



Pune Municipal Corporation

Final Report



Comprehensive Mobility Plan for Pune City



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URBAN INFRASTRUCTURE
SERVICES LIMITED

November 2008

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1. Introduction

1.1 About the CMP

The National Urban Transport Policy (NUTP) has been formulated by the Ministry of Urban Development in 2006 to transform the current urban transport system into a safe, convenient and efficient transportation system across all urban areas in India. In order to ensure that the various urban transport projects that are being developed by the cities are NUTP compliant, the ministry has in a March 2007 circular indicated that a “Comprehensive Mobility Plan (CMP) be prepared that focuses on mobility of people rather than vehicles and accordingly give priority to pedestrians, Non-Motorized Transport (NMT), all modes of public transport and IPT.” The CMP essentially will suggest various actions that lead towards a vision.

The Comprehensive City Mobility Plan addresses traffic growth of all modes of transportation and suggests a direction for the multi-modal transport system of Pune. The CMP will improve and emphasize Sustainable Transport Modes.

The objectives of this Study are:

- To understand present day traffic characteristics and prepare forecasts of these character through the development of a transportation model.
- To develop a transportation vision for Pune.
- To identify specific strategies and measures to address traffic growth of all modes of transportation in an effort to meet set goals.
- Prepare a programme of CMP implementations along with block cost estimates.

1.2 Need for the CMP

The growth and all the economic benefits brought with it an unprecedented stress on Pune’s transportation and land use. The city once called the “cycle-city” is now commonly referred to as a “motor-cycle city”. During the last few years, the urban sprawl has extended far beyond the existing territorial jurisdiction of the city administration and is continuing to spill over into the fringe areas of the city, including the adjoining industrial hub of Pimpri Chinchwad.

Pune Municipal Corporation and other agencies have undertaken various programmes/studies on the transportation system. Some are completed and some are ongoing. Several road widening and network improvement proposals (including planning and construction of flyovers and junction improvements) are underway, including proposals for a Bus Rapid Transit System. These programmes are however are isolated with each of them planned to meet an objective set by each programme. Also an important aspect of the improvement proposals is their lack of impact on a wider region namely that of Pune Metropolitan Area/Region (PMA/PMR).

A coordinated implementation strategy for the entire PMA is needed. It is wiser to first set goals for the PMR and establish strategies to meet these goals rather than implement isolated projects and hope that the net sum of these projects would meet required goals. Further the JNNURM under which many of the proposals are sought funding requires that a comprehensive mobility plan be prepared.

1.3 Study Methodology

A methodology for the Study has been evolved giving due consideration to:

- Study Area Demographic and Travel Characteristics
- Project Challenges
- Issues and Concerns of all project stakeholders

Five different stages have been involved in developing the Mobility Plan for the Study.

- Stage1: Mobilization and Reconnaissance
- Stage2: Data Collection
- Stage3: Urban Travel Demand Model Development and Forecast Traffic Characteristics
- Stage4: Draft Mobility Plan
- Stage5: Stakeholder Participation & Updation of Draft Mobility Plan

The Stage-wise methodology is explained in the **Chapter 2**.

1.4 Study Area

While the focus is on Pune Municipal Area, the study area included a much larger area taking into accounting all areas that have a influence on Pune's traffic. This study hence extends itself to the Pune Metropolitan Region PMR that includes Pimpri Chinchwad and all surrounding villages, Pune cantonment and khadki Cantonment. The PMR area is shown in **Figure 1.1**.

1.5 Organization of this Report

This report documents the project activities, the results and the findings of the study and is organized in nine chapters.

Chapter 1: Scope and objective and terms of reference for the study.

Chapter 2: Study methodology

Chapter 3: Urban development and growth direction

Chapter 4: Existing urban transport system characteristics

Chapter 5: Review of past studies

Chapter 6: Development of travel demand model & Traffic forecasts

Chapter 7: Vision for pune city

Chapter 8: Mobility Plan Elements

Chapter 9: Mobility Plan investment program



Figure 1.1: Study Area

2. Study Methodology

2.1 Stage1: Mobilization and Reconnaissance

The task includes mobilization of both human and material resources, involving the establishment of the project team and facilities. Staff deployment planning was done, paying due attention to the project plan and deliverable timelines. The project was assigned a project manager to coordinate with IL&FS and the city.

One of the first task that was to be undertaken to appreciate transport issues in Pune was to conduct a reconnaissance that covered land use, road system, public transport system (Bus, Rail and Air) and Institutional Structure of the city operations. The Consultant was involved in preparation of the report “Studies on Traffic and Transportation policies and strategies in Urban Area” under Ministry of Urban Development which included Pune City and hence is institutionally aware of most of the issues that face the city and its populace.

2.2 Stage 2: Data Collection

2.2.1 Secondary Data Collection

The secondary data required for the development of study was collected from various sources primarily from the Government/planning organizations of Pune. The secondary data includes information regarding the population and employment distribution, land use information, road network details, vehicle ownership details, and accident data. Also, transport policy plan and any relevant reports prepared for the improvement of traffic and transport problems of Pune, was collected. List of a few of the documents / reports referred to was as follows:

- BRT Pilot Route Project
- City Development Plan
- Report on Commonwealth youth Games 2008
- Environmental Status Report
- Comprehensive Traffic and Transportation Study
- Traffic Dispersal Study
- Sky Bus Report
- Report on MRTS
- Report on Cycle Track network
- Report on ATCS

2.2.2 Primary Data Collection

Various traffic surveys were conducted to study the existing travel characteristics of Pune city. The detailed survey methodology and results for traffic surveys are discussed in **Appendix 4.1**. The types of surveys conducted are listed below:

- Road Network Inventory
- Mid Block Traffic Volume Counts
- Road Side Interview Survey
- Speed and Delay Survey
- Parking Survey
- Pedestrian Crossing Count Survey
- House Hold Travel Survey
- Bus Passenger /Terminal Survey
- IPT Survey
- NMT Survey

2.3 Stage 3: Urban Travel Demand Model Building

An Urban Land use Travel Demand model has been build for forecasting travel characteristics for the study region. The model analyzes the present and future land use patterns to estimate the number, origin and eventual destination of trips through various travel modes. The detailed methodology is discussed in **Chapter 6**.

2.4 Stage 4: Draft Mobility Plan

2.4.1 Identifying Short Term Improvements

Based on the observations made during the field reconnaissance and the results from the analysis of the data, the most obvious problem areas have been identified. The findings from all the surveys and data analysis have been used in recommending short term improvement measures. Short term measures are those schemes that can be implemented immediately but have a short life period. Improvements are suggested to optimize existing facilities to the fullest using the Transportation System Management (TSM) Techniques.

2.4.2 Alternative Transport Plans and Land Use Plans

As the city is experiencing development of several new integrated townships, SEZs and IT parks, local and State governing bodies have prepared several studies. Each of these studies resulted in identifying appropriate solutions to meet the resultant transportation demands. Several road widening and network

improvement proposals (including flyovers and junction improvements) are underway, a key initiative towards addressing the public transportation system is the Bus Rapid Transit System (about 100 km of network), that is being implemented.

City Development Plan process initiated by the JNNURM and the existing Land Use Master Plan given one roadmap for the future land use development. From both the above mentioned transport proposals and land use plans composite land use transport plans have been prepared for testing the various proposals. If required these alternatives have been supplemented by additional land use transport scenarios for input into the long range transport model.

2.4.3 Transport Vision and Strategy

The Mobility Plan is developed in layers, from one broad, overarching vision through specific steps— such as goals/strategies—to a list of specific actions that will carry the city towards that vision.

PMC has developed a Transportation Policy as well as a City Development Plan. Both the documents contain a vision for the urban transport sector for the Pune city. The national urban transport strategy (NUTP) also lays a policy frame work for transport network development in urban areas across the country which has been used defines the vision. Several citizen groups have initiated developing a transport vision for Pune city.

The study had considered all the available national and local reports as well as public input through workshops before finalizing a broad vision statement. A set of strategies/goals have been identified towards achieving that direction of the mobility plan. The goals have been developed based on the available transport research in the country and consultant's experience and the consultation process. It is assumed that the improvement proposals or actions that have been short listed meet those goals or strategies.

In Pune, as indicated earlier a significant quantum of studies on improving the transport network has been already prepared. The strategy adopted in this study was to make use of these to the fullest extent (since many have been accorded approvals) ensuring however they fit into the overall scheme of things through a screening process.

2.4.4 Project Evaluation & Screening

The long range planning model developed under this study has been is utilized for identifying the impact of the proposals on the urban transport system. The project evaluation and screening framework provides a basis for systematically evaluating improvement proposals. This does not eliminate citizen judgment and involvement process. However, it assists decision-makers by guiding the investment proposals according to a set of criteria aligned with the city's long-range transportation objectives.

2.4.5 Identifying and Prioritizing of Improvements

For each infrastructure project an appropriate phasing plan has been suggested for the improvement proposals.

2.4.6 Institutional Framework

General guidelines have been suggested indicating the basic framework that will be necessary from the government for devising a proper institutional system for improvement of transport facilities in the city.

2.4.7 Mobility Plan

A mobility plan containing the vision, strategy and specific actions in the form of improvement proposals has been then developed.

2.5 Stage 5: Stakeholder Participation & Updation

2.5.1 Stakeholder Workshop/Meetings

To make the mobility plan a collaborative effort detailed meetings have been held to:

- disseminate the findings of the draft mobility plan
- solicit the comments and concerns from the stakeholders

Input from the stakeholder workshops and meetings have provided input to the development of the mobility plan on various aspects and issues of the transportation system. The public involvement has also given guidance to the outcome.

2.5.2 Updation of the Draft Mobility Plan

Subsequent to these meetings the input from the stakeholders has been compiled and all applicable comments and concerns have been addressed to the best possible effort and included. The mobility plan has been updated accordingly.

3. Pune Development & Growth Direction

3.1 Overview

Pune is the seventh largest city in India and second largest city in Maharashtra after Mumbai (Figure 3.1). Pune Municipal Corporation (PMC) jurisdiction extends up to an area of 243.84 sq. km. housing 2.54 million populace within 144 wards. Referred as ‘Detroit of India’, the city has experienced a long standing urban tradition: first as an historical centre of pre-colonial urbanism, then as an important military centre during British rule, after independence as a rapidly growing contemporary industrial centre, and today identified as a growing metropolis. Pune, also known as an ‘Oxford of India’, houses six Universities with about 600 functional higher education centers catering to an estimated 5 lakh student population. Additionally, Pune is popularly nicknamed as ‘Queen of Deccan’, ‘Pensioners Paradise’, ‘Cultural Capital of Maharashtra’, ‘Cyber City’ etc. owing to its location, pleasant climate, historical importance, vibrant culture and upcoming IT-BT centers.

3.1.1 Location

Situated on leeward site of Deccan Plateau (Sanhyadri Hills/Western Ghats) between 18° 32' North latitude and 72 ° 51' East longitudes, Pune is well connected by road, rail and air network with almost all the important cities within Maharashtra and India.

The city is located at the confluence of Mula and Mutha rivers (plains of Bhima and Nira River basin) at a height of 560 m above Mean Sea Level (MSL) and characterized by vast stretches of undulating plains inter spread by low and medium ranges of hills.

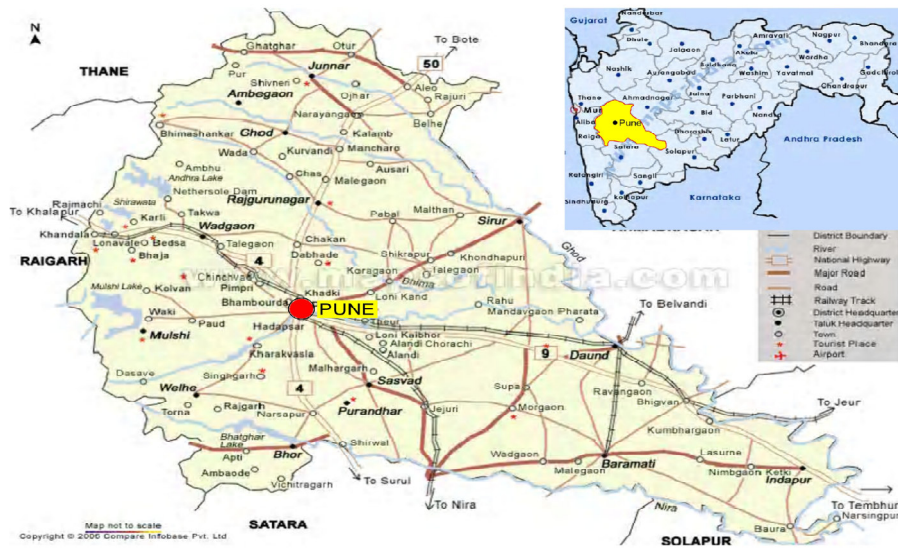


Figure 3.1: Location of Pune

3.2 Urban Development

3.2.1 Pune Metropolitan Region (PMR)

Urban development in PMC is greatly interlinked and supported by its surrounding areas. Considering this, boundaries of PMR were defined in early 1967. Spread out over an area of approximately 1,340 sq. km. in Haveli Taluk of Pune District, PMR consists of Pune Municipal Corporation (PMC), Pimpri Chinchwad Municipal Corporation (PCMC), Pune Cantonment (PC), and Khadki Cantonment (KC) and close to 100 other census towns and villages. The PMR Region is shown in **Figure 3.2**.

3.2.2 Urbanization and Population Growth Trend

Urbanization and urban population growth are pointers towards the change in the occupational pattern of the community, from agriculture and allied livelihoods to industrial and other non-agriculture occupations. The population growth for PMR is shown in **Figure 3.3**.

(i) **PMC.** PMC has a population of 2.54 million (2001) which accounts for 35 percent of the total urban population in Pune District and 60 percent of total PMR population. The PMC's population has grown from 1.57 million in 1991 to 2.54 million in 2001, and in the last decade experienced a compounded annual growth rate (CAGR) of 4.94 percent. PMC's growth is not limited to few but influenced by various factors. It is the most preferred destination for many citizens in Maharashtra for job, education, healthcare treatment, real estate investment, better quality of life etc. as Mumbai is already crowded complied with comparatively high cost of life. The same is for many citizens all over India who migrate to the city for better jobs and education. Industries, trade and commerce activities and number of educational centers in PMC attract floating population from all over India into the city. Rapid growth of the city however mainly attributed to industrialization of PMC/PCMC after 1960 and expansion of information technology (IT) industry in the last decade.

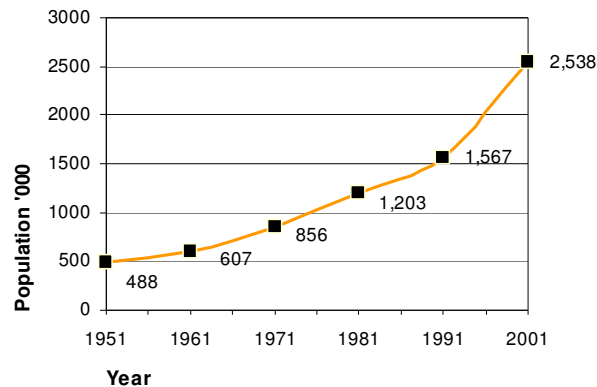


Figure 3.3: Population Growth – PMC

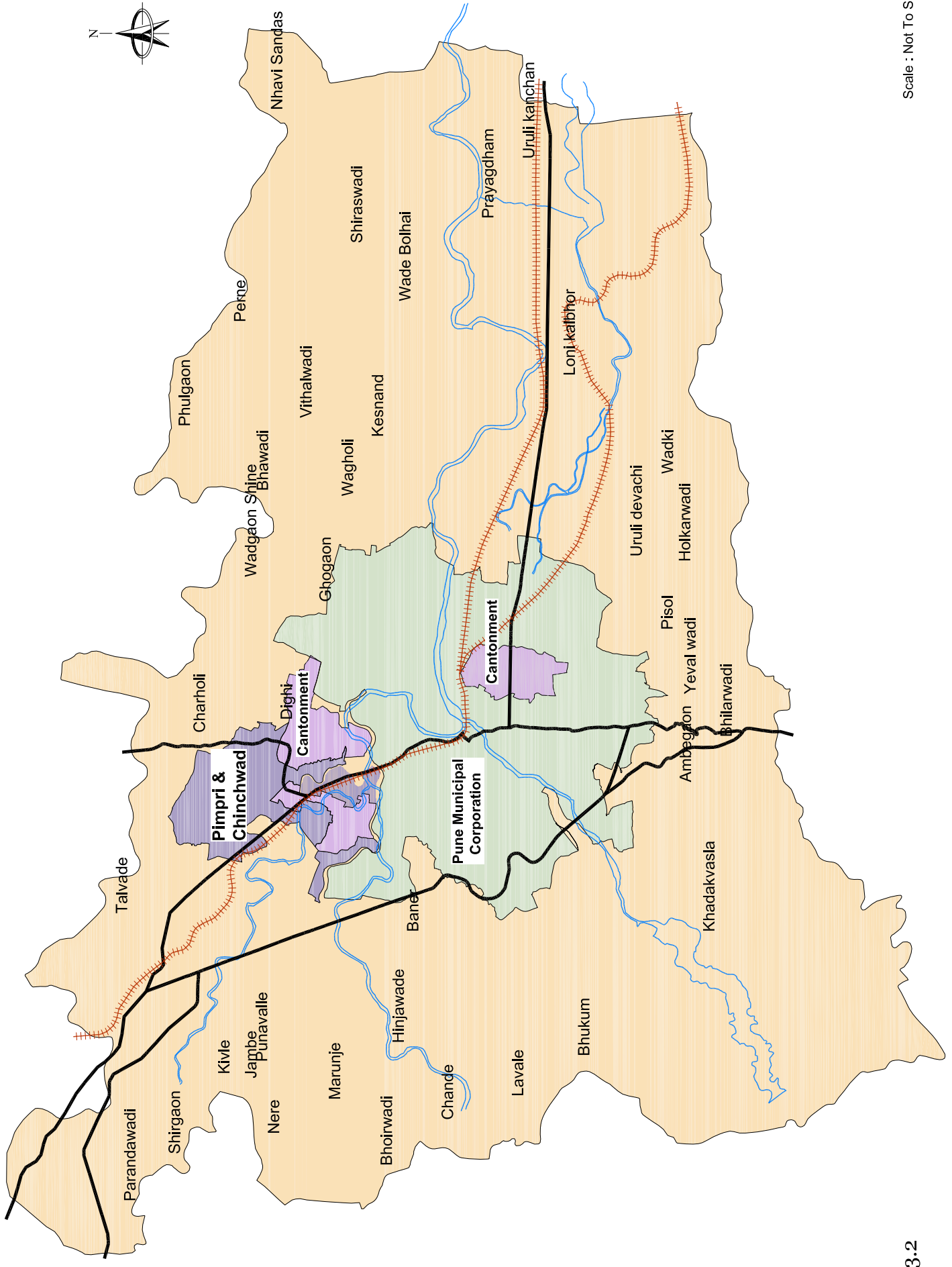


Figure : 3.2

Pune Metropolitan Region

Scale : Not To Scale

(ii) **PCMC.** PCMC is a twin city of PMC and houses most of the industrial developments. PCMC has a population of 1.01 million (2001) which accounts for 14 percent of the total urban population in the Pune District and 23 percent of the total PMR population. The PCMC's population has grown from 0.52 million in 1991 to 1.01 million in 2001. PCMC has experienced a high CAGR after its industrialization in 1960, almost thrice than that of PMC growth.

(iii) **PC and KC.** Pune is headquarters of the Indian Army Southern Command. PC and KC are the military bases established during British rule and still continue to operate as army bases for Indian army. KC is also famous for two ordnance factories: ammunition factory (AFK) and high explosive factory (HEF). PC and KC account for only four percent of the total PMR population and shown a slight growth in the last decade (CAGR 2.16 and 2.28 percent respectively) compared to negative growth during 1981-1991. Any development in these cantonment areas are under control of Indian army and have minimal impact on urbanization of the rest of the PMR.

(iv) **Rest of the PMR.** The remaining part of the PMR consists of close to 100 census towns and villages with population of 0.56 million that accounts for 13 percent of the total PMR population. The rest of the PMR is also shows a fast pace of urbanization in line with PMC and PCMC growth.

3.2.3 Area and Population Density

PMC jurisdiction extends up to an area of 243.84 sq. km. which constitutes approximately 20 percent of the total PMR area. Since 1951, PMC area has almost doubled from 125.75 sq. km. to 243.84 sq. km. Spatial growth of PMC over the last two centuries is shown in **Figure 3.4**. An average population density as per Census 2001 for PMC is 10,410 persons/sq. km. Population density ranges from as low as 1,476 persons /sq. km. to as high as 182,049 persons/sq. km. The Urban Development Plans Formulation and Implementation (UDPFI) guideline indicate average density of around 15,000 persons/sq. km. for the city, whereas in PMC, almost 60 percent of the wards have higher densities than the prescribed norm. Population densities are higher in the old city wards, and wards along major transport corridors (**Figure 3.5**).

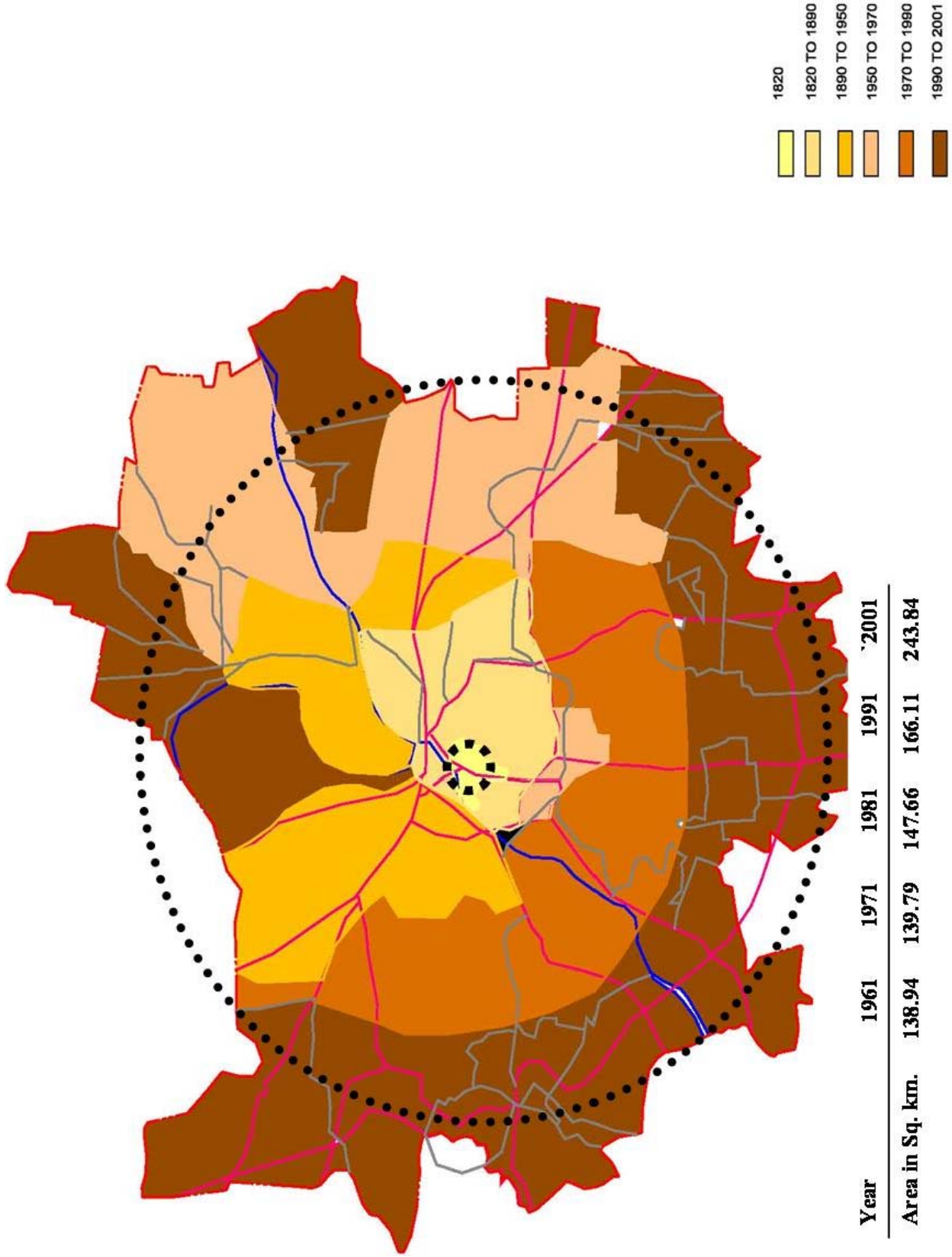
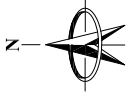
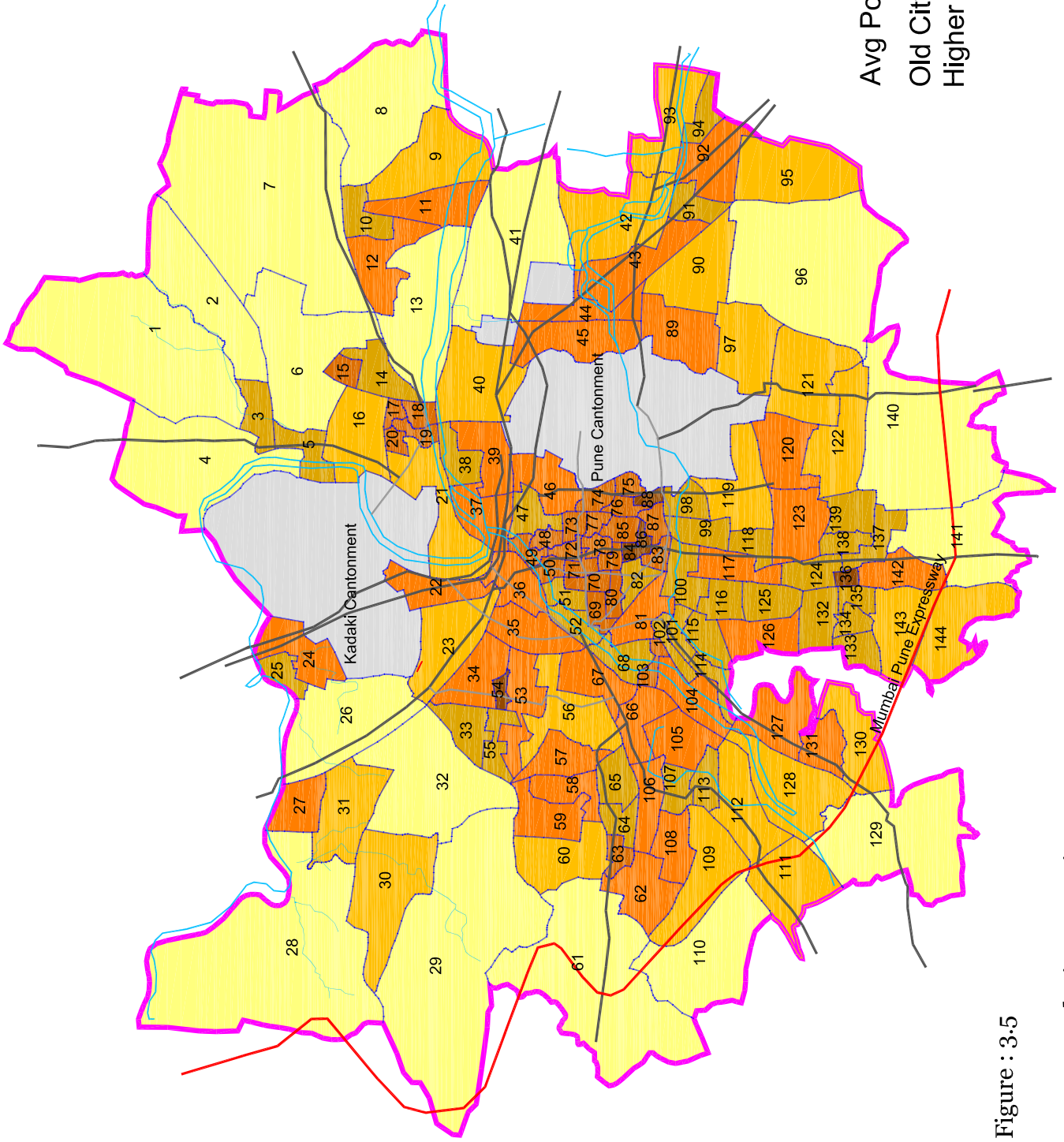
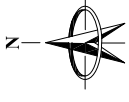


Figure : 3.4



Legend:-

[Lightest Yellow]	< 5000
[Light Orange]	5000 - 10000
[Orange]	10000 - 20000
[Dark Orange]	20000 - 50000
[Brownish Orange]	50000 - 100000
[Darkest Orange]	> 100000
[Grey]	Cantonment area

Avg Population Density ~10,410/Sq.km
Old City & Wards along Major Radials have Higher Densities

Scale : Not To Scale

Figure : 3.5

Table 3.1: Urbanisation in PMC

Year	PMC		PCMC		PC		KC		Rest of the PMR		Total PMR	
	Popn (No.s)	CAGR (%)	Popn (No.s)	CAGR (%)	Popn (No.s)	CAGR (%)	Popn (No.s)	CAGR (%)	Popn (No.s)	CAGR (%)	Popn (No.s)	CAGR (%)
1951	488,419	-	26,367	-	-	-	-	-	-	-	-	-
1961	606,777	2.19	39,654	4.17	65,838	-	58,496	-	101,363	-	872,128	-
1971	856,105	3.50	98,572	9.53	77,774	1.68	65,497	1.14	135,558	2.95	1,233,506	3.46
1981	1,203,351	3.46	251,769	9.83	85,986	1.01	80,835	2.13	233,881	5.61	1,855,822	4.12
1991	1,566,651	2.67	520,639	7.54	82,139	(0.46)	78,323	(0.32)	395,966	5.41	2,643,718	3.76
2001	2,538,473	4.94	1,006,417	6.81	101,723	2.16	98,090	2.28	556,770	3.47	4,301,473	5.38

(Source: Census of India.)

3.3 Economy and Employment

3.3.1 Workforce Participation

Workforce participation ratio for PMC at 34.08 percent (Census 2001) has shown an increase from Census 1991 value of 31.88 percent (**Table 3.2**). Since work category wise break up is not available for Census 2001, Census 1991 figures are evaluated here. Employment is mainly seen in the service sector, which also includes IT sector (30 percent of the total working population) followed by manufacturing and processing industry (25 percent) and trade and commerce activities (22 percent).

Table 3.2: Distribution of Workers in Pune

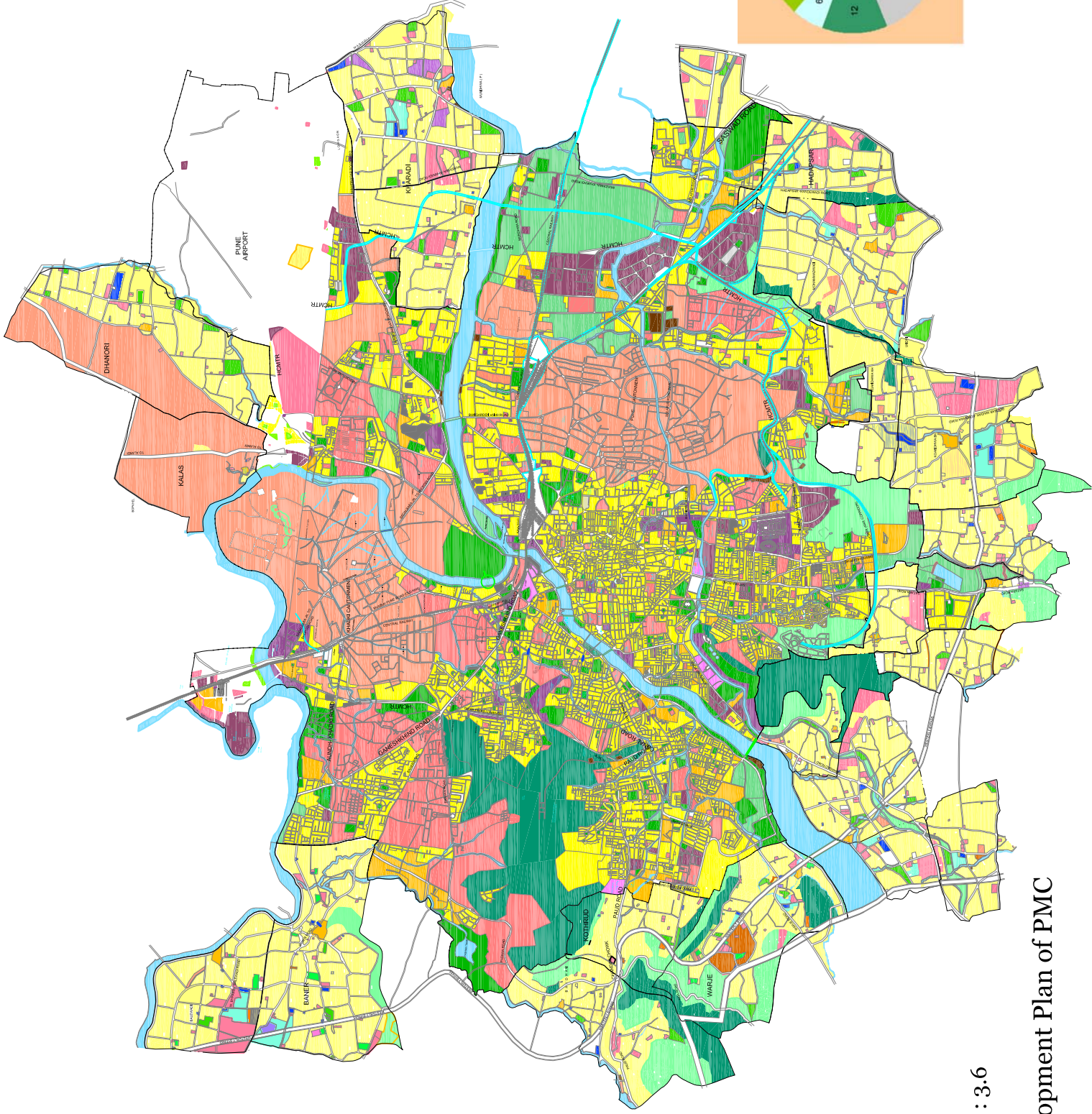
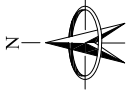
Sector	1991		2001	
	Nos.	%	Nos.	%
Primary Sector	6,873	1.27	10,246	1.32
Household Industry	9061	1.68	25430	3.28
Other Workers	523,607	97.05	739,943	95.40
Total Main Workers	539,541	100.00%	775,619	100.00%

(Source: Census of India 1981, 1991 and 2001).

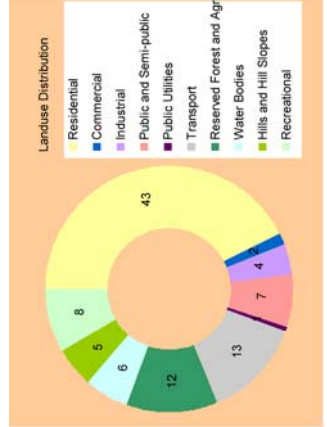
3.3.2 Industry

The growth of PMC is being driven by various industry segments. **Table 3.3** gives details on major existing and proposed industrial establishments in and around PMR (also refer **Figure 3.6**). Except Kharadi Knowledge Park, which is located with in PMC limits, all other industries are located outside PMC in PMR or close to PMR towards North-West, North and North-East. PCMC houses a majority of the industrial developments.

PCMC MIDC. PCMC saw a spate of industrial development following the setting up of Explosives units at Khadki during World War II. The next milestone was the entry of Kirloskar Oil Engines Ltd. into the city in the forties with which PCMC emerged as a known hub for diesel engine manufacturers. In 1960, MIDC set up a huge industrial estate at Bhosari. It was in fact this development, which is made PCMC the hometown for production. This development of PCMC an auto-hub has been particularly evident in the period 1960-1990. The MIDC in PCMC is an active industrial hub, hosting close to 3,200 units in production. With many highly rated clients such as Bajaj, Tata Motors, DGP Hinoday, Philips India Ltd .



LEGEND



Scale : Not To Scale

Figure : 3.6

Development Plan of PMC

and Centura Enka to its credit, the PCMC MIDC has been instrumental in facilitating the development of the Small and Medium Enterprises in the area that are today suppliers to the bigger established players there. Given the proximity of the PMC and the PCMC, some of the suppliers to the players in the PCMC have set up industrial operations in the PMC areas such as Hadapsar or Kondwa. In fact, one finds a lot of spilling over between the two corporation limits, whether in terms of industry logistics, talent pool or commercial business support systems.

Table 3.3: PMR Industries

Industrial Area	Completion Status	Area	Zoning	Distance From Pune	Sector
		Ha.	PSI ¹	Km.	
Pimpri Chinchwad MIDC	100%	1,225	A	18	Auto, Auto components
Rajiv Gandhi InfoTech Park Hinjewadi Phase I	100%	87	A	15	IT, ITES
Rajiv Gandhi InfoTech Park Hinjewadi Phase II	80%	218	A	16	BT
Rajiv Gandhi InfoTech Park Hinjewadi Phase III (SEZ)	0% Land Acquisition in Process	350	A	16	IT, ITES
Rajiv Gandhi InfoTech Park Hinjewadi Phase IV	Proposed	400	A	16	IT, ITES
Kharadi Knowledge Park	100%	27	A	PMC	Software
Talawade InfoTech Park	60%	75	A	18	IT
Talegaon Floriculture Park	NA	-	B	37	Floriculture
Ranjangaon Industrial Area	40%	925	C	55	White Goods
Chakan Industrial Area	40%	258	C	30	Auto, Auto components
Jejuri	NA	118	C	48	Mixed Profile
Bharat Forge SEZ	Proposed	1,800	-	40	Auto, Auto components

(Source: Maharashtra Industrial Development Corporation.)

Package Scheme of Incentives – Concessions on electricity and stamp duty and octroi refunds. Under the Package Scheme of Incentives (2001), have entitled manufacturing industries to receive several benefits depending on their area of operation. Thus, the different areas in Maharashtra state have been classified into different zones A, B, C, D and D+, where A indicates a high level of industrial development and D+ reflects very low level of the same. In order to create balanced regional development and incentive industries to re-locate to less developed areas, A and B zone are offered lesser incentives as compared to C, D and D+ zones. The Govt. of Maharashtra, in its IT and ITES Policy 2003, has identified the IT and IT Enabled Services to be a driver of growth in the state. Hence, one finds that even if manufacturing activities in A and B zone do not get incentives under PSI 2001, the IT and ITES units in A and B zones can still avail of certain benefits in these zones.

Ranjangaon Industrial Area. A recent study by Maratha Chamber of Commerce Industries and Agriculture (MCCIA) reveals that in the past 5 years, nearly 25 percent of the proposed investments by medium and large scale manufacturing units in Pune are along the Nagar road belt (Shirur taluka) at Supa, Sanaswadi or Ranjangaon. This is partly to do with the MIDC that has been developed at Ranjangaon. Ranjangaon MIDC is given status of '5-star industrial area' and avails the benefits of 'C' PSI zoning. Ranjangaon is getting to be popular as a White Goods hub, primarily because of the presence of players like LG, Anchor Daewoo, National Panasonic and Whirlpool. Some South Korean vendors of LG such as Nainko have also established operations at Ranjangaon. This has helped in giving an MNC touch to the Ranjangaon MIDC.

Chakan Industrial Area. MCCIA study also states that an additional 15 percent of proposals for setting up manufacturing operations are in Chakan MIDC. At a distance of 30 km. from PMC and 20 km. from PCMC, Chakan MIDC is suitable for its strategic location. Due to its proximity to PCMC MIDC, automobile and auto - related manufacturing operations are been set up in Chakan MIDC.

IT Industries. PMC is emerging as a major IT centre, with sprawling software parks mushrooming all over the city and PMR area. According to the Software Technology Parks of India (STPI), software exports from Pune has increased by 48 percent, touching the US\$2 billion-mark, even surpassing Mumbai's exports. Today, PMR houses more than 100 IT industries, one fourth of which are multinationals, who are involved in research and development, engineering services and embedded technology-related work. The biggest IT Park in PMR is MIDC promoted Rajiv Gandhi InfoTech Park (Phase I and II) at Hinjewadi, which has witnessed a spectacular growth. Currently spread over 305 Ha., it is likely to be expanded (additional 750 Ha.) in the next few years. Followed by Hinjewadi, Kharadi and Talawde IT Parks are also rapidly developing. In addition to IT Parks developed by MIDC, and since GoM as permitted several private developers to establish IT Parks, a series of IT parks are coming up in residential areas such as Kharadi, Magarpatta, and Kalyani Nagar etc.

3.3.3 Trade and Commerce

A large proportion of the city's population thrives on wholesale and retail trade and commerce. The city serves as the regional wholesale market for food grains and other commodities. It also serves as the

market centre for agricultural produce such as green peas, wheat, rice, pulses, oilseeds, maize, etc., which are cultivated in the rural hinterland. Pune also functions as a distributing centre for agricultural implements, fertilizers, drugs and medicines, iron and steel, cement and minerals, petroleum products and forest produces such as timber, and readymade garments and textiles. (Table 3.4) .

Table 3.4: Commercial Establishments in PMC

Category	Establishments	Employment
	Nos.	Nos.
Shops	11,718	28,866
Commercial Establishments	22,925	193,557
Hotels	3,967	9,237
Theaters	30	313
Total	38,640	231,973

(Source: PMC – Environmental Status Report, 2005.)

Currently, Central Business District (CBD) comprises areas of Camp (MG Road, East Road), Swargate, Laxmi Road (Tilak Road, Bajirao Road), Kalyani Nagar, Shivajinagar, Wakad Wadi, Deccan, FC Road, JM Road, and Ahmednagar Road (Figure 3.10). Main commercial activities observed in these areas are corporate offices/ headquarters for manufacturing and service units, business process outsourcing centres, call centres, banking, insurance, retail trading, shopping malls, entertainment, cinema theatres, health services, educational institutions, hotels and restaurants etc.

3.4 Land use Distribution

The first Development Plan (DP) for PMC was prepared in 1966 for a 10 year horizon till 1976 as per Maharashtra Town and Country Planning Act, 1966. Revision to this was made in 1982 which was sanctioned by the GoM in 1987. This second DP was prepared for 20 year horizon (to be valid till 2007) for PMC area of 138.36 sq. km. In 2001, PMC jurisdiction was extended by merging 23 neighbouring villages (in parts) and DP was exclusively prepared for this fringe area for a horizon of 20 years (valid till 2021). Distribution of land use as per 1987 and 2001 DP is given in Table 3.5. The combined percentage distribution for various land use categories is presented in Figure 3.7.

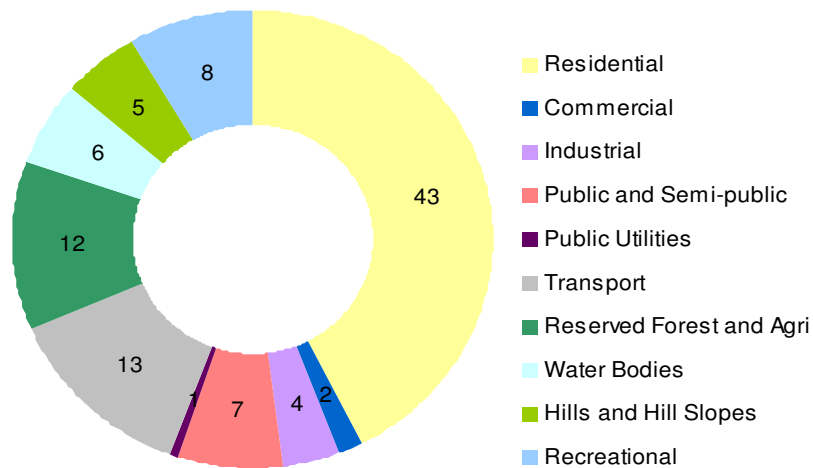


Figure 3.7: Percentage of Land use Distribution – PMC

Table 3.5: Land use Pattern – 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	1.70	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	11.00	1.37	6.83
Public Utilities	1.38	-	1.38	1.00	-	0.57
Transport	22.00	9.81	31.81	15.90	9.29	13.04
Reserved Forest and Agri	2.35	26.70	29.05	1.70	25.29	11.91
Water Bodies	12.04	2.48	14.52	8.70	2.35	5.95
Hills and Hill Slopes	12.45	-	12.45	9.00	-	5.10
Recreational	12.73	7.79	20.52	9.20	7.38	8.41
Total	138.36	105.58	243.94	100.00	100.00	100.00

(Source: City Development Plan (CDP), PMC).

The combined land use pattern shows that around 43 percent of the area is under residential zone, two percent is under commercial zone, four percent under industrial zone and 16 percent under public/semi-public and recreational use. The 1987 DP was implemented up to 30 percent only. Though statistics for the ground situation for changed land use is not available, from field surveys and discussion with PMC officials, it is observed that a lot of land use changes are taken place from the defined zones, especially for commercial areas. Old city wards are overcrowded with commercial establishments and the same is the case with areas along transport corridors. One can also see a number of IT offices in residential areas since IT industry is permitted in residential zones.

3.5 Growth Trends and Projection

3.5.1 Spatial Growth

Over the years PMC has grown in concentric rings. Future growth of PMC will be mainly governed by existing transport corridors, existing and future industrial developments in and around PMC and the expansion of central business district (CBD). Spatial growth of PMC will taken place towards employment nodes; in areas which are closer to these nodes and areas which gives immediate connectivity to these nodes. Along with this, few areas in PMC will be further densified and will be overcrowded in terms of commercial developments while out migration is expected from already overcrowded residential areas towards peripheral areas. A detailed discussion on spatial growth is given below. Overall PMR growth directions will be in line with PMC, however, below, potential areas within PMC are mainly furnished. Growth corridors of PMC are shown in **Figure 3.8**. Also refer **Figure 3.9** and **Figure 3.10** for PMR Industries and Future Growth, and PMC CBD and Future Growth.

West, North-West and North – IT and Auto hub. PCMC MIDC is fully developed and will continue to attract PMC citizens for jobs which are already created. Hinjewadi Phase I and II are attracting major investments while Phase III and IV are in the planning stage. Hinjewadi Phase III has given a Special

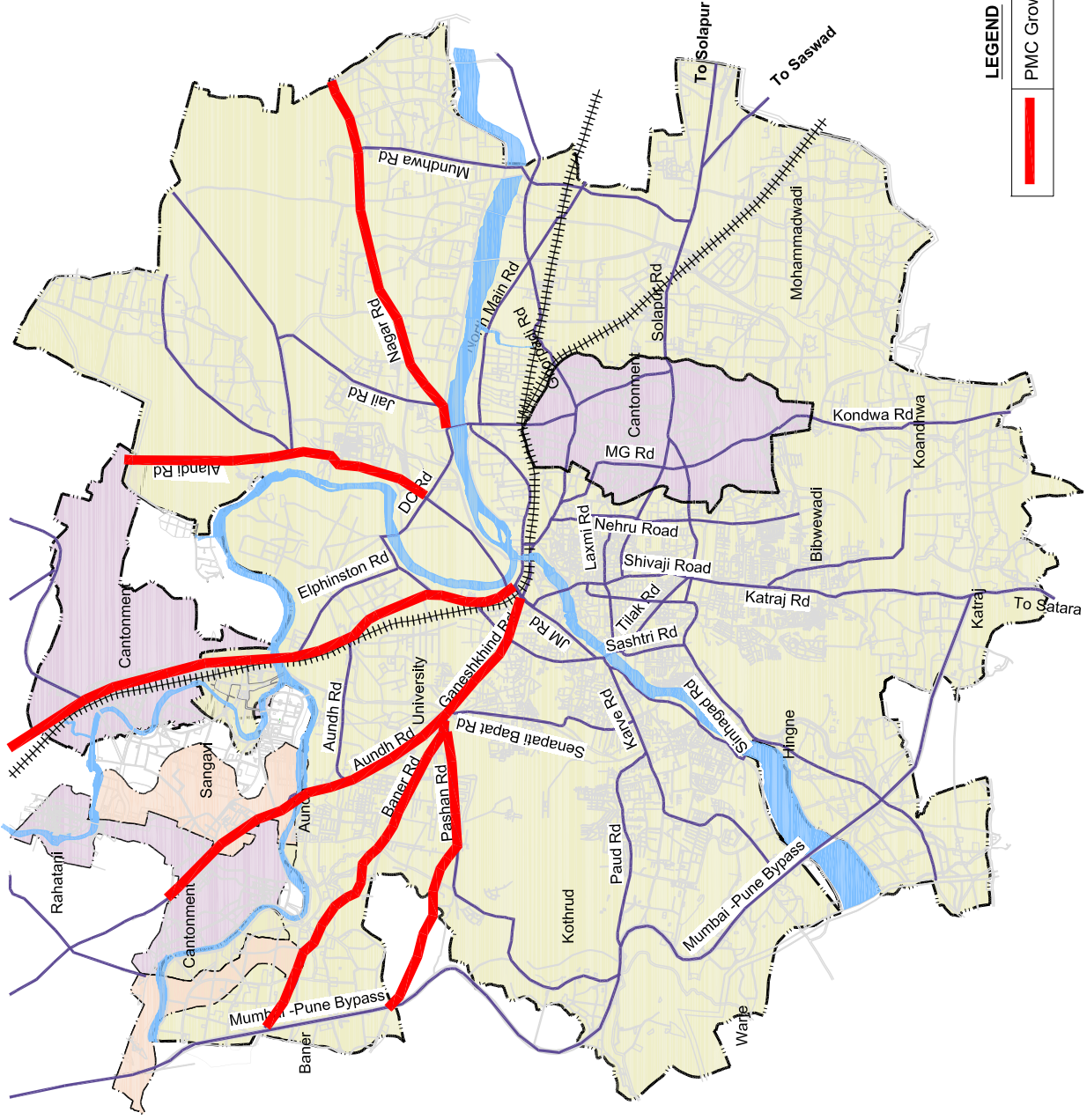
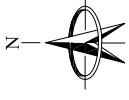


Figure : 3.8

PMC Growth Corridors

Scale : Not To Scale

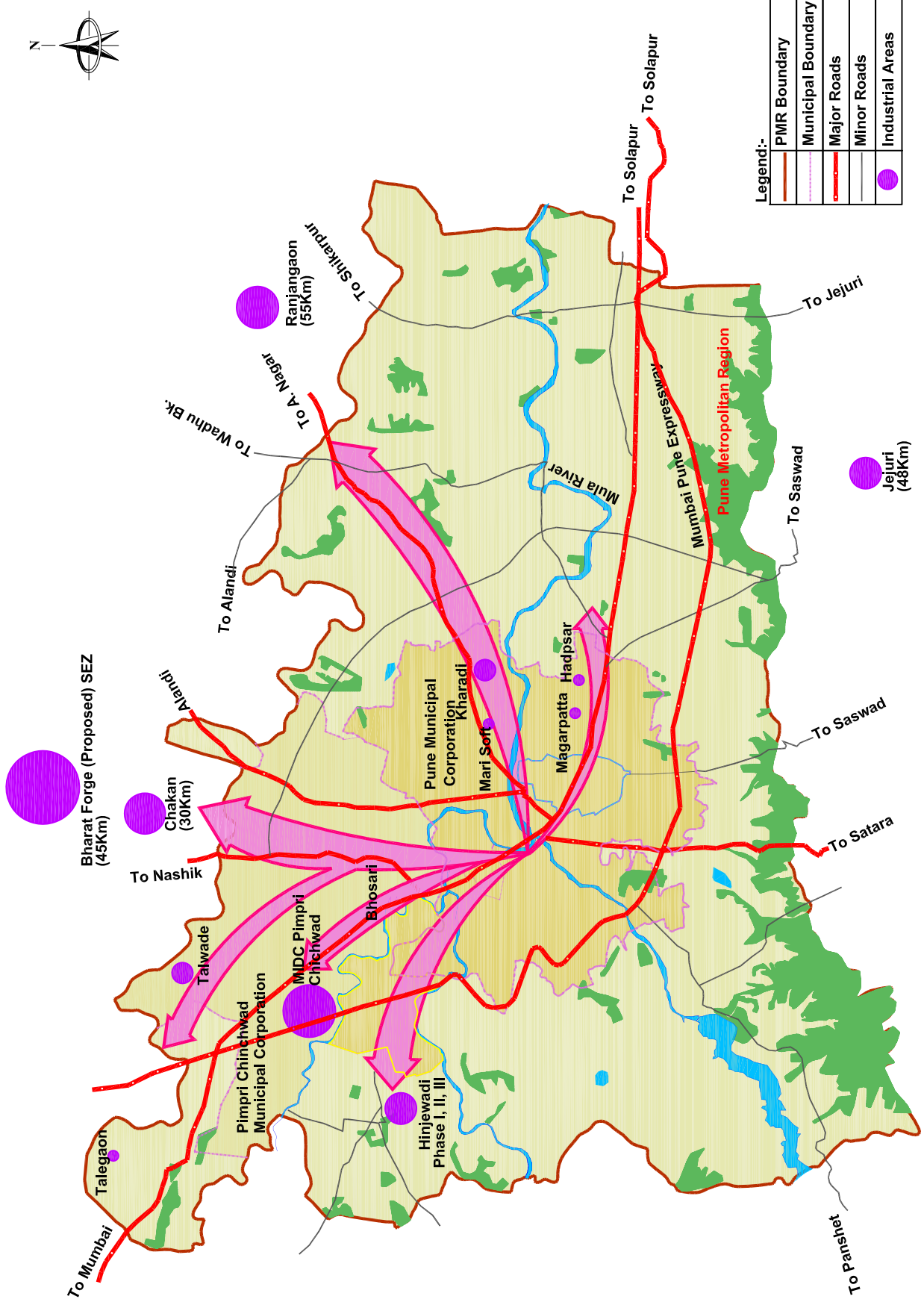
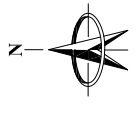


Figure : 3.9

Scale : Not To Scale

Economic Zone (SEZ) status and is borne to attract number of multinational companies. As already discussed in earlier sections Chakan MIDC is also attracting major investments and is developing as an extension to PCMC MIDC. Bharat Forge has proposed an SEZ just 45 km. North of PMC over an area of 1,800 Ha. to be developed majorly as auto and auto component industries. All these existing and future industrial developments are well connected with PMC through old and new NH-4 and Mumbai-Pune expressway through city roads such as Pashan Road, Sus Road (SH-57), Baner Road, Karve Road and Sinhagad Road. For future expansion of PMC in the West, North West, and North potential areas will be Baner, Balewadi, Sutarwadi, Pashan, and Aundh where a majority of residential growth is likely to take place. Though there is a spill over of developments into PCMC area (in and around Waked) which are closer to Hinjewadi and PCMC MIDC, PMC is the preferred destination as there have better level of infrastructure services. CBD expansion is expected in and around city roads leading to old and new NH4 and expressway.

North-East – IT, BPO and White Goods hub. North-East areas of Pune will receive equal attention for various developments along with West, North-West and North areas. Towards North-East, Ranjangaon MIDC with 'C' PSI zoning is attracting White Good's investments while areas of Kharadi, Kalyani Nagar, Parnakuti, Bund Garden along Pune-Nagar Road are attracting IT and BPO investments. This area has a proximity advantage to existing airport at Lohgaon while the proposed international airport at Chakan can be easily be accessed from Pune-Alandi Road. Along with these developments, Pune-Nagar Road is witnessing a high commercial developments along it in the last few years. For future expansion of PMC in the North-East potential areas will be Kharadi, Ramwadi, Wadgaon Sheri, Lohgaon, Parnkuti, Kalyani Nagar, Yerwada etc. CBD expansion is expected in and around Pune-Nagar Road.

South, South-East. Following West, North and North-East, South and South-East will be the potential area for PMC spatial growth. Hadapsar area has already seen a lot of spill over from PCMC MIDC and many investors have established their manufacturing operations here. Hadapsar industrial areas have advantage of Pune-Solapur Road connectivity. This area has also seen IT developments by private investors, where IT offices are developed as a self-contained city (along with residential areas, schools, amenities etc.). Magarpatta Cyber city is a good example of this. Southern areas of PMC will be further densified taking advantage of connectivity to industrial areas in West and North through Mumbai-Pune expressway. PMC's growth towards the extreme south and beyond its boundaries is restricted due to hills and forests. For future expansion of PMC in the South and South-East potential areas will be Hadapsar, Ramtekadi, Mahamadwadi, Kondhawa etc. CBD expansion is expected in and around Pune-Solapur Road.

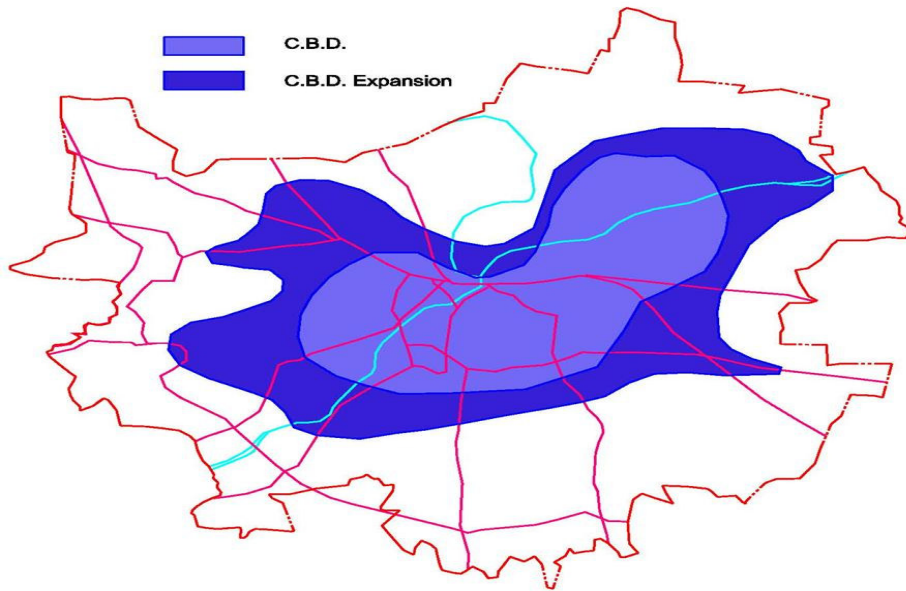


Figure 3.10: PMC CBD and Growth

South, South-West Expansion in South and South-West areas will be mainly triggered by Mumbai-Pune expressway link. Areas of Kothrud, Warje, Karve Nagar, Wadgaon will continue to receive attention for residential and commercial developments. These areas are already developed in terms of infrastructure services and availability of various amenities (education, health, banking services etc.) and hence preferred by many citizens. In the South and South-West, spill over of developments beyond PMC limits is not expected in future due to geographical restrictions such as Panshet and Khadakawasala dams, hills and forests. The area beyond PMC also lacks transportation linkages except for Pune-Satara Road.

3.5.2 Population and Employment Growth

Population and employment projections worked out for PMR, except PMC are mainly based on past trends. Population and Employment projections for PMC are based on assessment presented in earlier sections. This broadly includes:

- I. Land use distribution as per Old and New Development Plans, Land use Changes
- II. Spatial growth of PMC, existing and future Growth Corridors
- III. Existing density patterns
- IV. Existing and future investments in Industries
- V. Future growth of CBD, employment scenario
- VI. Future growth of residential areas
- VII. Average employment for commercial/public/industrial areas in different localities

For ward wise projections, wards were applied with different growth rates based on existing population density and employment in each ward and its potential for future development. Different growth rates were also applied over the decades such as for 2011, 2021, 2031 etc. considering overcrowding and out-migration issues. **Table 3.6** gives the summary of projected population and employment for PMR. A detailed ward wise projection for population and employment for PMC is given in **Appendix 3.1** and **Appendix 3.2** respectively. **Figure 3.11** shows the Population growth in PMC. Following are the major observations from population and employment projection analysis:

- I. PMC population will grow to 5.63 Mn. by 2031
- II. PMC employment will grow to 2.36 Mn. by 2031 to have workforce participation rate of around 42 percent
- III. PMC average population density in 2007 will be 12,173 persons/sq. km., in 2011 will be 13,718 Persons/sq. km., in 2021 will be 18,064 persons/sq. km. and in 2031 will be 23,102 persons/sq. km.
- IV. Population density will be more than twice of population density in 2001.
- V. PMR population will grow to 11.41 Mn. by 2031
- VI. PMC employment will grow to 4.85 Mn. by 2031 to have workforce participation rate of around 43 percent

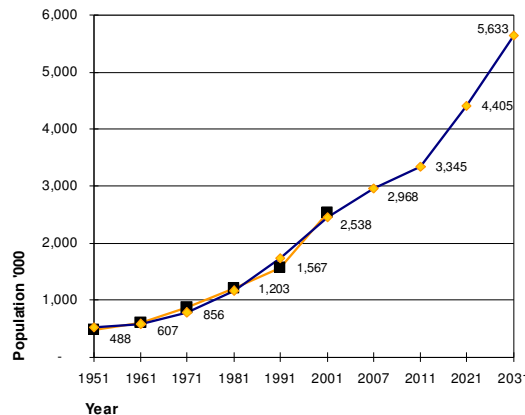


Figure 3.11: PMC Population Growth

Table 3.6: Projected Population and Employment

Region	Population (Million)				Employment (Million)			
	2007	2011	2021	2031	2007	2011	2021	2031
Pune Municipal Corporation	2.97	3.34	4.40	5.63	1.11	1.35	1.78	2.36
Pune Cantonment	0.11	0.12	0.13	0.14	0.04	0.04	0.05	0.05
Khadki Cantonment	0.12	0.12	0.13	0.15	0.04	0.04	0.05	0.05
Pimpri-Chinchwad Municipal Corporation	1.42	1.74	2.75	4.10	0.54	0.72	1.26	1.89
Rest of the PMR	0.70	0.79	1.07	1.39	0.25	0.29	0.39	0.50
Total Pune Metropolitan Region (PMR)	5.31	6.11	8.48	11.41	1.98	2.44	3.52	4.85

(Source: Analysis.)

4. Existing Urban Transport System

4.1 Traffic Surveys and Data Collection

The following surveys were undertaken to develop/update the traffic and transportation data for the study:

- Traffic volume count
- Road side interview
- On street parking survey
- Pedestrian count survey
- Speed and delay survey
- Off street parking survey
- NMT survey
- IPT survey

4.1.1 Screen Line flows

The traffic flow data was collected two screen line locations for 12 hours. The screen lines are shown in **Figure 4.1**. The summary of the counts for all locations are given in **Table 4.1**.

The composition of traffic which is predominantly two wheeler oriented is shown in **Figure 4.2**.

The detailed survey methodology and survey results are presented in **Appendix 4.1**.

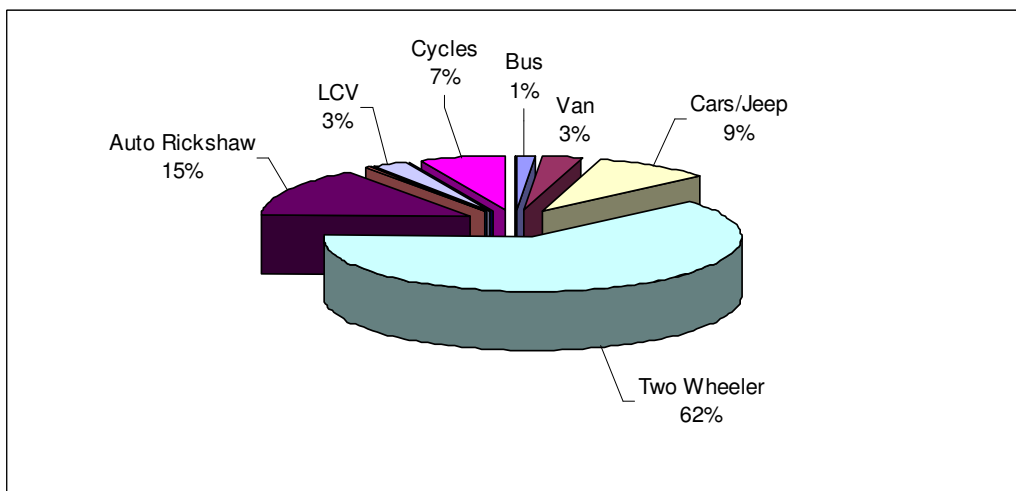


Figure 4.2: Composition of Traffic flow at screen line locations

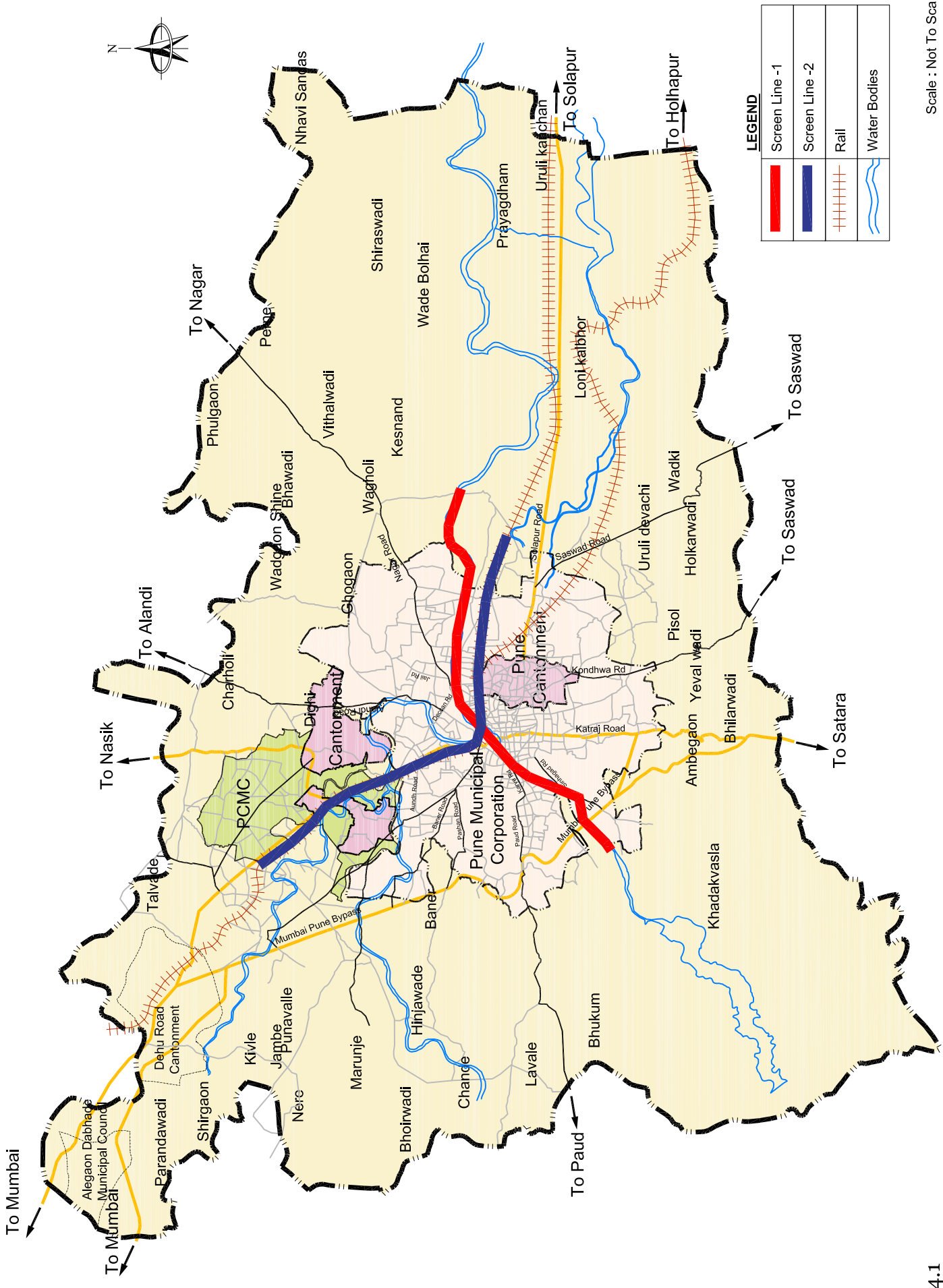


Figure : 4.1

Screen Line Selected for the Study

Table 4.1: Summary of Screen Line Counts (12hrs)

Sl. No.	Location	Buses			Pvt Vehicles & IPT				Goods Vehicles				Slow Moving Vehicles				TOTAL	
		Standard Bus	Other Bus	Mini Bus	Van	Cars/Jeep	Two Wheeler	Auto Rickshaw	Trucks	MAV	LCV	Tractor	Cycles	Carts	Cycle Rickshaw	Total Vehicles	Total PCUs	
Screen Line - 1 (Railway Line Between Mumbai to Solapur)																		
1	RUB near Harries Bridge	274	79	135	1,160	4,228	13,913	3,312	948	154	873	2	1,241	14	0	26,333	27,882	
2	RUB at Aundh Road	216	66	171	2,059	4,369	12,069	3,569	2,185	76	1,988	20	1,863	23	2	28,676	32,263	
3	RUB at Range hill Road	1	61	103	1,476	3,568	8,801	842	568	39	163	1	791	0	0	16,414	14,900	
4	RUB at Joshi Road	0	0	0	519	2,263	21,238	3,996	98	0	842	0	1,991	57	0	31,004	29,007	
5	ROB near Sancheti Hospital	4,718*	2,493*	919*	1,528*	17,699*	30,701*	8,335*	395*	35*	2,119*	13*	3,794*	7*	5*	72,761*	81,732*	
6	RUB near Railway Station	1,161	398	392	3,025	9,240	27,895	10,964	1,041	253	2,001	13	2,432	0	0	56,815	66,260	
7	ROB near Alankar Theatre	2,710	314	111	997	4,709	29,269	7,506	109	4	805	22	4,257	110	0	50,923	52,883	
8	ROB at Wadia college	10	99	114	980	5,296	25,500	5,556	2,524	1,385	1,234	3	1,720	2	0	44,423	50,448	
9	ROB near Koregaon Park	55	159	155	2,215	12,390	51,614	8,175	451	259	2,214	13	1,300	2	0	79,002	76,073	
10	Level crossing at Ghorpadi Road	468	493	386	322	3,919	8,123	5,606	608	107	1,581	1	4,064	79	47	25,804	30,482	
Screen line 2 (Mula Mutha River)																		
1	Wanje Bridge	912*	794*	845*	2,2468*	11,103*	17,441*	2,389*	6,723*	1,118*	3,158*	65*	647*	6*	1*	47,448*	58,533*	
2	Raja ram Bridge	0	0	13	2,132	6,077	36,066	5,043	9	7	1,368	0	5,608	0	0	56,323	46,097	
3	Mathre Bridge	349	196	357	4,053	8,581	48,145	6,683	180	37	2,976	36	3,735	1	2	75,331	64,850	
4	S.M.Joshi Bridge	0	3	29	1,531	3,366	24,013	2,950	19	0	935	2	2,160	7	0	35,015	28,734	
5	Near Sanjeevani Hospital	0	0	15	75	1,144	18,662	2,703	43	0	274	0	1,160	3	0	24,079	21,592	
6	Sambhaji Bridge	2,143	452	299	1,585	7,751	0	15,769	165	29	2,129	0	5,638	0	0	35,960	53,310	
7	Godzli Bridge(TW only)	0	0	0	0	0	17,707	0	0	0	0	0	205	0	0	17,912	13,362	
8	Z- Bridge	0	0	0	408	1,869	25,428	3,813	0	0	436	0	2,148	38	0	34,140	30,520	
9	Tilak Bridge	0	0	1	329	2,397	12,505	3,943	0	1	271	0	1,310	37	0	20,794	20,974	
10	Shinde Bridge	1	5	16	642	2,838	26,591	5,894	21	7	796	0	2,778	5	0	39,594	37,558	
11	Shivaji Bridge	1,382	122	178	955	3,689	39,233	11,551	228	67	2,019	114	1,823	24	0	61,385	65,576	
12	Dengale Bridge	2,335	389	132	311	7,285	42,364	10,496	286	835	612	7	6,174	36	0	71,262	73,947	

Sl. No.	Location	Buses			Pvt Vehicles & IPT				Goods Vehicles					Slow Moving Vehicles			TOTAL	
		Standard Bus	Other Bus	Mini Bus	Van	Cars/Jeep	Two Wheeler	Auto Rickshaw	Trucks	MAV	LCV	Tractor	Cycles	Carts	Cycle Rickshaw	Total Vehicles	Total PCUs	
13	Ambedkar Bridge	227	217	321	2,947	7,055	29,669	9,896	279	10	1,024	6	1,138	12	1	52,802	56,096	
14	Yenwada Bridge	1,466	1,467	535	5,143	22,507	65,967	15,676	1,699	1,186	3,424	3	6,022	1	0	1,25,096	1,31,431	
15	Kalyani Bridge	41	48	138	2,840	12,271	33,898	5,735	864	5	1,676	442	3,910	19	0	61,887	55,457	
16	Kharadi Bridge	114	76	239	710	4,404	19,280	2,700	2,079	809	2,328	184	8,510	196	0	41,629	40,043	
17	Sangam Bridge	2,794	1,168	666	3,633	30,260	50,921	11,327	2,909	1,881	1,944	8	2,522	33	0	1,10,066	1,22,205	

Note: * -Survey Results corresponds to 24 hours

4.1.2 Cordon Flows

Road Side Interview surveys are also carried along with Classified Volume Count survey at cordon points.

Outer Cordon: is the boundary of Local Planning Area, along which, ten locations have been selected. The directional classified volume count surveys were conducted for 24 hours across these points. The summary of the data collected for 24 hours is presented in **Table 4.2** and the peak hour details is shown in **Table 4.3**.

Table 4.3: Peak hour traffic across Outer Cordon

Sl. No.	Corridor	Location	Peak Hour			Total (24 Hours)	
			Time	Vehicles	PCUs	Vehicles	PCUs
1	Alandi Road	Dighi	18.00-19.00	2,295	2,021	24,399	24,756
2	Aundh Road	Pimple Nilakh	07.00-08.00	4,167	3,716	67,224	57,240
3	Mumbai Pune Road	Kasarwadi	18.00-19.00	10,284	11,150	1,12,712	1,22,188
4	Kondhwa Road	Khondhava Budarch	09.00-10.00	927	1,501	14,320	18,505
5	Mumbai – Pune Expressway	Wakad	18.00-19.00	4,788	6,289	56,833	75,133
6	Nagar Road	Near Hadapser Bypass	18.00-19.00	6,255	9,806	64,019	97,930
7	Pirangut Road	Bhukan	07.00-08.00	1,037	1,591	15,485	17,851
8	Saswad Road	Toll plaza	06.00-07.00	1,524	2,385	32,246	46,533
9	Satara road	Toll plaza	00.00-01.00	1,219	2,578	26,658	43,836
10	Solapur Road	Toll Plaza	11.00-12.00	3,480	6,230	50,389	88,131

The analysis of the classified volume count across the outer cordon suggests that Kasarwadi on Mumbai pune road and Near Hadapser Bypass on Nagar road are the two locations that account for majority of the traffic entering / exiting the region. Kasarwadi is busiest of all the locations with about 1, 12,712 vehicles. The composition of traffic across the outer cordon is presented in **Figure 4.3**.

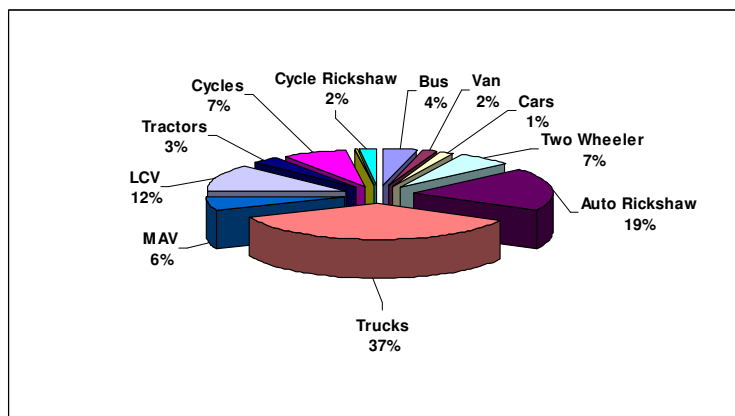


Figure 4.3: Composition of traffic across the outer cordon location

Table 4.2: Summary of Outer Cordon Counts

Sl. No.	Location	Buses			Pvt Vehicles & IPT				Goods Vehicles					Slow Moving Vehicles				TOTAL	
		Standard Bus	Other Bus	Mini Bus	Van	Cars	Two Wheeler	Auto Rickshaw	Trucks	MAV	LCV	Tractors	Cycles	Carts	Cycle Rickshaw	Vehicles	PCUs		
1	Dighi	394	111	276	703	5502	10359	1405	1352	119	3068	67	1033	6	4	24399	24756		
2	Pimple Nilakh	762	989	993	3438	14376	37562	3264	2063	138	1930	19	1689	1	0	67224	57240		
3	Kasarwadi	5560	2972	1797	2510	17323	59639	7945	4524	2227	4311	46	3856	1	1	112712	122188		
4	Kondhawa Budarich	68	128	193	627	1419	5333	2373	1973	413	1038	182	527	33	13	14320	18505		
5	Wakad	1214	2366	1373	5772	15558	17882	1654	7688	816	2349	17	144	0	0	56833	75133		
6	Near Hadapsar Bypass	1484	551	1089	2825	12652	21715	4871	9845	2421	5037	114	1393	6	16	64019	97930		
7	Bhukan	125	56	125	1924	3863	5704	205	1392	285	1708	51	46	1	0	15485	17851		
8	Toll plaza (Saswad Road)	1126	227	315	4450	4754	8208	3476	3514	1777	3048	288	929	78	56	32246	46533		
9	Toll plaza (Satara Road)	1939	248	234	655	6721	6375	254	5749	708	3494	68	205	8	0	26658	43836		
10	Toll plaza (Solapur Road)	910	548	369	4441	6000	11648	4595	10130	4459	6079	518	644	20	28	50389	88131		

4.1.3 Road Side Interview

The collected data was coded, processed and expanded to total traffic. Average sample size obtained for various categories of vehicles for the O-D survey across outer cordon locations are given in **Table 4.4**.

Table 4.4: Average Sample Size for Outer Cordon Points

Sl. No.	Vehicle Type	Sample Size
1	Car	2%
2	Auto	2%
3	T/W	1%
4	Truck	10%
5	LCV	3%
6	MAV	15%

Trip Frequency: The detailed trip frequency distribution is shown in **Figure 4.4**. Daily trips(50%) and multiple trips(23%) account for nearly greater of all trips. Trip frequency across outer cordon points is presented in **Table 4.5**.

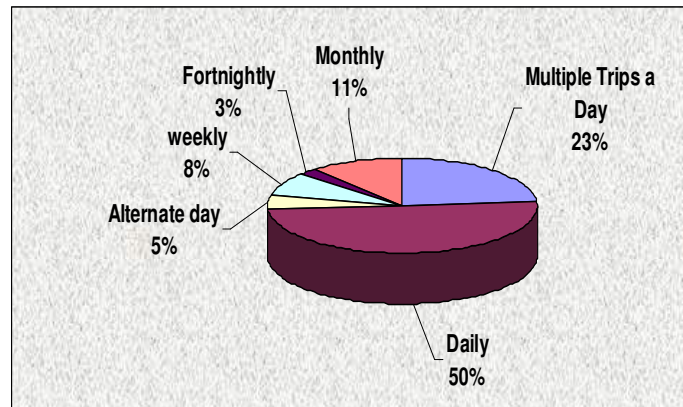


Figure 4.4: Average Trip Frequency across Outer Cordon Point

Table 4.5: Trip Frequency on Outer Cordon Points

Location Name	Frequency of the Trip						Total
	Multiple Trips per day	Daily	Alternate day	Weekly	Fortnightly	Monthly	
Dighi	16%	44%	4%	16%	11%	9%	100%
Pimple Nilakh	14%	62%	4%	9%	0%	11%	100%
Kasarwadi	29%	54%	4%	4%	2%	7%	100%
Kondhawa Budarch	37%	42%	5%	9%	2%	5%	100%
Wakad	7%	55%	5%	9%	3%	22%	100%

Location Name	Frequency of the Trip						
	Multiple Trips per day	Daily	Alternate day	Weekly	Fortnightly	Monthly	Total
Near Hadapsar Bypass	35%	54%	5%	4%	0%	3%	100%
Bhukan	53%	30%	6%	8%	1%	3%	100%
Toll plaza (Saswad Road)	13%	48%	4%	15%	4%	17%	100%
Toll plaza (Satara Road)	28%	36%	7%	6%	6%	17%	100%
Toll plaza (Solapur Road)	25%	45%	5%	8%	3%	13%	100%
Average	23%	50%	5%	8%	3%	11%	100%

Purpose of Journey: Analysis on purpose of journey revealed that the work trips constitute more with 49% followed by business trips of 24% and Education 9%. Trip purpose at all the locations across outer cordon points is shown in **Table 4.6**. The work trips are predominant at all the points on outer cordon locations. Tourism/pilgrim trips are observed on Satara road, Solapur road and Saswad road.

Table 4.6: Purpose of Journey on Outer Cordon Points

Location Name	Purpose of the Trip						Total
	Work	Business	Education	Social & Recreation	Tourism/Pilgrimage	Others	
Dighi	42%	47%	3%	3%	1%	5%	100%
Pimple Nilakh	68%	15%	3%	1%	4%	8%	100%
Kasarwadi	60%	19%	5%	7%	4%	4%	100%
Kondhawa Budarch	26%	25%	41%	5%	2%	2%	100%
Wakad	74%	10%	4%	1%	3%	8%	100%
Near Hadapsar Bypass	74%	14%	5%	4%	2%	1%	100%
Bhukan	36%	26%	26%	9%	2%	2%	100%
Toll plaza (Saswad Road)	23%	31%	2%	13%	6%	25%	100%
Toll plaza (Satara Road)	37%	37%	1%	13%	8%	3%	100%
Toll plaza (Solapur Road)	51%	22%	1%	13%	9%	4%	100%
Average	49%	24%	9%	7%	4%	6%	100%

Occupancy: Analysis on occupancy of the vehicles revealed that the average occupancy of car is 2.9, which of two-wheeler is 1.6 and the average occupancy of auto is 3.8. Distribution of average occupancy based on vehicle type has been shown in **Figure 4.5**. The average occupancy at all the locations across outer cordon points is shown in **Table 4.7**.

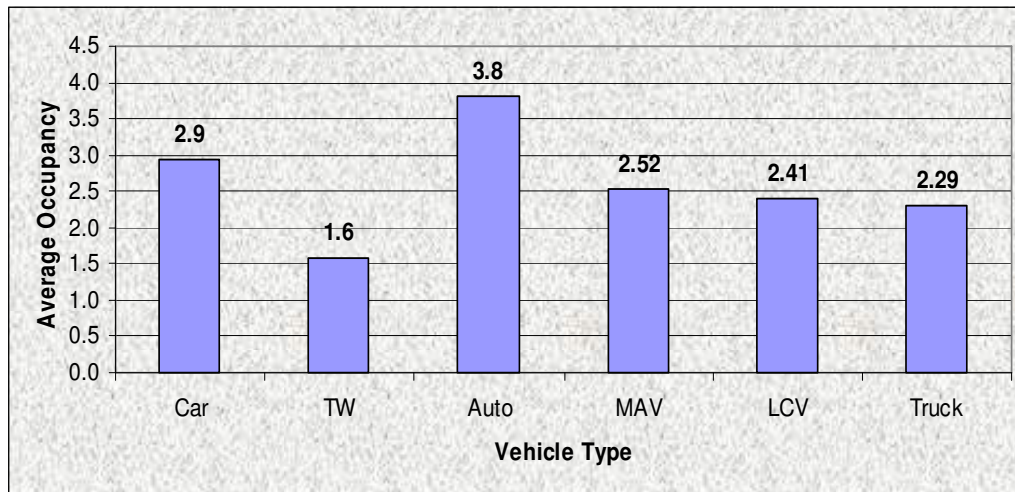


Figure 4.5: Average Occupancy by vehicle type across Outer Cordon Point

Table 4.7: Average Occupancy by vehicle type on Outer Cordon Points

Location Name	Average Occupancy by Vehicle Type					
	Car	TW	Auto	MAV	LCV	Truck
Dighi	2.46	1.88	4.73	2.91	1.61	2.37
Pimple Nilakh	2.64	1.41	2.73	2.05	2.84	2.03
Kasarwadi	2.86	1.49	3.24	2.52	2.19	3.06
Kondhawa Budarch	3.36	1.48	5.38	2.57	3.51	2
Wakad	3.37	1.57	2.82	2.64	2.9	2.19
Near Hadapsar Bypass	2.34	1.54	3.17	2.4	2	2.17
Bhukan	4.21	1.87	5.39	2.34	2.03	2.03
Toll plaza (Saswad Road)	3.43	1.71	3.18	2.45	2	2.28
Toll plaza (Satara Road)	3.61	1.33	3.29	2.45	2.53	2.45
Toll plaza (Solapur Road)	1	1.65	4.2	2.87	2.47	2.36
Average	2.9	1.6	3.8	2.5	2.4	2.3

Trip Characteristics: The zones have been broadly sectorized into three major sections for analyzing the trip characteristics. They are:

Pune Municipal Corporation – Zones 1 to 146

Pune Metropolitan Area – Zones 146 to 161

Outside Pune Metropolitan Area – Zones 162 to 169

The Road Side Interview survey revealed that 24% of all trips entering Pune city are destined to places outside Pune. The percentage of trips between sectors for all vehicles and Goods vehicles separately is given in Table 4.8 and Table 4.9. It is seen that trips between zones outside PMC (E-E category in the Table 4.8 and Table 4.9) is significant at all major corridors.

Table 4.8: Percentage of Trips Originating and Destining between Sectors

Location	I - E	E- I	E-E
Dighi	20%	63%	16%
Pimple Nilakh	38%	35%	23%
Kasarwadi	46%	36%	11%
Kondhawa Budarch	38%	28%	21%
Wakad	29%	23%	48%
Near Hadapser Bypass	41%	37%	18%
Bhukan	61%	13%	26%
Toll plaza (Saswad Road)	17%	54%	29%
Toll plaza (Satara Road)	46%	19%	35%
Toll plaza (Solapur Road)	41%	34%	25%
Average	38%	34%	25%
I & E = Trips between Internal (PMC) Zones & External Zones			
E & I = Trips between External Zones & Internal Zones			
E to E = Trips between External Zones to External Zones			

Table 4.9: Percentage of Trips Originating and Destining between Sectors for Trucks

Location	I - E	E- I	E-E
Dighi	43%	32%	25%
Pimple Nilakh	39%	28%	33%
Kasarwadi	45%	33%	22%
Kondhawa Budarch	32%	34%	34%
Wakad	26%	17%	57%
Near Hadapser Bypass	37%	35%	28%
Bhukan	66%	11%	23%
Toll plaza (Saswad Road)	20%	31%	48%
Toll plaza (Satara Road)	27%	19%	54%
Toll plaza (Solapur Road)	45%	22%	36%
Average	38%	26%	36%
I & E = Trips between Internal (PMC) Zones & External Zones			
E & I = Trips between External Zones & Internal Zones			
E to E = Trips between External Zones to External Zones			

4.1.4 Speed and Delay

The speed and delay survey data was gathered along various corridors during the peak period. The summary of the speed and delay data gathered along the nineteen corridors during the peak period is presented in **Table 4.10**. Average journey speed in the city on the major corridor is about 22kmph.

Table 4.10: Speed & Delay Survey Results for Peak Hour

Sl.No.	Name of the Stretch	Direction		Distance (mts)	Journey Speed (kmph)	Running Speed (kmph)
		From	To			
1	Parvati Villa Road	Cantonment Hospital	Lulla Nagar	2300	25	30
		Lulla Nagar	Cantonment Hospital		25	30
		Average			25	30
2	Koregaon road	Commissioner office	Yerwada	3000	18	20
		Yerwada	Commissioner office		14	17
		Average			16	19
3	Mathre Bridge Road	Nal Stop	Sena dutta Police Chowk	1700	13	16
		Sena dutta Police chowk	Nal stop		11	15
		Average			12	15
4	Tanajivade to Swargate	Tanajivade	Swargate	5200	12	15
		Swargate	Tanajivade		18	19
		Average			15	17
5	Aundh Road	Sancheti Hospital	Railway Track	14600	29	31
		Railway Track	Sancheti Hospital		26	30
		Average			27	30
6	Ghorpadi to Sancheti	Ghorpadi Junction	Sancheti Hospital	3000	23	24
		Sancheti Hospital	Ghorpadi Junction		22	26
		Average			23	25
7	Alandi Road	Sangamwadi	Mental Hospital corner	2000	36	36
		Mental hospital corner	Sangamwadi		36	36
		Average			36	36
8	Deccan College Road	Mulla Road	Sangamwadi	2100	41	41
		Sangamwadi	Mulla Road		43	44
		Average			42	43
9	Elphinstone Road	Mulla Nagar Road	Mumbai – Pune Road	3200	29	30
		Mumbai – Pune Road	Mull Nagar Road		30	31
		Average			29	31
10	Jhangli Maharaj Road	Deccan	Sancheti Hospital	2200	15	16
		Sancheti Hospital	Deccan		16	21
		Average			15	19
11	Joshi Road	Balgandharva	Kumbekar Chowk	1200	13	14
		Kumbekar Chowk	Balgandharva		15	18
		Average			14	16
12	Karve Road	Deccan	Karve Nagar	3200	18	21
		Karve Nagar	Deccan		18	22
		Average			18	22
13	Nagar Road	Bund garden	Ramwadi	4470	16	24
		Ramwadi	Bund Garden		18	25
		Average			17	24
14	Pune – Mumbai Road	Abevantha Maha Vidhyalaya	Joshi road	900	29	30
		Joshi Road	Abhevantha Maha Vidhyalaya		30	31
		Average			29	31
15	Wellesley Road	Sancheti hospital	Jahangir chowk	2600	9	14
		Jahangir Chowk	Sancheti Hospital		22	25
		Average			15	20
16	Ganeshkhind Road	Sancheti Hospital	University Chowk	2800	22	25
		University Chowk	Sancheti Hospital		22	23
		Average			22	24
17	Shivaji Road	Sancheti Hospital	Swami Vivekananda Statue	6200	17	22
		Swami Vivekananda Statue	Sancheti Hospital		18	22
		Average			18	22
18	Sinhagad Road	Sarabagh	Mutha River junction	3300	32	35
		Mutha River Junction	Sarasbagh		19	23
		Average			26	29
19	Solapur Road	Phule Gate Chowk	Magar peth Chowk	4700	19	26
		Magar Peth Chowk	Phule Gate Chowk		27	35
		Average			23	30
Average					22	25

4.1.5 On Street Parking

Parking survey was conducted for a period of 12 hrs continuously at eight identified locations/stretches. The Parking Car Equivalent (PCE) adopted for different vehicle types for the analysis is given in **Table 4.11**.

Table 4.11: PCE Values Adopted for Various Vehicle Types

Sl. No.	Vehicle Category	PCE
1	Car	1.0
2	Two Wheelers	0.2
3	Bus	2.5
4	Trucks	2.5
5	LCV	1.75
6	Auto Rickshaws (IPT)	0.5

The terms used are explained below.

Parking Accumulation : The number of vehicles parked in an area at any specific moment constitutes.

Parking Index : Percentage of theoretically available length of the kerb space to be actually occupied by vehicles.

Hourly Variation: The parking demand exists uniformly through out the day with slightly higher demand during the period from 11.00 to 11.30. The demand for parking begins at around 08.00 and lasted till 20.00 hours. The hourly parking accumulation at all the locations is shown in **Figure 4.6**.

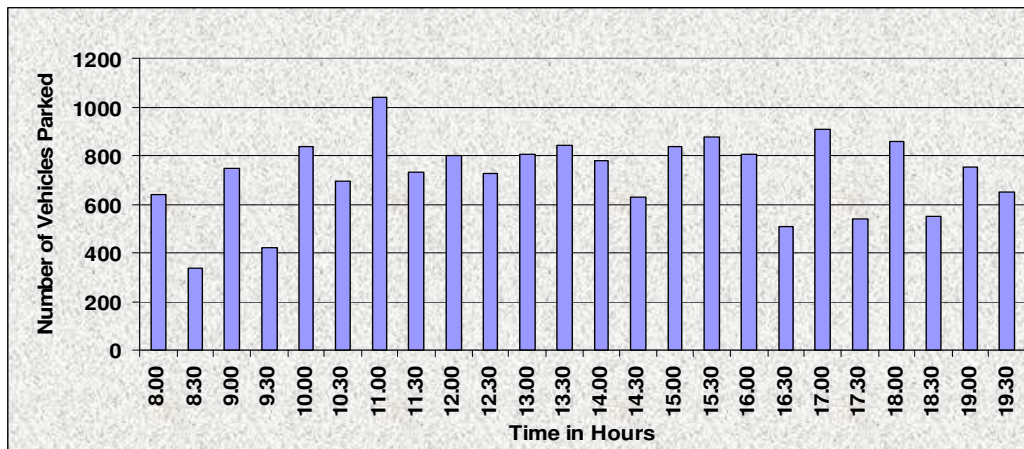


Figure 4.6: Hourly Parking Accumulation

Parking Duration: There is no significant variation in terms of duration of parking for different vehicle types. **Figure 4.7** shows the duration of vehicles parked at all survey locations.

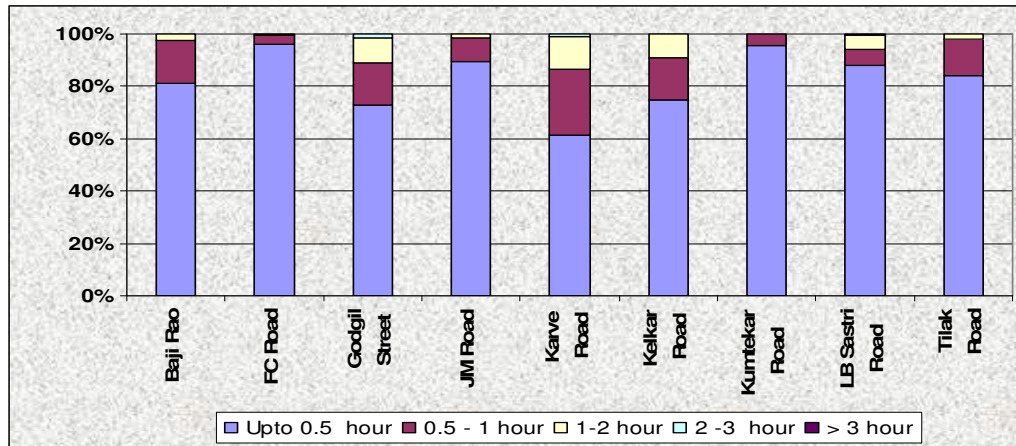


Figure 4.7: Parking Duration

More than 70% of the vehicles are parked less than one hour as the selected locations are in commercial areas. The percentage of parking duration at different locations is shown in **Table 4.12**.

Table 4.12: Location-wise Parking Duration

Sl. No.	Location	Parking Duration (%)					Total
		Up to 0.5 Hour	0.5 to 1 Hours	1 to 2 Hours	2 to 3 Hours	More than 3 Hours	
1	Baji Rao Road	81%	16%	3%	0%	0%	100%
2	FC Road (LHS)	95%	5%	0%	0%	0%	100%
3	FC Road (RHS)	97%	2%	0%	0%	0%	100%
4	Godgil Street	73%	16%	10%	1%	0%	100%
5	Jhangli Maharaj Road(LHS)	91%	7%	1%	0%	0%	100%
6	Jhangli Maharaj Road(RHS)	89%	10%	1%	0%	0%	100%
7	Karve Road	61%	25%	13%	1%	0%	100%
8	Kelkar Road	75%	16%	9%	0%	0%	100%
9	Kumtekar Road(LHS)	97%	3%	0%	0%	0%	100%
10	Kumtekar Road(RHS)	94%	6%	0%	0%	0%	100%
11	LB Sastri Road(LHS)	82%	7%	10%	1%	0%	100%
12	LB Sastri Road(RHS)	94%	6%	1%	0%	0%	100%
13	Tilak Road(LHS)	84%	14%	2%	0%	0%	100%
14	Tilak Road(RHS)	84%	15%	1%	0%	0%	100%
Average		85%	11%	4%	0%	0%	100%

The total number of parked vehicles during the count period is given in **Table 4.13**. Truck/LCV parking is observed on LB Sastri Road and Godgil Street. Maximum parking is observed on FC road, with 3,845 vehicles in 12 hours.

Table 4.13: Summary of Parked Vehicles

Sl. No.	Road	No. of Vehicles Parked(12 hrs)					Total
		Two-Wheeler	Car/van	Auto	Bus	Truck/LCV	
1	Baji Rao Road	632	251	7	0	4	894
2	FC Road	1,809	1,530	506	0	0	3,845
3	Godgil Street	643	159	94	0	25	921
4	Jhnagli Maharaj Road	1,316	534	184	5	5	2,044
5	Karve Road	738	227	31	0	12	1,008
6	Kelkar Road	920	260	89	0	13	1,282
7	Kumtekar Road	1,333	407	186	3	2	1,931
8	LB Sastri Road	1,413	576	372	71	136	2,568
9	Tilak road	1,359	272	66	7	0	1,694

Highest amount of parking activity was found on FC road with 3,845 parked vehicles during the count period and the least amount of parked vehicles was found on Baji Rao road among the survey locations.

Composition of Parked Vehicles: The average composition of vehicles parked at all the locations is shown in **Figure 4.8** and in **Table 4.14**. Two-wheelers shared the majority of the total vehicles parked, which share 63% of the total vehicles.

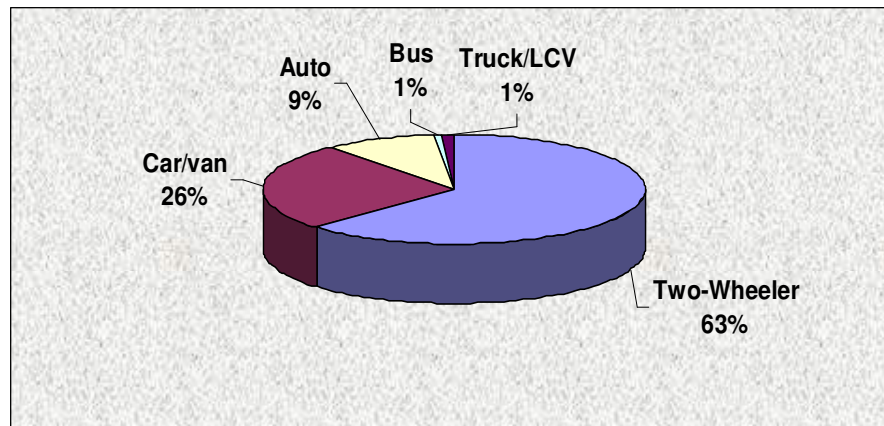


Figure 4.8: Average Composition of Parked Vehicles

Table 4.14: Location-wise Composition of Parked Vehicles

Sl. No.	Road	Composition of Parked Vehicles				
		Two-Wheeler	Car	Auto	Bus	Truck/LCV
1	Baji Rao Road	71%	28%	1%	0%	0%
2	FC Road	47%	40%	13%	0%	0%
3	Godgil Street	70%	17%	10%	0%	3%
4	Jhnanli Maharaj Road	64%	26%	9%	0%	0%
5	Karve Road	73%	23%	3%	0%	1%
6	Kelkar Road	72%	20%	7%	0%	1%
7	Kumtekar Road	69%	21%	10%	0%	0%
8	LB Sastri Road	55%	22%	14%	3%	5%
9	Tilak road	80%	16%	4%	0%	0%
Average		63%	26%	9%	1%	1%

4.1.6 Off Street Parking

Off street parking survey were conducted for a period of 12 hrs continuously. The duration of vehicles parked at all the survey locations is presented in **Figure 4.9**.

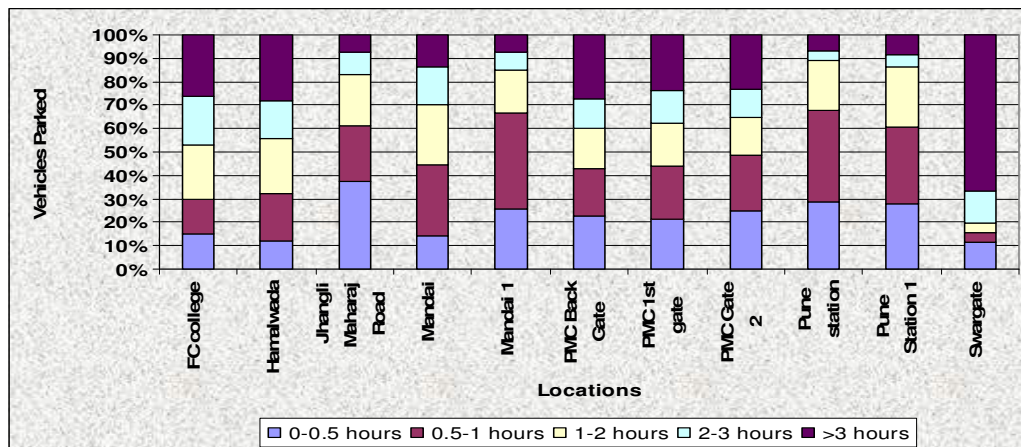


Figure 4.9: Parking Duration

Long time parkers i.e. more than 3hrs duration are significant at Swargate, F.C College, PMC and Hamalwada. The percentage of parking duration at different locations is shown in **Table 4.15**.

Table 4.15: Location-wise Parking Duration of Vehicles Parked

Sl. No.	Location	Parking Duration (%)					Total
		Up to 0.5 Hour	0.5 to 1 Hours	1 to 2 Hours	2 to 3 Hours	More than 3 Hours	
1	FC college	15%	15%	23%	21%	26%	100%
2	Hamalwada	12%	20%	24%	16%	28%	100%
3	Jhangli Maharaj road	37%	24%	22%	10%	7%	100%
4	Mandai	14%	30%	26%	16%	14%	100%
5	Mandai 1	26%	41%	18%	7%	8%	100%
6	PMC Back Gate	22%	21%	17%	12%	28%	100%
7	PMC Gate 1	21%	23%	18%	14%	24%	100%
8	PMC Gate 2	25%	24%	16%	12%	23%	100%
9	Pune Station	29%	39%	21%	4%	7%	100%
10	Pune Station 1	28%	33%	26%	5%	9%	100%
11	Swargate	12%	4%	4%	14%	67%	100%
Average		22%	25%	19%	12%	22%	100%

The total number of parked vehicles during the count period is presented in **Table 4.16**. Car parking is significant at Hamalwada, Mandai, PMC and Pune Station. Maximum parking is observed at PMC, accounting about vehicles 1567 in 12 hours.

Table 4.16: Summary of Parked Vehicles

Sl. No.	Road	No. of Vehicles Parked				Total
		Car/van	Two Wheeler	Auto	Cycle	
1	FC college	110	654	22	23	809
2	Hamalwada	412	297	21	50	780
3	Jhangli Maharaj road	95	460	29	10	594
4	Mandai	363	456	6	0	825
5	Mandai 1	93	381	22	11	507
6	PMC Back Gate	22	1124	68	353	1567
7	PMC Gate 1	150	795	0	7	952
8	PMC Gate 2	465	558	0	0	1023
9	Pune Station	433	59	0	0	492
10	Pune Station 1	0	1307	0	0	1307
11	Swargate	0	812	39	16	867

Composition of Parked Vehicles: The average composition of vehicles parked at all the locations is shown in **Figure 4.10** and in **Table 4.17**. Two-wheelers shared the majority of the total vehicles parked, which shared 65% of the total vehicles. Cars and auto shared 25% and 3% respectively; Cycles shared 7% of the Total vehicle parked.

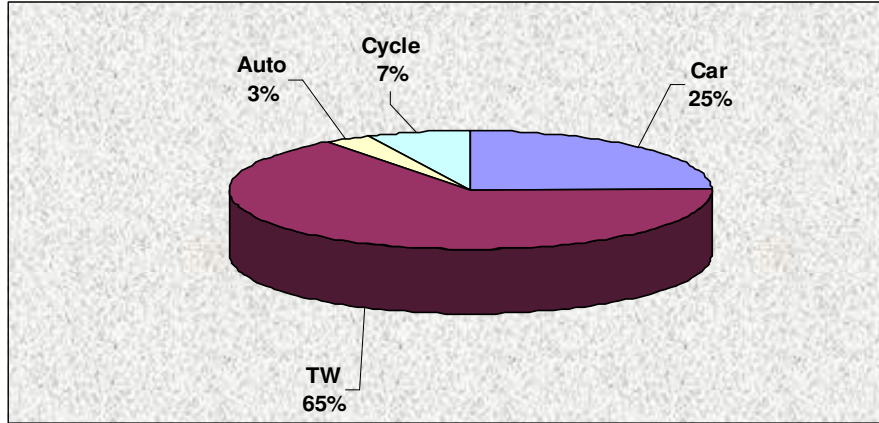


Figure 4.10: Average Composition of Parked Vehicles(off street)

Table 4.17: Location-wise Composition of Parked Vehicles

Sl. No.	Road	Composition of Parked Vehicles			
		Car	Two Wheeler	Auto	Cycle
1	FC college	14%	81%	3%	3%
2	Hamalwada	53%	38%	3%	6%
3	Jhangli Maharaj road	16%	77%	5%	2%
4	Mandai	44%	55%	1%	0%
5	Mandai 1	18%	75%	4%	2%
6	PMC Back Gate	1%	72%	4%	23%
7	PMC Gate 1	16%	84%	0%	1%
8	PMC Gate 2	45%	55%	0%	0%
9	Pune Station	88%	12%	0%	0%
10	Pune Station 1	0%	100%	0%	0%
11	Swargate	0%	94%	4%	2%
Average		25%	65%	3%	7%

4.1.7 Pedestrian Counts

Mid block Counts

The survey was conducted at seventeen locations across Pune city for duration of 12 hours from 8:00 AM to 8:00 PM. The summary of pedestrian counts at all the locations is presented in **Table 4.18**.

Table 4.18: Details of Pedestrian counts

Sl. No.	Locations	Peak Hour	Peak Hr Count	12 hr Volume
1	Ambedkar Road(Near Court)	5.00 pm- 6.00 pm	352	2327
2	Baji Rao Road (Near Chitle bandhu)	3.00 pm- 4.00pm	290	2324
3	Near Collector office	6.00 pm- 7.00pm	999	10373
4	FC Road(Near First Gate)	10:00 am-11:00 am	396	1743
5	Ganesh Khind Road (Near university Chowk)	5.00pm- 6.00 pm	446	3581
6	Jawaharlal Nehru Road(near Market)	7.00 pm- 8.00 pm	385	3397
7	Juna Bazar	9.00 am -10.00 am	249	1721
8	Khelkar Road	6:00 pm-7:00 pm	505	3175
9	Kumtekar Road	9.00 pm- 10.00 pm	385	3476
10	Laxmi Road	5.00 pm- 6.00 pm	497	3611
11	LB Sastri Road	6.00 pm- 7.00 pm	149	1210
12	MG Road(Near Arora Towers)	7.00 pm- 8.00 pm	173	1346
13	Motilal Road (Near Lemeridian)	9.00 am- 10.00am	54	354
14	Senapati Bapat Road	5.00 pm – 6.00pm	454	3626
15	Shivaji Road	1.00 pm- 2.00 pm	233	2204
16	Station Road	7.00pm- 8.00 pm	630	6084
17	Tilak Road	5.00 pm- 6.00 pm	241	1880

Heavy pedestrian crossings is observed at Collector office road, Station road and Kelkar road with a peak hour count of 999, 630 and 505 respectively.

Junction Count

The pedestrian survey was also conducted at twenty five intersections across Pune city for a duration of 12 hours from 8:00 AM to 8:00 PM. The summary of pedestrian counts at all the intersections is presented in **Table 4.19**. From the table, it is clear that significant pedestrian crossing activity is existing at major intersection also.

Table 4.19: Details of Pedestrian counts

Sl. No.	Locations	Peak Hour	Peak Hr Count	12hr Volume
1	Ahilya Devi Chowk	6.00 pm- 7.00 pm	2,235	17,746
2	Alka cinema Talkies Chowk	6.00 pm- 7.00pm	1,118	9,663
3	Ambedkar Chowk	6.00 pm- 7.00pm	821	6,620
4	Appa Balawant Chowk	8:00 am-9:00 am	3,091	24,890
5	Bal Ghandharv Chowk	9.00am- 10.00 am	1,750	17,049
6	Belbagh Chowk	12.00 pm-01.00 pm	1,753	14,013
7	Bhorpadi Junction	5.00 pm - 06.00 pm	2,088	18,160
8	Dandekar Chowk	11.00am- 12.00 pm	1,670	15,395
9	Engineering College	11.00am- 12.00 pm	532	5,527
10	Fathima Nagar Junction	12.00pm- 01.00 pm	1,735	15,283
11	Golibar Chowk	6.00 pm- 7.00 pm	816	7,417
12	Goltekdi Chowk	6.00 pm- 7.00 pm	1,049	8,878
13	Hadapser Bypass	9.00 am – 10.00am	1,433	12,425
14	Jahangir Chowk	6.00 pm- 7.00 pm	691	5,918
15	Khandooji Baba Chowk	6.00pm- 7.00 pm	789	7,493
16	Kumbarwes Chowk	11.00 am-12.00 pm	1,428	12,145
17	Laxmi Nagar Junction	10.00am– 11.00 am	2,027	14,311
18	Lal Deval Chowk	9.00am-10.00am	2,780	17,501
19	Limbharaj Maharaj Chowk	12.00pm-1.00pm	2,480	20,321
20	Maldhakka Chowk	05.00pm-06.00pm	1,884	15,445
21	Mitra Mandhal Chowk	05.00pm-06.00pm	390	3,399
22	Nal Stop Junction	07.00pm-08.00pm	921	8,490
23	Puram Chowk	05.00pm-06.00pm	1,684	14,688
24	Sant Kabir Chowk	06.00pm – 07.00pm	745	7,428
25	Sena Dutta Chowk	08.00am-09.00am	846	5,794

4.1.8 House Hold Survey Results

About 5000 Household were visited and trip information has been collected. The average trip rate is found to be 1.3 and the average trip length is 6.14 Km. The summary of survey results are given in Table 4.20.

Table 4.20: Summary of Survey Results

Average House Hold size	3.12
Average Trip length by all modes	6.14
Per Capita Trip Rate (All modes)	1.3
Per Capita Trip Rate (Motorised)	0.88
Mode Share	
Walk	22%
Cycle	11.1%
Two wheeler	37.2%
Car/Jeep	10.2%
Public Transport	12.2%
Auto	7.2%
Average Household Income	11,500

4.1.9 Road Network Characteristics

Road Network Inventory has been carried out on major radial and circumferential roads in the study area. The summary of type of road surveyed is shown in **Table 4.21**. The road network inventory details is shown in **Figure 4.11**.

Table 4.21: Summary of Road Network Inventory

Sl.no	Number of Lanes	Percentage
1	Intermediate lane	2%
2	Two lane	35%
3	Four lane Divided	42%
4	Four lane Un Divided	12%
5	Six Lane Divided	10%

The Network inventory survey elicited the following information:

- Lane configuration
- Foot path details
- Landuse Pattern
- Parking details
- Hawker details
- Encroachment details
- Median details
- Traffic signal and Pavement marking details

This data is a key input to the transportation model.

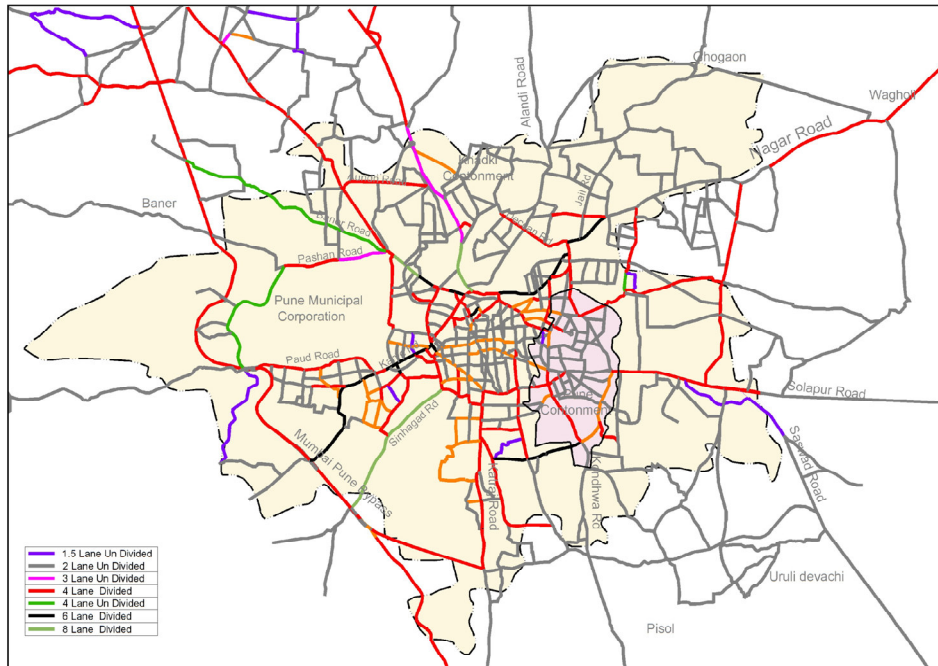


Figure 4.11: Road network inventory

4.2 Public Transport

Pune has a low share of public transport and high share of private transport. Pune Municipal Transport popularly known as PMT is operating buses in the PMC limits. A fleet of about 960 buses transporting nearly 5.50 lakh passengers in a day, a staff of about six and a half thousand, six depots, eighteen main bus stations and about 200 routes operated and maintained by PMT. PMPML has been recently formed merging PMT and bus corporation of Pimpri Chinchwad. The gap between transport demand and supply is increasing in pune. Mumbai's BEST had a fleet of 1800 buses in 1971 when it had to cater to a population of 27 lakh people. Pune, today has roughly the same number of people [today as Mumbai did back then] but the PMPML has only about 960 buses in running condition.

Average age of PMT buses	8 Years 3 month 3 days
TATA & Ashok Leyland make buses	960
No. of BRT buses	10
Rental buses	149
No of Depots	7
Average vehicles on road	85 to 90% daily
Average vehicle Km covered daily	215
Daily Kms covered	1,39,399
Cancellation of Kms due to Traffic Congestion, Accident, Breakdown etc	9.1% (12778 Km)
Daily Passenger traveled	5,67,978
Break down rate	0.43 for 10000 Km
Kilometer per liter of diesel	3.38
Kilometer per liter Engine of	885 km
Bus Staff ratio	9.95
Workshop Staff	1.01 (Whereas CIRT norms 1.71 per bus)
Earning per km	Rs.22.26
whereas cost of bus operation	Rs. 30.58 per km
Semi low floor buses	15 (TATA make)
Semi luxury buses	11 (TATA make)
Pune Sight seeing luxury buses	2 Buses TATA make

Source: PMT, Swargate Depot

4.3 Terminals

4.3.1 Bus Terminals

There are four major bus terminals in Pune namely Shivaji nagar, Pune Railway station, Swargate and Pune Municipal Corporation. Some of the major problems associated with these bus terminals are:

- Access roads leading to these bus terminals are narrow and encroached by hawkers, shop keepers and parked vehicles.
- Inadequate facilities with in bus terminals in terms of bus bays, boarding alighting platforms and circulation.

Following are the seven bus depots/terminals situated in the city.

- Swargate Depot
- N.T.Wadi (Shivaji nagar) Depot
- Kothrud Depot
- Katraj Depot
- Hadapsar Depot
- M.Yard Depot
- Pune Station Bus Terminal
- Mahatma Gandhi Bus Terminal

Among these seven bus terminals Swargate, Shivaji Nagar and Pune Station bus terminal are situated in the congested area.

4.3.2 Truck Terminals

The major truck terminals in Market Yard area, Pune Station and Maldhakka where loading and unloading of goods takes place. Parking for trucks is located in the terminal area. Market yard is a well-planned terminal situated on the southern outskirts of the old municipal limits. But with the addition of new areas in the new Development Plan 2026 it can no longer be called outskirts. Under the present circumstances the location is right within the heart of the city. The operation of these terminals especially Maldhakka causes traffic congestion.

4.4 Non Motorized Transport

Historically, Pune was known as the "cycle city of India", however cycling has decreased in popularity as the ownership and use of motorized two-wheelers has increased. From House hold survey analysis it was observed about 11% of trips are made by cycles. But in most of the roads there is no segregation for the cycle traffic from the motorized traffic causing potential unsafe conditions.

4.4.1 Foot Paths

Footpaths of major roads as well as narrow streets of the dense urban core are encroached by hawkers and vendors. In many cases these activities have spread on the carriageway reducing its effective width.

Pedestrians are forced to walk on the carriageway which is not safe. Road surfaces are deteriorated by spillage of water and garbage by Fruit/ vegetable/ food stalls. On some roads (e.g. near Pune Station) illegal squatters/ slums have sprung up on the footpaths. From the road inventory it is observed that about 50% of roads do not have foot paths on both sides. The detailed inventory is given in **Appendix 4.2**.

4.5 Traffic Safety

Traffic accidents on roads in major urban areas have become a matter of great concern to all. The number of accidents on the roads of Pune and the resulting casualties has been on the rise in the last decade. From the figures available with the RTO, fatal accidents form 24% of the total accidents recorded in Pune. 11% accidents are serious and 65% are minor accidents. As regards the vehicular mode and involvement in accidents, buses have the highest involvement at 67 accidents per 10,000 registered vehicles followed by trucks at 52 accidents per 10,000 registered vehicles. This clearly presents the case to enhance traffic safety and reduce the number of accidents on the roads of Pune. **Figure 4.12** and **Figure 4.13** gives the Accidents statistics of the PMT buses.

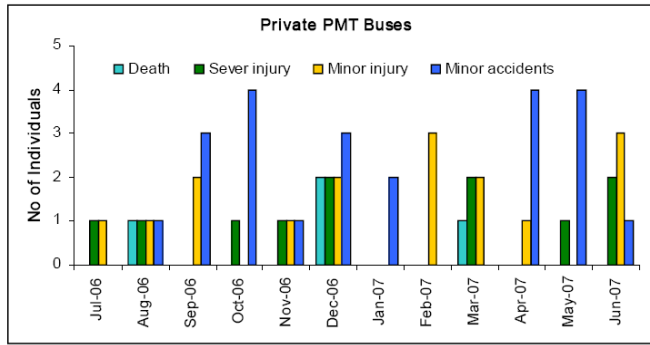
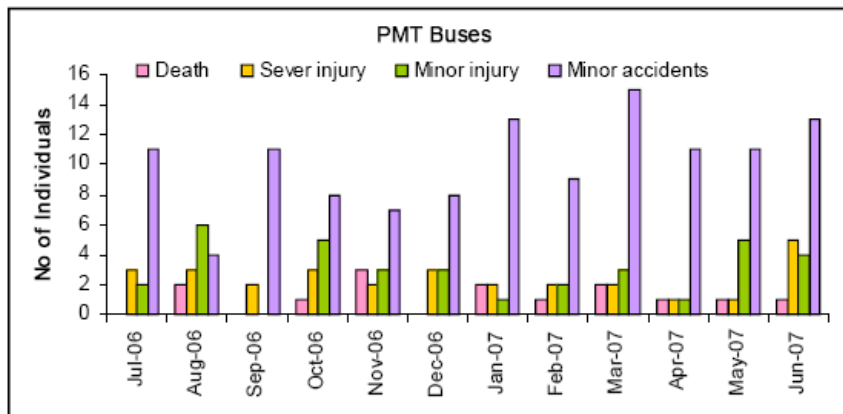


Figure 4.12: Comparative Statistics of Accidents and fatalities by Private PMT buses



Source: PMT, Swargate Depot

Figure 4.13: Comparative Statistics of Accidents and Fatalities by PMT buses

Travel in the city has become more risky with accident rates having gone up from 1.6 lakh in 1981 to over 3.9 lakh in 2001. The number of persons killed in road accidents has also gone up from 28,400 to over 80,000 during the same period. This again has tended to impact the poor more severely as many of those killed or injured tend to be cyclists, pedestrians or pavement dwellers.

4.6 Intermediate Public Transport

As of 2007, about 58,916 three wheelers are running on the streets of Pune. They provide better connectivity to the city core which has a narrow road network. Many people prefer them to local bus service due to lower wait time and near point to point service. Auto rickshaws tend to serve areas with poor bus service provision and offer a relatively cheap source of transport; for example, they are used to transport groups of children to school. Six seater autos are becoming increasingly popular however are causing higher level of pollution. According to Pune Traffic Control Branch, three wheelers wait for commuters at 500 designated stands on streets.

4.7 Private Vehicle Transport

The population in Pune has increased over the last decades due to employment opportunities, arrival of IT Parks and Socio economic Zones. The lack of public transport system pushing people into private modes such as cars and two wheelers. The city (in 2007) has an estimated 14, 45,364 vehicles registered of which 11, 23,898 are two wheelers accounting for about 78% share. The growth trend of two wheeler and Car is shown in **Figure 4.14** and **Figure 4.15**.

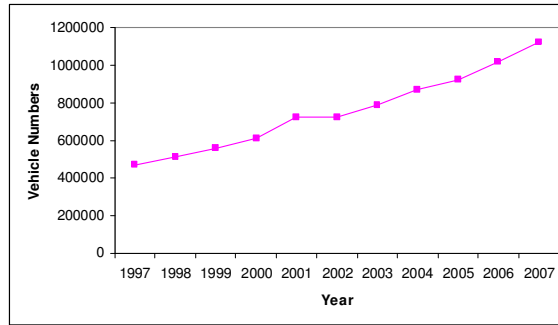


Figure 4.14: Growth trend of two wheeler

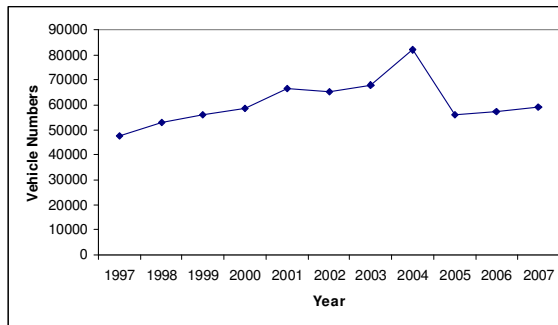


Figure 4.15: Growth trend of Car

4.8 Commercial Vehicles

From Road side interview it was observed that about 30% of the commercial traffic is through traffic, i.e., long distance and bypassable. The trip details are given in **Table 4.22**. But at present due to non availability of ring roads and bypasses these traffic is passing through the city roads.

Table 4.22: Through Traffic Details at outer cordon locations

Location	Through Trips	Total trips
Kasarwadi	6431	28897
Alandi road	2122	8489
Kalewadi	3273	10013
Kondhawa Road	2390	7123
Nagar Road	10237	36441
Pirangut road	1626	6960
Saswad Road	8877	18462
Satara Road	13200	24660
Solapur Road	18607	51719
Wakad road	14717	25803

Presently pune has a westerly bypass. This bypass allows the NH4 through traffic to bypass the city. But commercial vehicle between NH4 and Solapur and Nagar road do not have an easterly bypass and consequents spill on to city roads.

4.9 Pollution

The Maharashtra Pollution Control Board has also carried out ambient air quality mainly at Jog Centre Building, Mumbai – Pune Road, Wakadewadi during January 2002 to May 2002 and the results are shown in **Table 4.23**.

Table 4.23: Air quality results at Wakadewadi

SL. No.	Date	SO ₂	Nox	SPM
1.	05.01.02	15.62	32.55	218.80
2.	18.01.02	29.15	49.95	450.20
3.	31.01.02	25.00	25.80	173.10
4.	14.02.02	20.75	23.75	123.10
5.	26.02.02	22.25	38.35	222.90
6.	05.03.02	17.90	41.65	978.30
7.	12.04.02	30.15	44.75	149.70
8.	03.05.02	38.95	41.25	366.60

From the above results, the SO₂, Nox levels are observed within the limit, but Suspended Particle Matter levels have gone up to 978.3 in March 2003. It is predicted that due to vehicular movement on National Highway No.4, the SPM level has gone high. The percentages of contribution of pollution by different vehicles are shown in **Figure 4.16**.

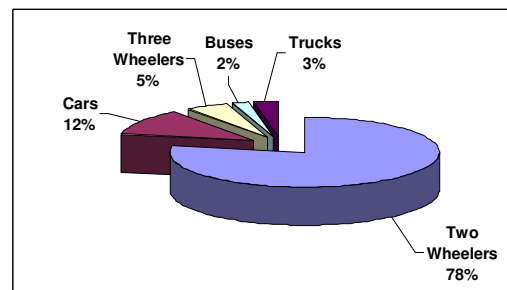


Figure 4.16: Percentages of contribution of pollution by different vehicles

4.10 Inter state Bus Transport and Private Bus transport

There are two major inter-city bus terminals in the city located at Swargate and Pune Station. These two terminals cater to inter-city traffic with origin and destination other than Pune. The Swargate terminal is located on the southern side of the city and the Pune station terminal is located next to the railway station in the heart of the city. The CTPP study observed that 74% of the passengers have a waiting

time of less than 10 minutes at the Swargate terminal. At the Pune station terminal, this percentage is 90 indicating adequacy with respect to inter-city operations. Private buses also operate their inter state operations. At present there is no terminal facility for private buses. The major location observed in the city is Swargate, Pune Station and Shivaji Nagar.

4.11 Commercial Markets

There are two major markets located in the CBD area. One is located near Shivaji road and the other is located at Bibewadi. Goods vehicles survey was conducted at these two locations. From the analysis it was observed that the goods types carried by commercial vehicles are mostly food items. The results are shown in **Table 4.24**.

Table 4.24: The Results of goods vehicle survey

Sl.No	Goods Type	Percentage (%)
1.	Food	56
2.	Wood	1
3.	Fisheries	2
4.	Stones, coals	1
5.	Industrial materials	7
6.	Petroleum Products	4
7.	Building materials	4
8.	Consumer items	11
9.	Empty	14
10.	Others	1

4.12 Local Trains

There are 17 pairs of trains between Pune and Lonavla, and three pairs of trains up to Talegaon in service currently. The services are run with four rakes, with nine compartments each. However, with a considerable increase in the number of commuters, the demand for increasing the frequency of trains has also become stronger. The commuters have been demanding that the number of compartments should be increased from nine to 12 per train. The railway authorities have said that this demand has already been recognised. The schedule of local trains is presented in **Table 4.25**.

Table 4.25: The schedule of local trains

Train	Name of Train	Time
L2UP	Pune to Lonavla	4.30
L4UP	Pune to Lonavla	5.45
L6UP	Pune to Lonavla	6.30
T2UP	Pune to Talegaon	6.55
L8UP	Pune to Lonavla	8.00
L10UP	Pune to Lonavla	9.50

Train	Name of Train	Time
L12UP	Pune to Lonavla	11.35
L14UP	Pune to Lonavla	12.30
L16UP	Pune to Lonavla	13.25
T4UP	Pune to Talegaon	14.00
L18UP	Pune to Lonavla	15.30
T6UP	Pune to Talegaon	16.45
L20UP	Pune to Lonavla	17.40
L22UP	Pune to Lonavla	18.10
L24UP	Pune to Lonavla	18.50
L26UP	Pune to Lonavla	20.00
L28UP	Pune to Lonavla	21.25
L30UP	Pune to Lonavla	23.30
L1DN	Lonavla to Pune	6.50
L3DN	Lonavla to Pune	7.50
T1DN	Lonavla to Pune	9.00
L5DN	Lonavla to Pune	9.12
L7DN	Lonavla to Pune	10.05
L9DN	Lonavla to Pune	11.40
L11DN	Lonavla to Pune	13.05
L13DN	Lonavla to Pune	15.00
T3DN	Talegaon to Pune	16.10
L15DN	Lonavla to Pune	16.47
L17DN	Lonavla to Pune	17.25
T5DN	Talegaon to Pune	18.40
L19DN	Lonavla to Pune	21.15
L21DN	Lonavla to Pune	21.15
L23DN	Lonavla to Pune	22.00
L25DN	Lonavla to Pune	22.40
L27DN	Lonavla to Pune	0.45
L29DN	Lonavla to Pune	1.20

4.13 Performance Indices

Performance indices for PMC were calculated based on the primary and secondary data collected. The Results are shown in **Table 4.26**.

Table 4.26: Performance Indices

INDEX	Formulation	EXISTING
Network Speed	Average Running Speed for all vehicles	18
PT Mode Share(Motorized)	Public Transport Trips / Total Motorized Trips	18%

INDEX	Formulation	EXISTING
NMT Mode Share	NMT Trips / Total Trips	33%
Volume Capacity Ratio	Road Traffic Volume / Road Capacity	1.4
Accessibility	Work trips with Travel Time less than 15 min / Total Trips	33%
Bus Supply	Bus Fleet / Lakh of Population	30
IPT	Registered IPT vehicles / Lakh of Population	1841
Walkability	Footpath Length / Road Length	53%
Cyclability	Cycle Track Length / Road Length	0%
Fatality	No. of Fatalities / Lakh of Population	11
Parking	Parkable Road Length / Road Length	23%

Note:

Network Speed Index; Average Network speed estimated from the model

Accessibility Index; Based on House hold interview surveys conducted as part of this study in addition to the study Traffic and Transport Policies and Strategies for Urban Areas in India

Bus Supply-Bus fleet from Enviromental Status Report-2007

IPT – Registered IPT Vehicles form the Enviromental Status Report-2007

Fatality-Fatal accident details for the year 2001 from Comprehensive Traffic and Transportation Study.

Parking Index- Based on the Road Network Inventory survey carried out as part of CMP in addition to the Study Traffic and Transport Policies and Strategies for Urban Areas in India.

Walkability- Based on the Road Netwrok inventory survey carried out as part of CMP

5. Past Studies

5.1 General

PMC & PCMC have carried out several traffic studies to improve the transport of study area. Some of the recommendation of the studies is already implemented and some are under considerations. Major studies carried out are briefly detailed here.

5.2 Mass Rapid Transit System for Pune Metropolitan Area, RITES LTD, January 2001

Scope

The scope of the study included

- Forecast the demand for travel on a High Capacity Mass Transport System using a fresh economic forecast.
- Selection of an optimum system to meet the demand to suit conditions of Pune. Geometric design of the route alignment, land for facilities, structural outlines, typical station plans, environmental impact assessment and evaluation of economic/ financial viability of the transit system.
- Identify private parties to implement the system on BOOT (Build, Own, Operate and transfer) basis and recommended means to raise finance for implementation, through cross subsidy schemes

Some Salient Conclusions & Recommendations are as follows;

- Approximately 91 lakhs passenger trips by all modes are expected in PMA by 2026.
- Transport demand analysis established that the transport demand is beyond the capacity of road based mass transport system.
- Public transport facility for passenger trips/day by the year 2026 is to be provided which emphasizes a need for a rail -based mass transport system supplemented by feeder bus.
- MRTS network comprising 6 lines (91.278 km) radiating. Agriculture College at Shivaji nagar is recommended. Phase I of the network with a corridor length of 22.646 km comprising Lines (1) and (2) is to be commissioned by the years 2002 and 2006 respectively.
- The system is expected to carry passengers daily by the year 2026 on phase I-stand alone basis. Phase-II and Phase III of the network with corridor length of 68.632 km comprising Line (3) Line (4)Line (5) and Line(6) are proposed to commissioned by the year 2026. The Proposed alignments are shown in **Appendix 5.1 (Figure a)**.
- About 132.18 hectares of land is required for Phase I. For the remaining phases 95.865 Ha of land shall be required, most of which is agriculture.
- Modern energy efficient electrically operated and single or double articulated vehicles. These vehicles are recommended towards rolling stock .will have to be imported.

- The technical feasibility of the full system has been examined and was found technically feasible.
- The full system was estimated to cost Rs.4326.10 crores at 1998 level of prices. The operations and maintenance cost of full system will be Rs141.15 crores for the year 2026.
- The study proposed to charge Rs5 for an average trip length of 7.6km in Phase I ,6.86 km for Phase I and II and 6.92 km for Phases I, II and III. In case higher fares are charged, the ridership is expected to fall.
- Since the project IRR is much below the commercial borrowing rates, it is not attractive for private sector investment. Operations and maintenance cost of the system can be recovered through fare box revenue.
- Establishment of the separate authority is necessary to execute the project and operate the system.

5.3 Comprehensive Traffic & Transportation Study, Span Consultants,2003

The main objectives of the study shall be to match the demand and supply in terms of the existing and proposed infrastructure system control and management with optimal utilization of existing infrastructure. The study will cover the city area and suburban areas, linkages for inter and intra-vehicular movements and goods traffic.

The study will include the estimation of existing traffic situation and project proposals and arrive at an Action Plan which will include low-cost and short-term solutions, medium and long-term strategies for safe and efficient traffic -transportation system.

Some Salient out come of the Study one listed below:

1. The long term recommended improvements include
 - To reduce the traffic congestion due to through traffic 6 links must be developed to complete the outer ring road
 - To complete the inner circumferential road network 5 links have to be developed
 - Flyovers are proposed at 9 locations for improvement of speed on arterial roads by reducing delays caused at the intersections
2. Short term improvements include
 - Widening of existing roads
 - Improving road surface
 - Central verges and medians
 - Foot-paths
 - Road Safety and Prevention of accidents
 - Other traffic management measures
3. Various junction improvement measures in terms of geometric improvements are suggested for the 32 intersections.

4. 9 mid block locations are identified for separation of pedestrians from vehicular traffic. Out of that 6 locations are recommended to have separate pedestrian crossing and 3 locations are recommended for grade separation.
 5. 22 roads are selected for providing cycle track. On existing arterial and sub-arterial roads Cycle track of 2 M width would be provided on either sides of the road.
 6. Parking Improvements
 - Off-Street Parking - Out of the seven plots reserved for parking, currently only two are partly developed as multi-storey parking lots. The PMC has been able to acquire only four plots. The study proposes that the PMC should acquire remaining plots and construct parking facilities using space saving techniques like Auto-Parking.
 - On-street parking - In densely developed zones, to maintain a good flow of traffic, parking can be designated P1/P2.
 - 2 new parking areas have been identified.
 - No Parking zone is recommended in the surrounding areas of Pune station and on the Jawaharlal Nehru Road.
 7. Various Parking Policy measures on pricing etc were proposed.
 8. Improvement of Terminals –ST buses can be restricted to outskirts of Pune by providing integrated passenger terminals at five locations along the national highways, state highways etc on arterial roads. Terminal improvement schemes are also recommended for the existing terminals.
 9. To prevent the heavy goods vehicles from operating in required parts of the road network truck terminals are proposed and 5 sites have been identified for the purpose.
 10. The Octroi nakas in Pune are located in congested areas of the city, and the study suggested relocation and integrate these octroi nakas with the proposed truck terminal facilities.
 11. Restructure of PMT services and operations is suggested.
 12. Keeping into account the existing public transport system & issues thereof following policy guidelines & measures were proposed, these include: Fleet augmentation, Headways, Bus stops location, HCBS etc.
- The proposals are shown in **Appendix 5.1(Figure b)**.

5.4 Detailed Project Report - Sky bus, Konkan Railway Corporation LTD, July 2004

A preliminary proposal for implementing Sky Bus Metro in Pune was submitted by Konkan Railway Corporation Limited (KRCL), KRCL to Pune Municipal Corporation (PMC), Pune. A Detailed Project Report (DPR) highlighting the techno-economic feasibility of the Sky Bus Metro system for implementing the same in Pune in the most technically suitable and financial viable Corridors was prepared and submitted. The Traffic forecasts by RITES were retained in the study. Some key Conclusion are listed below.

CONCLUSIONS

- The Study concluded that the Sky Bus Metro System is the ideal system to provide relief for traffic congestion in Pune City.
- Two alignments were proposed (**Appendix 5.1- Figure C**)
 - System “A”: Aundh Toll to Varje Toll viz. Pune University – Raj Bhavan – Ashram – Agricultural College – Chaphekar Chowk - Shivajinagar – Gymkhana – Garware College – Rajguru Chowk – Karve Chowk – Kothrud – Kal Bhairav Temple – Varje Toll Naka. The approximate length of Sky Bus Metro System A is 14.00 Kms.
 - System “B” Pune Railway Station (along Sanjay Gandhi Road and Wellesley road – Shivaji Road – Pune Municipal Corporation – Baji rao road – Tilak Road – Swargate – along Shivaji Road up to Shivaji Bridge). The total length of the System B is 7.24 Kms.
- The service hours will be from 5hrs to 22 hrs on all days. The total passenger trips have been assessed at 2.14 lakhs for System A and 1.1 lakhs for system B. Annual earnings in the year 2009 and from other sources are assessed at Rs.115.54 Crores.
- The annual operations and maintenance expenditure for the year 2009 have been assessed at Rs.46.32 Crores.
- The risk involved in investment in the project is low and can be mitigated
- For the implementation of Sky Bus Metro, a suitable legislation will have to be made under Ministry of Transport, Government of Maharashtra.
- It is recommended that Government of Maharashtra should initiate action to take up the project of Sky Bus Metro Mass Transit System for Pune City as per the proposed alignment on Build Own and Operate and Transfer (BOOT) basis.
- Sky Bus Metro System “A” from Aundh Toll to Varje Toll for the length of 14.00 Kms be taken first and completed within period of two years and commence for operation from the year 2009, followed by taking up of Sky Bus Metro System “B” from Pune Railway Station to Swargate (Laxmi Narayan) Station.
- Sky Bus Metro System “A” maintenance facilities have been recommended at Varje.

5.5 Comprehensive Study of Integrated Traffic Dispersal System for PCMC & PMC, CES, July 2004.

The overall objective of the techno-economic feasibility study is to prepare Master Plan for road network improvement and road linkages to rail stations in the study area.

Various road network improvements proposed in PCMC and PMC areas. A combination of widening of the existing roads, elevated roads, missing links etc. has been proposed. Some of the identified road network improvements are required to be implemented immediately where as others are required at a later stage.

Road Improvement Works were proposed at

- Mundhwa Kharadi road
- Katraj Kondhawa Hadapser Saswad Road in PMC Limits
- Katraj Kondhawa Hadapser Saswad Road in PWD
- Hadapser Saswad Loni Kalbhor Road
- Tingarenagar to Longaon Road
- Wakad Aundh Road Widening
- Baner Road Widening

ROBs were proposed at

- ROB at Phursungi
- ROB at Mundhwa
- ROB at Theur, ROB at Truck Terminal Road at Kiwale
- ROB at Khadki Railway station
- ROB at Ghorpadi
- ROB at Udaybag Kawade Road
- ROB at Sasanenagar
- ROB at Manjari
- Widening of ROB at Wadia College

River Bridges were proposed at

- Bridge on Mula River at Sangamwadi
- Bridge on Pawna River near Ravet

Flyovers were proposed at

- Flyover at Hadapser Saswad Phata
- Flyover at Swargate
- Flyover at Hotel Seven Loves Square
- Pune Flyover at Balgandharva chowk
- Flyover at University + Senapati Bapat Road
- Flyover at Null Stop Junction
- Flyover at Alka Talkies
- Flyover at Sinhgad Road near Panmala
- Flyover at Mundhwa
- Flyover at Sancheti Hospital
- Flyover at Simla Office Junction
- Flyover at Rahul Talkies Junction
- Flyover at Vetali chowk on Senapati Bapat Road
- Flyover at Market Yard Junction Flyover at Nehru Road Junction.

The proposals are shown in **Appendix 5.1 (Figure d)**.

5.6 Common Wealth Youth Games Report

Pune is the host city for the III Commonwealth Youth Games (CYG). Pune Municipal Corporation have identified projects costing up to 477 crores to develop the city on par with standards set worldwide, in view of the CYG.

Some key proposals are listed below:

- Bus rapid transit System (BRTS), which will segregate traffic by designing a special buses-only corridor on selected roads.
- Road improvements for connectivity. Connectivity to the areas where these games are going to take place is a major issue of concern.
- Tunnels to avoid the congestion on the roads leading from various parts of the city to the Balewadi stadium and Flyovers as a part of long-term strategy for improvement of speed on arterial roads by reducing delays caused at the intersections.
- Pedestrianization / Non-motorized transport schemes for improving and retrofitting of existing facilities for pedestrian use by introducing cycle tracks, footpaths and pedestrian subways
- Terminals Facilities designed more precisely to improve the efforts to segregate traffic according to mode (pedestrian/ IPT/ Private Vehicles/ public transport etc).
- Junction development by the inclusion of Area Traffic Control system and the civil works. Area traffic control system will be provided both at junctions and mid-block pedestrian crossings. Civil works will include provision of footpaths at junctions, fixing of railings, provision of channelizers etc.
- Heritage sites improvement by developing the tourists places and improving the excursion facilities
- Sewerage and Drainage improvement will include the cleaning of roads, corridors and maintaining the ambience of the city.

The proposals are shown in **Appendix 5.1(Figure e)**.

5.7 DPR on Tramways, Consult Team Bremen, 2007

PMC & PCMC under the city sistership cooperation with Bremen prepared a detailed project report (DPR) for the tramways. The consultancy firm Consult Team Bremen (CTB) prepared the study report and recently submitted to the civic bodies. The following are the observations and conclusions from the report:

- The tram system is recommended not based on the Ridership but from cost and energy considerations.
- No right of way acquisition is assumed in the report as all the constructions would happen within the ROW. Land acquisition for depots and other electrical facilities are however assumed.

- The Tramway Network is proposed to be developed in two Phases, Phase-I and Phase-II with a total of 92KM of network. Proposed Tram network is shown in **Table 5.1**. The network is also shown in **Appendix 5.1(Figure f)**.
- The report does not estimate candidate Ridership based on the planning data and demand. Assuming 2 minute tram frequency on important routes and 5 minutes on other routes the Ridership is estimated to be 2,98,500 trips per day for all the alignments.
- The capital cost is estimated to be approximately Rs. 4,440 crores. Unit cost per km works out to be approximately Rs 48 crores per km.
- Capital subsidy is considered at 30% of basic capital cost

Table 5.1: Proposed Tram Network

No.	Route/ Line No.	Type	Description	Length (Km.)	
1	1	At Grade	Nigdi (Bhakti Shakti chowk) to Government Poultry Farm at Wakdewadi	15.8	
2	1	Under ground	Government Poultry Farm at Wakdewadi to Naraveer Tanajiwadi junction Shivajinagar to Shimla Office to Court	2.025	
3	1	At Grade	Court to Kumbharves to Juna Bazar	1.148	
4	1	Underground	Juna Bazar to Pune Railway Station to MG Road	3.86	
5	1	At Grade	MG Road to Cantonment Water Works to Race Course to Hadapsar	6.64	
6	1	A	At Grade	Government Poultry Farm Wakdewadi to Patil Estate River Bridge to Kharadi along the River.	9.804
7	2	At Grade	From Nashik Highway Junction to Tata Motors along HCMTR corridor	5.582	
8	2	A	At Grade	Branch out from route-2 on Telco road to Bhosari, further along NH50 towards CIRT joining Route-2 opposite CIRT	5.428
9	3	At Grade	Cantonment Water Works to Swargate to Saras Baug	3.35	
10	4	At Grade	Kumbharves to Surya Hospital	0.25	
11	4	Under ground	Surya Hospital to Mahatma Phule Market to Laxmi narayan Cinema	2.82	
12	4	At Grade	Laxmi narayan Cinema to Katraj	5.39	
13	5	At Grade/Elevated	From Pune Municipal Corp. building to Warje	7.98	
14	6	Under ground	Shimla Office to University Junction up to Rajbhavan	3.583	
15	6	At Grade	Rajbhavan to Aundh to Jagtap Dairy to Hinjewadi	12.78	
16	6	A	At Grade	Nashik Phata to Rahatni joining Route-6 at Jagtap Dairy	4.643
			Total Length at Grade	78.795	
			Total Length Underground	12.288	
			Total Length	91.083	

5.8 Master Plan for Bus Rapid Transit System, CIRT, March 2008

Master plan for Bus Rapid Transit System integrated with bicycle network was prepared by CIRT. In the BRT master plan about 21 corridors are proposed for implementations. Riverside roads with BRT are also proposed.

- To make it integrated with other land uses and with other modes of transportation; the bicycle plan was proposed.
- The cycle network phasing was assessed based on estimated benefits, philosophy and network level proposal was carried out. A detailed design criterion was done and the network level, facility level and traffic calming measures were done.
- Costing and phasing of project includes the estimation of costs, cost estimate criteria, estimated project cost, catchments area of BRT system and efficient use of road space.

The proposals are shown in **Appendix 5.1(Figure g)**.

5.9 DPR for Metro Rail in Pune Metropolitan Area, DMRC, February 2008

The objective of the study was to provide Detailed Project Report for Metro Rail System in Pune Metropolitan Area for a length of 30 km.

Scope of Work

The study included the following tasks:

- Update Travel Demand Model
- Identify Landuse Development in Horizon Years
- Identify Phase I network (approximately 30 km)
- Detailed ridership on priority network
- Detailed plans, system selection, Depot location
- Social & Environmental Study
- Cost Estimates

The traffic study was done by IIT-Mumbai and contained a travel demand forecast model. The study recommended a high capacity rapid transit system on six alignments. The following alignments were finalized for the Metro:

Line 1: Agricultural College to Nigdi via Pune Mumbai Rd elevated of 16 km length

Line 2: Agricultural College to warje Via JM and Karve Rd elevated of 8.7 km length

Line 3: Agricultural College to Swargate and Katraj via Shivaji Rd elevated of 7 km and
Underground of 5 km length

Line 4: Agricultural College to Vagholi via Bund Garden Rd elevated of 16 km length

Line 5: Agricultural College to Hinjewadi via Aundh elevated of 17.5 km length

Line 6: Agricultural College to Hadapsar via Mhatre Bridge elevated of 16 km length

5.10 Bus-based Rapid Transport System, PCMC, March 2008

The objective of the study was to develop a comprehensive mobility plan for Pimpri Chinchward including a feasibility report for developing BRTS master plan for the Pimpri Chinchward city.

The study included the following tasks:

- Traffic surveys to capture the present traffic scenario
- Development of a transportation forecast model
- Land use study to study existing land use patterns and recommend transit oriented pattern
- Feasibility of BRTS

The study considered the following parameters for identifying BRTS corridors:

- Estimated traffic load along the corridor
- Estimated revenues that can be generated along the corridor by using land as resource
- Availability of land for implementation of the project and
- Alignment of roads being considered by PCMC for improvement through its Annuity road projects coinciding with BRT corridors

Seven trunk routes are proposed for BRTS: Aundh Ravet, NH4, Telco Road, Dehu-Alandi, NH50, KSB Chowk to Kalewadi, MDR 31 to Auto Cluster. Two of the BRTS corridors, NH4 & NH50 are planned as mixed use corridors without dedicated bus lanes. About 55km of the feeder routes have been planned as part of the master plan. Bi-cycle network was also planned as part of the CMP.

The study also concluded the following:

- BRT system should be implemented as part of a comprehensive transportation network which includes a good feeder network and pedestrian friendly services.
- Based on the land use study, it has been observed that by using the concept of Transit Oriented land- use structure and developing transport infrastructure, land along BRT corridors can be used as a resource by PCMC. In the long term large amounts of revenues can be generated from the land along proposed BRT corridors.
- It is recommended that the rolling stock that would be procured shall conform to the requirements of both the cities.

6. Development of Travel Demand Model

6.1 Introduction

A travel Demand model for Pune has been calibrated for evaluating existing travel conditions and forecasting future travel demand. The model analyzes the present and future land use patterns to estimate the origins and destinations of trips. It then assigns these trips to different travel routes and travel modes based on the type and quality of the transportation network.

Travel Demand models can be used for testing different scenarios without actually implementing projects.

For example, one can see the impact of adding a mass transport use like a BRT. Similarly impact on transportation network due to changes in the land use patterns can be analyzed. The broad framework for the transport modeling for Pune city is given in the Figure 6.1.

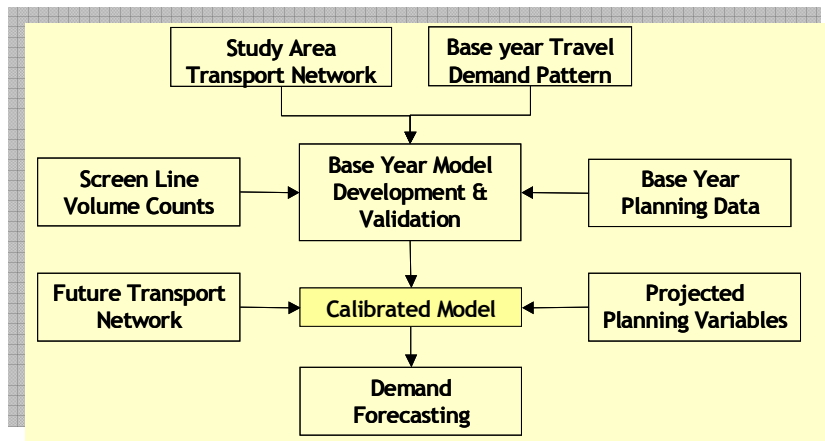


Figure 6.1: Methodology for Travel Demand Modelling

Several software programs are available for developing travel demand models. The Pune transport model has been developed using **CUBE (a state-of-the-art Travel Demand Modeling software)**.

6.2 Model Structure

The model is based on a conventional 4-stage transport model approach. It includes:

- Trip Generation – calculating the number of origins and destinations for each zone.
- Trip Distribution – attaching the origins and destinations for complete trips.
- Mode Choice – determining the mode for each trip (TW, car, auto, Public transport).
- Assignment – assigning passengers to their respective highway and transit networks.
- The highway (road) network with all the major roads and some key minor roads.

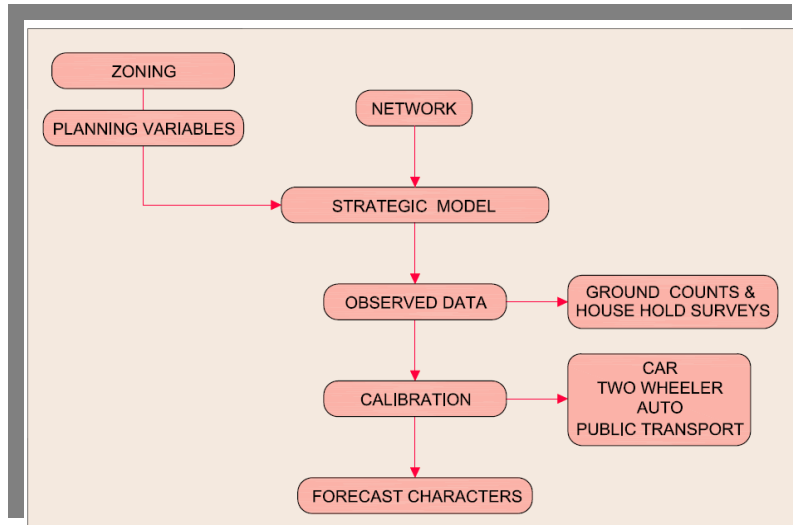
Model Input

- Road network inventory
- Public Transportation Details
- Planning variables by zones
- Trip End Information

- The transit system would be built with the existing public transport system in all its forms i.e. bus and rail with their routes, frequency, fare structure etc.

Calibration:

Trip ends (derived from the Trip end models) will be used to build base year trip matrices by mode using distribution functions from past information. Distribution function is adjusted until assigned flows compare well with observed flows. These base year trip matrices are checked for their accuracy by assigning distributed trips by mode on the road network. The assigned traffic across the



screen lines are compared with the observed traffic. Once the model is calibrated, it can be used to predict the future travel patterns under different land use transport scenarios.

The model is responsive to

- Street congestion, travel costs, availability of competing transport modes including other Public Transport systems and the growth of the city.
- Generalized costs that include out of pocket costs i.e. fare, vehicle operating cost etc. and perceived user costs such as value of travel time, cost of waiting time for transit etc. The assumed values are given in Annexure 6.1.
- The economic development of the region. A comprehensive data on economic development in the form of land-use and transport development proposals will be collected.

Model Outputs

- Trip distribution and Mode split equations
- Traffic flow
- Ridership and Revenue estimate for various system options
- Identification of suitable public transport system

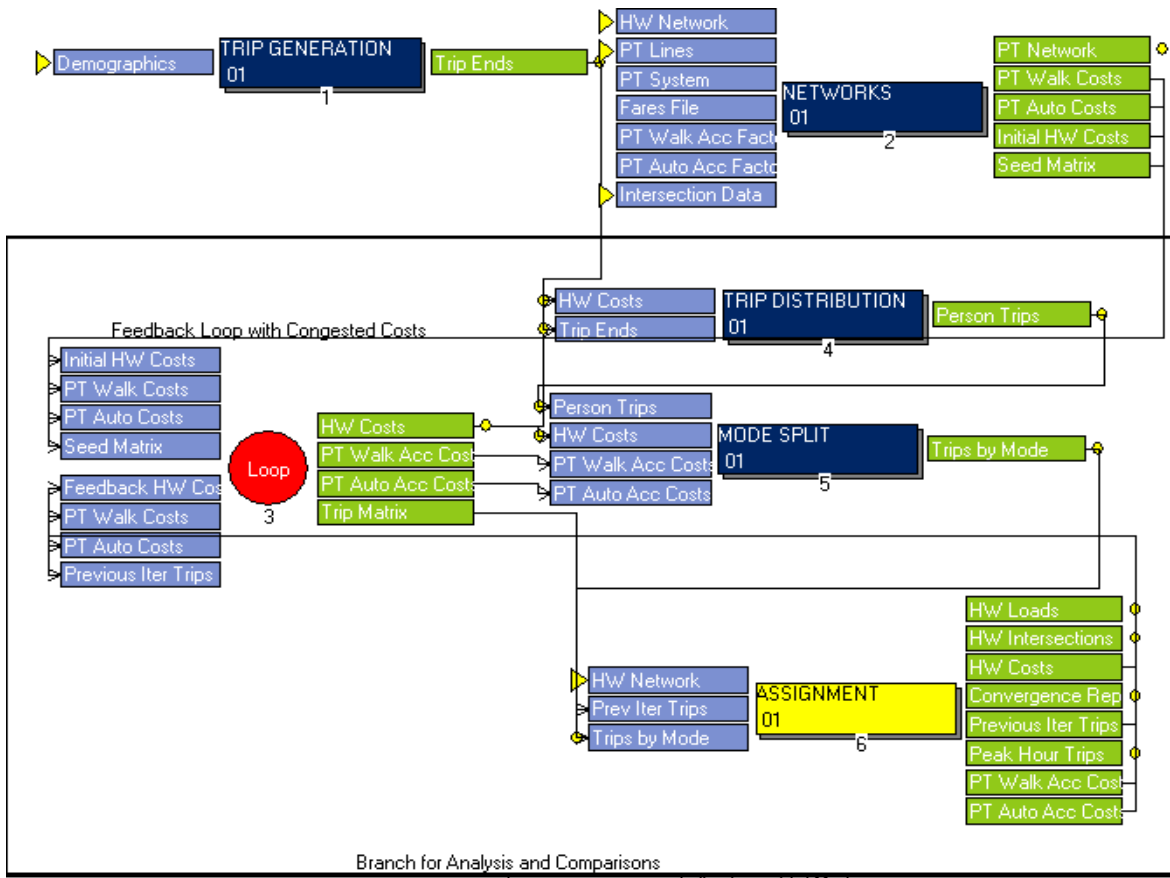
The model focuses on morning journey to work peak period conditions. Peak period models provide much more accurate indications of directional travel patterns during design conditions than do daily models. From the surveys it was observed that the city morning peak hour is during 10 am to 11 am. So the model was built for this duration.

Planning Period: Since this study is initiated in 2007, the year 2007 is taken as the base year. Demand forecasting on the network and on any proposed mass transit system is required over a 25 year period. In order to analyze the travel demand in the study area and estimate the likely traffic patronage on any proposed system, all relevant data have been collated for the base year 2007, the horizon year 2031 and the two intermediate years (2011 & 2021).

Modes: The modes that are modelled in the study include two wheeler, car, auto rickshaw and public transport.

Software:

“CUBE 4.1” has been used to develop the Travel Demand Model. It is user-friendly software for modeling a wide variety of planning policies and improvements at the urban, regional and long-distance level. The software provides interactive data input and analysis, GIS functionality via ArcGIS, model building and documentation, and scenario development and comparison. Its Application Manager uses a flow-chart system for designing, coding, documenting and running the model. The structure allows the professional planner to add functions as required without the need to learn a new interface and without the need to create multiple databases. The flow chart below illustrates the model structure in CUBE.



The following sections detail out the Travel Demand Model developed for the project.

6.3 Study Area Zoning

The zoning has followed the ward boundaries in the Pune Corporation. The regions outside PMC upto PMR have also been included. The zoning plan in this region follows village boundaries. All villages have not been assigned individual zones but have been combined. Pimpri Chinchwad has been coded into 3 zones. The **Table 6.1** below presents the zones system for the study area. **Figure 6.2** represents the zoning system.

Table 6.1 Study area Zoning

Sl.No	Sub Area	No of Zones
1	PMC	146
2	PCMC	3
3	Rest of PMR (App. 100 villages)	12
4	External	8
5	Total	169

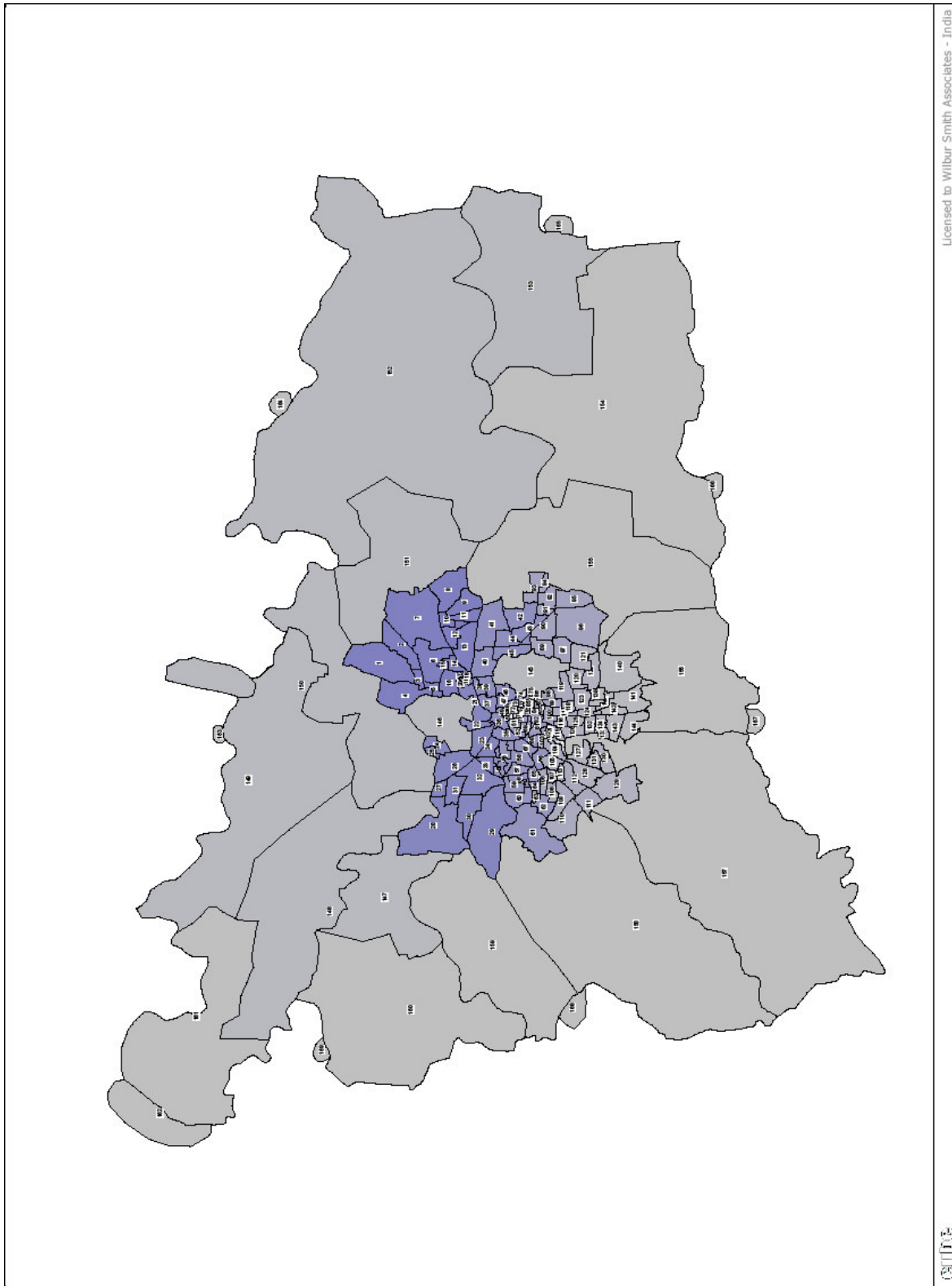


Figure.6.2. Study Area Zoning Map

6.4 Network Development

Transport network developed for the model comprises of two components,

- Highway Network for vehicles
- Transit Network for public transport system i.e. buses, rail and any new public transportation system. Each of the networks is described in detail below.

Highway Network

The coded highway network for the study area represents the nodes (intersections) and links between them. Connectivity between the network and zones is provided through centroid connectors. Based on the network inventory, each link has been assigned attributes such as: number of lanes; divided or undivided carriageway; encroachments; availability of footpaths etc. Identified road network for the city area is given in **Figure 6.3**.

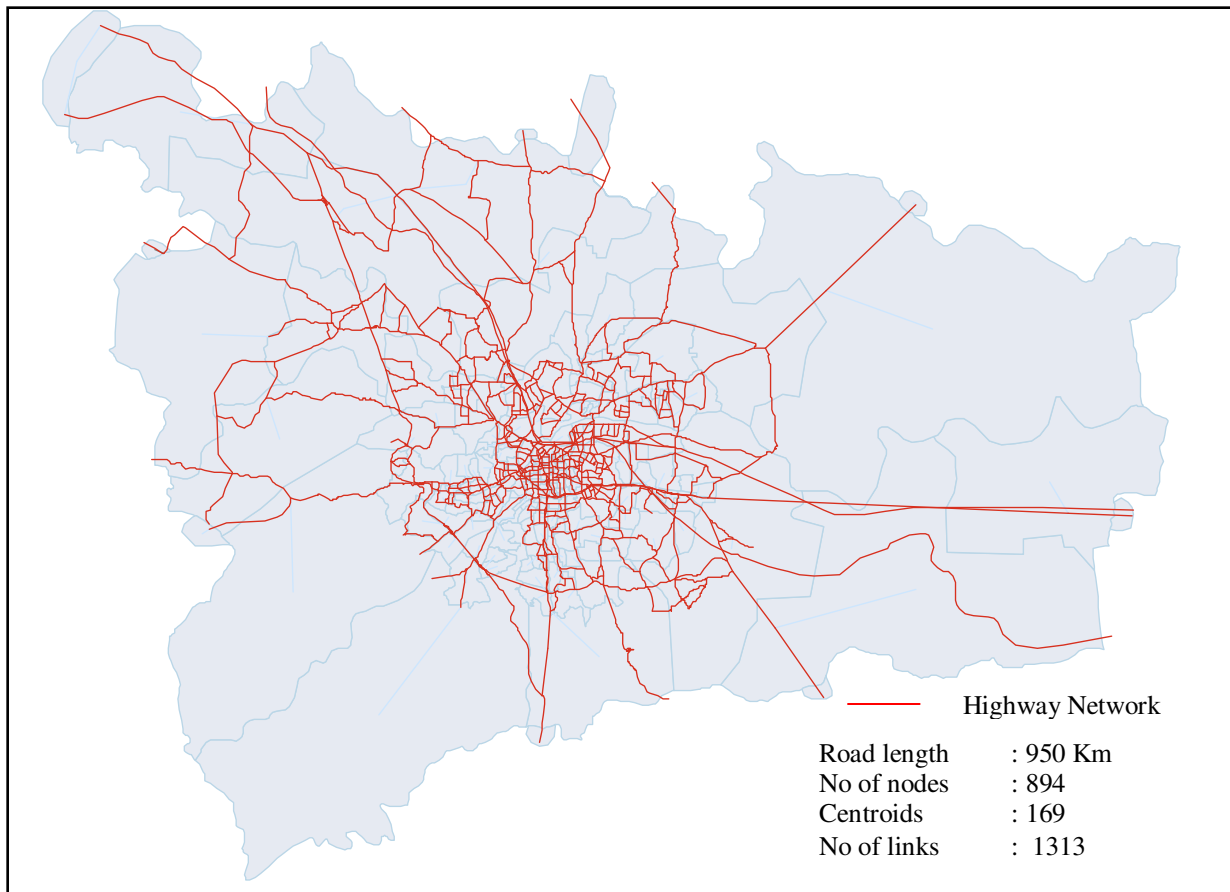


Figure.6.3. Base Year Study Area Road Network

Transit Network

The transit network represents the connectivity, headways, speeds and accessibility of transit services. Pune's bus transport system is included in the model's transit network. The transit routes are specified as those using the transport links and having stops/stations at determined locations. The access to the stops/stations from zone centroids and other nodes is provided either by existing highway links or by defining exclusive walk links. **Figure 6.4** presents the transit network for the study area.

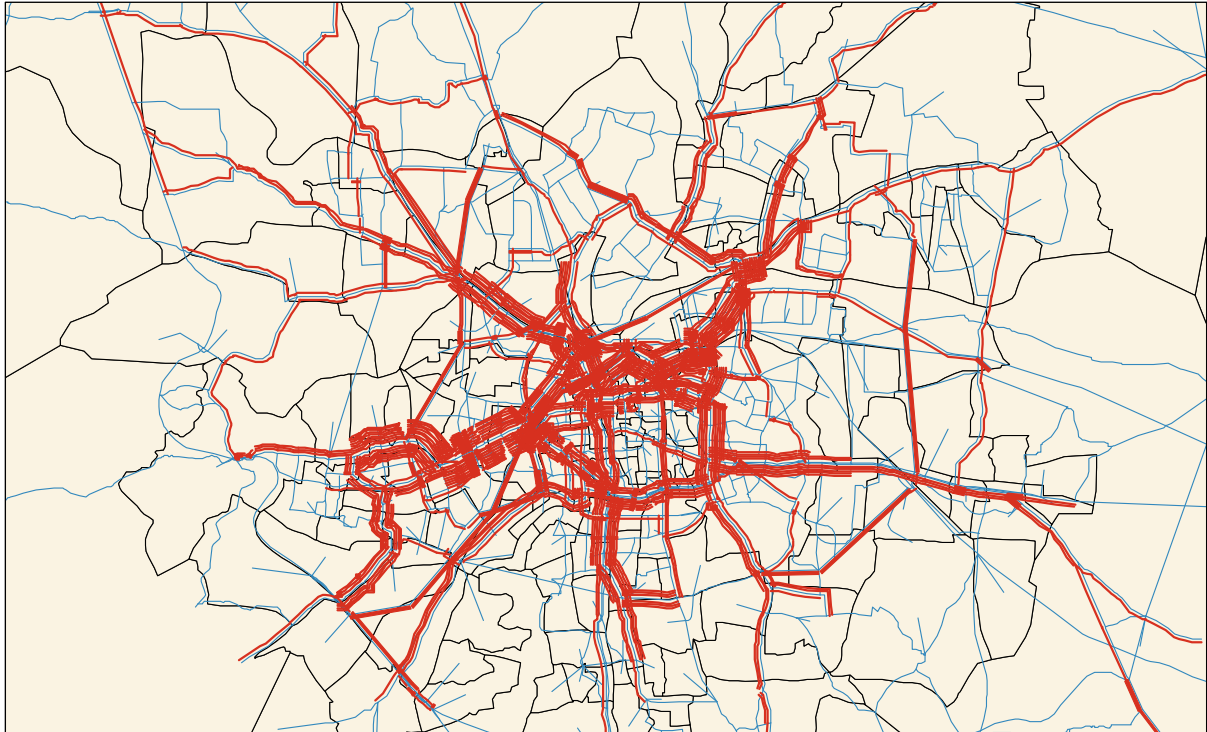


Figure.6.4. Transit Network in the Study Area

Currently, about 260 bus routes are operated in the PMR region with a fleet of 1100 buses. Information on the same was collected and coded in to the system. Fare structure and frequency for each of these services are also included.

6.5 Base Year Travel (2008) Pattern

We have synthetic trips using trip distribution and mode choice models from past studies. The trip matrices have significantly updated using fresh household survey and roadside interview.

The external trips for the car, two wheeler, auto and public transport were constructed based on the O-D survey conducted at the outer cordon. The trip matrices thus derived were then compared with the passenger trip rates for study area derived from the household interview data. The results of the travel demand estimation for base year and trip rate analysis is summarized in the **Table 6.2**.

Table 6.2 Summary of Estimated Base Year (2008) Peak hour Travel Demand

Per capita Trip rate					1.30
Motorised Trip rate					0.88
Sl. No	Mode	Internal Trips		External Trips	Total Trips
		PMC	Rest of PMR		
1	TW Passengers	103892	109609	14180	227681
2	Car Passengers	51356	19900	10979	82235
3	Auto Passengers	26565	16323	7098	49986
4	Public Transit Passengers	52448	9996	12327	74771
	Total	234261	155828	44584	434673

6.5.1 Assignment and Observed O-D Validation

Base year modewise matrices developed were then assigned on the network. The assigned volume on the network was compared with the observed volume on the screen lines adopted for the study area. Screenlines running on physical barriers were selected judiciously. The selected screenlines are along Mutha River and along the rail line (Refer Figure 4.1). Classified volume count survey was carried out at the crossing points across these screenline (Refer Appendix 4.1). Table 6.3 gives the comparison of assigned flows with the traffic volume observed on the road.

Table 6.3A: Results of Observed OD Validation on Screen lines

MODE	Pune		
	OBSERVED	ASSIGNED	% DIFFERENCE
SCREEN LINE –Mutha River			
TW	38835	35387	9%
CAR	13216	14837	-12%
AUTO	12163	12104	0%
PT	80327	74890	7%
SCREEN LINE – Rail			
TW	32214	31582	2%
CAR	13717	13116	4%
AUTO	8951	9701	-8%
PT	57255	49866	13%

Point validation was done for the important outer cordon locations like National Highway 4, Express way connecting Pune and Mumbai, old Mumbai Pune road and Alandi road. **Figure 6.5** shows the desire line diagram for the study area. Percentage difference of observed with the assigned are within an acceptable limit of $\pm 15\%$.

Table 6.3B: Base Year Observed OD Validation on Outer Cordon

LOCATION	OBSERVED	ASSIGNED	% DIFFERENCE
OUTER CORDON (in Trips)			
NH4	64460	59828	7%
AUNDH ROAD	15251	16774	-10%
EXPRESSWAY	25630	26494	-3%
ALANDI ROAD	5538	6261	-13%

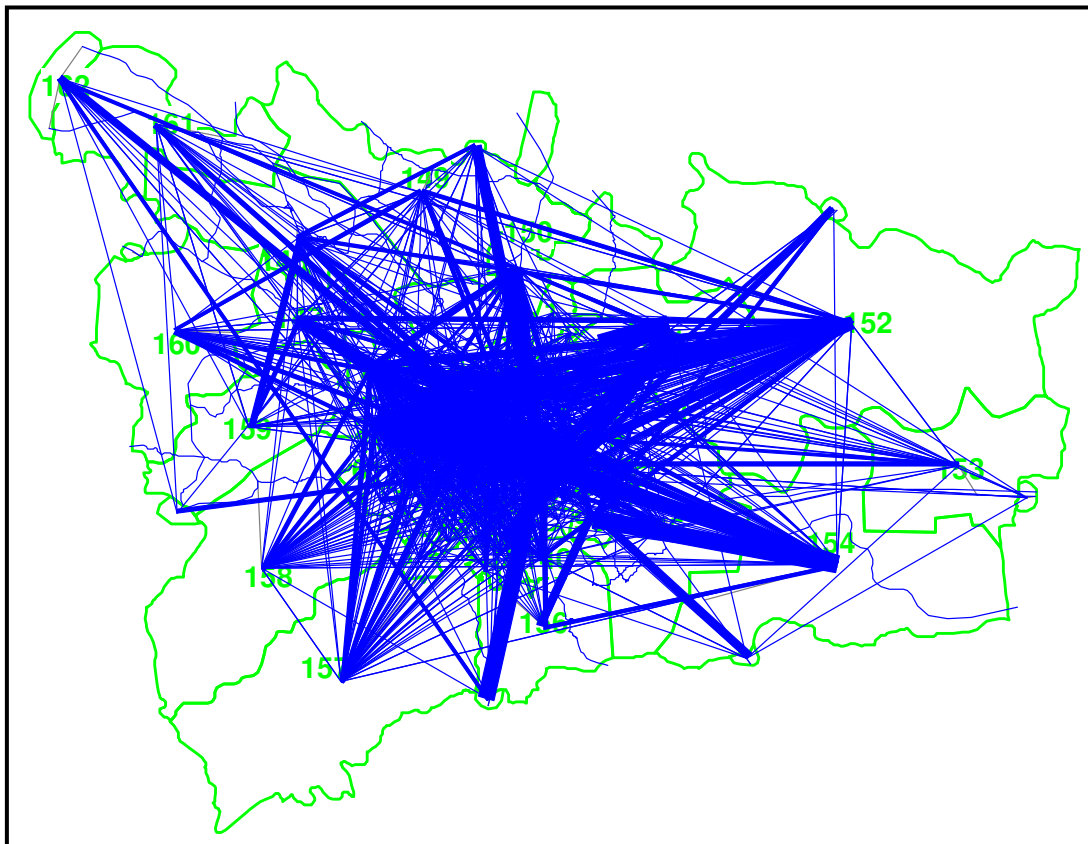


Figure.6.5. Base Year 2008 Desire Line

6.6 Base Year Results

The traffic characteristics of the study area in terms of average network speed, volume to capacity ratio, vehicle distance travelled, total passenger hours etc. is given below.

Traffic characteristics (PMC) - 2008	
Trips assigned (Peak hour)	: 399113
Trips assigned-Tw (Peak hour)	: 220319(55%)
Trips assigned-Car (Peak hour)	: 68822 (17%)
Trips assigned -Auto (Peak hour)	: 40779 (10%)
Trips assigned-PT (Peak hour)	: 69193 (17%)
Average Network Speed	: 18 Km/hr
Average Trip Length	: 8.4 Km
Total Passenger Km (Daily)	: 40,230,590 Passkm
Total Passenger Hour (Daily)	: 2,235,033 Passhrs
Total Vehicle Km (Daily)	: 17,528,338 Vehkm
Total Vehicle Hour (Daily)	: 973,797 Vehhrs

6.7 Calibration

Trip Generation

Daily trip end models were calibrated by relating the trip produced from and attracted to the zones with the Land use. The zone-wise planning variables are given in **Appendix 3.1** and **3.2**. **Table 6.4** presents the base year population and employment for the study area.

Table 6.4: Population and Employment - 2008

Sub area	Population	Employment
PMC	2978187	1,108,826
PC	112,630	40,547
KC	115,387	41,539
PCMC	1,416,210	538,576
Rest of PMR (App. 100 villages)	696,982	250,913
TOTAL	5,319,396	1,980,401

The calibrated daily trip end models are presented below.

Productions:

$$TP = 0.86 * \text{Population} \quad R^2 = 0.50$$

Attractions:

$$TA = 1.6 * \text{Employment} \quad R^2 = 0.73$$

Trip Distribution

A combined gravity (distribution) model formulation was calibrated. The base year trip ends, zone-to-zone cost skims derived from the highway and transit networks were used to calibrate the gravity model.

The equation for the distribution function is as follows:

$$T_{ij} = A_i O_i B_j D_j F_{ij}$$

Where

'O' Trip Productions

'D' Trip Attractions

A & B are balancing factors

'F' Deterrence Function

$$F_{ij} = aC_{ij}^b e^{-cC_{ij}}$$

a, b and c are the calibration function

'C' is the generalized cost of travel between zones

The parameters for the deterrence function were calibrated. It was found that the combined Gamma function fitted best for the study area. The combined Gamma function follows the form:

$$F_{ij} = aC_{ij}^b e^{-cC_{ij}}$$

The calibrated parameters for the deterrence function (Gamma Function) are provided in the Table below.

A	B	C
49.47	0.9529	0.01

Mode Choice

A multinomial mode choice model of the following form shown below is calibrated in order to split the trips among the modes, public transport, car, and two Wheeler and Auto rickshaws. The public transport assignment module shall achieve the modal split among the public-transport modes i.e., Bus, and Rail. Utility functions (VM) for each mode were calibrated using the disaggregate person trip and mode choice data derived from the observed o-d, travel time and travel cost for each individual.

$$V_M = \alpha TT_M + \beta TCM$$

Where,

TTM - Travel Time by Mode M

TCM - Travel Cost by Mode M

α and β are modal calibration parameters

The information on the alternate modes, i.e., travel time and travel cost, available to user, was generated from the time and cost skims obtained in public transport and highway assignment procedures.

The calibrated parameters are given in **Table 6.5**.

Table 6.5: Calibrated Mode Choice Parameters

Mode	α	β
Two Wheeler	-0.00313	0.040399
Car	-0.00038	0.0028173
Auto	-0.00106	0.0000108
Public Transport	-0.003199	0.047983

Synthetic Validation

The synthetic matrices developed from the calibrated trip end, trip distribution and mode choice functions were assigned on the network. The following validation checks were done to see that the model is realistic and could be used for forecasting. **Table 6.6** and **Table 6.7** present validations across screen line and the comparison of estimated and observed trips.

Table 6.6 Validation across Screen lines

MODE	Pune		
	OBSERVED	ASSIGNED	% DIFFERENCE
SCREEN LINE –Mutha River			
TW	32214	33400	-4%
Car	13717	11800	14%
Auto	8951	9080	-1%
PT	57255	51255	10%
SCREEN LINE – Rail			
TW	38835	39821	-3%
Car	13216	15123	-14%
Auto	12163	10890	10%
PT	80327	76563	5%

Table 6.7 Validation- Trips

Mode	Passenger Trips		% Difference
	Observed	Estimated	
TW	213501	202341	5%
Car	71256	68432	4%
Auto	42888	43789	-2%
Public Transport	62444	60345	3%

Validation- Average Trip length

To assure the reliability of the model, the average trip length by mode from the model is compared with the results obtained from the Household interview survey. It was observed that the average trip length from the model is closely matching with House hold interview survey. **Table 6.8** presents the comparison of average trip length obtained from the model and the House Hold Survey. Comparison of speeds from the model and spot speed studies are presented in **Table 6.9**

Table 6.8 Mode wise Trip Length

Mode	Model	Household Survey
PV	7.5	7.3
PT	8.58	9.2

Table 6.9 Validation- Speeds (Kmlhr)

Road	Speed from the model	Observed Speed
Karve Road	19.9	18
Nagar Road	20.2	17
Mumbai Pune Road	27.0	29
Ganesh Khind Road	19.0	22
Solapur Road	23.1	23

6.8 Travel Demand Forecast

The strategic Urban Travel Demand Model developed under this study is used to predict the travel patterns and modal shares in the horizon year i.e. 2031 under respective land-use and transport network scenarios. Trip End models have been used to predict the number of trips generated from and attracted to each of the zones in the study area. Projected trip ends along with the network options in the future were provided as inputs to the distribution and modal split models to arrive at future trip matrices for Car, Two Wheeler, Auto Rickshaws and Public Transport. The methodology for travel demand forecast in the study area is presented in the **Figure 6.6**.

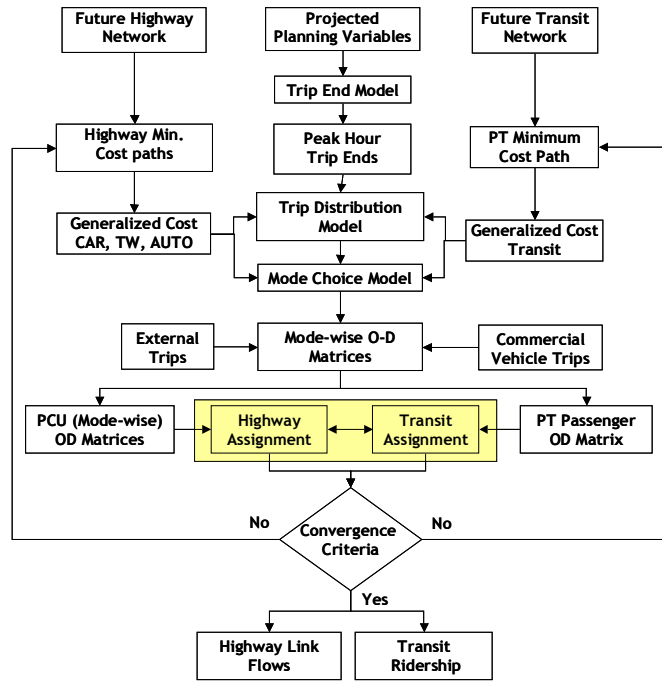


Figure.6.6: Methodology for Travel Demand Forecast

6.8.1 Horizon Year Land-Use Scenario

The projected population and employment for 2011, 2021 and 2031 were used for estimating trip ends in the corresponding years. The population and employment projections are given in Table 6.10 and Table 6.11 respectively.

Table 6.10: Population projections in study area

Name of the Area	Projected Population in the Study Area			
	2007	2011	2021	2031
PMC	2978187	3344877	4404682	5633173
PC	112,630	116,377	126,070	136,225
KC	115,387	120,735	134,875	150,112
PCMC	1,416,210	1,735,729	2,747,043	4,102,868
Rest of PMR (App. 100 villages)	696,982	794,545	1,070,151	1,391,039
TOTAL	5,319,396	6,112,264	8,482,822	11,413,417

Table 6.11: Estimated Employment in the study area

Name of the Area	Projected Employment in the Study Area			
	2007	2011	2021	2031
PMC	1,108,826	1,346,925	1,776,703	2,356,551
PC	40,547	41,896	45,385	49,041
KC	41,539	43,465	48,555	54,040
PCMC	538,576	719,708	1,259,488	1,889,232
Rest of PMR (App. 100 villages)	250,913	286,036	385,254	500,774
TOTAL	1,980,401	2,438,030	3,515,386	4,849,638

6.8.2 Future Transport Network Scenarios

Information on the transport network improvement proposals was collected from various agencies responsible for implementation of road projects (Refer Chapter 5). The base year network was updated with the same for development of horizon year network.

6.8.3 Traffic Forecast Under Do-Nothing Scenario

The summary of the projected peak hour passenger travel demand in the study area and the corresponding modal share is given in **Table 6.12**.

Table 6.12: Summary of Forecasted Peak Hour Passenger Demand (2031)

				Per Capita Trip Rate	1.66
				Motorised Trip Rate	1.14
No	MODE	INTERNAL	EXTERNAL	TOTAL	
1	Two Wheeler	565445	29778	595223	
2	Car	181929	19762	201691	
3	Auto	128878	12776	141654	
4	Public Transport	99878	25887	125765	
5	TOTAL	976130	88203	1064333	

The traffic characteristics of the study area is extracted from the model in terms of average network speed, volume to capacity ratio, vehicle distance travelled, total passenger hours etc. The same is given below.

Traffic characteristics (PMC) - 2031

Trips assigned (Peak hour)	: 797705
Trips assigned-Tw (Peak hour)	: 462088 (58%)
Trips assigned-Car (Peak hour)	: 148675 (19%)
Trips assigned -Auto (Peak hour)	: 105321 (13%)
Trips assigned-PT (Peak hour)	: 81621 (10%)
Average Network Speed	: 10 Km/hr
Average Trip Length	: 10.4 Km
Passenger Km (Daily)	: 99,553,584 Passkm
Passenger Hour (Daily)	: 9,955,358 Passhrs
Vehicle Km (Daily)	: 46,154,637 Vehkm
Vehicle Hour (Daily)	: 4,615,464 Vehhrs