population has remained stable over time. In terms of population growth, Hinjawadi is an exception and is expected to see an increase in population of 14.4% from 2012 to 2018, which will decline to 7.2% during 2018 to 2028 and then to 3.4% in 2028 to 2038.

3 Comprehensive Master Plan for Rajiv Gandhi InfoTech Park, CES. 2008.

Table 3.6.1 Forecasted Population Growth for PMR by Area (in millions)

Area	2011	2012	2018	2028	2038
PMC	3.12	3.25	3.77	4.73	5.80
PCMC	1.69	1.76	2.25	3.19	4.23
Hinjewadi	0.11	0.13	0.28	0.57	0.79
Cantonment	0.21	0.21	0.22	0.24	0.25
Rest of PMR	0.73	0.74	0.81	0.95	1.17
Total	5.85	6.09	7.34	9.68	12.24

Source: Forecasts by Study Team & existing data from Indian census.

Table 3.6.2 Forecasted Population Growth Rate by Area for PMR

Area	2012-2018	2018-2028	2028-2038
PMC	2.5%	2.3%	2.1%
PCMC	4.2%	3.6%	2.9%
Hinjewadi	14.4%	7.2%	3.4%
Cantonment	0.8%	0.7%	0.7%
Rest of PMR	1.5%	1.6%	2.1%
Total	3.2%	2.8%	2.4%

Source: Study Team

Employment was forecasted after examining and essentially applying the work participation ratios (WPRs) of the Comprehensive Mobility Plan. It is expected that employment will increase from about 2.5 million in 2012 to approximately 3.1 million, 4.2 million, and 5.5 million in the years 2018, 2028, and 2038, respectively (see Table 3.6.3). The WPR is also expected to increase from 41% in 2012 to 45% in 2038.

Table 3.6.3 Trend in Employment in the PMR Area

Area	2011	2012	2018	2028	2038
PMC	1,259,238	1,313,433	1,526,161	1,962,863	2,461,979
PCMC	697,397	734,710	998,456	1,467,622	2,025,481
Hinjawadi*	78,475	109,864	222,397	368,279	545,146
Cantonment	69,795	71,370	81,486	84,792	88,906
Rest of PMR	267,470	273,153	297,110	343,185	417,538
Total	2,372.374	2,502,530	3,125,610	4,226,739	5,539,050
Work Participation Ratio	41%	41%	43%	44%	45%

*: There were 75 companies in Hinjawadi in 2012.

Source: Forecasts by Study Team & existing data from Indian census.

3.7 Future PMR Transport Network

The future PMR transport network is based mostly on the 2008 “Comprehensive Mobility Plan”, as well as other relevant planning reports, and on current information available as to the likelihood of projects being implemented. The contents of these projects, which include BRTs, metros (lines 1 &2), and road widening are described in Table 3.7.1 and 3.7.2. The configuration of the LRT, which assumes a partially instead of a fully elevated structure owing to cost considerations, is shown in Table 3.7.3.

3.7.1 Future Improvement in PMC/PCMC Transport Network

Table 3.7.1 Expected Future Infrastructure Improvements for PMC/PCMC

Name of Corridor	Length (km)	Proposed Improvement	Expected Year of Operation	Jurisdiction
Yerwada to Vishranthwadi Rd	4.5	4-Lane to 6-Lane with BRT	2018	PMC
Ahmednagar Rd	5.4	4-Lane to 6-Lane with BRT	2018	PMC
Karve Rd	6.4	4-Lane to 6-Lane with BRT	2018	PMC
High Capacity River Side Rd	17.0	4-Lane/2-Lane to 6-Lane with BRT*	2018	PMC
Vishranthwadi – Dhanori Rd	6.0	4-Lane/2-Lane to 6-Lane with BRT*	2018	PMC
Baner Road	3.2	4-Lane to 6-Lane with BRT	2018	PMC
Hotel Green Park to Balewadi Stadium crossing Westerly Bypass	5.7	4-Lane to 6-Lane with BRT	2018	PMC
Old Mumbai Rd	5.5	4-Lane to 6-Lane with BRT	2018	BOTH
Nehru Rd	5.0	4-Lane/2-Lane to 6-Lane with BRT*	2018	PMC
Pashan Rd	6.1	4-Lane to 6-Lane with BRT	2018	PMC
Kondhwa Rd	8.1	4-Lane to 6-Lane with BRT	2018	PMC
Aundh Rd	14.7	4-Lane to 6-Lane with BRT	2018	PMC
Karve Road & Nagar Rd	20	Metro	2028	PMC
Core Area Inner Ring	13.0	4-Lane/2-Lane to 6-Lane with BRT*	2038	PMC
NH4 Bypass Rd	40.0	40 km 4-Lane to 6-Lane	2028	BOTH
Aundh Ravet Rd	14.4	4-Lane to 6-Lane with BRT	2018	PCMC
NH4	14.6	4-Lane to 6-Lane with BRT	2018	PCMC
Telco Rd	12.0	4-Lane to 6-Lane with BRT	2018	PCMC
Dehu to Alandi Rd	10.6	2-Lane to 6-Lane with BRT	2018	PCMC
NHSO (Nashik phata to Moshi)	14.5	4-Lane to 6-Lane with BRT	2018	PCMC
Alandi Rd	5.2	4-Lane/2-Lane to 6-Lane with BRT*	2018	PMC
NH-4 (Old Mumbai Pune Highway)	18.0	4-Lane to 6-Lane with Metro	2038	BOTH
Nashik Phata to Wakad	10.4	2-Lane/4-Lane to 6-Lane with BRT*	2018	PCMC
Hinjewadi to Dehu-Alandi Rd	7.8	2-Lane/4-Lane to 6-Lane with BRT*	2018	PCMC
Kalewadi-KSB Chowk-Dehu Alandi Rd	13.3	2-Lane/4-Lane to 6-Lane with BRT*	2018	PCMC
Vishrantwadi-Alandi	11.8	2-Lane to 4-Lane with BRT	2018	PCMC
Kiwale to Bhakti Shakti	13.3	2-Lane to 4-Lane with BRT	2018	PCMC
Pradhikaran	16.7	2-Lane to 4-Lane with BRT	2028	PCMC
Hinjewadi to Tata Motors	68.7	2-Lane to 4-Lane with BRT	2028	PCMC
Bhakti Shakti to Talwade	8.4	2-Lane to 4-Lane with BRT	2028	PCMC
Road Parallel to Aundh Ravet	11.6	2-Lane to 4-Lane with BRT	2028	PCMC

Source: 1) Comprehensive Mobility Plan for Pune City, Wilbur Smith Assoc & IL&FS, Nov. 2008.
2) Comprehensive Mobility Plan for Pimpri-Chinchwad City, Crisil Infrastructure Advisory, Nov. 2008.

3.7.2 Future Improvement in Hinjawadi Transport Network

Table 3.7.2 Expected Future Infrastructure Improvements for Hinjawadi

Road & Road Section	2018	2028	2038
NH 4 Bypass			
i) Dehu to Waked Police Station	4 to 6 lane		
ii) Wakad Police Station to Wakad Flyover		4 to 6 lane + Service Road	
iii) Wakad Flyover to Banner Rd. Jct.		4 to 6 lane + Service Road	
iv) Banner Road Jn. to Sus Road Jct.	4 to 6 lane		
MDR – 31			
i) Wakad Police Station. To Hinjewadi. Chowk		2/4 to 6 lane	
ii) Hinjewadi Chowk to Infosys Chowk		2/4 to 6 lane	
iii) Infosys Chowk to 'R' Jct.		2 to 4 lane	4 lane to 6 lane
iv) 'R' Junction to Pirangut		2 to 4 lane	
MDR – 30			
i) KPIT Jn to' X' Jct.		2 to 6 lane	
ii) X Jn to Marunje		2 to 4 lane	4 lane to 6 lane
MIDC: Spine Road			
i) Wakad Flyover to Hinjawadi Chowk		2/4 to 6 lane	
ii) Hinjawadi Chowk to KPIT		2/4 to 6 lane	
iii) KPIT to Disha Jct.		2/4 to 6 lane	
iv) Disha Jn to 'B' Jct		2/4 to 6 lane	
v) 'B' to 'N' to 'D' Jct.		2/4 to 6 lane	
Wakad Police Stn. To 'X' Jct.			2 to 6 lane
Disha Jn. To Infosys		4 to 6 lane	
Punavale Road Extension (new roads)			
i) Up to MDR 30	2 lane with shoulder	2 lane with shoulder to 4 lane	
ii) MDR 30 to	2 lane with shoulder	2 lane with shoulder to 4 lane	
iii) To MDR 31		4 lane	
Jn. X to Disha Jct.		4 lane	4 lane to 6 lane
Up to MDR 31	-	4 lane	
RP Rd - PH I to Main Rd	-	4 lane	

Source: Comprehensive Master Plan for Rajiv Gandhi InfoTech Park, Hinjawadi,Pune, CES, April 2010.

3.7.3 LRT Station Configuration

Table 3.7.3 LRT Stations & Configuration

ID	Station Name	Structure	Mileage	Distance
St. 1	Shivaji Nagar AST	Elevated	0k070m	0m
St. 2	Shivaji Nagar	Elevated	0k590m	520m
St. 3	Police Ground	Elevated	1k000m	410m
St. 4	Pune Central	Elevated	1k800m	800m
St. 5	E-Square	Elevated	2k300m	500m
St. 6	Pune University	At-Grade	3k650m	1,350m
St. 7	Armament Colony	At-Grade	4k250m	600m
St. 8	PWD Office	At-Grade	5k000m	750m
St. 9	Aundh District Office	Elevated	5k550m	550m
St. 10	Police NAKA	Elevated	6k350m	800m
St. 11	State Hospital	At-Grade	7k650m	1,300m
St. 12	Pimple Nilakh	At-Grade	8k655m	1,005m
St. 13	Wakad Road Mall	Elevated	10k600m	1,945m
St. 14	Wakad Chowk 1	At-Grade	11k490m	890m
St. 15	Wakad Chowk 2	Elevated	12k800m	1,310m
St. 16	Hinjawadi Road Shopping Mall	Elevated	14k700m	1,900m
St. 17	Shivaji Chowk	Elevated	15k450m	750m
St. 18	RGIP Phase 4	At-Grade	16k900m	1,450m
St .19	Wipro Circle	At-Grade	17k600m	700m
St. 20	Infosys Circle	At-Grade	18k700m	1,100m
St. 21	Mahindra Tech 2	At-Grade	21k600m	2,900m

Source: Study Team

3.8 Forecasts for LRT in 2018, 2028, 2038

Forecasts for LRT ridership are carried out using the fare levels shown in Table 3.4.17 and the LRT configuration described in 3.7.3. Figure 3.8.1 shows the peak hour peak direction traffic (PHPDT) for the years of 2018, 2028, and 2038, with LRT ridership naturally decreasing as fares increase. Figure 3.8.2 shows the maximum sectional load or the station-to-station section with the largest number of passengers. Except for Fare Level-1, all of the fare levels have a maximum sectional load that is within or close enough to 15,000 that can be accommodated by the LRT. An important thing to note about the ridership for Fare Level-1 is that in 2028 there are only 2 sections that have more than 15,000 passengers in the peak hour and in 2038 this number rises to 3 out of a total of 21 stations. From this viewpoint, it is suggested that it would be better to increase the fare slightly and avoid the need for a new and much more expensive MRT. Note also that according to the SP survey results most people are willing to pay Fare Level-2, which results in the best usage of the LRT. Daily ridership for Fare Level-2 is given in Figure 3.8.3, which grows from about 159,000 passengers in 2018 to 653,000 in 2038. LRT matrices for daily ridership are given in Tables 3.8.1 to 3.8.3.

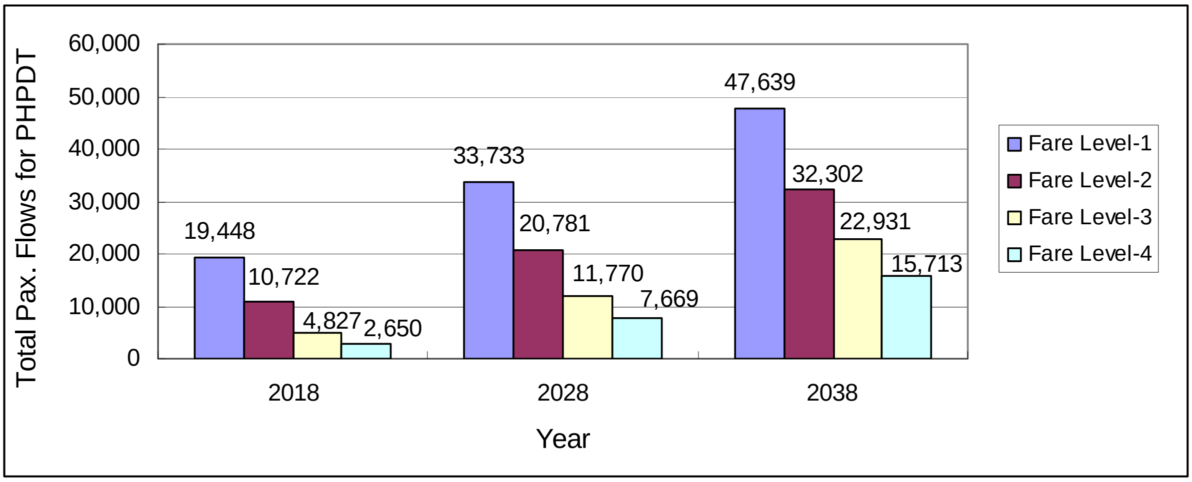


Figure 3.8.1 Peak Hour Peak Direction Passenger Flows for Partially Elevated LRT

Source: Study Team

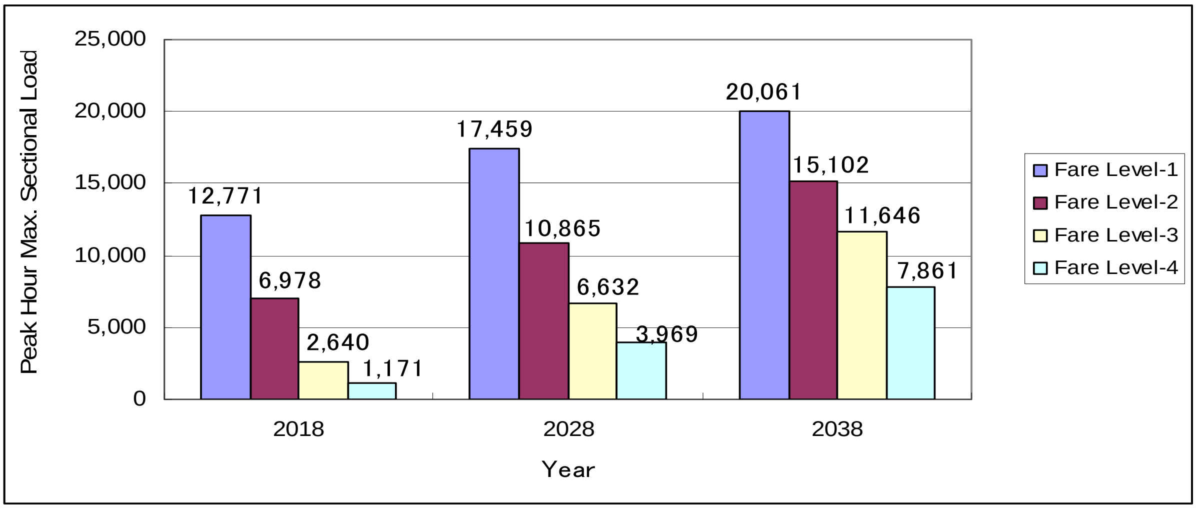


Figure 3.8.2 Peak Hour Maximum Sectional Load for Partially Elevated LRT

Source: Study Team

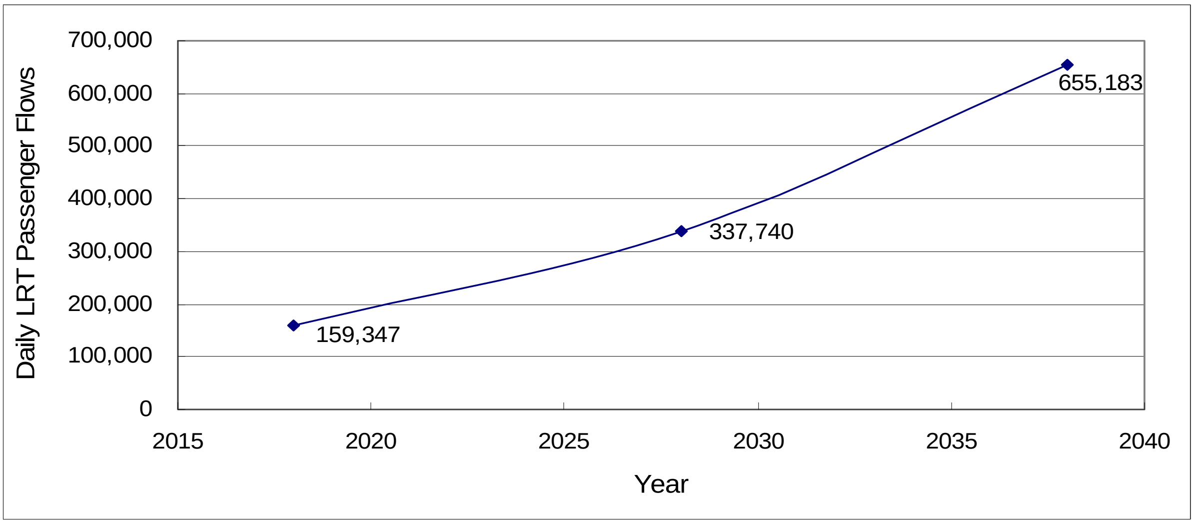


Figure 3.8.3 Daily LRT Passenger Flows for Partially Elevated LRT

Source: Study Team

Table 3.8.1 LRT Daily Trip Matrix-2018

Shivaji Nagar–Hinjewadi	Shivaji Nagar AST	Shivaji Nagar	Police Ground	Pune Central	E-Square	Pune Univ.	Armament Colony	PWD Office	Aundh District Office	Police NAKA	State Hospital	Pimple Nilakh	Wakad Road Mall	Wakad Chowk 1	Wakad Chowk 2	Hinjewadi Rd. Shopping Mall	Shivaji Chowk	RGIP Phase 4	Boarding	Alighting
Shivaji Nagar AST	0	100	12	455	719	625	236	866	695	373	253	1212	431	265	386	466	1257	1142	9493	10428
Shivaji Nagar	97	0	12	202	288	425	140	776	548	277	209	1115	365	234	364	441	1109	982	7584	8592
Police Ground	12	12	0	27	18	217	68	1165	489	112	49	511	337	138	269	541	1416	1558	6939	8424
Pune Central	418	193	30	0	226	302	156	562	559	307	189	976	237	243	289	389	1218	720	7014	8142
E-Square	620	259	18	217	0	240	107	462	436	265	167	912	224	205	263	336	1160	725	6616	7770
Pune Univ.	702	483	261	350	283	0	35	180	269	308	175	505	216	334	198	234	565	453	5551	5431
Armament Colony	276	163	85	182	127	35	0	65	113	130	116	358	161	269	140	203	489	432	3344	3369
PWD Office	1008	912	1420	672	552	193	64	0	295	246	212	936	272	304	261	259	691	581	8878	8354
Aundh District Office	785	628	594	652	509	254	108	275	0	308	324	1347	436	1177	440	468	1007	871	10183	10290
Police NAKA	394	294	133	344	293	275	115	221	298	0	232	1320	349	524	374	518	1453	1173	8310	9095
State Hospital	249	211	56	205	183	163	106	195	305	222	0	681	191	475	202	255	878	788	5365	5990
Pimple Nilakh	1304	1249	619	1144	1079	496	342	984	1402	1474	798	0	1090	689	308	339	1249	1071	15637	15142
Wakad Rd. Mall	431	379	408	265	254	202	153	252	403	349	194	937	0	856	177	255	825	704	7044	7675
Wakad Chowk 1	282	257	165	269	238	318	254	278	1245	558	526	755	1018	0	1232	723	425	328	8871	8210
Wakad Chowk 2	417	405	325	338	308	198	140	263	456	406	228	356	196	1027	0	253	266	375	5957	5943
Hinjewadi Rd. Shopping Mall	523	503	658	460	397	257	228	277	509	577	292	394	292	640	270	0	477	748	7502	7134
Shivaji Chowk	1525	1348	1728	1484	1413	682	593	833	1217	1760	1068	1522	1004	460	317	560	0	870	18384	15372
RGIP Phase 4	1385	1196	1900	876	883	549	524	700	1051	1423	958	1305	856	370	453	894	887	0	16210	13521

Source: Study Team

Table 3.8.2 LRT Daily Trip Matrix-2028

Shivaji Nagar - Hinjewadi	Shivaji Nagar AST	Shivaji Nagar	Police Ground	Pune Central	E-Square	Pune University	Armament Colony	PWD Office	Aundh District Office	Police NAKA	State Hospital	Pimple Nilakh	Wakad Road Mall	Wakad Chowk 1	Wakad Chowk 2	Hinjewadi Road Shopping Mall	Shivaji Chowk	RGIP Phase 4	Wipro	Infosys	Mahindra Tech	Boarding	Alighting
Shivaji Nagar AST	0	1154	600	605	1066	884	348	2130	2660	762	663	1375	637	1059	787	342	578	706	896	774	624	18650	18539
Shivaji Nagar	1210	0	90	279	446	555	208	1715	1920	579	535	1071	493	803	655	294	501	536	931	646	533	14000	15440
Police Ground	696	96	0	82	20	52	8	571	402	232	163	670	424	636	316	112	314	150	439	357	329	6069	6781
Pune Central	592	280	69	0	217	270	178	1418	1915	353	199	607	129	366	391	296	558	479	854	585	499	10255	12640
E-Square	918	394	17	229	0	182	96	990	1294	297	172	502	116	215	309	223	500	414	772	542	466	8648	8851
Pune University	866	543	52	306	209	0	81	638	1134	641	360	600	257	1365	438	264	508	533	923	633	530	10881	11060
Armament Colony	355	206	10	196	110	76	0	103	313	220	205	331	148	998	203	109	350	216	522	406	363	5440	5270
PWD Office	2458	1986	640	1714	1195	738	103	0	1051	528	464	862	331	1482	473	167	432	360	707	522	441	16654	15089
Aundh District Office	2882	2084	427	2262	1522	1135	291	970	0	376	416	923	333	2087	584	291	259	556	955	403	543	19299	18081
Police NAKA	707	528	196	384	310	566	186	450	354	0	426	1201	347	1312	711	468	513	1054	1331	752	801	12597	13537
State Hospital	571	462	135	201	170	318	173	394	371	381	0	358	120	644	235	152	187	433	547	307	477	6636	7207
Pimple Nilakh	1291	1033	564	696	576	576	292	823	924	1291	408	0	606	1001	934	618	812	1858	2344	1293	1216	19156	20847
Wakad Road Mall	549	429	354	134	117	227	127	282	290	316	111	541	0	1054	461	440	533	1217	1537	848	633	10200	12099
Wakad Chowk 1	894	681	524	331	203	1152	828	1225	1833	1154	579	1047	1246	0	5025	987	654	960	1231	803	528	21885	23068
Wakad Chowk 2	770	653	278	458	360	445	192	449	603	765	262	1127	553	4236	0	1016	491	1855	2342	1300	966	19121	21220
Hinjewadi Road Shopping Mall	386	333	116	357	268	311	126	186	340	550	180	753	536	1015	1222	0	581	1932	1459	1493	1036	13180	13665
Shivaji Chowk	383	294	73	373	303	309	118	211	308	612	224	990	650	682	591	641	0	3980	1120	2440	2210	16512	16855
RGIP Phase 4	856	649	182	584	505	647	262	434	676	1283	528	2269	1487	1140	2265	2324	1699	0	2092	1946	2285	24113	25645
Wipro	1084	2823	1230	1737	637	818	329	551	855	1620	666	2863	1877	1454	2858	1949	1009	1767	0	1183	2143	29453	34163
Infosys	621	471	1129	1408	354	960	687	820	484	908	371	1578	1036	903	1583	1738	3817	4110	3637	0	856	27471	18199
Mahindra Tech	450	341	95	304	263	839	637	729	354	669	275	1179	773	616	1179	1234	2559	2529	9524	966	0	25515	17479

Source: Study Team

Table 3.8.3 LRT Daily Trip Matrix-2038

Shivaji Nagar - Hinjewadi	Shivaji Nagar AST	Shivaji Nagar	Police Ground	Pune Central	E-Square	Pune University	Armament Colony	PWD Office	Aundh District Office	Police NAKA	State Hospital	Pimple Nilakh	Wakad Road Mall	Wakad Chowk 1	Wakad Chowk 2	Hinjewadi Road Shopping Mall	Shivaji Chowk	RGIP Phase 4	Wipro	Infosys	Mahindra Tech	Boarding	Alighting
Shivaji Nagar AST	0	402	214	1616	3145	1798	558	3843	3295	2242	550	3496	1694	820	1160	179	208	195	2253	1858	2431	31957	28583
Shivaji Nagar	400	0	89	854	1227	1989	440	4124	2794	1224	383	3084	1433	616	650	94	128	160	1343	1570	2442	25044	28753
Police Ground	214	95	0	255	201	531	66	2202	965	334	88	905	436	143	183	28	19	42	2191	1141	1284	11323	14252
Pune Central	1709	962	298	0	1486	1386	453	3030	4243	1731	495	1408	881	673	1000	130	117	214	2734	1260	1674	25884	25119
E-Square	2960	1196	202	1454	0	1828	474	2561	3691	1955	568	1473	856	337	742	126	168	161	2712	1177	1104	25745	25001
Pune University	2057	2325	626	1635	2188	0	248	2223	2446	2678	687	2663	1244	935	978	270	206	144	2205	143	1153	27054	25810
Armament Colony	651	524	78	518	564	273	0	449	611	563	318	1340	717	501	826	134	98	31	2148	142	1113	11599	11514
PWD Office	4472	4918	2665	3603	2981	2508	489	0	1950	2220	797	2393	1309	1636	1899	234	270	95	2328	181	1136	38084	36521
Aundh District Office	3460	3014	1095	4845	4278	2597	596	2001	0	1804	889	4212	2034	1927	2255	353	497	292	2882	224	1106	40361	36272
Police NAKA	1962	1099	306	1633	1899	2336	473	1934	1661	0	1133	4690	2268	2932	2316	434	834	513	1819	387	1100	31729	31336
State Hospital	477	342	78	448	541	614	269	696	883	1087	0	1207	748	568	629	103	303	155	2599	139	1159	13045	11663
Pimple Nilakh	2959	2647	795	1272	1301	2275	1116	2152	3866	4426	1247	0	2761	1885	1651	272	1792	1012	4809	1228	1350	40816	44069
Wakad Road Mall	1413	1203	369	757	742	1045	593	1093	1742	1977	654	2476	0	1726	1116	259	2051	1581	5654	1260	850	28561	32953
Wakad Chowk 1	676	511	117	556	287	776	412	1352	1602	2445	475	1781	1972	0	2877	859	1425	900	4813	944	770	25550	25395
Wakad Chowk 2	960	546	152	831	633	816	677	1572	1905	1968	542	1574	1104	2422	0	189	1023	2305	6714	2042	903	28878	34199
Hinjewadi Road Shopping Mall	148	80	130	112	109	226	110	195	298	375	190	260	259	741	188	0	2814	5053	5555	4917	1620	23380	25119
Shivaji Chowk	199	3128	3170	112	174	210	2082	2263	2512	937	345	2143	2474	1457	1180	2485	0	2983	5755	4529	3298	41436	35949
RGIP Phase 4	228	3191	2151	2259	2094	1069	1034	1112	348	618	187	1232	1928	1078	2812	4920	3568	0	4929	5324	4031	44113	35995
Wipro	2244	1395	1201	1873	818	1222	1143	1384	1063	2158	1683	5828	6875	3407	8148	7558	7233	5011	0	3753	3581	67578	74773
Infosys	892	650	169	315	209	1148	141	1193	269	471	162	1485	1535	1143	2487	4750	9653	7239	4421	0	1605	39937	36236
Mahindra Tech	502	525	347	171	124	1163	140	1142	128	123	270	419	425	448	1102	1742	3542	7909	6909	4017	0	31148	33710

Source: Study Team

3.9 Summary

From the preceding analysis the following main points can be made:

- The model used in the 2008 Comprehensive Mobility Plan has been successfully updated and validated in order to carry out transportation demand analysis for a LRT to run from central Pune to Hinjawadi IT park.
- The SP survey executed indicates that of the 4 fare levels considered respondents were willing to pay 1.5 times the fare of the Delhi Metro, or Fare Level-2.
- Fare Level-1 results in greater ridership but would require a MRT to cater to those few stations that exceed LRT capacity, resulting in overdesign
- From a systems viewpoint, Fare Level-2 for a partially elevated structure would be the best scenario.
- If the length of the LRT is extended from 60m to 70m it is capable of dealing with demand til the year 2048.

Chapter 4 Concept Design for Pune-Hinjawadi Urban Railway

4.1 Current Condition and Development Strategy for Pune-Hinjawadi Corridor

4.1.1 Current Condition of Pune-Hinjawadi Corridor

The Pune region mentioned in Chapter 2 is the corridor which connects Pune City, Pimpri – Chichwad City and Hinjawadi IT Park. The Pune City proposed concept for the future is aimed at the period up to 2031 and this concept is presented in the Final Report, Comprehensive Mobility Plan for Pune City (Hereinafter called CMP). This report indicates urban transport demand forecasts, proposal for urban transport policies and strategies with the goal of 2031, and future frames of transportation planning and transportation investment plans. The report is a guideline for putting difficulties in perspective regarding urban development and presenting strategies for their solution. In the CMP, there are 4 alternate scenarios considered; (1. Augment PMPML (Pune Mahanagar Parivahan Mahamandal Limited), 2. PMPML Bus System＋BRT (Bus Rapid Transit), 3. PMPML Bus System＋BRT +Ring Corridors, 4. MPML Bus System＋BRT +Ring Corridors +High Capacity System (LRT/Metro/Mono Rail etc.) The Number of trips of two wheelers and cars are investigated using 4 scenarios. Also, in Pune, introduction of medium-capacity rail and mass public transportation systems are considered. Regarding the latter, the basic design and preliminary feasibility study of the metro has already been implemented.

To develop a multi-polar urban structure, an industrial area has been developed by MIDC in the suburban area of the Pune metropolitan area. IT parks are overrepresented in the industrial development. Particularly, the Rajiv Gandhi InfoTech Park Area, RGIP, is a large scale industrial area. The industrial area in Pimpri Chinchwada, for the auto industry, is sold out. TATA motors is situated in the industrial area.

PMC, urban municipality, which was established in 1950, consists of 14 wards and 144 sub-wards. There are many educational institutions such as the University of Pune, and research institutes in PMC. Therefore, PMC is called the “Oxford of the East”. There are cantonment areas in the east and north parts of PMC. With the urban sprawl, the jurisdiction of PMC has also expanded. The jurisdiction has expanded to 244 square kilometres as of 2012 from 139 square kilometres as of 1961.

Urban planning in PMC is conducted based on the development plan for PMC and the development control regulations for PMC. These land use plans and regulations have legal force based on state law, MRTPA. PMC has been using the JNNURM scheme to develop the infrastructure. To be approved under the JNNURM project, it is required to develop a mid-term city development plan, with a target of 4 or 5 years. PMC also developed the city development plan targeted for 2006 to 2012.

The population, jurisdiction and population density of PMC has increased. The expansion of the jurisdiction increases the number of trips that people make. The increase in population density increases traffic volume. Furthermore, economic growth has caused an increase in car ownership and motorcycle users. This might cause environment impacts in PMC.

PCMC, urban municipality was established in 1970. The residential area for refugees from Pakistan, which was developed in 1948, consisted of 4 wards. There are cantonment areas in the south part of PCMC. With the urban sprawl, jurisdiction of PCMC has also expanded, the same as in PMC. The jurisdiction has expanded to 170.51 square kilometres as of 2012 from 86.01 square kilometres as of 1970. There is an industrial area which was developed by MIDC in the centre of PCMC. PMCM is next to the Hinjawadi area. This is one characteristic in the Pune-Hinjawadi Corridor.

The Hinjawadi Industrial area, the Rajiv Gandhi I.T. Park (RGIP) at Hinjawadi is built across 4 villages, Hinjwadi, Man, Marunje and Mahalunge. MIDC has conducted land acquisition, development, management and is selling lots. The development plan is divided into 6 phases. Total development area is approximately 2,300 hectares. At present, the phase 1 and 2 areas are sold out. The phase 3 area as special economic zone has been under construction and sold gradually. The phase 4 area has been approved. However, the land acquisition has bogged down. The phase 5 and 6 areas are pending approval. The area outside of the industrial area is the jurisdiction of the Pune district.

Since there is not much residential area in the Hinjwadi industrial area at present, workers commute from PMC and PCMC. On the other hand, some major roads are congested in the peak hour, since there are not many access roads into the industrial area. It seems that the public transportation is effective since access routes to the industrial area are limited.

Consequently, the Pune-Hinjawadi IT Park Line will be designed to run from JM Temple where it will cross both Pune-Metro Lines-1 and 2 to the phase 3 as the terminal station in Hinjawadi IT Park which is under construction and development as a special economic zone.

4.1.2 Development Strategy for Pune-Hinjawadi Corridor

To alleviate traffic congestion and prevent slum areas from growing in urban areas, in 1990 a multi-polar urban structure was proposed in the regional plan instead of over concentration in Pune. Seuru, Kanapur, Hinjawadi, Moshi, and Waguholi, Phursungi, Khadakwasla, Shivane are specified as new development cores in addition to PMC and PCMC, the existing cities. Therefore, the Pune-Pimpri Chinchwada -Hinjawadi Corridor is in an important position to establish the regional plan.

The population, jurisdiction and population density of PMC has increased. The expansion of the jurisdiction increases the number of trips that the people take. The increase of population density increases the traffic volume. Furthermore, economic growth has caused an increase in car ownership and motorcycle users. The increase in car ownership and motorcycle users increases the environmental impacts caused by traffic in PCMC.

The 32 % of the total trips concerning Hinjawadi industrial area are trips to / from PCMC, 14% are trips to / from PMC and 27% are trips to / from the area southeast- of PMC. The 73% of trips for the

Hinjawadi industrial area are trips via PMC or PCMC areas. The modal share of commuter buses, which are operated by private companies in the industrial area, is 30% of the total trips. Since there are not many access roads into the industrial area, some major roads are congested in the peak hour. However, the peak ratio of these roads is approximately 9%. This is not a very high ratio for a road into an industrial area. This might be because of the Shift-work system of companies in the industrial area. Therefore, the development strategy of the Pune- Pimpri Chinchwada -Hinjawadi Corridor is not only required to provide access to Hinjawadi IT Park but also is considered as one of the development strategies to alleviate the traffic congestion.

Consequently, the Pune- Hinjawadi IT Park Line will be designed as the urban railway for the alleviation of congestion along the corridor, which is about 22 km long and with the function of interconnecting both points from Pune city via Pimpri Chinchwada to Phase 3 as the special economic zone in Hinjawadi IT Park.

4.2 Traffic Demand Forecast of Pune- Hinjawadi Corridor

4.2.1 Traffic Demand Forecast and Fare Level

Numerous studies on the construction of new infrastructure to alleviate congestion and/or increase the transport capacity of major corridors in Pune Metropolitan Region (PMR) have been carried out over the years. One of those corridors, all of which are crucial to the future of PMR's continued growth and success, is the corridor connecting central Pune with Hinjawadi IT Park via Ganeshkhind, Aund, and Wakad roads (hereafter referred to as the Pune-Hinjawadi Corridor) and it is therefore taken up. Therefore, the objective of this chapter is to construct a model to determine the demand for Light Rail Transit (LRT) that would improve transport capacity along the heavily travelled Pune-Hinjawadi Corridor. This would also alleviate road congestion and reduce travel time, which is useful to understand the features.

The stated preference (SP) survey was carried out at three locations on the Study corridor (i.e., the Pune bus terminal, Shivaji Nagar bus stop, & Hinjawadi IT Park), and 2000 samples were collected from cars, 2-wheelers, 3-wheelers, and bus users to asses willingness to pay for the proposed LRT. The fare that was considered is based on the fares of the Delhi Metro and the Delhi Airport Line.

Population growth for the entirety of PMR is expected to be 3.2%, 2.8%, and 2.4%, respectively, for the periods of 2012-2018, 2018-2028, and 2028-2038. Depending on the area of PMR, population growth varies, with PMC and PCMC gradually declining as these areas are becoming more settled. On the other hand, it is expected that the rest of PMR (i.e., the suburbs) will experience an increase in growth rate, exclusive of the cantonments whose population has remained stable over time. In terms of population growth, Hinjawadi is an exception and is expected to see an increase in population of 14.4% from 2012 to 2018, which will decline to 7.2% during 2018 to 2028 and then to 3.4% in 2028 to 2038.

The future PMR transport network is based mostly on the 2008 “Comprehensive Mobility Plan”, as well as other relevant planning reports, and on current information available as to the likelihood of projects being implemented. The forecasts of LRT ridership for the maximum number of passengers between stations and the peak hour peak direction traffic (PHPDT) for the years of 2018 for opening, 2028, and 2038 are carried out using those fare levels. LRT ridership after 30 years from 2018 will be considered for the configuration of LRT to deal with increasing demand.

4.3 Development Plan of Pune-Hinjawadi Corridor

4.3.1 Location Plan and Route Plan of Pune- Hinjawadi Corridor

TOD（Transit Oriented Development）is an urban development method to not only create a residential and commercial area in about 500m^2 area but also to plan new residential areas around suburban nodes of public transportation. This development method will efficiently provide easy access for residents by Public Transportation to leisure activities, commercial areas and schools without private cars. TOD will not only encourage transit ridership, but also it will bring in stable ridership and benefits for the operator of the public transportation.

Developing unification between commercial and residential facilities and development of public transportation will increase the income from non-rail businesses such as the real estate business.

The planned Shivaji Nagar Station area will function to provide easy transfer to long distance buses, city buses, railways, taxis etc. Moreover, the future network of MRT and BRT will provide a new means of transportation in the JM Temple area, Pune University Area, State Hospital and Wakad Chawk Area.

Consequently, the location of these LRT stations should be close to the BRT/MRT stations and make transit access smooth. Development of these transit stations is expected to encourage people’s use of LRT, and also to attract private investors to this LRT project. And the consideration of development of LRT’s depot located in Hinjewadi IT Park will also be expected to attract private investment.

In this study, the horizontal and vertical surveys have been executed along the planned LRT line of about 15km from around Sancheti Hospital of Pune City to Shivaji Chowk where the entrance to Hinjawadi IT Park is located.

However, since the objective of the technical survey is to determine the basic alignment and railway structures and to estimate the general project cost, the survey area of both sides of the road will be executed up to the border line between the public land and private land by cross-section and horizontal survey every 100m.

The roads within the PMC are narrow and complex with heavy traffic as is indicated by the fact that the major road from JM Temple, which is the starting point, to Pune University has three flyovers. From Pune University the road is a simple one without any major intersections. Within PCMC the road widening of about 45m for current BRT operation is taking place and some sections are already completed. In Hinjawadi IT park area a four-lane road of two lanes each way has many undulations. The alignment of the LRT will be studied based on these conditions.

Since making use of the characteristics of LRT in at-grade sections increases the convenience for passengers, the route plan will consider at-grade sections as much as possible in the corridor. But in order to improve accessibility from adjacent areas to the main road and promote the efficient use of the road width in the BRT sections abreast of the LRT in PCMC the structure plan will compare the advantages and disadvantages between a partial at-grade system and an entirely elevated system in view of the station plans, road plan, construction cost and so on.

4.3.2 Railway System for Pune-Hinjawadi Corridor

In order to meet the future demand forecast described in Chapter 3, the most suitable urban railway system will be selected in consideration of the peak-hour passenger demand (PPHPD). When studying the urban railway system, the "Detailed Project Report on Pune Metro Project" (July 2009) by Delhi Metro Rail Corporation will be referred to as the reference document.

On the other hand a suitable urban railway system such as LRT and MRT systems will be considered based on the relationship between PPHPD and Operation Speed.

MRT has great potential because of its capacity of more than 20,000 persons. In the case of about 15,000 persons the selected urban railway system will be an LRT system.

Therefore an LRT (Tram) system as a mid-capacity transportation system will be compared on technical and economic points between conventional LRT such as receiving electric power from an overhead catenary during running and a battery-driven rail system called a “Battery Tram System” which makes it possible to operate continuously without any disruptions of electricity supply.

The acquisition of private land is one of the biggest issues for the city when an urban transport system is constructed. The selection of an urban railway system will be considered to use the maximum public land and to do the least land acquisition possible.   In terms of alignment, the minimum 20m radius of LRT will be able to minimize the land acquisition in the corridor.

Consequently, the urban railway system will be selected based on the demand forecast and use of public land.

In an urban railway system, a large area is required for a depot yard for stabling rolling stock and its maintenance. The study team proposed three locations, the Pune University site in PMC, the military reservation site in PCMC and a Hinjawadi IT Park area in MIDC, as a depot yard of about 12 hectares. Finally, the location of the depot yard will be selected in the Phase-4 area along the road in Hinjawadi IT Park that will be prepared by MIDC.

4.4 Implementation of LRT project

In the past, there was the difficulty that most of the public infrastructure facilities have been developed in the form of a "One-tiered System" in which the public sector undertakes the finance, plan design, construction and operations and maintenance, and it has been observed that a long time has been spent in arranging financing and also there was a long lead time in implementing the project.

Some projects have been implemented with a PPP Scheme, where the projects were structured under a "Two-tiered System", or "One-tiered System", dividing the sub-structure by the public sector whereas the super-structure was by either the private sector or by the public sector. Thus cases exist in which the private sector was responsible for finance and construction, but it has become clear that the fare box revenue did not generate sufficient revenue.

As a project implementation scheme to improve viability, a BOT Gross Cost Scheme (Fare box revenue, is collected by the public sector and is then given to the private sector) is introduced. The private sector arranges financing to reduce the public burden and to raise the possibility of accelerating the project implementation and realization.

In order to introduce an environmental friendly railway system in India, its facility development, maintenance and operation is suited to be arranged with a PPP scheme, and the implementation of the project will be reviewed in this study.