PLANNING COMPACT TRANSIT ORIENTED DEVELOPMENT

CASE: PUNE, PIMPRI-CHINCHWAD

A DISSERTATION

Submitted in partial fulfillment of the
requirements for the award of the degree
of

MASTER OF URBAN AND RURAL PLANNING

By

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JUNE, 2012

DISSERTATION REPORT

ON

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(Candidate, DAAD German Exchange Program, 2011-12)

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CANDIDATE'S DECLARATION

I hereby certify that the work, which is being presented in the dissertation, entitled **Planning Compact Transit Oriented Development, Case: Pune, Pimpri-Chinchwad**, in partial fulfillment of the requirements for the award of degree of Master in Urban and Rural Planning submitted to the Department of Architecture and Planning, Indian Institute of Technology Roorkee, Roorkee, INDIA is an authentic record of my own work. This dissertation has been carried out by me under DAAD-German Academic Exchange Program 2011-2012 from June 2011 to May 2012 under the joint supervision of Prof. Shankar, Department of Architecture and Planning, Indian Institute of Technology Roorkee, Roorkee, INDIA and Prof. Dr-Ing Annette Rudolf Cleff, FG Entwerfen und Stadtentwicklung, TU Darmstadt, GERMANY.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree.

मानस मराठे

Mr. Manas Rajendra Marathe

Date: May 23, 2012

Place: Darmstadt

This is to certify that the above statement made by the candidate Mr. Manas Rajendra Marathe is correct to the best of our knowledge.

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Acknowledgement

This dissertation would not have been possible without the whole-hearted support and guidance of *Prof. Dr. - Ing. Annette Rudolf- Cleff* and *Dipl.-Ing. Bjorn Hekmati*, Department of Architecture, TU Darmstadt, Germany as well as Prof. R. Shankar, Department of Architecture and Planning, IIT Roorkee, India. I am very thankful to them for their valuable comments and observations throughout the progress of my dissertation. I extend my warm gratitude towards the colleagues of *Prof. Annette Rudolf-Cleff*; *Britta Eiermann*, Doris Arnold, *Sarah, Sebastian, Diana, Stanko, Ruzica and Simone Guby-Wuttke* for their assistance at TU Darmstadt. The staff and participants of Mundus Urbano Program have also been very supportive throughout the period of dissertation.

It would not have been possible to carry out this study in Germany without the support and scholarship offered by DAAD. I am thankful to DAAD for giving me this opportunity to study and gain valuable experience in Germany. The international office and its staff at TU Darmstadt played a vital role in ensuring a peaceful stay for me in Darmstadt, Germany.

I am also thankful to the Head of Department, faculty members and friends in IIT Roorkee for their constant help and support.

The Staff of ITDP- Pune, *Ar. Nitin Warrier*, *Ar. Pranjali Deshpande* and *Mr. Suraj Bartakke* have constantly helped me in providing the necessary data about BRT project in Pimpri-Chinchwad. I thank them for their guidance and technical help. I am also thankful to *Girish Bapat* for helping me in the survey work and *Supriya Giroti* for doing the proof reading of my dissertation.

No work is successful without the blessings, support and encouragement by parents, relatives and close friends. They all share a major part in successful completion of this dissertation. I am thankful to *Deepanjan, Sneha*, *Aditya*, *Ganesh* and *Yogesh* for their help. Last but not the least; I am grateful to the Almighty Lord for showering his blessings upon me and keeping me fit and healthy throughout the period of dissertation.

Abstract

There is a growing concern amongst people all over the world about increasing urban sprawl, decreased open spaces within the city, traffic, congestion and rapid depletion of natural resources. The roots of these problems lie partly in the practice of strict zoning followed in many countries after World War II. Excessive network of highways and promotion of private auto-oriented development has further aggregated the above problems.

Several planning and urban design theories have been proposed since the end of the twentieth century which stress on restoring back the pre-World War II planning pattern of transit adjacent urban development. Transit-oriented development (TOD) is one such theory stressing the importance to plan a compact, high-density, mixed-use development which will encourage the use of public-transit instead of private automobile. It is a multi-dimensional process having several qualitative aspects which focus on better place making.

In a developing country like India where several high budget transit projects are being planned in many cities, it is possible to plan these projects in accordance with the principles of TOD. TOD needs to be seen as a new paradigm of sustainable development in India.

The dissertation is an attempt to consider TOD as one of the toolkits for planning sprawling Indian metropolises like Pune and Pimpri-Chinchwad. It concentrates on the area within Pimpri-Chinchwad Municipal Corporation limit and attempts to come up with certain broad recommendations for planning around a public transit corridor. It attempts to plan the Punawale village area along the Aundh-Rawet BRT Corridor as a compact, mixed-density, mixed–use and mixed-income settlement having a high degree of accessibility by means of walking, cycling or by the use of public transport. This could then serve as a demonstrative model for planning future TOD projects in India.

[Keywords: *compact, high-density, mixed-use, public transit, accessibility, new paradigm*]

Foreword

The dissertation, "Planning Compact Transit-Oriented Development: Case-Pune, Pimpri-Chinchwad" has been prepared under the joint supervision and guidance of Prof. R. Shankar, IIT Roorkee and Dr-Ing. Annette Rudolf-Cleff , TU Darmstadt.

The research is a part of the exchange program DAAD, 2011-2012. DAAD is the abbreviation for *Deutscher Akademischer Austausch Dienst* or German Academic Exchange Service. The preliminary work on the research like selection of topic, defining the aim and the objectives of the research and primary data collection about the study area was done in India during the months of May 2011-August 2011. The work thereafter was carried out in Germany during the months of September 2011-April 2012.

The periodic discussions with Prof. Dr-Ing. Annette and Dipl- Ing Bjorn Hekmati helped in carrying forward the dissertation smoothly. Prof. Shankar also gave his valuable observations via email. The lecture modules of Mundus Urbano program at TU Darmstadt have been very helpful to gain a deeper knowledge about the study topic. Live case studies have been carried out by visiting certain cities in Germany as well as other countries in Europe which have done significant work in promotion of public transit.

The recommendations and guidelines given at the end of the report are an outcome of this joint research carried out at Indian Institute of Technology, Roorkee, INDIA and Technical University, Darmstadt, GERMANY.

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Abbreviations

BRT- Bus Rapid Transit

BRTS- Bus Rapid Transit System

CDP- City Development Plan

CMP- Comprehensive Mobility Plan

CRISIL- Credit Rating and Information Services of India Ltd

DP- Development Plan

DPR- Detailed Project Report

ITDP- Institute for Transportation and Development Policy

JNNURM- Jawaharlal Nehru National Urban Renewal Mission

KC- Khadki Cantonment

NMV- Non-motorized Vehicles

PC- Pune Cantonment

PCMC- Pimpri-Chinchwad Municipal Corporation

PMC- Pune Municipal Corporation

PMPML- Pune Mahanagar Parivahan Mahamandal Ltd. (Bus operator in Pune Region)

PMT- Pune Municipal Transport

PMTA- Pune Metropolitan Transport Authority

PMR- Pune Metropolitan Region

SPV- Special Purpose Vehicle

TAD- Transit Adjacent Development

TJD- Transit Joint Development

TOD- Transit Oriented Development

TRIPP- Transportation Research and Injury Prevention Program (IIT, Delhi)

UDPFI- Urban Development Plans Formulation and Implementation

Executive Summary:

Indian metropolitan cities have witnessed tremendous growth trends with compounded infrastructure and management problems in the post economic reforms era of late twentieth century. Transit Oriented Development (TOD) combined with compactness is a multi-dimensional planning approach advocating close knit, high density, missed use, accessible and public transit adjacent development. In a developing country like India, where several high budget public transit projects are being planned across many cities, TOD can serve as a toolkit for integrating land use and transportation, to conserve land, and plan compact, highly accessible settlements wherein all daily requirements can be accessed with ease by walking, cycling or use of public transport.

The dissertation "Planning Compact Transit-Oriented Development: Case-Pune , Pimpri Chinchwad" is an attempt to understand the theory of Transit-Oriented Development (TOD) and how this theory can be applied for planning sprawling Indian Metropolises. The era of privatization and globalization in India has altered the pattern of compact, transit oriented city development. Since 1991, there has been a huge boom in auto-industry of India. The promotion of private auto-oriented development coupled with increase in real estate investment has led to large scale housing projects coming up haphazardly along the city fringe areas. Huge parcels of fertile agricultural land continue to be utilized for large scale housing projects causing serious ecological imbalance. These projects lack basic infrastructure facilities including a connection to the city public transport system. It is extremely vital to curb this unsustainable growth of urban areas. The availability of land as a resource is limited and therefore its cautious use is extremely important. Several large scale transit projects are being planned in many metropolitan cities of India. The city development plans and comprehensive mobility plans of many cities make a mention of Transit-Oriented Development as a 'tool for integrating transport and land use." However, in the name of TOD, intensive development is planned along the transit corridors to partly recover the huge investments done in transit development. This dissertation therefore attempts to understand the real principles of TOD through analysis of available literature and a brief study of certain settlements in Europe promoting use of public transit. This analysis would then form the basis for developing a rationale for making Indian urban development compact and transit-

oriented. The research for the dissertation has been carried out jointly in India and Germany as a part of DAAD German Exchange Program 2011-2012.

The main aim of the dissertation is, "To plan a compact transit-oriented development for an identified area of Pune, Pimpri-Chinchwad." The dissertation focuses on physical planning of urban fabric around the proposed Aundh-Rawet BRT Corridor in Pimpri-Chinchwad city of Maharashtra State as per the guidelines of TOD. The study area is limited to the Pimpri-Chinchwad Municipal Corporation (PCMC) administrative boundary. However, the results and broad recommendations would serve as guidelines for planning future urban development in other cities.

Transit-Oriented Development (TOD) is the primary domain of this dissertation. The study can be broadly divided into three parts: i) Understanding the theory of TOD through literature review and through an analytical look at certain settlements in Europe promoting the use of public transit, ii) Application of TOD in the study area of Pune, Pimpri-Chinchwad and iii) Preparing a comprehensive TOD model for a selected area of PCMC based upon recommendations and guidelines.

The methodology adapted here aims to comprehensively understand the theory of TOD and how the theory can be applied to plan the selected planning area. This involves a detailed analysis of all development proposals, master plans, mobility plans and policies pertaining to the selected research area. The proposals and recommendations have been compared with the available literature on transit-oriented development. Additional data required for the study has been collected through direct personal investigation and questionnaires. Appropriate case studies have been carried out pertaining to the issue. The results and findings serve as guidelines for framing broad recommendations and policy guidelines. A selected part of the study area is worked out in details in accordance to the recommendations and guidelines of TOD.

The first chapter of introduction explains briefly the background behind the theory of Transit-Oriented Development. It states the aim, objectives, scope and limitations of the research proposal.

The second chapter of literature review throws light on the unsustainable growth trends in Indian metropolitan cities followed by a detailed understanding of the

theory, definitions, principles and various aspects of TOD. The section also analyses the latest trends in TOD through review of two books; 'The New Transit Town' by Hank Dittmar and Gloria Ohland and 'Seven Rules for Sustainable Communities' by Patrick Condon published in the years 2003 and 2010 respectively. The book review provides direct hints in terms of do's and don'ts for successful implementation of TOD.

The case studies attempt to understand the approach of different countries towards land use and transport integration. The selected examples include Curitiba in Brazil, Vauban in Germany and GWL terrain, Westerpark in Amsterdam.

The chapter dealing with study appraisal of planning area contains an in-depth analysis of Pimpri-Chinchwad area through analysis of city development plan, comprehensive mobility plan and other planning policies. Any additional data requirement has been fulfilled through personal investigation. After analysis of the planning area, a detailed analysis has been carried out about Aundh-Rawet BRT corridor to study its potential for TOD. The analysis is carried out through study of existing literature and photographic documentation of the recent development around the corridor. The data about people's travel pattern and characteristics has been gathered through a questionnaire. (Refer Appendix). However, the data collected is only to get a very rough estimate about the travel characteristics. The survey carried out is not scientific and represents the opinion of a particular class of people belonging to the study area.

The inferences of the entire analytical data on TOD, selected planning area and Aundh-Rawet BRT Corridor have been used to propose a comprehensive TOD Model. The suggested planning proposal consists of three main parts: i) Conceptual model for integrating various modes of transit, ii) Broad recommendations and suggestions for TOD along the entire stretch of Aundh-Rawet Corridor and iii) Detailed TOD working model for Punawale Area along the Aundh-Rawet Corridor.

In the concluding chapter, the dissertation highlights the achievements of TOD through a comparative analysis between the existing planning proposal for Punawale Area and the suggested TOD model for planning the same area. The outcome of the research clearly indicates that it is possible to conserve land to the extent of more

than 50% by planning a compact, high density, highly accessible and transit-oriented development and utilize this conserved land for agriculture, social forestry, etc. The research also raises certain questions whether any modifications or alterations are required in the existing planning policies and development control rules of the study area to facilitate a compact, high density and mix-use development.

The selected case of Pune and Pimpri-Chinchwad showcases only a small part of the unsustainable growth trend in Indian metropolitan cities. The issues of urban sprawl, depleting natural resources, decreased open spaces are very complicated and finding a solution to any one of these problems simply raises new problems. The dissertation is a small step in investigating the possibility of conserving land through compact, high density, mixed use, transit-oriented development.

1. Introduction

1.1. Background:

In his personal chronicle 'My works and days', renowned philosopher and literary critic Lewis Mumford says, "Forget the damned motor car and build the cities for lovers and friends." The Post World War II planning principles of strict zoning and over segregation of land uses altered the process of urban development which had traditionally been transit adjacent. The boom in automobile industry as well as large investments in real estate gave rise to haphazard, sprawl development in many parts around the world. Gradually, many planners and urban designers began to realize the negative effects of such a pattern of development. Many theories and models have been proposed since then, which stress the importance of restoring back the earlier sustainable models of compact, mixed-use, easily accessible cities.

Transit Oriented Development (TOD) is one such toolkit of planning a compact, sustainable development. It concentrates on developing high-density, mixed-income, settlements wherein every person in a household could conveniently and safely access his daily necessities either by walking, cycling, or by using public transit. Though, TOD may not provide solutions to all the urban problems, it is surely an important approach as it concentrates on transit which is the backbone for any society to progress.

The population of India has increased from 361 million in 1951 to 1210 million in 2011. The decadal growth in urban population for the decade 2001-2010 is 31.85%. There are 53 urban agglomerations in India with population of more than 1 million. (Census of India 2011). The era of privatization and globalization in India altered the pattern of city development within the country. There was a tremendous boom in real estate sector and large housing projects started to come up haphazardly in the city fringes. The city fringe areas as well as the surrounding villages faced rapid urbanization. Huge parcels of fertile agricultural land continue to be utilized for large scale housing projects causing serious ecological imbalance. Along with population control, it is extremely vital to curb

this unsustainable growth of urban areas. The availability of land as a resource is limited and therefore its cautious use is extremely important.

Pune Metropolitan Region (PMR) with a population of 5.52 million inhabitants is one such rapidly growing metropolis covering an area of 1352 sq.km. The city of Pimpri-Chinchwad is located within the PMR. It has a population of 1.73 million and covers an area of 170.5 sq.km. (PCMC C. , 2006). Currently, there is a Bus-rapid transit system (BRTS) being implemented in the city of Pimpri-Chinchwad under Jawaharlal Nehru National Urban Renewal Mission (JnNURM)[1] along ten major corridors. The Detailed Project Report (DPR) of BRT, 2008 recommends Transit-Oriented Development (TOD) as a toolkit for "integrating land use and transportation and using land as a resource." But, the DPR uses the term TOD in a superficial manner. It proposes a high-density commercial and industrial development along the BRT Corridors; which could then be sold at high prices to incur back the investment involved in road infrastructure and execution of BRT. The DPR fails to address issues like good accessibility to public amenities and affordable housing to all.

The dissertation takes up the case study of Pimpri-Chinchwad as a rapidly growing city and attempts to plan the upcoming areas along the BRT as per the principles of Transit-Oriented Development. It further attempts to plan the Punawale Village area along the Aundh-Rawet BRT Corridor in detail considering the various planning and designing aspects of TOD.

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[1] Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is a mission started by Government of India in 2005 under the Ministry of Urban Development. The aim of this mission is to encourage reforms and fast track planned development of certain identified cities in India. The main thrust of the Mission will be on infrastructure projects relating to water supply, sanitation, sewerage, solid waste management, road network, urban transport and redevelopment of old city area. The BRTS project initiated in the city of Pimpri-Chinchwad receives funds under this scheme. (Source: http://jnnurm.nic.in)

1.2. Research Questions:

1. What are the main features and recent advancements discussed in international literature about Transit-Oriented Development (TOD)?
2. How is TOD discussed in various planning proposals of Pune and Pimpri-Chinchwad?
3. What role does TOD play in planning a sprawling metropolis like Pune?
4. Can TOD be integrated with the current ongoing transport projects in Pimpri-Chinchwad?
5. How can the analysis and recommendations be used to develop future TOD projects in other cities of India?

1.3. Aim:

"To plan a compact transit-oriented development for an identified area of Pune, Pimpri-Chinchwad"

1.4. Objectives:

1. To understand the origin, principles, strategies of Transit-Oriented Development (TOD) and draw relevant inferences and planning guidelines from relevant case studies.
2. To analyze the past growth trends, land use structure and transportation of Pimpri-Chinchwad and sub-urban area.
3. To analyze the City Development Plan (CDP), Comprehensive Mobility Plan (CMP), other development policies, bye-laws in relation to proposed development pattern.
4. To analyze the existing and proposed BRT network in Pimpri-Chinchwad
5. To analyze the existing socio-economic, and institutional setup for successful implementation of TOD.
6. To plan and design urban development in the line with the principles of TOD along a proposed BRT Corridor.

1.5. Scope:

1. The dissertation focuses on physical planning of urban fabric around the proposed Aundh-Rawet BRT Corridor in Pimpri-Chinchwad city as per the guidelines of TOD.

2. The study area is limited to the Pimpri-Chinchwad Municipal Corporation (PCMC) administrative boundary. However, the results and broad recommendations would serve as guidelines for future urban development in other cities.
3. Designing of the transit-system itself and a detailed economic analysis of the proposal is not within the scope of this dissertation.
4. Proposal has been given for Aundh-Rawet BRT Corridor which is under implementation. The recommendations shall be applicable to other BRT routes with certain alterations as per micro level context.

1.6. Limitations:

1. To work within the framework of current development plan of Pimpri-Chinchwad.
2. To take cognizance of the proposed BRT routes, bus stops and broad recommendations enlisted in the DPR of BRTS.
3. Certain haphazard development which has already taken place in certain pockets has to be retained.
4. It is assumed that the land required for development will be readily available and all disputes and litigations pertaining to the selected land will be resolved.
5. Due to time constrains, detailed land use planning cannot be carried out for all proposed BRT routes.

1.7. Methodology:

The methodology adapted here aims to comprehensively understand the theory of TOD and how the theory can be applied to plan the selected planning area. This involves a detailed analysis of all development proposals, master plans, mobility plans and policies pertaining to the selected research area. The proposals and recommendations have been compared with the available literature on transit-oriented development. Additional data required for the study has been collected through direct personal investigation and questionnaires. Appropriate case studies have been carried out pertaining to the issue. The results and findings serve as guidelines for framing broad recommendations and policy guidelines. A selected part of the study area is worked out in details in accordance to the recommendations and guidelines of TOD.

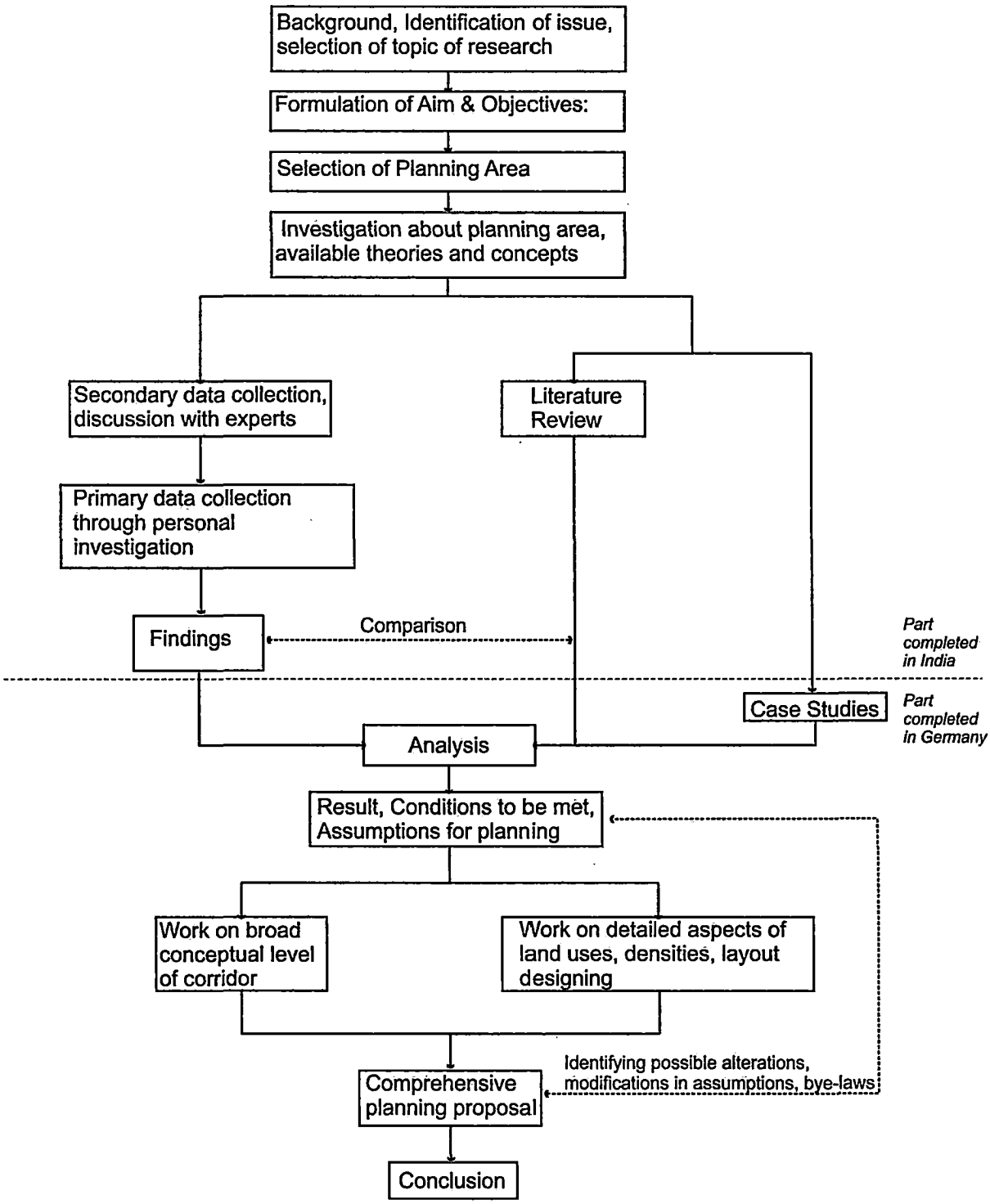


Figure 1-1: Flowchart showing Methodology of Work:

1.8. Structure of Dissertation:

Transit-Oriented Development (TOD) is the primary domain of this dissertation. It attempts to use the theory of TOD for planning sprawling metropolitan cities of India. The research is carried out by taking the case-study of Pimpri-Chinchwad area within Pune Metropolitan Region. The study can be broadly divided into three parts:

i) Understanding the theory of TOD,
ii) Application of TOD in the study area of Pune, Pimpri-Chinchwad and
iii) Preparing a comprehensive TOD model for PCMC area based upon recommendations and guidelines.

The dissertation is divided into the following sections:

Literature Review:

It studies the theory, definitions, principles and various aspects of TOD. The section also analyses the latest trends in TOD through review of two books; 'The New Transit Town' by Hank Dittmar and Gloria Ohland and 'Seven Rules for Sustainable Communities' by Patrick Condon published in the years 2003 and 2010 respectively.

Case Studies:

This section attempts to understand the approach of different countries towards land use and transport integration. The study has been carried out through case-studies of Curitiba in Brazil, Vauban in Germany and GWL terrain, Westerpark in Amsterdam. The section also contains photographic documentation of good transit practices in Europe.

Study Appraisal of Planning Area:

This includes an in-depth analysis of Pimpri-Chinchwad area through analysis of city development plan, comprehensive mobility plan and other planning policies. Any additional data requirement has been fulfilled through personal investigation.

Analysis of Selected BRT Corridor:

It analyses the selected Aundh-Rawet BRT corridor for carrying out TOD. The analysis is carried out through study of existing literature and photographic documentation of the recent development occurring around the corridor.

Proposal for BRT Corridor:

This section proposes certain broad recommendations and guidelines for planning TOD along the Aundh-Rawet BRT Corridor. It also proposes a conceptual model for developing the areas along the BRT Corridor.

TOD Proposal for Punawale Area:

The detailed proposal for Punawale Area contains recommendations about aspects like land use, densities, accessibility, open spaces, activity areas, etc. It also proposes a detailed TOD layout for the Punawale Area.

Reframing of planning guidelines:

This section investigates whether any modifications or alterations are required in the existing planning policies and development control rules of the study area to facilitate a compact, high density and mix-use development.

Conclusion:

The dissertation concludes by attempting to provide answers to the research questions and discussing the outcome of the research.

2. Literature Review

2.1. Background: Need of TOD in India

Many Indian cities are facing uncontrolled growth trends. The following section briefly mentions some of these uncontrolled growth trends in some of the Indian metropolitan cities. It then analyses the theory of TOD through available literature, case studies and how the theory of TOD could be applied for planning Indian cities through case study of Pimpri-Chinchwad.

2.1.1. Uncontrolled growth of private vehicles and lack of efficient public transit system

Due to tremendous boom in auto industry, post the era of privatization and globalization, there has been an uncontrolled growth in the number of private 2-wheelers and cars.

Table 2-1: Growth of vehicles in India

	1991 (Registered vehicles in millions)	2009 (Registered vehicles in millions)
Two-wheelers	14.2	82.4
Cars	3	15.3
Public buses	0.3	1.4

Source: (Wing, 2011)

Table 2-1 shows that the number of 2-wheelers in India has increased six fold from 14.2 million in 1991 to 82.4 million in 2009, with an average annual increase of 26.7%. Similarly, the number of cars has increased fivefold from 3 million in 1991 to 15.3 million in 2009, with an average annual increase of 22.8%. On the other hand, the number of public buses has grown by mere 11,600 over the past 18 years from 1.06 lakh in 1991 to 1.17 lakh in 2009. (Wing, 2011). Thus, there are only 10 public buses per one lakh of population. While as per the norms of Central Institute of Road Transport (CIRT), 40 buses are required for a population of one lakh. (PCMC C. , 2008)

2.1.2. Urban Sprawl of cities:

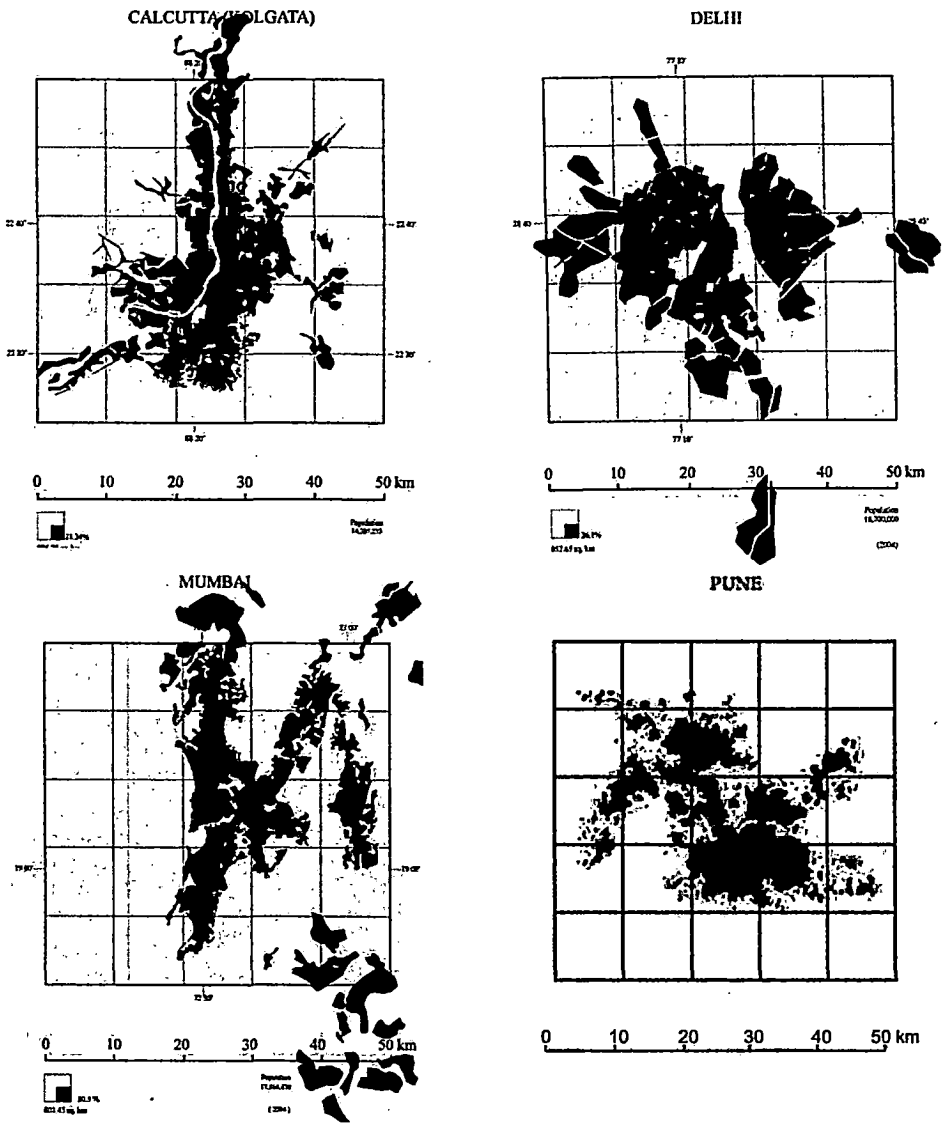


Figure 2-1: City footprints
Source: (Bosselmann, 2008)

Figure 2-1 shows the footprint area for four cities of Kolkata, Delhi, Mumbai and Pune. The sprawl in the city suburbs is clearly evident from the figure. The city extents spread beyond the 50km by 50km grid. The boom in real estate industry and availability of comparatively cheap land in the city fringe areas has led to sprawling suburbs in many cities. This physical growth of cities is unsustainable as it results in sparse, low density development in the city fringe areas. Also, in most cases, fertile agricultural land is

utilized for housing purpose leading to serious ecological imbalance. There is a lack of an integrated approach towards transit and land use planning. Most of these suburban areas lack even the basic infrastructure facilities including a lack of connection to a public transit system.

2.1.3. Lack of integration between transit and land use:

The UDPFI Guidelines are considered as standard guidelines for planning a particular development in India. The guidelines specify the minimum number of schools, commercial space, recreational space, shopping, etc for a particular size of settlement but they do not make any mention of accessibility to these infrastructure facilities. As a result, though a particular settlement has all the necessary facilities, they may not be easily accessible by walking, cycling or by the use of public transit.

2.1.4. Lack of consideration for pedestrians and cyclists

Walking and cycling are non-polluting and sustainable modes of transport. A 2008 study of 30 cities showed that 16% - 57% of all trips, involve no vehicles at all. (R Gupta, 2009). In spite of this, most of the Indian cities lack good footpaths for pedestrians, dedicated bicycle lanes and bicycle parking facility.

Need for studying TOD:

Several large scale transit projects are being planned in many metropolitan cities. The city development plans and comprehensive mobility plans of many cities make a mention of Transit-Oriented Development as a 'tool for integrating transport and land use.' However, in the name of TOD, intensive development is planned along the transit corridors to partly recover the huge investments done in transit development. This section therefore attempts to understand the real principles of TOD through analysis of available literature and a brief study of certain settlements in Europe promoting use of public transit. This analysis would then form the basis for developing a rationale for making Indian urban development compact and transit-oriented.

2.2. Theory of Transit Oriented-Development:

2.2.1. Historical Context:

It is necessary to understand the relationship between transit and urban development pattern. Though the term Transit-Oriented Development (TOD) was coined by Peter Calthorpe in 1993; cities have been partially shaped by their transportation modes- whether walking, animal-drawn carts, streetcars or automobiles. Most of the urban design principles which we speak of today have already existed before the advent of the automobile. Thus, the challenge faced today is to alter the pattern of urban development which currently encourages the use of private automobile instead of public transport. (Dittmar, Belzer, & Autler, 2003, p. 5). The evolution of transit can be categorized into three important periods:

The Early Twentieth Century: Development-Oriented Transit:

In the early 1900's before the advent of private automobile, public transportation was the main mode of travel. The transit lines were very often laid by a single owner or developer to add value to the residential establishments. They served as an important link connecting the residential areas to the workplace. The private developers developed transit to serve their development rather than vice-versa. As a part of this formula, the transit stops often had small retail clusters to serve commuters as well as local residents.

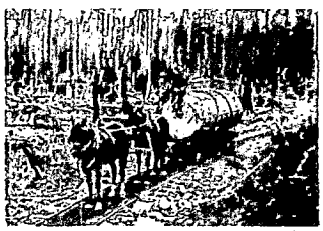
The Post-War Years: Auto-Oriented Transit:

The Post- World War II saw a decline in public transit use and private automobile became the popular mode of transport. The interdependence between housing, jobs, and transit inherent in the early streetcar suburbs was broken apart by the automobile. In the 1930's, roads including highways became the preferred transportation infrastructure. Development was no longer dependent on transit. Though, buses became primary mode of transit, they were the least preferred mode compared to the private automobile as they shared the same road space and did not perform well due to traffic and congestion. (Dittmar, Belzer, & Autler, 2003, pp. 1-7)

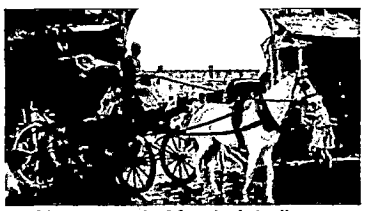
Today: Transit- Related Development:

Public transit systems enhance the value of adjacent land parcels. The federal governments and transit agencies are promoting large scale real-estate developments along properties owned by transit agencies. This is being done to partly recover the huge investments done in transit development. This approach is problematic because it concentrates only on the profitability aspect. The "highest or best use" in financial terms is not always the best for either transit users or the neighborhood. As a result, TOD is being talked about increasingly as it provides many other benefits besides capturing increase in land value. (Dittmar, Belzer, & Autler, 2003)

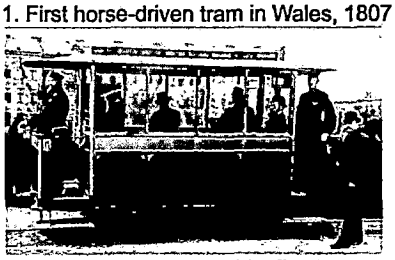
1. First horse-driven tram in Wales, 1807



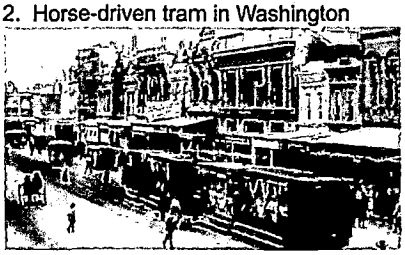
2. Horse-driven tram in Washington



3. Horse-cart in Mumbai, India

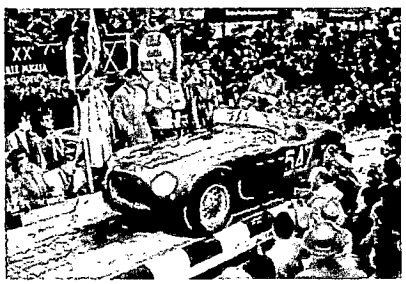


4. First tram in Lichterfelde, Berlin, Germany, 1881



5. Early development in US around street cars

6. Early development concentrated around tram line, Kolkata, India



7. Early private vehicles emerging in Europe

8. Car boom in Post World-War II in Toronto

9. Car and two-wheeler boom in India

Figure 2-2: Evolution of transit

Sources: 1. (BBC Mobile News India) 2. (Obergfell), 3. (BBC Mobile News India), 4. (First electric tram, Siemens, 1881) 5. (authority), 6. (Nithin), 8. (http://basementrug.com) 9. (BBC Mobile News India)

2.2.2. Parallel Concepts: New Urbanism, Smart Growth, TAD and TJD

"New Urbanism" and "Smart Growth" have emerged as buzzwords in the planning profession, and have gained some recognition in the mainstream media as progressive approaches to solving problems associated with suburban sprawl. Both, New Urbanist and Smart Growth movements advocate some of the basic elements of transit-oriented development; so it is useful to very briefly discuss each of them.

"New Urbanism" or "Neo-traditional Planning" is being promoted by urban designers and architects like Peter Klatz, Andres Duany, Elizabeth Plater-Zyberk, Peter Calthorpe and Daniel Solomon. These New Urbanists generally advocate returning to the pre- World War II town planning principles with an emphasis on designs that provide mixed land uses, narrow streets laid out in tight grid mesh, decreased setbacks, and reduced parking, among others. However transit is not a required feature of New Urbanist development.

"Smart growth" is considered by planners and urban designers as development that revitalizes central cities and older suburbs, supports and enhances public transit, and reserves open spaces and agricultural lands. It generally calls for higher density, transit-oriented development with an emphasis on providing a balanced mix of housing, jobs, and shopping opportunities, within a community. (Kunstler, 1996)

Transit Adjacent Development (TAD) - A TAD is just that development that is physically near transit; it fails to capitalize upon this proximity, however to promote transit riding. (Parsons, Brinkerhoff, Quade, & Douglas, 2001)

Transit Joint Development (TJD): Real estate development that is closely linked to public transit services and transit facilities and takes advantage of the market and locational benefits provided by them. (Keefer, 1984)

2.2.3. TOD Definitions:

There are several definitions given by different authors, researchers and organizations about Transit- Oriented Development. Most of the definitions lay stress on certain points like mix-use, high-density, accessibility, etc

Table 2-2: TOD Definitions

S. No	Author/ Researcher/ Organization	Definition:	Year	Country
1	Peter Calthorpe	A Transit-Oriented Development (TOD) is a mixed-use community within an average 2,000 feet walking distance of a transit stop and core commercial area. Transit-oriented developments mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot or car.	1993	United States
2	Salvensen	Development of land uses within a specified geographical area around a transit station with a variety of land uses and a multiplicity of land owners.	1996	United States
3	Bernick & Cervero	A compact, mixed-use community, centered around a transit station that, by design, invites residents, workers and shoppers to drive their cars less and ride mass transit more.	1997	United States
4	Scott Lefaver	Higher density residential or mixed-use developments built along transportation	1997	United

		corridors, i.e. rail and major bus lines as well as freeways.		States
5	Porter	Development which is generally within half a mile of transit railway stations.	1997	United States
6	Boarnet & Crane	The practice of developing or intensifying residential land use near rail stations	1998	United States
7	Maryland Department of Transportation	A place of relatively higher density that includes a mixture of residential, employment, shopping and civic uses and types located within an easy walk of a bus or rail transit center. The development gives preference to the pedestrian and bicyclists, and may be accessed by automobiles.	2000	United States
8	California Department of Transportation	Moderate to higher density development located within an easy walk of a major transit stop, generally with a mix of residential, employment, and shopping opportunities designed for pedestrians without excluding the auto. TOD can be new construction or redevelopment of one or more buildings whose design & orientation facilitate transit use.	2001	United States
9	Oregon Revised Statues, Section 307-600-1	A mix of residential, retail and office uses and a supportive network of roads, bicycle and pedestrian ways focused on a major transit stop designed to support a high level of transit use.		United States

Source: (Chisholm, 2002, pp. 5-6)

Observation: It is clearly evident that all the TOD definitions available in literature are given by US planners and urban designers. But TOD is being used as a potential solution against urban sprawl in many countries around the world.

Some of the aspects of TOD stated in the above definitions are part of a specific local government planning guidelines. They are more suitable to the local context. As a result, some of the aspects of TOD occur in specific definitions while others are more universal.

As a result, an analysis of all the definitions is carried out to study which are the common points about TOD occurring in majority of the definitions. This helps in deciding the absolutely essential planning guidelines necessary for successful implementation of TOD. (Ref Table 2-3)

Table 2-3: Evaluation of TOD Definitions:

		1	2	3	4	5	6	7	Score
S. No	Author/ Organization	Compact & High Density	Encourage public transit	Discourage private automobile	Mixed-use	Accessible to community facilities	Pedestrian & Bicycle friendly	Stations as community hubs	
1	Peter Calthorpe	√	√	√	√	√	√	√	7
2	Salvenson				√				1
3	Bernick and Cervero	√	√	√	√	√	√		6
4	Scott Leafaver	√	√		√				3
5	Porter	√	√						2
6	Boarnet and Crane	√							1
7	Maryland Department of Transportation	√	√		√	√	√	√	6
8	California Department of Transportation	√	√		√	√	√	√	6
9	Oregon Department of Transportation	√	√		√	√	√	√	6
	Score	8	7	2	7	5	5	4	

Source: (Author)

- The definitions given by Peter Calthorpe, Bernick and Cervero are comprehensive covering maximum aspects.
- The rating for the attributes is as: 7 - 9 score= absolutely essential 4 – 6 score= essential below 4= preferable
- From this it is evident that compact, high density, mixed use & to encourage public transit are the absolutely essential attributes of TOD.

2.2.4. Transit-Oriented Development (TOD) – Principles

Principles by Peter Calthorpe:

The term Transit-Oriented Development (TOD) has been coined by Peter Calthorpe. He has articulated the urban design related principles of TOD in his book, "The Next American Metropolis" written with associate Shelley Poticha. The authors mention the following TOD principles:

- Organize growth on a regional level to be compact and transit-supportive.
- Place commercial, jobs, parks, and civic uses within walking distance of transit shops.
- Create pedestrian-friendly street networks that directly connect local destinations.
- Provide a mix of housing types, densities, and costs.
- Preserve sensitive habitat, riparian zones[1], and high quality open space.
- Make public spaces the focus of building orientation and neighborhood activity. Encourage infill and redevelopment along transit corridors within existing neighborhoods (Calthorpe, 1993)

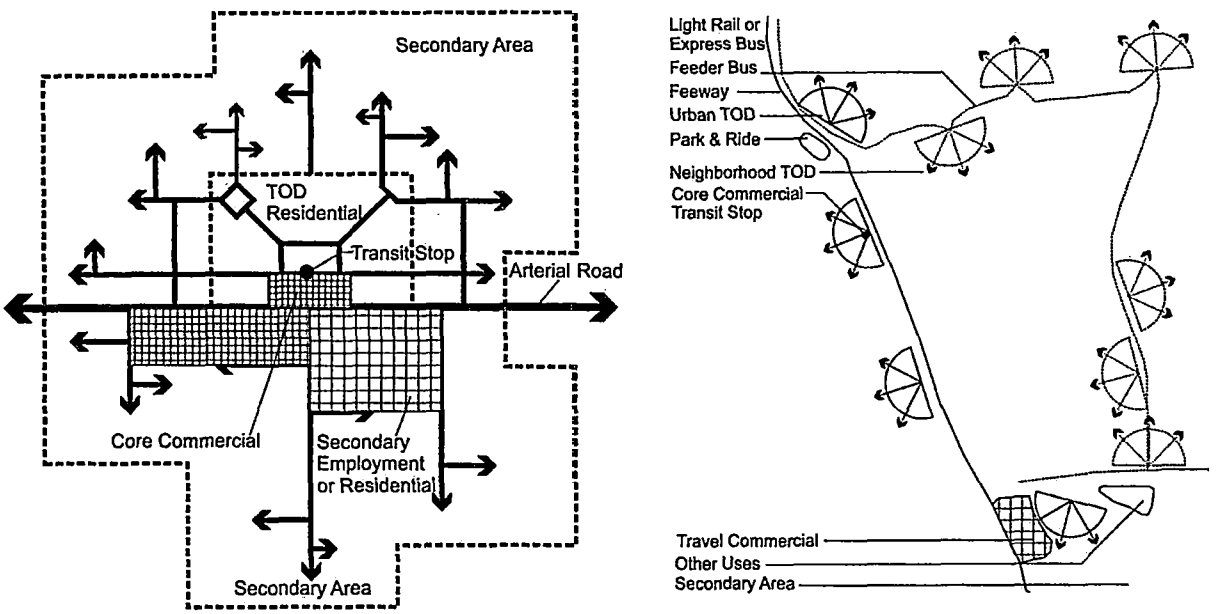


Figure 2-3: TOD Model-Peter Calthorpe
Retraced by author (Calthorpe, 1993)

[1] Riparian zone is the interface between land and a river or stream. This area has a rich ecosystem. The flora and fauna found in this area are distinguishingly different from those found in the adjoining areas. Source: (Freitag, 2010)

Elements of TOD by Robert Cervero and Michael Bernick:

Robert Cervero, professor at the University of California at Berkley has centered his research on relationship between transit and metropolitan development. He has consistently stressed the relationship between urban form and the type of transit best suited to serving a particular urban form. In their book- *Transit Villages in Twenty-First Century,* Robert Cervero and Michael Bernick have used a case study approach to gather much new evidence about both styles of transit and styles of development. According to Bernick and Cervero, the elements of transit-oriented development are:

i. Enhanced mobility and environment
ii. Pedestrian friendliness
iii. Alternative suburban living and working environments
iv. Neighbourhood revitalization
v. Public safety
vi. Public celebration

The above elements can be briefly expressed as follows:

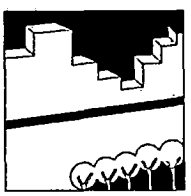
Table 2-4: Elements of TOD

S. No	Element	Description
1	Enhance Mobility & environment	• Improvement in air quality • Park and ride trips are converted to walk or bicycle trips
2	Pedestrian friendliness	• Development of land uses that encourage walking
3	Alternative suburban living	• Live in the suburbs without being entirely dependent on automobile
4	Neighbourhood revitalization	• Stimulate economic growth • Promote mix-income housings
5	Public Safety	• Mix-use allows for a continual security by virtue of constant activity
6	Public Celebration	• TOD should include spaces like plaza, park, gathering place for parades, performances, concerts, etc

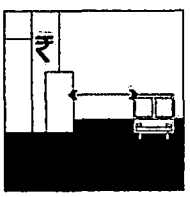
Source: Author Ref (Cervero, 1997)

The major design features suggested by Bernick and Cervero are as follows:

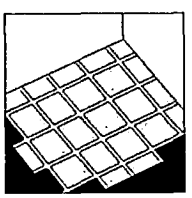
- Have continuous and direct physical linkages between major activity centers; site buildings and complementary uses near transit shops.



- Streetwalks of ground-floor retail and varied building heights, textures, and facades enhance the walking experience; site commercial buildings near the edge of sidewalks.



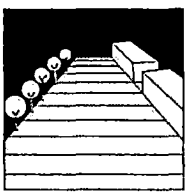
- Integrate major commercial centers with the transit facility



- Grid like street patterns allow many origins and destinations to be connected by foot; avoid cul-de-sacs, serpentine streets, and other curvilinear arrangements creating circuitous walks.

- Minimize off-street parking supplies; where land costs are high, tucking parking under buildings or place it in peripheral structures. In other cases, place parking at the rear side of the buildings instead of the front side.

- Provide pedestrian amenities as attractive landscaped elements. Continuous and paved sidewalks, street furniture, urban art, screening of parking, building overhangs, weather protections, and safe street crossings promote walking



- Create public open spaces and plazas that are convenient to transit.

Graphics by Author:

Application to Planning Area:

The principles by Calthorpe, Bernick and Cervero form the basis of TOD theory. The overall degree of success of TOD is directly dependent on the degree of success of individual principle. These principles provide direct hints for planning the selected study area.

Remark:

The principles of TOD were proposed by Calthorpe, Bernick and Cervero during the 1990s. TOD projects actually started coming up after 2000-01. As a result, the theory was tested at a later stage based upon the success of these projects. It has been realized since the execution of initial TOD projects that there are many other aspects apart from the TOD principles, which determine the success of TOD projects. These aspects have been analyzed in the following book review.

2.3. Book Review 1: The New Transit Town

The New Transit Town: Best Practices in Transit Oriented Development,
Hank Dittmar, Gloria Ohland,
Island Press, Washington DC,
2004

This book is an excellent approach to describe the various multi-dimensional aspects of TOD. It derives the various principles, aspects of TOD by evaluating the first generation TOD projects in the US. The results are more realistic without any prejudice. The book is divided into 11 chapters. Chapter 1 is the introduction to the topic of TOD. Chapters 2-7 describe the various aspects of TOD; while chapters 7-11 examine TOD practices through a series of case studies. Every chapter is an essay written by different authors.

The book review is an attempt to highlight the important points and main arguments from every chapter. These points could then serve as guidelines for TOD in the selected planning area.

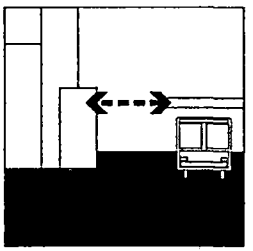
2.3.1. Defining Transit-oriented Development: The New Regional Building Block:

Hank Dittmar and Shelley Poticha.

Refining the definition of TOD:

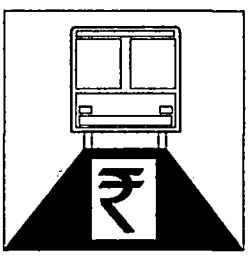
This chapter focuses on the aspects of TOD which are essential for better place making. Certain performance benchmarks have been suggested to judge the success of TOD projects. These consist of following the five main goals:

i. Location efficiency
ii. Rich mix of choices
iii. Capture value by efficient transit service
iv. Place making
v. Resolving the tension between node and place

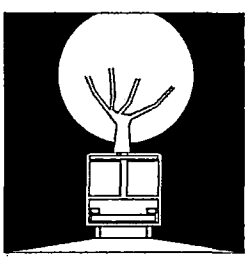


- Location efficiency: It involves conscious placement of homes in close proximity to transit stations. Sufficient customers should be located within walking or cycling distance with good transit accessibility.

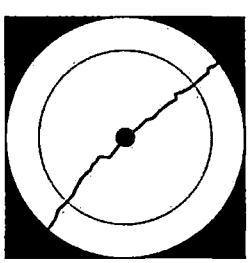
- Rich mix of choices: Many options of dwelling types like bungalows, large family homes, single-family homes, town houses, live-work apartments should be available for the potential customers to chose from.



- Capture value by efficient transit service



- Place making: Enrich the experience of people about their community place



- Resolving the tension between node and place: Balance between the functional aspect of transit stop as node in transit network and an activity place in neighbourhood.

Graphics by Author

2.3.2. The Transit-Oriented Development Drama and its actors:

Dena Belzer, *Gerald Autler, Ohland Judith Espinosa, Sharon Feigon, Gloria*

The Chapter tries to analyze the complex and contradictory role played by various stakeholders of TOD. This is summarized in the table below.

Table 2-5: Goals of stakeholders involved in TOD

Agency/ Stakeholder	**Goals:**
Transit Agency	• Maximize monetary return on land • Maximize ridership • Capture value in long term
Riders	• Create/ maintain high level of parking • Improve transit service and station access • Increase mobility choices • Develop convenient mix of uses near station • Maximize pedestrian access
Neighbors	• Maintain/ increase property values • Minimize traffic impact • Increase mobility choices • Improve access to transit, services and jobs • Enhance neighborhood livability • Foster redevelopment
Local Government	• Maximize tax revenues • Foster economic vitality • Please constituents • Redevelop underutilized land
Federal Government	• Protect public interest and set limits on how federal investments can be made
Developer/ Lender	• Maximize return on investment • Minimize risk, complexity • Ensure value in the long term

Source: Compiled by Author from chapter

Some of the goals are in contradiction to one another like maintaining a high level of parking and maximizing pedestrian access to station. Thus a proper balance is required in many cases and the goals may be reconstituted in such cases.

2.2.3. Regulations shape reality: Zoning for Transit-Oriented Development:

Ellen Greenberg

The author states that, the municipal government is the primary player which fixes the planning and zoning laws for TOD. In case of different cities or nations, following three dimensions are considered as the basic ABC's of TOD. They are:

Active walkable streets

Building intensity and scale

Careful transit integration

All the zoning regulations, laws must cater to these three ABC's of TOD.

Practices in TOD Zoning:

Generally two approaches are considered for the process of zoning in TOD:

i. *Planning and Policy Approach:*

In this, the local government's approach may be specific to TOD; in others the locality may use the same approach for TOD that it employs in planning other types of desirable development.

ii. *Regulatory Provisions:*

In this, the details are addressed through specific provisions unique to the project under consideration to TOD generally.

Planning & Policy Approach:

The author suggests six recommendations for the planning and policy approach after studying various case studies. These may be explained as follows:

i. *Create Customized Zoning for projects integrating transit-facilities*

This involves planning unit development (PUD). The specific plan focuses on specific small area, sometimes with multiple ownerships, and both express policy and establish development regulations uniquely tailored to the location. The specific plans are prepared by the local government and the developer has to submit a detailed master plan to demonstrate compliance with the specific plan's provisions. Specific plans determine precise land-use patterns, zoning, setbacks, and design with defined boundaries.

ii. *Minimize customized planning and discretionary review for standardized projects*[2]

The standardized projects should promote the ABC's of TOD. Uses that will strengthen these characteristics should be permitted as of right, and discretionary review of development proposals incorporating them should be minimized and eliminated.

iii. *Provide an explicit foundation in policy and politics*

Clear and sustained public policy favoring transit-oriented development is enormously important. Formal policies as well as funding and program priorities help establish shared expectations among community members, transit agencies, and developers and smooth the way for development projects. A clear and consistent policy framework frequently contributes to a focused and effective public involvement process.

iv. *Engage transit organization policy leadership:*

Projects have benefited from activist agencies that have a comprehensive view of their goals and mission rather than one that focuses exclusively on conventional notion of transit productivity. Transit agency leadership has stimulated TOD on private property and assisted with careful transit integration.

v. *Meet multiple objectives:*

Best TOD projects integrate diverse elements to serve multiple public and private objectives.

vi. *Anticipate a lengthy timeline for customized projects:*[3]

Customized projects and major developments in transit districts take a long time to plan, design and build. It is important to realize this fact and planning and policy needed to support them may start many years in advance of development.

---

[2] Standardized projects are small to medium size projects of routine production activity. They are projects within a transit district but do not incorporate a transit station.

[3] Customized projects are long term, high investment projects which integrate transit facilities on site, as well as larger TOD projects which do not include a transit facility.

2.2.4. Financing transit-oriented development:

Julia Parzen and Abby Jo Sigal

The chapter discusses the various strategies of financing TOD projects. It also enlists certain measures to reduce the uncertainties involved in a heavy investment project. Some of the measures suggested for creating greater certainty and making it easier to leverage more financing sources to complete a TOD project are as follows:

- Partner with experienced developers
- Put zoning and permitting in place
- Create a broad vision and get community support
- Build a detailed business plan with strong market analysis
- Public investment in predevelopment can jump-start private investment
- Phase the project to produce early cash flows
- Cultivate new and special interest equity investors
- Providing a variety of housing types and costs

2.2.5. Traffic, Parking, and Transit-Oriented Development:

James M. Daisa

The author describes two primary components which determine the transit and parking demand characteristics of transit-oriented development.

- The demand generated by the transit facility independent of the adjacent land uses.
- The demand generated by the land uses.

The parking should not be excessive as the main aim of TOD is to encourage people to walk. Some of the suggested ways which are effective to change travel behavior are as follows:

- Configure parking so that it does not dominate
- Charge for parking
- Reduce off-street parking requirements
- Utilize on- street parking
- Use remote parking facilities with shuttle and express connections to major intermodal transit stations

- Unbundle parking, create parking districts

2.2.6. Conclusion:

The points discussed in the book provide practical guidelines necessary for implementation of TOD. The guidelines are very much realistic as they have been framed after analyzing the executed first level TOD projects. It lays down these guidelines step by step very systematically in the form of different essays. The only shortcoming of analyzing this book is that all the examples discussed in it are of American cities. As a result, certain guidelines, prescribed population densities, land uses need to be modified to suit the situation in India.

2.3. Book Review 2: Seven Rules for Sustainable Communities

Seven Rules for Sustainable Communities
Design Strategies for the Post-Carbon World
Patrick .M. Condon
Island Press, Washington D C
2010

The book is written with the background of Intergovernmental Panel on Climatic Change (IPCC) Meet held at Copenhagen in 2009. The author's main point of argument is that cities are responsible for 80% of Greenhouse Gas (GHG) emissions and therefore it is vital to plan our cities carefully. The book describes how simple alterations in the planning and design of metropolitan areas can help to considerably reduce the carbon emissions and improve livability in the cities. These alterations required for planning our cities are suggested in the form of 7 principles. These 7 principles of sustainability are also helpful to form the basis for planning a compact, transit-oriented development. They are as follows:

2.3.1. Restore the streetcar city:

Almost all the cities in US and Canada, prior to World War II, had a network of streetcar. However, most of the streetcar lines became non-functional due to promotion of private auto-oriented development. The author recommends restoring back the streetcar network. In more global context, he suggests planners and decision makers to restore back the public transit system.

The focus of the author is not on the streetcar alone but on the total system and sustainable relationship between land use, walking and transportation. This system is important to the citizens since many of the cross roads in American and European cities still continue to be the hub of activities. The street car system also serves as an important mode of transport connecting the main city centre and the sub-urban

areas. Though the average speed of street car or tram is less compared to private automobile, it reduces the total Vehicle Miles Travelled (VMT).[4]

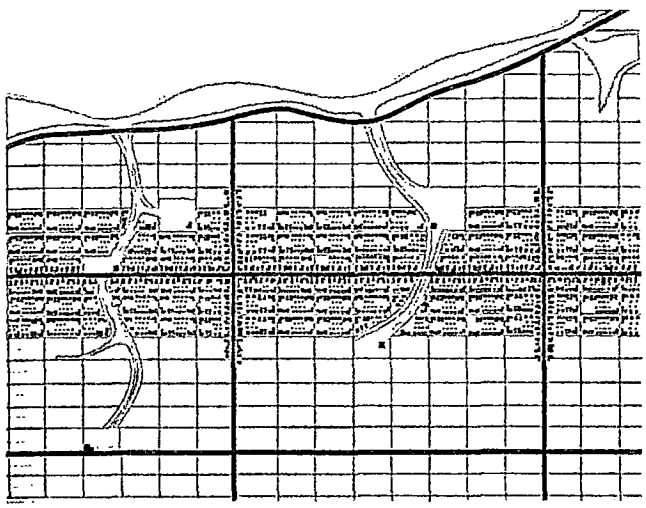


Figure 2-4: Network of public transport
Source: (Condon, 2010)

The three important criteria mentioned in the chapter for selecting a good transit system are:

a. Have shorter trips than longer trips
b. Low carbon emissions better than high carbon emissions
c. Choose what is most affordable over long term

2.3.2. Design an interconnected street system

The main point described in the chapter is that the interconnected road system is better than the cul-de-sac system in terms of better connectivity and making the trips as short as possible. The interconnected road system also enables to have a high density of settlements per unit area than a cul-de sac road system.

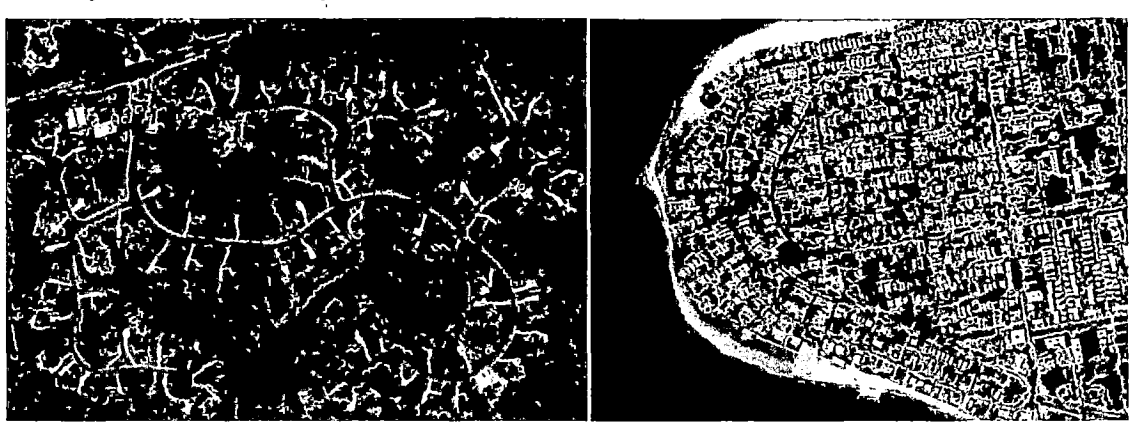
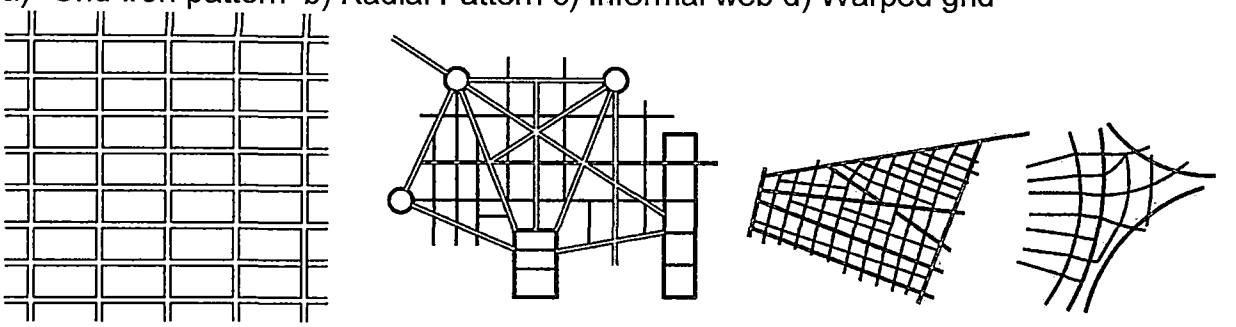


Figure 2-5: Street System
(left: Atlanta National Gated Community cul de-sac road system, Atlanta, Georgia; right: Seagate interconnected road system, New York)
Source: (Condon, 2010)

[4] Vehicle Miles Traveled (VMT) is the total number of miles driven by all vehicles within a given time period and geographic area. It is used by regional transportation and environmental agencies for planning purposes. VMT is influenced by factors such as population, age distribution, and the number of vehicles per household. However, the greatest influencing factor is how the land uses are arranged in relation with the public transit line.(Ref: http://streetswiki.wikispaces.com)

Four types of interconnected road systems are described in the chapter.

a) Grid-iron pattern b) Radial Pattern c) Informal web d) Warped grid



Grid-iron pattern	Radial Pattern	Informal Web Pattern	Warped Grid
Ex: Vancouver	Ex: Washington DC	Ex: Massachusetts	Ex: Illinois

Figure 2-6: Types of interconnected street patterns
Source: (Author)

2.3.3. Locate Commercial Services, frequent transit, and schools within a 5-min walk.

People are discouraged to use their private vehicles, if the required day-to-day activities are located within a 5-min walking distance. It is also important to plan these activities in close relation with the transit stop.

2.3.4. Locate good jobs close to affordable homes:

Most of the daily vehicular trips are for work purpose. Most of these trips are long trips as the work place is far away from the residential area. Locating good jobs close to affordable housing can reduce the travel time significantly. It also results in short distance trips.

2.3.5. Provide a diversity of housing types:

There should be a rich choice of dwelling units available to people to choose from. Over-segregation of housing types based on economics, building type is not sustainable. Zoning should not be used as a tool for separation but as a tool for integration.

2.3.6. Create a linked system of natural areas and parks

Parks and natural areas are important as a means to connect all parts of a district. As planners, it is important to locate natural systems into visible public amenity; i.e. locate them on front door of community and not on rear property lines.

2.3.7. Invest in lighter, greener, cheaper and smarter infrastructure.

The topic of this chapter is green infrastructure for roads and drainage. The author defines green infrastructure as, "roads and drainage systems that work with, and not against, natural systems. It manifests itself in a set of engineering and construction standards that make road and drainage infrastructure lighter, greener, cheaper and smarter."

2.3.8. Conclusion:

The seven principles mentioned in the book provide direct clues for actual planning and detailing of a TOD. Each of the design principle is very much rational; supported by adequate live examples of cities. However, the existing planning guidelines and bye-laws of the study area will have to be modified to implement these planning principles.

2.3.9. Guidelines for planning area: Do's and Don'ts

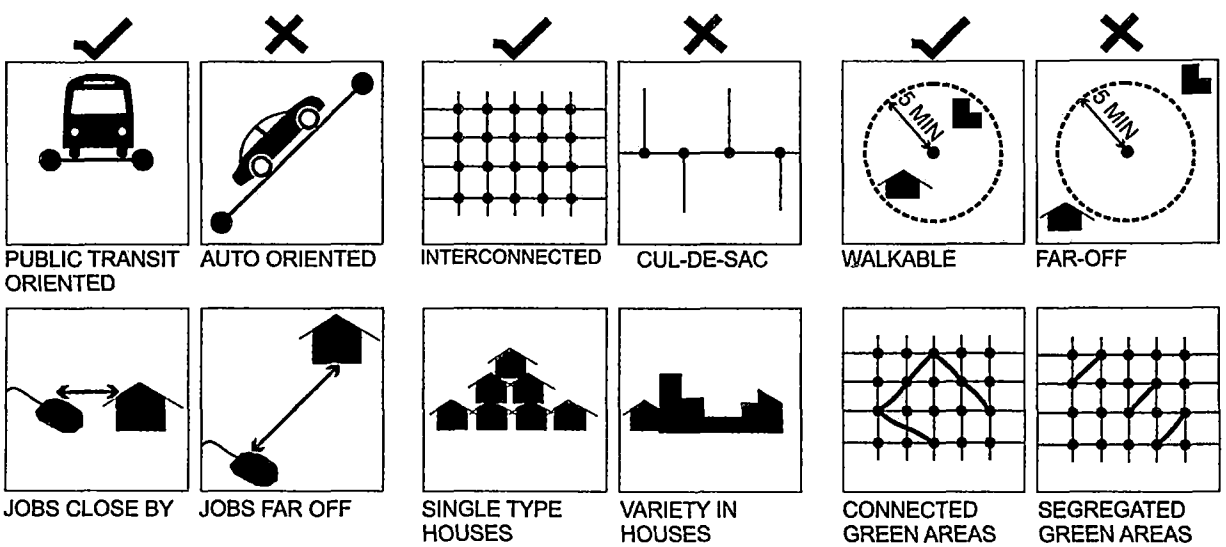


Figure 2-7: Planning Recommendations, Do's & Don'ts
Source: Author

2.4. Policy Review: National Urban Transport Policy (NUTP)

National Urban Transport Policy (NUTP) Government of India, 2006

The National Urban Transportation policy was launched by Government of India in 2006 to deal with problems related to traffic and transportation. The policy focuses on three aspects of traffic and transportation, 1) efficiency, 2) affordability and 3) safety.

2.4.1. Vision:

- To recognize that people occupy centre-stage in our cities and all plans would be for their common benefit and well-being.
- To make our cities the most livable places in the world and enable them to become the 'engines of economic growth' that power India's development in the 21st century
- To allow our cities to evolve into an urban form that is best suited for the unique geography of their locations and is best placed to support the main social and economic activities that take place in the city.

2.4.2. Objectives related to integrated transit and land management:

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement.
- Integrating land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education and other social needs, especially for marginal segments of the urban population is improved
- Encourage greater use of public transport, non-motorized modes by offering central financial assistance for this purpose.

The report elaborates further on the objective of integrated land use and transport planning by stating, "Cities in India vary considerably in terms of their population, area, urban form, topography, economic activities, income levels, growth constraints, etc. Accordingly, the design of the transport system will have to depend on these city

specific features. Further, transport planning is intrinsically linked to land use planning and both need to be developed together in a manner that serves the entire population, yet minimizes travel needs. In short, an integrated master plan needs to internalize the features of sustainable transport systems. In developing such plans, attention should also be paid to channel the future growth of a city around a preplanned transport network rather than develop a transport system after uncontrolled sprawl has taken place. Transport plans should, therefore, enable a city to take an urban form that best suits the geographical constraints of its location and also one that best supports the key social and economic activities of its residents."

2.3.10. Conclusion:

The significant part of this policy is that it focuses on "better place making". It looks at integrating transportation and land use for the betterment of living conditions in the cities and not as a means of profit-making by selling the development around the transit corridors. The policy also stresses on the importance of comprehensive planning; linking land uses with the transport network right from the initial stage of planning. But, the CMP of Pimpri-Chinchwad neglects these guidelines and focuses only on profit-making by selling the land parcels along the transport corridor at higher prices.

3. Case studies

3.1. Curitiba:

3.1.1. Background:

"A problem realized in time is half solved". Curitiba is a very good example to study how advanced planning, clearly defined vision and goals can prevent the occurrence of serious urban problems in future. The city's growth rate had been 11.3% which was 7.1% higher than the national average of 4.2%. Thus, appropriate planning measures were started in 1950's to avoid future problems of urban sprawl, lack of good quality public transport, etc.

3.1.2. Brief overview of the city:

Curitiba is the capital and largest city in the Brazilian state of Parana. The land in the central part of the city is relatively flat and major development has occurred in this part.

Figure 3-1: Location of Curitiba
Source: maps.grida.no

Table 3-1: Curitiba Overview

REGION	AREA	TOWNS	POPULATION (2008)	DENSITY	
CURITIBA	775 KM²	25	32,25,000	4160/KM²	
CITY	AREA		POPULATION (2008)	DENSITY	GREEN SPACE PER INHABITANT
CURITIBA	432 KM²		16,00,000	4500/KM²	51.5 SQ.M

Source: Compiled by author Ref: (Metropolitana, 2007)

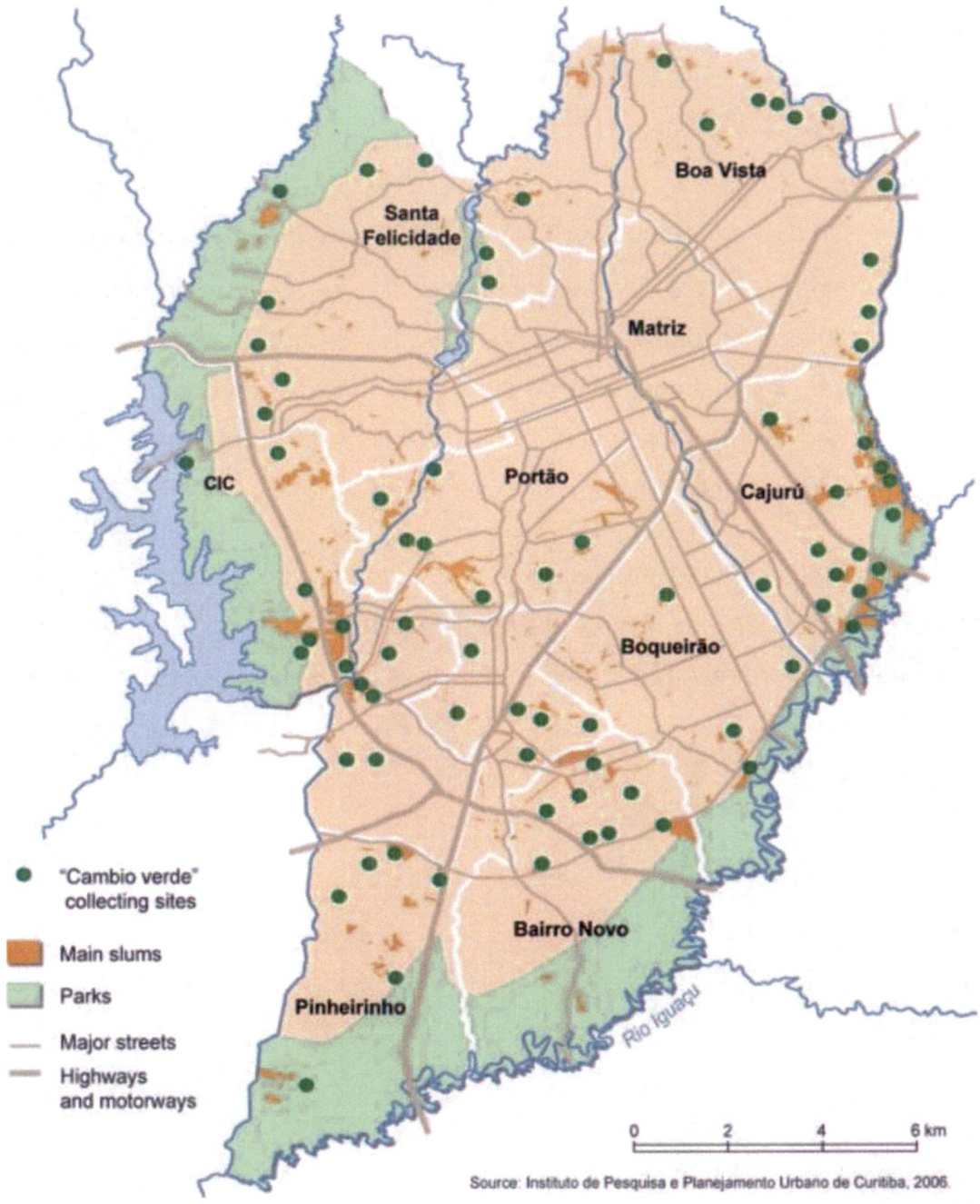


Figure 3-2: Plan of Curitiba
Source: Urbano de Curitiba, 2006

3.1.3. Steps taken in the direction of TOD:

Transport system was planned as a means to promote city's growth along particular corridors. The entire MTS is currently operated by *Urbanizacao de Curitiba* (URBS), a publicly-administered, privately funded company; together with Institute for Research & Urban Planning in Curitiba (IPPUC). Both agencies are responsible for land use development, maintenance & extension of MTS. A surface system was planned for two major reasons:

i. When a system is buried, the citizen loses reference with the city. He no longer knows in which part of the city he is.

ii. Elevated system spoils the city skyline, is difficult for the aged and cannot have universal accessibility. Also, the adjacent structures lose their privacy.

The buses run on a trinary road pattern, i.e. the central lane is exclusively for rapid buses in opposite directions while the remaining two side lanes are meant for private vehicles running parallel in opposite directions. About 1100 buses make 12,500 trips a day, serving about 1,300,000 passengers in the main city. Additional 800 buses transport 1,900,000 passengers in the adjacent towns. There are 25 transfer terminals, 221 tube stations and 340 routes. There is a tube station at an interval of every 500 meters. The maximum time for which a citizen has to wait for boarding a bus is 2 minutes. (Taniguchi)

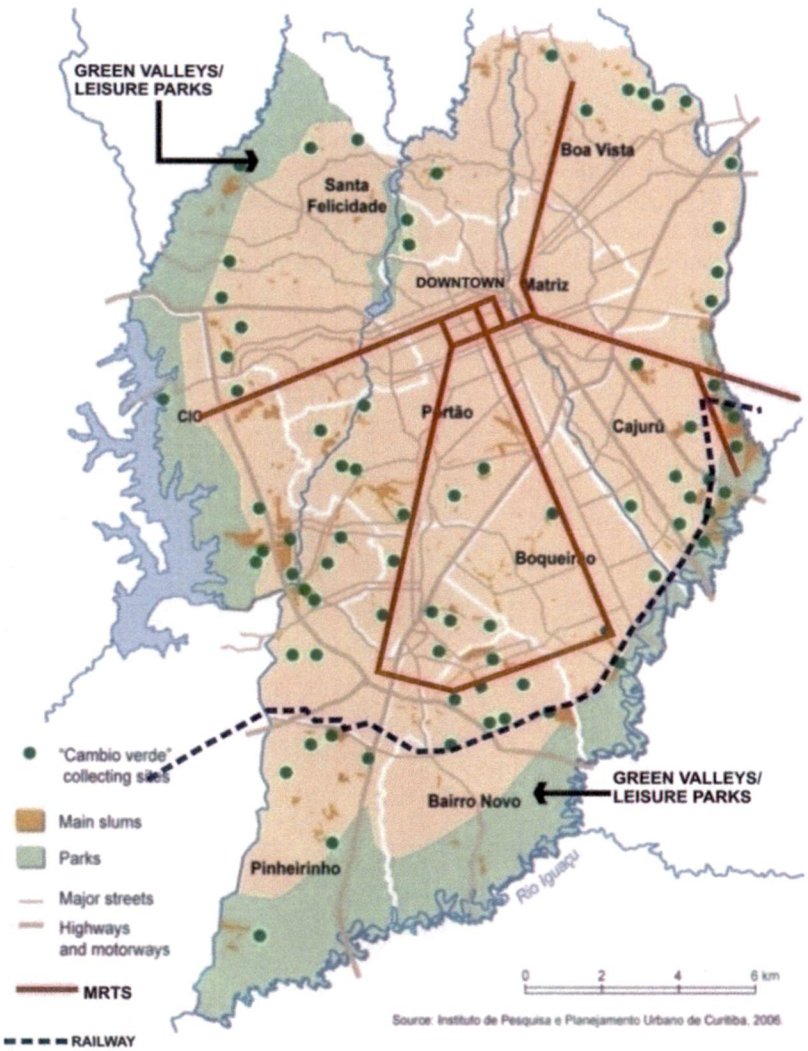


Figure 3-3: Bus corridors of Curitiba
Source: (mappery.com)

The planning process which was initiated in 1950's is responsible for the TOD success in Curitiba and can be summarized from the table given below:

Table 3-2: Chronology of major planning events in Curitiba

Period	Physical Planning	Socio-Economic	Environmental
Mid 1950's	Alfred Agache co-founder of the French Society of Urban Studies hired to prepare the First City Plan. 2 years for preparation of plan. Features: Mandatory Setback of 5 m for all buildings in main city, trees planted as buffer		Surveys related to green areas were done
1960	Mayor Aruza commissioned Curitiba Research & Planning Institute to prepare integrated plan for city considering land uses & road system		
1969	Mayor Omar Sabbag developed preliminary mass transportation plan		
1971	Architect Mayor Jamie Lerner implemented the plan	Curitiba Collaboration Model: People were involved in laying of road paving. In return nurseries, schools, dispensaries' made free for working people	Liesure & recreation prog: Creation of parks, leisure valleys. Program criticized because of its name. Hence passed in the name of Flood Control Plan
1980	Buses started running with a single fare between any two transit points in the city		
1990		Municipal Housing Fund- Financial support to lower income groups	Each landlord received a pair of trees to plant & an hour consultation with architect to develop their plan.
1996	Most Innovative City Award- United Nations Conference on Human Habitat		
2000	Zoning & Land Use Law: Development along transport corridor controlled		
2001	Mass Rapid Transit System covering entire city limit & other neighbouring towns	Allowing only small & medium industries to develop & creating 15000 jobs for local people	
2004		Development of Smart Card for citizens, comprehensive mode for payment of all taxes & gaining services	
2010	Global Sustainable City Award: To Municipality for undertaking sustainable measures		

Source: Author Ref: (Taniguchi)

3.1.4. Success of TOD:

No system is perfect. The bus system in Curitiba is also experiencing some problems with congestion during peak hours. The government is not interested in increasing the number of buses but is chalking out an overall policy to study the location of workplaces, particular lines of congestion, etc & trying to find a solution for long term efficiency. It continuously monitors data regarding delay in service if any, discomfort caused to citizens, any alterations in land use if required & more importantly periodic maintenance.

Tangible benefits:

1. Every citizen of Curitiba spends only 9% of his monthly salary on transportation and can reach the farthest peripheral point of region (70 km approx) from its downtown in one hour during peak traffic hours
2. The city of Curitiba earns 4% of the revenue for its buses from tourism.
3. The pollution in Curitiba is 43% less as compared to other cities in surrounding region due to good transport system.
4. The fuel has a soybean additive. Its cultivation in rural areas serves as an income to 50,000 rural families.

Intangible benefits:

1. In a survey conducted by Reader's Digest Magazine, 99% of the citizens said that they are extremely happy as citizens and would never plan to leave the city.
2. People constantly extend their support to any good government policy and are actively involved in preparing annual budget, preparation of Master Plan, etc
3. Every citizen has 52 sq.m green area
4. Shifting from paper tokens to smart cards & metal tokens has saved cutting down of around 1200 trees annually.

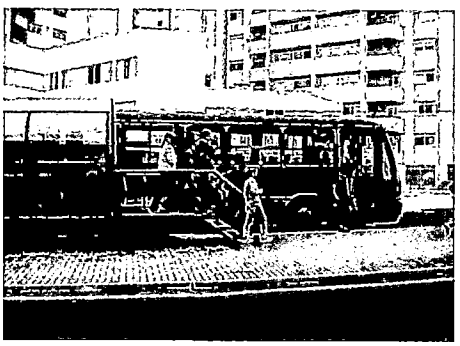


Figure 3-4: Bus system and Tingui Park
Source: (Taniguchi)

3.1.5. Inference:

In Curitiba, every mayor made sure that the proposed city plan is implemented. A strong political will is the main reason behind success of Curitiba's TOD. No system whether transportation, housing, revenue generation was thought of in isolation. Every system was a part of a larger comprehensive city plan. The investors were ready for long term investments. The transport system took 20 odd years for its full implementation. Involving people & gaining their confidence is another important aspect in Curitiba's planning process. The government assures that the traffic rules are strictly followed by the citizens of Curitiba. The government cautiously monitors the entire planning system which ensures that the fruits of development are enjoyed more or less equally by all the citizens of Curitiba.

3.2. Vauban-Freiburg, Germany

3.2.1. Introduction:

Vauban is a sub-urban neighborhood with a population of 5000 inhabitants located at the southern edge of Freiburg city; 3km from the city centre. In 1992, the French army vacated 41 hectare Vauban area which was under their control. Out of the total site area, squatters won their ownership right over 3 hectares of land. The remaining 38 hectares were acquired by Freiburg City Council who delegated the work of planning the area to a community group called Forum Vauban. Forum Vauban decided to develop the area as a 'car-free housing' [1]area.

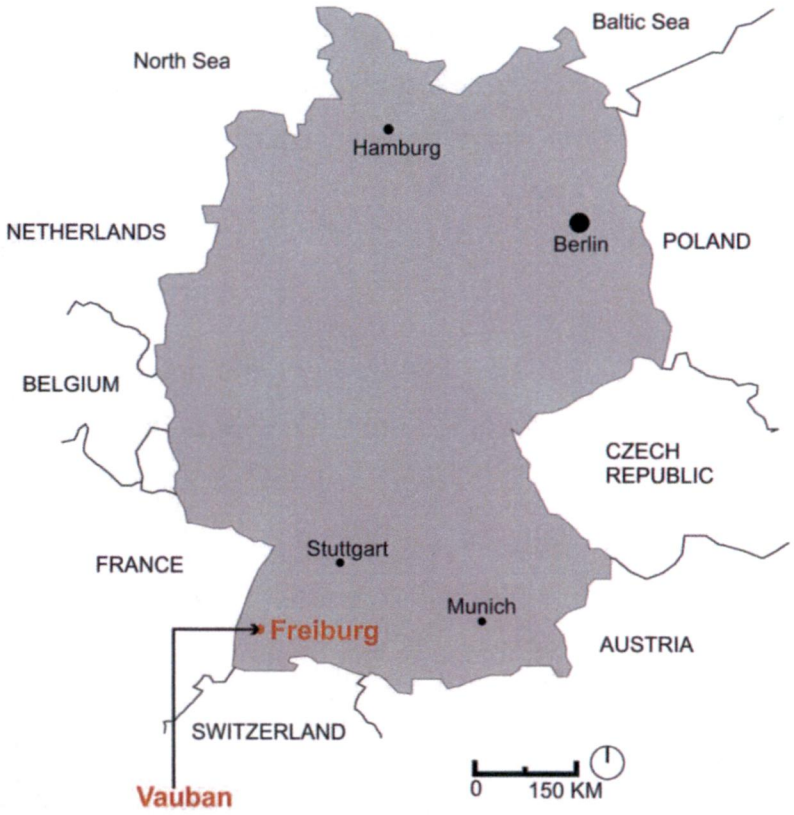


Figure 3-5: Location of Vauban, Germany
Source: Sketch plan by Author: Ref (www.elearning-conf.org)

[1] Car-free housing concept is supposed to have originated in Bremen, Germany in 1992. The concept does not completely eliminate car-use but instead limits the number of car-parking spaces. The residents have to purchase a car-parking space. As a result, many residents save on the cost of car-parking construction by deciding not to own a car. There are such car-free housing communities in Amsterdam, Hamburg, Vienna and Edinburgh (Scheurer, 2001)

3.2.2. Demography:

The population of Freiburg is around 200,000. The Vauban area has approximately 5000 inhabitants. The area has also generated around 600 jobs. The net residential density is around 100 persons/hectare. The neighborhood consists of 3-4 storeyed *walk-up* apartment blocks, each block housing 3-21 households. The average household size is 3.34. (www.vauban.de).

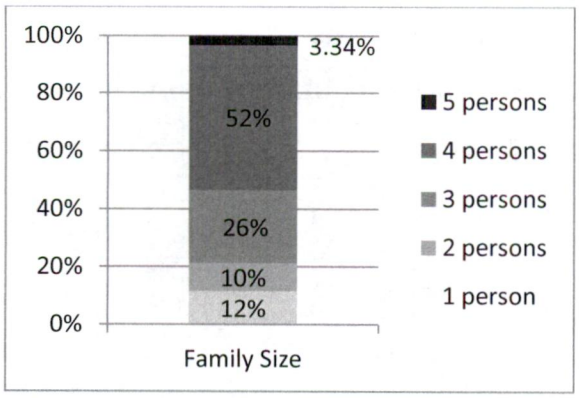


Chart 3-1: Vauban family structure

Chart 3-1 shows that many nuclear families stay in the Vauban area. Almost 55% of the families have four or more than four family members. There are a few students and single working persons which account for 12%

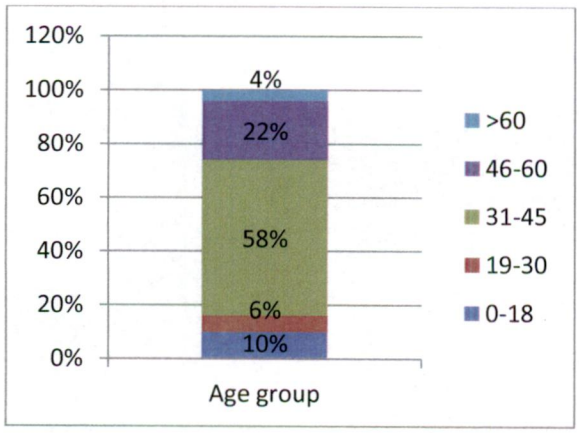


Chart 3-2: Vauban age structure

Chart 3-2 shows that the percentage of people above the age of 60 years is less (4%). Almost 96% of the families staying in the neighbourhood have one child. (Scheurer, 2001)

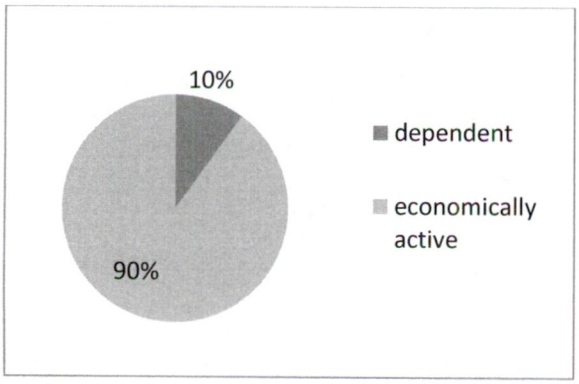


Chart 3-3: Vauban economically active persons
Source: (Scheurer, 2001)

As 86% of the people belong to the age group of 19yrs-60yrs, the percentage of people who are economically active is as high as 90%.

3.2.3. Planning:

The Vauban area was developed in five stages.

Stage1: Construction of a student housing and alternative commune (S.U.S.I.)

Stage2: The eastern part of the site was developed which consists of 240 units, 90% of these units are car-free

Stage3: The eastern side development was duplicated on the western side. It also included construction of a regional rail stop and tram terminus.

Stage 4: It included construction of about 210 energy-efficient solar houses in district of Schlierberg.

Stage 5: Under this stage the northern part of the site will get developed which shall hold some commercial and light industrial use.

The entire planning process was a ground-up process instead of the top-down process. Community groups were formed prior to the actual execution of the project which had their own say in the construction of building units.

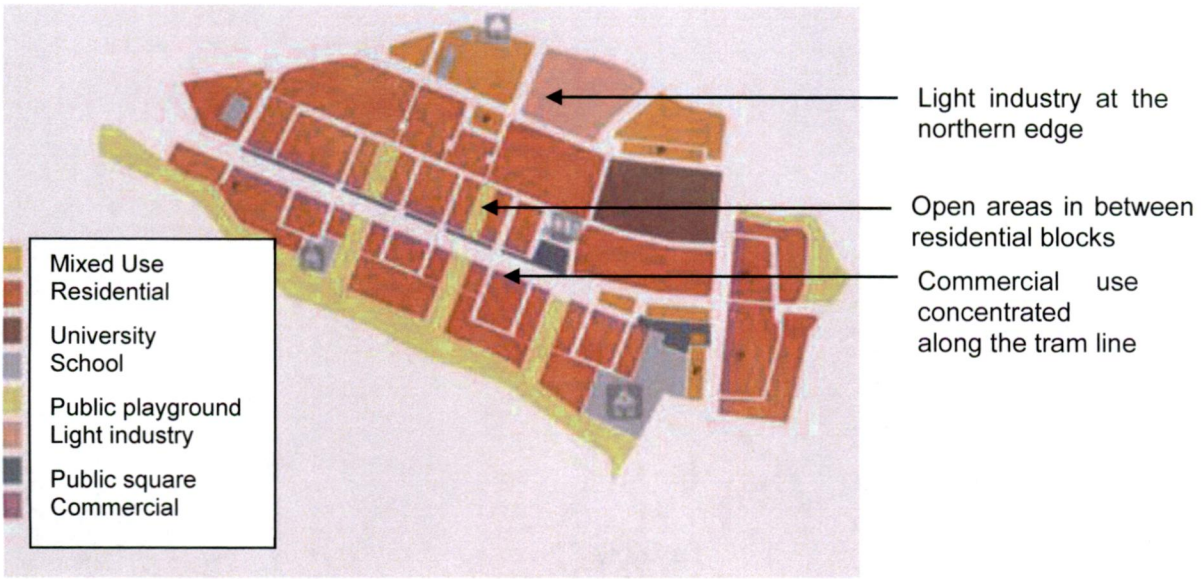


Figure 3-6: Vauban Land use Plan
Source: (Hesse)

3.2.4. Land use:

Vauban is a mixed-use neighborhood. Residential blocks having small retail or commercial use on the ground floor are located on both sides of the central tram line. The neighborhood also has educational facilities like a kindergarten, a school and a university located in close proximity to the tram stops. Light industries are located at the northern edge of the neighborhood.

3.2.5. Transport Network:

The transport network of Vauban has been planned to discourage the use of private car. Vauban is a very good example of integrated transportation planning. The local transportation is very well connected to the regional transportation network. The tram or bus stops are located in close proximity with the surrounding mix-use development. The focus of transportation planning is on the mobility of people rather than on the mode of transportation itself. This enables the people to make quick interchanges between different modes of transport.

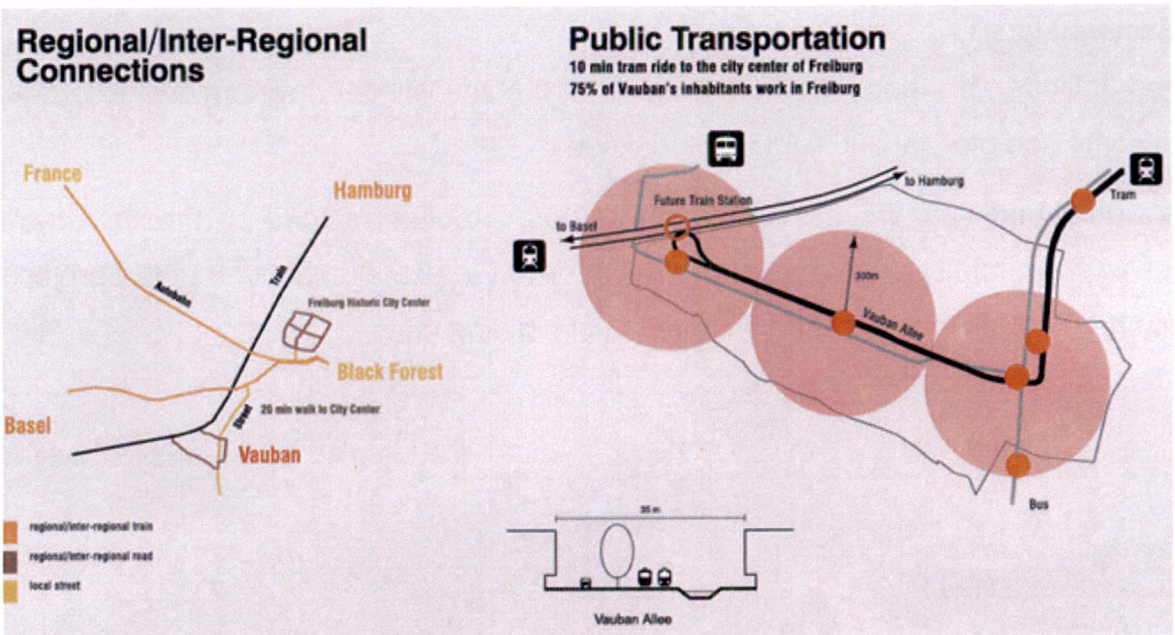


Figure 3-7: Vauban Transportation:
Source: (Hesse)

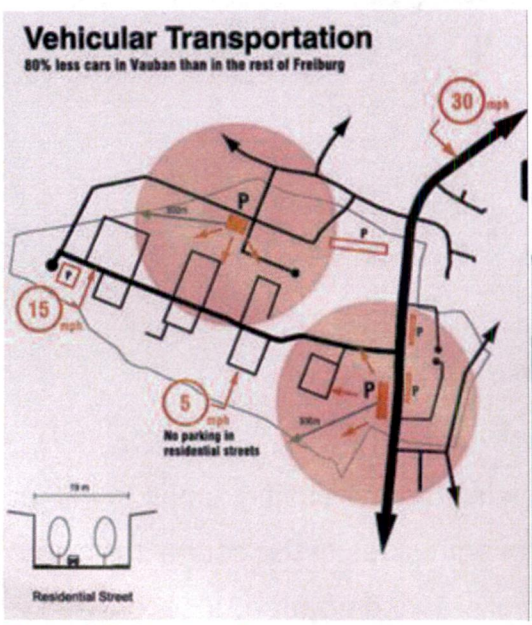


Figure 3-8: Vauban development along tram line
Source: Author, 25-02-201

3.2.6. Transport Policy:

The salient features of the Vauban Transport policy are as follows:

- Extension of public transport network: Vauban area is very well connected with the Freiburg City centre by a tram and bus line. The residents of Vauban can use the bus or tram to reach their workplaces in Freiburg in about 15 minutes. Buses and trains can be used by the people to travel in the entire Breisgau Region[2]. Through mutual tie-up with the Deutsche Bahn[3] and regional transportation, members of car-sharing association, upon payment of certain deposit, get passes to travel freely in the black forest region and travel at half the price in Germany.

- Promotion of cycling: Almost 27% of the residents in Vauban use bicycles as a mode of travel to access the places of their daily visit. The roads in Vauban area as well as in Freiburg have dedicated bicycle lanes and the city council encourages bicycle ridership.

- Traffic restraint: The entire neighborhood of Vauban was planned as a car-free neighborhood. As a result, private motor vehicles are allowed to run only on the main access road with a speed limit of 30km/hr and on the side roads with a speed limit of 15km/hr. This policy of restricting the speed limit for motorized vehicles makes the roads safe for pedestrians and bicycle users.

- Parking space management: The main idea behind planning of Vauban area was to provide limited car-parking space to its residents. Therefore, every resident who owns a car has to purchase a car parking space. A car parking space may cost as high as 17,500 € (Melia, 2006).This price is far higher as compared to the price of the car itself. Besides this, the car owners have to pay additional monthly fee to cover the maintenance costs of parking spaces. As a consequence, the residents of Vauban voluntarily opt of not using a car; but instead use public transport to travel to their work places.

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[2] The western edge of Black forest in the Upper Rhine Plain is considered to be the Breisgau Region. It is a part of the state of Banden- Wurttemberg, Germany. Freiburg im Breisgau is located towards the south-west of this city. (www.wein.de)

[3] Deutsche Bahn or DB is the German national railway company

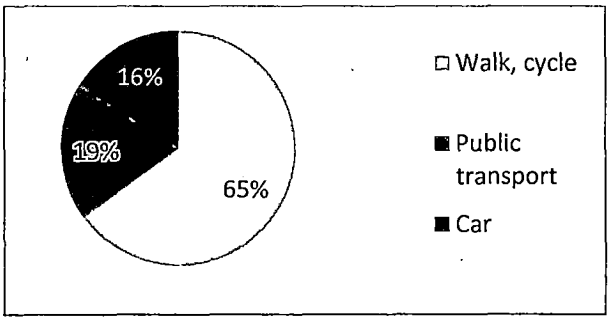


Chart 3-4: Vauban modal split

3.2.7. Mobility characteristics:

Due to provision of excellent facilities for pedestrians and cyclists, 65% residents either walk or use bicycles to travel to their work places

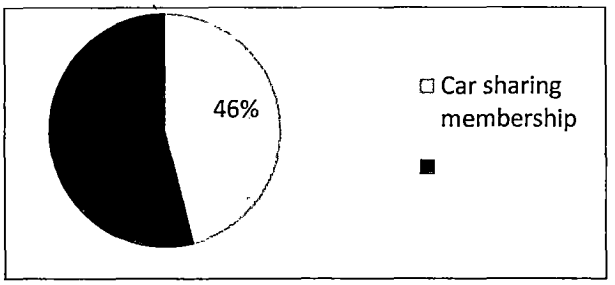


Chart 3-5: Vauban car sharing

Chart 3-5 shows that almost half of the residents are members of the car-sharing association. The members can travel using public transport at discounted fares.

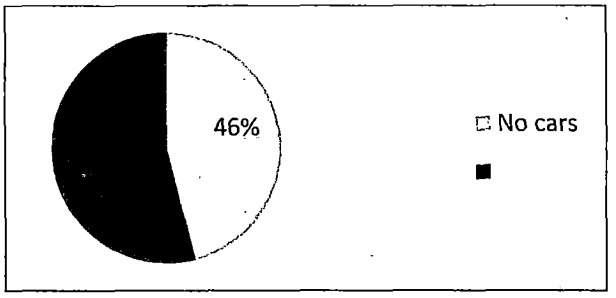


Chart 3-6: Vauban car ownership

To avoid the cost of buying a car parking space, 46% of the Vauban residents opted for not using their own private car. The remaining 54% mostly share their cars with other residents of the neighbourhood.

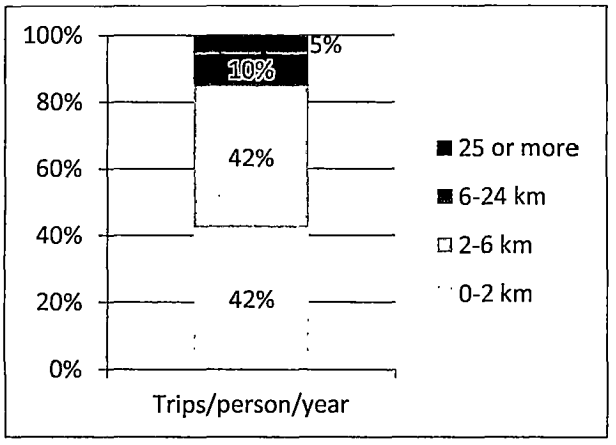


Chart 3-7: Vauban annual trip distribution
Sources: (Scheurer, 2001)

84% of the total trips are less than 6km. This is mainly due to location of good jobs within the Freiburg city centre itself which is 3km from the Vauban area. The remaining people have the option of using buses or trains to travel to far off places.

3.2.8. Transit Oriented Development:

As discussed earlier, Vauban area is a mixed-use settlement. Facilities like retail shops, kindergarten, school, are all located within easy walking distance from the residences. Most of these daily requirement facilities are located within 300m radius from the tram or bus stop as shown in the figure below.

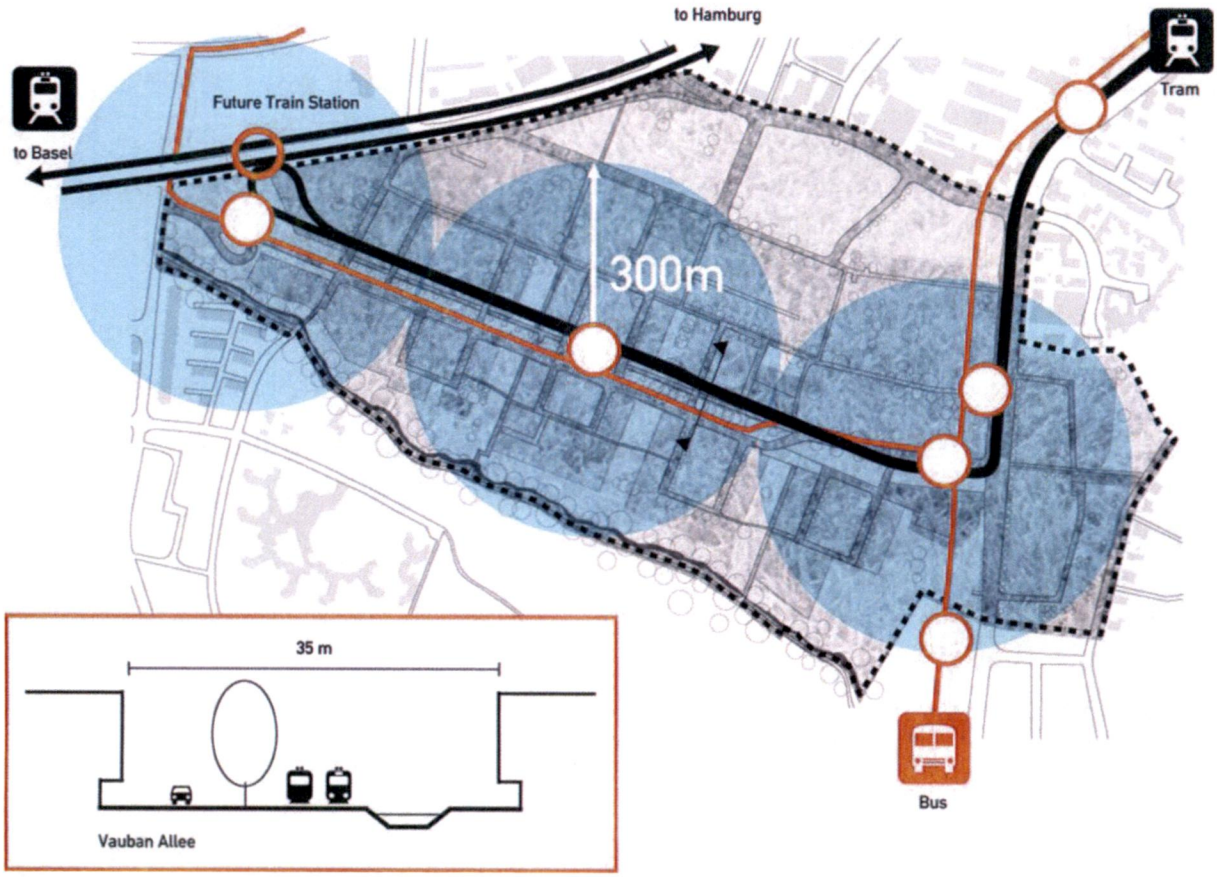


Figure 3-9: Vauban TOD
Source: (Hesse)

Figure 3-10: Vauban:School & workplace located near the transit stop
Source: Author 25-02-2012

3.2.9. Critical observations:

Figure 3-11: Central access road
Source: Author 25-02-2012

The width of central access way is almost 3 times the height of the surrounding structures. This scale of the access way does not enable it to act as a vibrant public street. Vehicular traffic and pedestrian movement are placed on opposite sides of access way separated by a central tram line. As a result, pedestrians can walk freely only on one side of the main road.

Figure 3-12: Vauban: Car park on central access road
Source: Author 25-02-2012

The retail businesses along the vehicular way are not easily visible to the pedestrians on other side of the street due to continuous car-parking in between.

3.2.10. Conclusion:

Vauban is a very good example to study how landuses can be well integrated with a public transportation network. It also showcases the importance of community participation in planning. However, an efficient public transport system is a prerequisite to introduce a concept like car-free community in India. It also requires a serious reconsideration of the existing bye-laws in India; specifying the minimum compulsory parking spaces to be provided per tenement.

3.3. GWL Terrein–Amsterdam, Netherlands

3.3.1. Introduction:

GWL Terrein is a small neighborhood located in the western district of Westerpark in Amsterdam. It is located 3 km away from the main city centre and historical centre of Amsterdam. It is connected by a tram line to the city centre. The GWL terrain project has an area of 6 hectares and was developed during 1995-98 on a former water works site used by municipal water utility. The housing consists of 600 dwelling units. In addition to this, the neighborhood consists of 1200 sq.m of office space and accommodation for older people. At the project's inception, the borough council ran a newspaper advertisement to inform the public of its plans, resulting in 4000 serious respondents interested in buying or renting a unit on GWL-terrein. Future residents were asked to sign a non-obligatory declaration of support for the car-free nature of the site. The apartments were completed in stages between late 1996 and early 1998. The housing is a mixture of 50% owner occupied apartments and 50% rented apartments. (Scheurer, 2001)

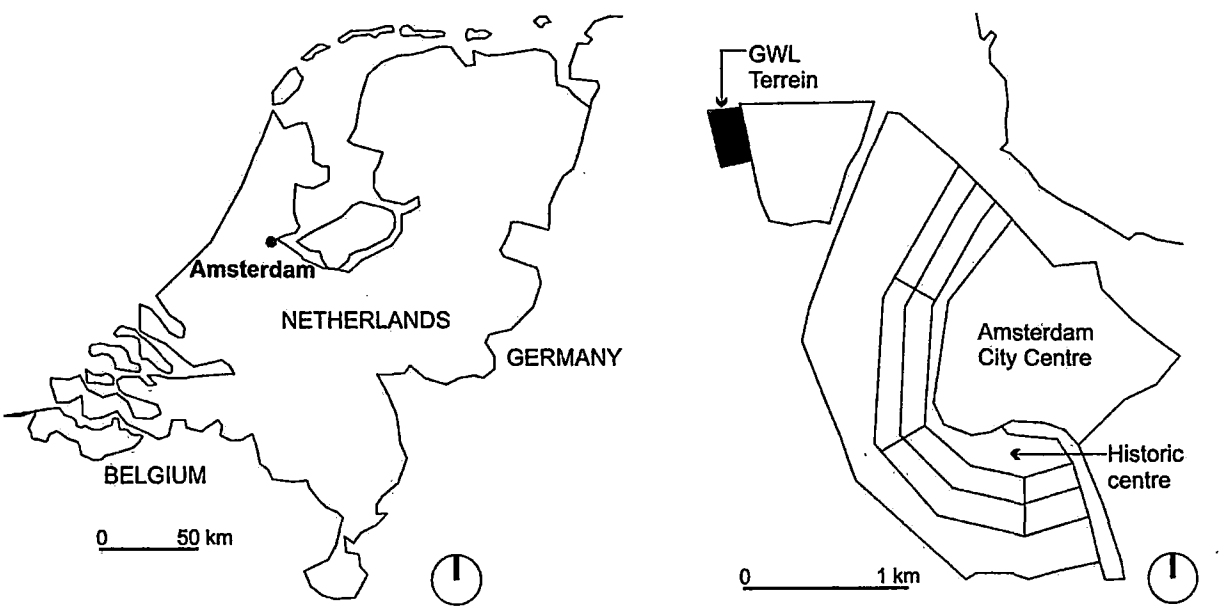


Figure 3-13: GWL Terrein location
Source: Traced from map Ref: www.sustainability murdoch.edu, europa.eu

3.3.2. Demography:

The GWL Terrein consists of 600 dwelling units which accommodate a population of 1400 inhabitants. The net residential density is 100 units per hectare. The neighborhood consists of five storeyed apartment blocks. The average household size is 2.3. The average unit size in 87 sq.m & average dwelling area per person is 37.1 sq.m.

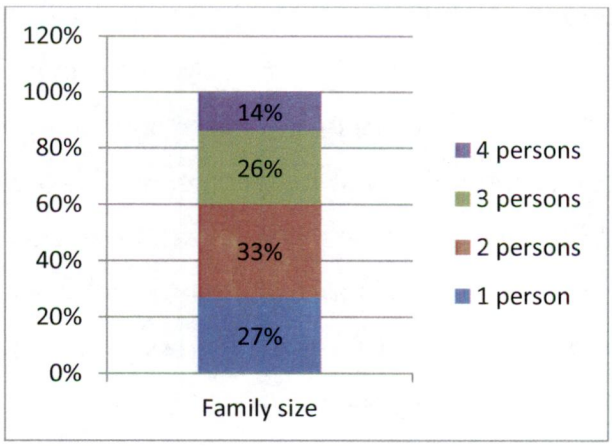


Chart 3-8: GWL Terrein Family Structure
Source: (Scheurer, 2001)

Chart 3-1 shows that there 60% households have single or double occupancy. This is also reflected in the average unit size which is 87 sq.m

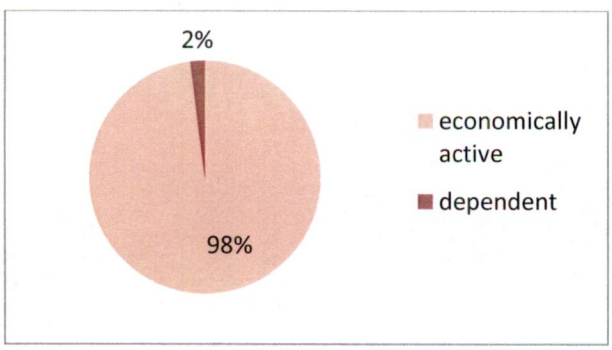


Chart 3-9: GWL Terrein Economical status of inhabitants
Source: (Scheurer, 2001)

The significant point about the GWS Terrein housing is that 98% of its residents are economically active while only 2% are dependent. This results in many daily trips for job purpose. Many people use public transit for this purpose

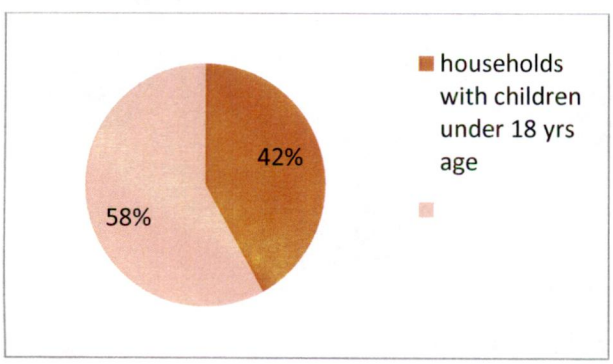


Chart 3-10: GWL Terrein Households with children
Source: (Scheurer, 2001)

Chart 3-3 also shows that 42% of the households have children who are under the age of 18 years. Besides work trips, there are significant daily trips for educational purpose also.

3.3.3. Planning:

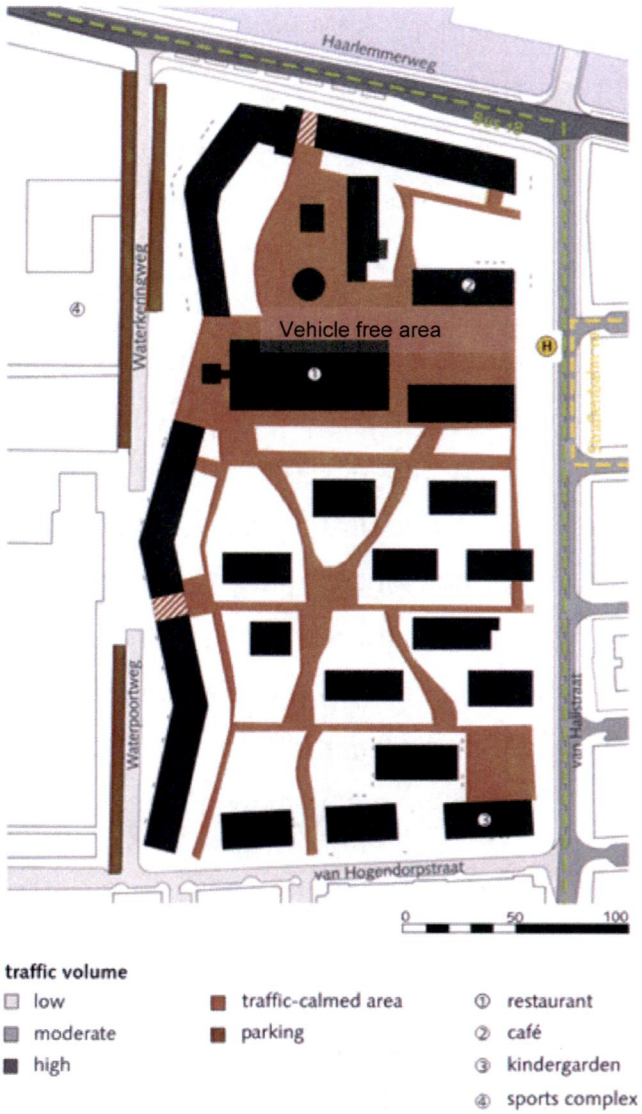


Figure 3-14: GWL Terrein Layout Plan
Source: (GWL Terrein in Amsterdam)

GWL Terrein housing consists of 5 storeyed apartment blocks and a surrounding 5-10 storeyed continuous perimeter building on the northern and the western sides as indicated in Fig 3-22.

The housing is connected by a bus and tram line running parallel along the Van Hallstraat Street towards the eastern side. Traffic is calmed along this road and the footpath is widened giving priority to pedestrians. Only 110 parking spaces are provided for 20% of the residents. The interior is made vehicle free, making it safe for children and residents to move freely.

Figure 3-15: GWL Terrein before and after development
Source: www.itdp.org

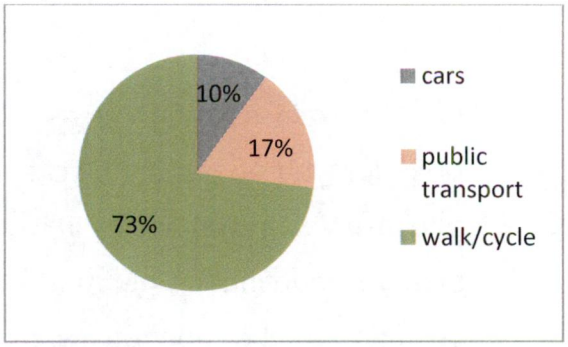


Chart 3-11: GWL Terrein Modal Split:
Source: (Scheurer, 2001)

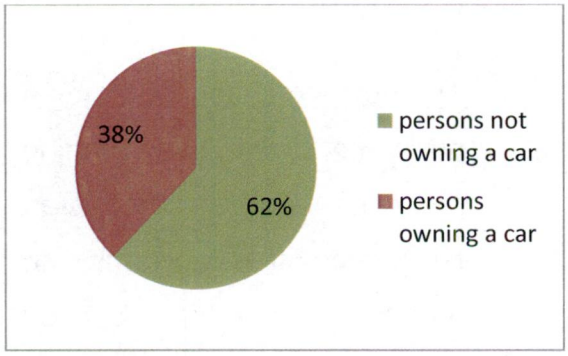


Chart 3-12: GWL Terrein, car ownership
Source: (Scheurer, 2001)

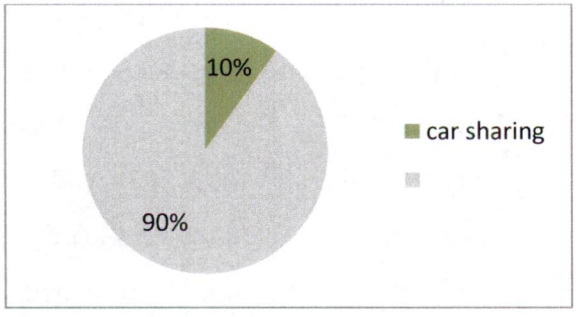


Chart 3-13: GWL Terrein car sharing
Source: (Scheurer, 2001)

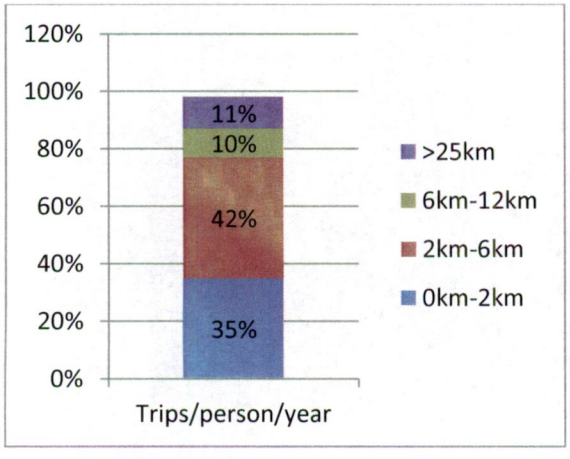


Chart 3-14: GWL Terrein: annual trip distribution
Source: (Scheurer, 2001)

3.3.4. Mobility characteristics:

The city of Amsterdam is famous for its pedestrian and bicycle network. This is reflected in the travel pattern of GWL residents, wherein 73% of the residents walk or cycle to reach their destination.

The average supply of parking spaces is 0.2 per unit. Due to limited provision of paid parking space, good frequency of bus and tram service, 62% of the GWL households have voluntarily opted for not using a car. Still, 38% of the households own a car which they often park in their friend's car parking space; outside the main housing area.

Around 10% of the housing residents are members of the car sharing association. People mainly prefer the car sharing option to travel to far off places.

GWL Terrein is a mixed-use settlement. Since most of the facilities of daily requirement are located within or around the settlement itself, 35% of the trips have trip length less than 2km while 42% of the trips have trip length between 2km to 6km.

3.3.4. Observations:

Figure 3-16: GWL Terrein: Connection to public transport
Source: Author, 07-03-2012

The surface level of housing is raised above the adjacent road level to prevent cars from entering into the housing area. The housing area and the main vehicular street are separated by a bicycle track and a pedestrian walkway in between. The building blocks are located right along the edge of bicycle track without leaving any setback.

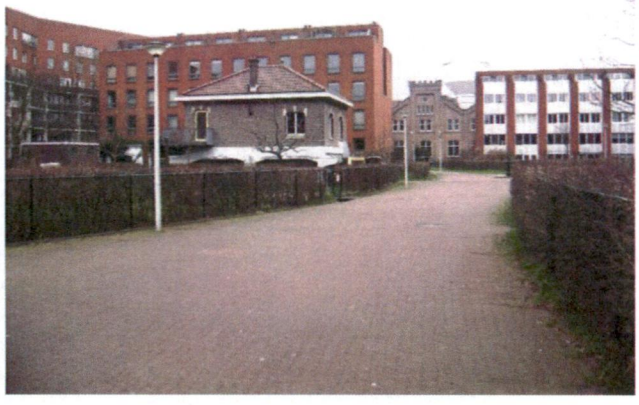


Figure 3-17: GWL Terrein: Pedestrian ways
Source: Author, 07-03-2012

The free flowing walkways break the rigid rectangular geometry of building units and create interesting intersections for pedestrians. The water tower serves as a reference for the visitors to orient themselves within the housing area.

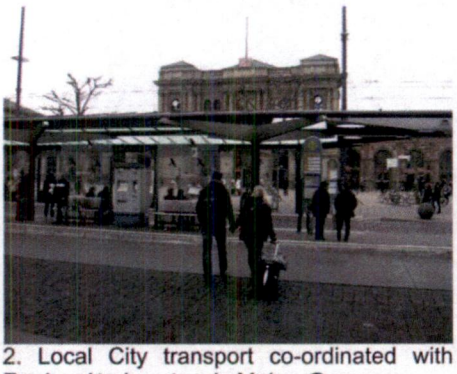
3.3.5. Conclusion:

GWL Terrein is a good example of cluster development, wherein the vehicular movement is restricted to the periphery of the housing and the interior is made completely vehicular free and safe for children, pedestrians and the aged. The car-free sharing concept of the settlement has contributed in promoting Amsterdam's green policy of walking and cycling as main modes of transport.

3.4. Learning through examples from cities in Europe:

Almost all the cities in Europe have been promoting walking, cycling and the use of public transport system. A photographic documentation of these sustainable transport practices was done as under:

1.Provision for cycle parking outside train station- Gent, Belgium (04-03-2012)

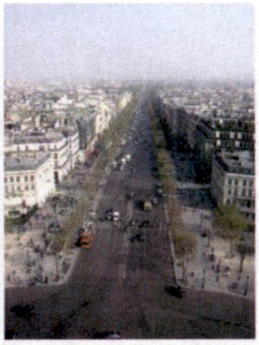


2. Local City transport co-ordinated with Regional train network- Mainz, Germany (03-03-2012)

3. Promotion of cycling, Rotterdam, Netherlands (05-03-2012)

4. Limiting width of vehicular carriageway and introducing central pedestrian walkway & green area- Rotterdam, Netherlands (05-03-2012)

5. Central pedestrian plaza - La Rambla, Barcelona, Spain (03-01-2012)



6. Wide pedestrian walkway-Paris, France (01-04-2012)

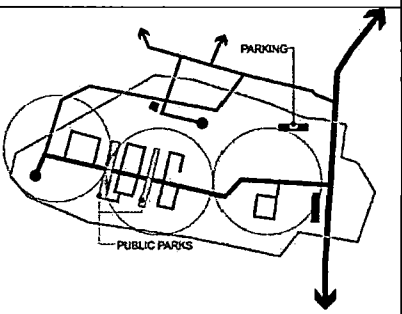
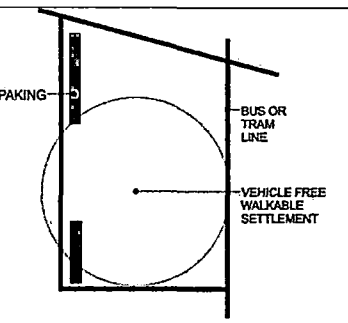
Figure 3-18: Sustainable transit practices in Europe
Source: Author

Observation:

The significant aspect about the transport system in Europe is that many cities have retained the traditional tram system in spite of developing rapid transit systems like metro. The tram system is a very good option for travelers willing to travel at a moderate speed, experiencing the city character. The main city core or the historical area is vehicle free in many cases. Pedestrians and cyclists can move freely, which also benefits the local market and traders in that area.

3.5. Summary: Comparison of case studies:

Table 3-3: Summary of case studies

	Curitiba	Vauban	GWL Terrein
Purpose of case study	This case study has been selected to analyze TOD from the point of view of policy making	This case study has been selected to analyze the planning and design details of TOD at the neighborhood level	GWL Terrein has been selected to analyze the aspects of planning a cluster along a public transport line at neighbourhood level
Planning Concept	The concept was to create a well-connected bus network in the city of Curitiba.	 Linear development along both sides of bus and tram service	 Cluster development along one side of public transit
Significant aspects	Long term vision and goals. Integrated approach towards transportation, housing, revenue generation	Reducing private vehicles through planning strategies and public participation Locating good jobs along transit line. Promotion of walking and cycling	Best reuse of earlier water works site Creation of vehicle-free space within a cluster Location of jobs within housing cluster itself Preventing entry of cars in housing through design rather than enforcement.

Source: Author

4. Status Appraisal of Planning Area

4.1. Introduction:

This chapter critically analyses the current physical, social and economic status of Pimpri-Chinchwad Area which is a part of larger Pune Metropolitan Region. The study is carried out to a large extent by analyzing extensive secondary data available in the form of city development plans, development policies and development control rules. These plans and policies are comprehensive, providing relevant information with the help of figures and statistics. Any additional data required for the study apart from the data obtained through secondary sources is obtained through surveys, interviews and questionnaires.

Table 4-1: Data Inventory of plans and policies referred

S. No	Report/ Document Referred	Year	Institution/ Organization
1.	*Comprehensive Transport Policy for Pune Metropolitan Region (PMR)*	2007	Pune Municipal Corporation (PMC), Assistance by CRISIL
Purpose of the study: • To study the various transport guidelines, recommendations & broad visions let down for Pune Region • To analyze whether the guidelines are in line with the National Urban Transport Policy (NUTP)			
2.	*City Development Plan for Pimpri-Chinchwad Under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) 2006-2012*	2006	PCMC. Technical Assistance by CRISIL
Purpose of the study: • To study the various transportation proposals which are sanctioned as part of JNNURM • To study the overall visions enlisted in the Development Plan • Formulating strategy			
3.	*Comprehensive Mobility Plan for Pimpri-Chinchwad Municipal Corporation (PCMC)*	2008	PCMC, Assistance by CRISIL

Purpose of the study:

- Assess existing road network, traffic and travel characteristics
- Review existing & proposed land use plans
- Identify short, medium & long term measures
- Assess existing road network, traffic and travel characteristics
- Review existing & proposed land use plans
- Forecast travel demand & identify transport requirements
- Identify short, medium & long term measures

4.	*Pimpri-Chinchwad Detailed Project Report for BRTS*	2008	PCMC

Purpose of the study:

- Assess traffic & travel characteristics of the study area
- Forecast travel demand & identify transport requirements
- Identify BRT corridor, design & develop segments
- Project scheduling & cost estimates
- Project phasing
- Financial analysis of corridor
- Set recommendations with respect to JnNURM reforms

5.	*Master Plan for BRTS Integrated with Cycle Network for PCMC*		TRIPP, IIT Delhi & CIRT, Pune

Purpose of the study:

- Assess traffic & travel characteristics of the study area
- Forecast travel demand & identify transport requirements
- Integration of NMV along with BRTS
- Compile information for Aundh-Rawet BRTS Corridor

6.	*Special Township Scheme*	2004	Government of Maharashtra

Purpose of the Study:

- To analyze the government's perspective about private investment in housing sector
- To understand the criteria, regulations for a township to qualify as a special township scheme

4.2. Pune Metropolitan Region:

Pune Metropolitan Region (PMR) is the major urban agglomeration in the Haveli Taluka of Pune District in the state of Maharashtra. PMR is the eighth largest metropolitan region in India in terms of population and second largest metropolis in the state of Maharashtra after Mumbai.

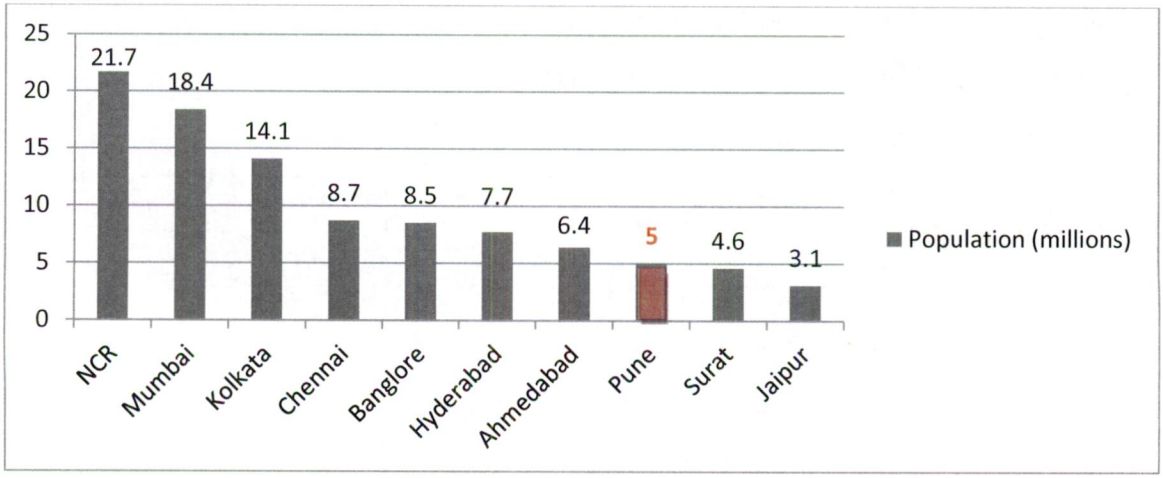


Chart 4-1: Ten most populated metropolitan regions of India, 2011
Source: (Office of the Registrar General & Census Commissioner, 2011)

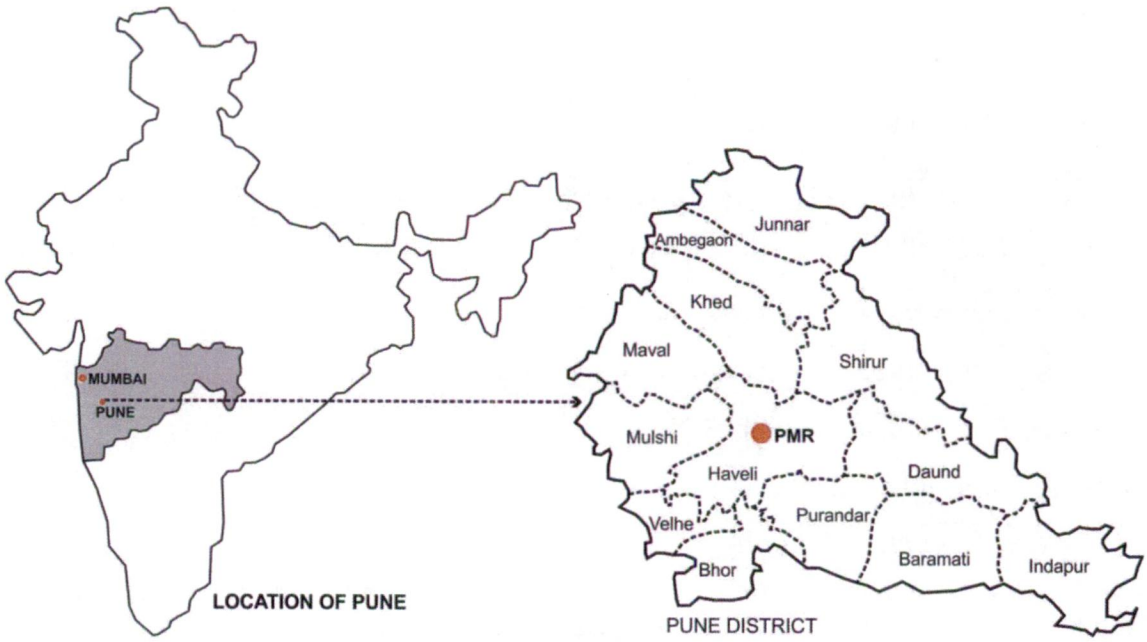


Figure 4-1: Location of Pune Metropolitan Region (PMR)
Source: Traced by author (Map indicative, not to scale: Ref-punediary.com)

Pune Metropolitan Region (PMR) is spread over an area of about 1340 sq.km. It consists of 4 major administrative bodies and close to 100 surrounding towns and villages

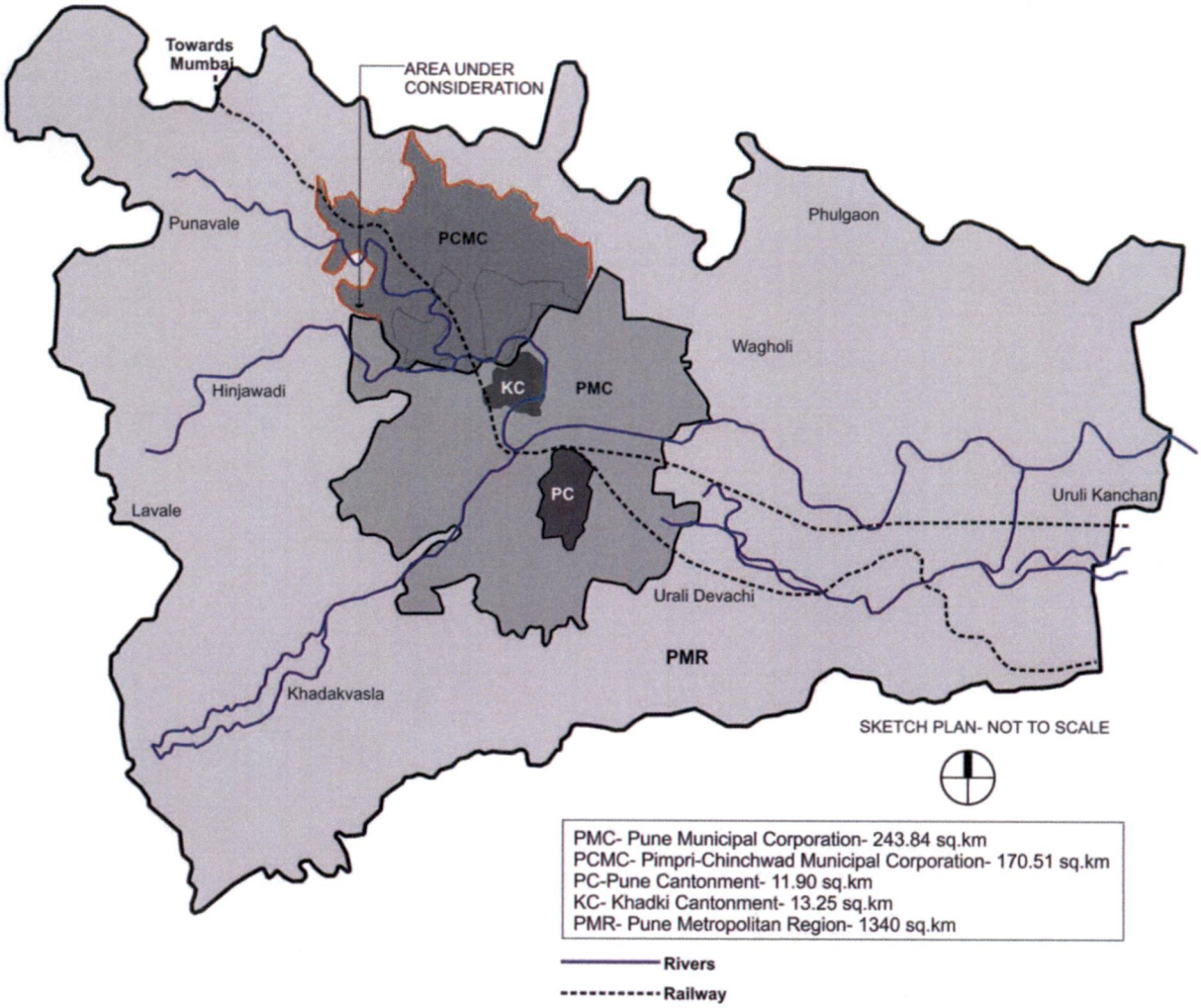


Figure 4-2: Pune Metropolitan Region
Source: Author

A 30 member Pune Metropolitan Planning Committee (PMPC) was constituted in April 2008 to decide about the formulation and structure of a Pune Metropolitan Regional Development Authority (PMRDA). The PMRDA was supposed to have the powers of regional planning for entire PMR. However, PMRDA is still on paper and has not been constituted till date. (Umbrajkar, 2011)

The PMR consists of following four major administrative divisions:

I. Pune Municipal Corporation (PMC)
II. Pimpri-Chinchwad Municipal Corporation (PCMC)
III. Pune Cantonment (PC)
IV. Khadki Cantonment (KC)

Table 4-2: Overview of PMR[1]

Administrative body	Area (sq.km)	Population (million)		Growth in past decade 2001-2010	Overall Population density No of persons/ sq.km		Projected Population	
		2001	2011		2001	2011	2021	2031
PMC	243.84	2.54	3.34	31.5%	10410	13698	4.40	5.63
PCMC	170.51	1.01	1.73	71%	5902	10142	2.75	4.10
PC	11.90	0.08	0.07	-15%	6719	5704	1.30	1.40
KC	13.25	0.07	-	-	6035	-	1.07	1.39
Rest	900.50	0.56	-	-	622	-	1.07	1.39
Total PMR	1340	4.30	5.52	28.37%	3208	4119	8.48	11.41

Observation:

From the table above, it is clear that the population in PCMC has increased by 0.72 million from 2001 to 2011 with a decadal growth rate as high as 71%. This increase in population of PCMC is maximum as compared to the population increase in any other administrative body in PMR. This increase in population is mainly due to development of industries, information technology sector and good connection to Mumbai by means of Mumbai- Pune expressway.

[1] The table is prepared by referring to the following:
CMP, PMC, 2008
Preliminary Census Report-2011: www.censusofindia.gov.in
Pune Cantonment Board: punecantonmentboard.com accessed on 19-02-2012
Khadki Cantonment Board:
Newspaper Articles: DNA-Pune on April 4, 2011
Indian Express-Pune on May 20, 2011.

4.3. Pimpri-Chinchwad Municipal Corporation Planning Area :

4.3.1. Introduction:

Pimpri-Chinchwad Municipal Corporation is the main administrative body looking after the land-use and growth management for towns of Pimpri, Chinchwad as well as surrounding 18 villages. Under Bombay Provincial Municipal Corporation Act (BPMC), 1949, PCMC is obliged to undertake land-use planning as well as provision of basic infrastructure services. It is important to briefly take an overview of evolution of a small industrial area into a town with 1.7 million population.

Table 4-3: Growth of PCMC and major events:

Year	Event:	Population
1956	Setting up of Hindustan Antibiotics Limited in the area of Pimpri-Chinchwad	26,367 in 1951
1961	Establishment of Maharashtra Industrial Development Corporation (MIDC). Many industries established.	39,654
1970	A 'C' Class Pimpri-Chinchwad Municipal Council formed for 4 villages, Pimpri, Chinchwad, Bhosri and Akurdi	98,572 in 1971 Growth rate of 148.6% for the decade of 1961-1970
1972	Pimpri-Chinchwad New Town Development Authority Constituted for development of adjoining areas.	
1975	Pimpri-Chinchwad Municipal Council converted from 'C' class to 'A' class.	
1982	Pimpri-Chinchwad Municipal Corporation (PCMC) constituted and preparation of DP started for an area of 86 sq.km.	2,51,769 in 1981 Growth rate of 155.4% for the decade of 1971-1980
1995	The DP sanctioned and came into force after 13 years.	5,20,639 in 1991 Growth rate of 106.8% for the decade of 1981-1990

1997	The villages under PCNTDA merged with PCMC taking its area of jurisdiction from 86 sq.km to 170.51 sq.km	
2007-08	The DP was under revision.	10, 06,417 in 2001. Growth rate of 93.3% for the decade of 1991-2000
2011	Ongoing implementation of BRTS	17,29,320 as per preliminary census, Growth rate of 71%

Source: Author Ref: (PCMC C. , Pimpri-Chinchwad- City Development Plan 2006-12 under JNNURM, 2006)

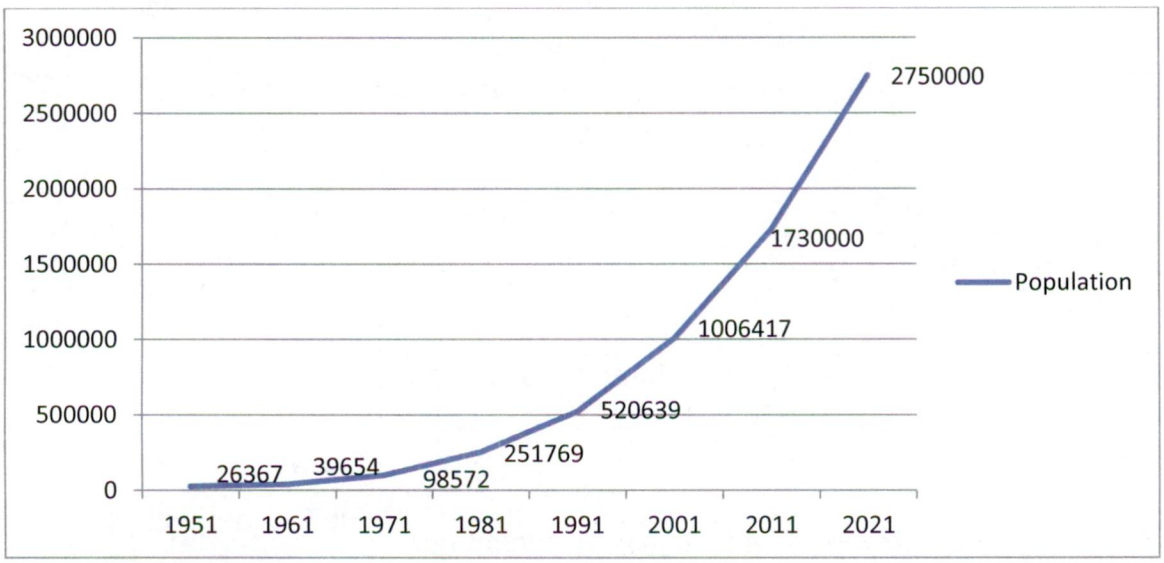


Chart 4-2: Population Growth in PCMC
Source: (PCMC C. , Pimpri-Chinchwad- City Development Plan 2006-12 under JNNURM, 2006, p. 35)

Observation:

Table 4-3 and Chart 4-2 indicate that the population growth of Pimpri-Chinchwad started form 1961 with setting up of industries. The decade of 1971-80 witnessed the maximum growth rate of 155.4%. Many people settled in Pimpri-Chinchwad due to creation of job opportunities. Since then the growth rate has been nearly 100% because of the development of following sectors:

- Auto and ancillary industry
- Higher education centres
- Information Technology Sector (IT)
- Bio-technology Hubs

- Agro and food processing industry.

The planning process has been extremely slow and has failed to cope up with the pace of population growth. The CDP of PCMC, states that, "The primary issue with regard to physical planning in Pimpri Chinchwad is time consuming implementation of DP that has resulted in the haphazard developments on the periphery of the city."

The current area of jurisdiction under PCMC and the newly merged villages are indicated in the following map. (Fig 4-3)

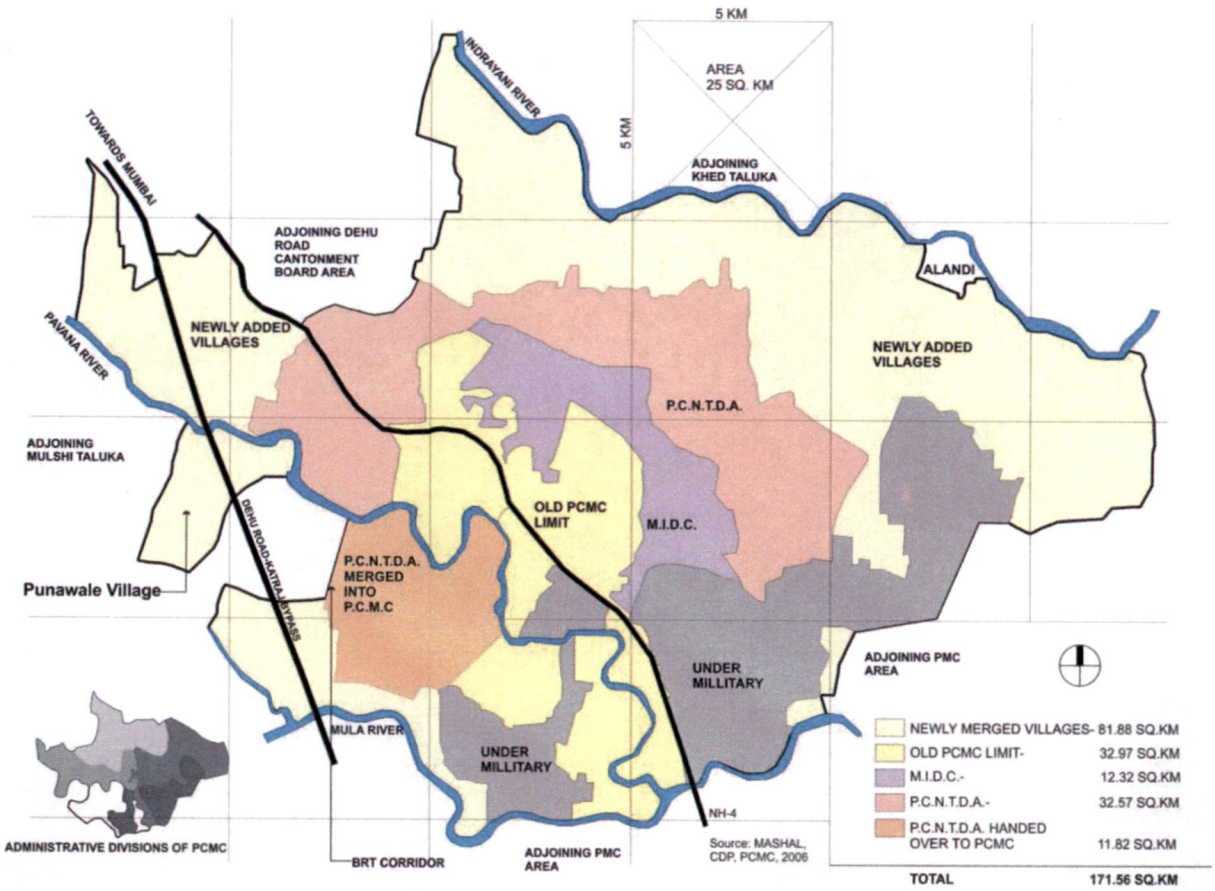


Figure 4-3: PCMC Limit
Source: Traced by author Ref: MASHAL, CDP, PCMC, 2006

4.3.2. Population Density:

As indicated in Table 4-2, 170.51 sq.km area of PCMC has a population of 1.73 million. The overall population density is 10,142. Area wise population density is indicated in the following figure

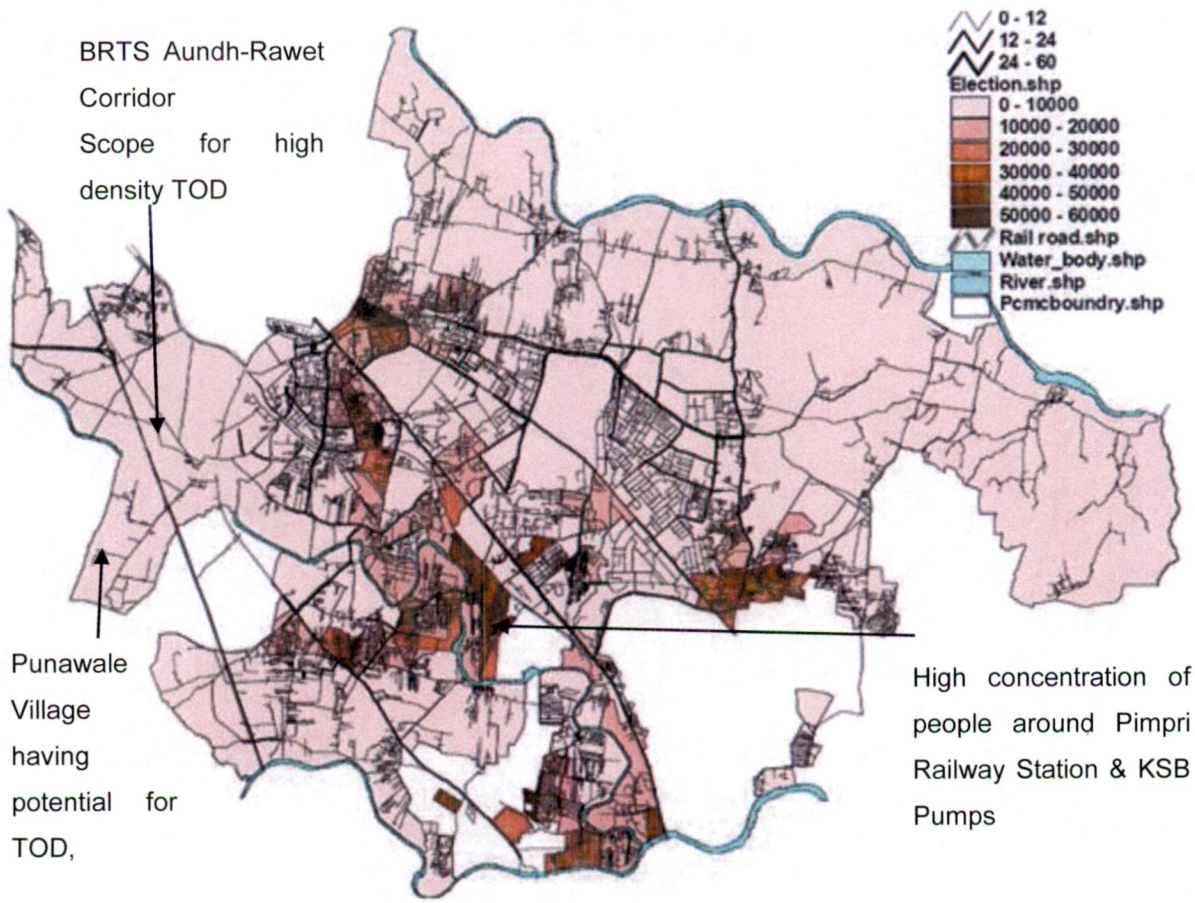


Figure 4-4: PCMC Population Distribution
Source: (PCMC C. , 2008)

Observation:

Major population is concentrated in the Industrial Area of Pimpri-Chinchwad, in close vicinity to National Highway-4 (40,000-60,000). Comparatively, the areas surrounding the Aundh-Rawet Highway have less population (less than 10,000). This corridor is important as it meets the Mumbai-Pune Expressway. As a result, it is extremely important to recognize the future urban growth along the highway and plan the land uses accordingly.

4.3.3. Proposed Land Use:

PCMC has prepared a combined draft development plan for the old PCMC areas as well as for the newly merged areas. This plan is still pending for state approval.

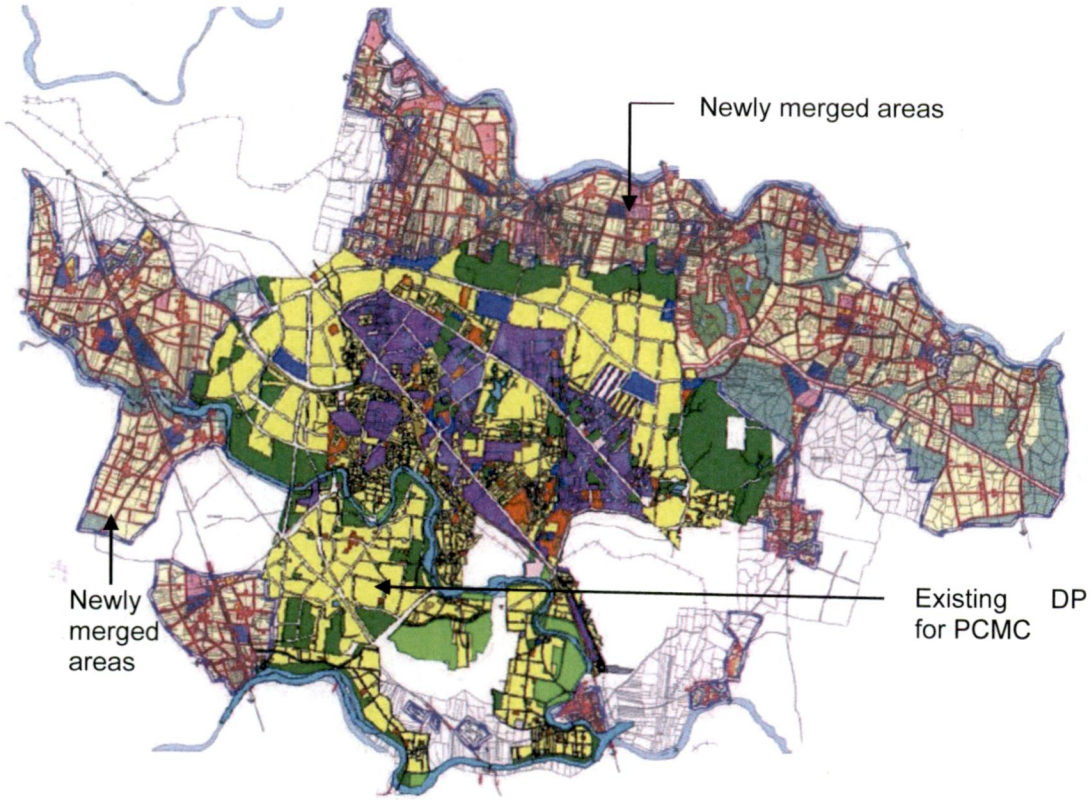


Figure 4-5: PCMC Draft Land Use Plan
Source: (PCMC C. , 2008)

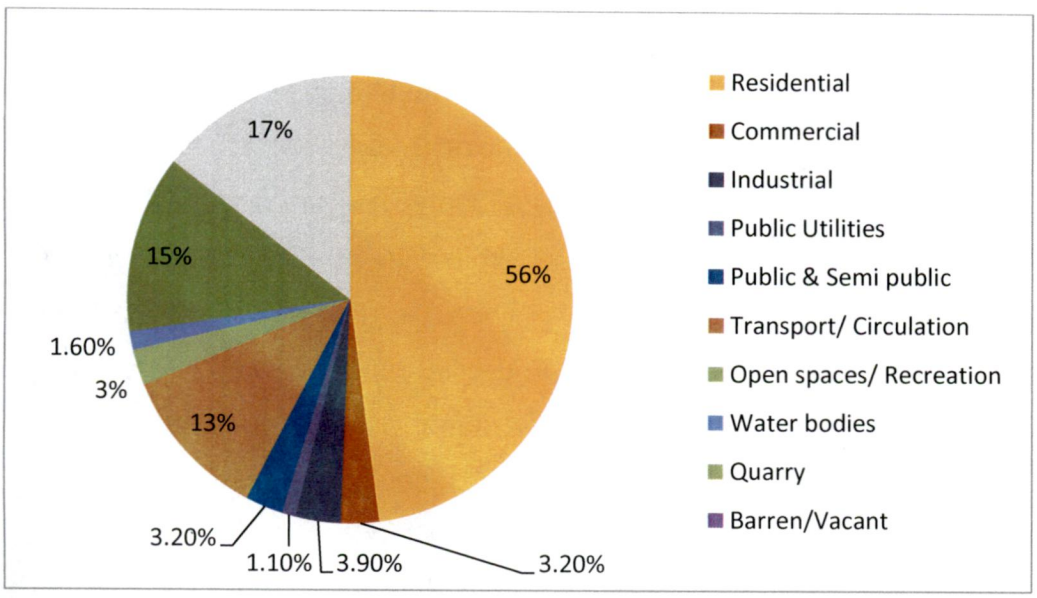


Chart 4-3: PCMC Land Use break up
Source: Author Ref: (PCMC C. , 2008, p. 34)

Observation:

The proposed land use plan for PCMC is a combined plan taking into consideration the current area within the municipal corporation limits as well as the surrounding newly merged villages. The current municipal limit was planned predominantly as an industrial area. As a result, major industries are located in the current city limit. The newly added villages have been planned primarily as residential areas (56% residential land use). It is important that these residential areas are well connected to the workplaces. A well planned public transport network is necessary to achieve a good connection between areas of residence and areas of work. The land use plan has 13% of total area reserved for circulation and transportation. Thus, it becomes vital to plan in detail the landuses along these transportation links so that places of stay and places of work are well connected with each other.

4.3.4. Proposed FAR:

The proposed FAR for the existing core areas as well as newly merged areas is as follows:

Table 4-4: Existing FAR in PCMC

Use	FAR	Maximum allowable FAR:
Core Area		
Residential	1.5	
Mixed	2	
Commercial	2	
Institutional	1.5	2.25
New Areas		
Residential	1	
Mixed	1	
Commercial	1	
Institutional	1	

Source: Author Ref: (PCMC C. , 2008, p. 35)

Observation:

The newly added areas have been allocated a very low FAR as compared to the existing areas. Also, institutional, commercial and mixed use areas have been allocated a uniform FAR of 1; similar to the residential areas. There is no provision made to identify special areas especially around major transport corridors which could have a higher FAR.

4.3.5. Existing housing types:

It is important to understand the existing housing typologies in PCMC and analyze the resultant pattern of development.

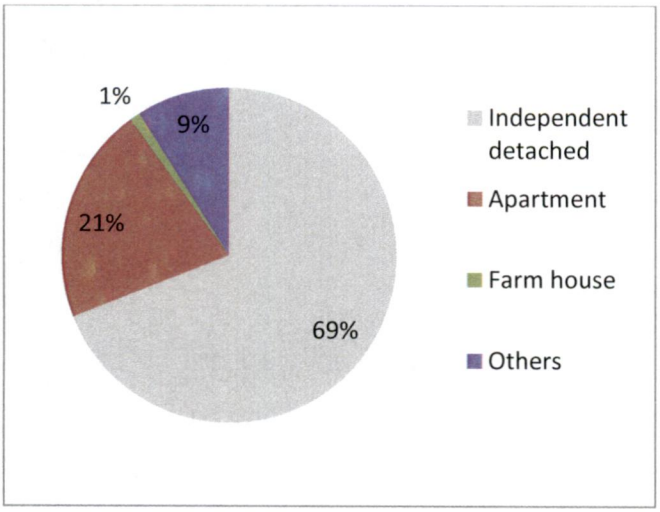


Chart 4-4: PCMC:Type of housing based on typology
Source: (PCMC C. , 2008)

The chart alongside shows that due to the existing development control regulations in PCMC, 69% of the housing development is in the form of independent detached building blocks with front, side and rear margins left from the plot boundary. This results in a very sparse, low density development.

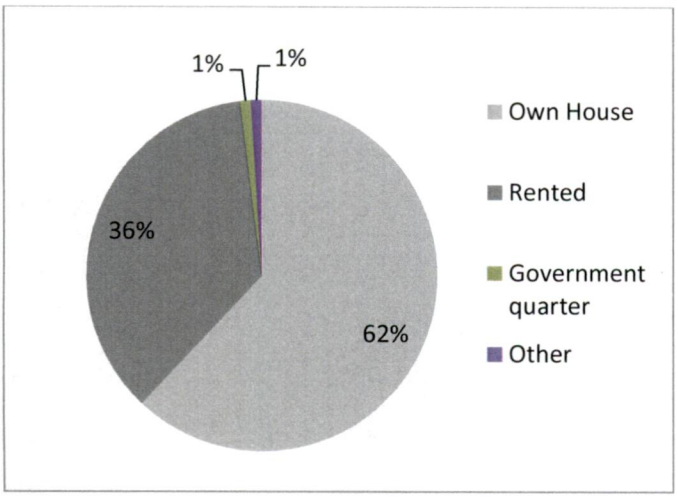


Chart 4-5: PCMC:Type of housing based on ownership
Source: (PCMC C. , 2008)

From the chart alongside, it can be seen that 36% of the population stays in rented houses. These people are people like industrial workers who cannot afford to have their own house.

Relevance to planning proposal:

Providing the users with a variety of housing types is an important consideration for the success of TOD. The planning proposal should take this aspect into consideration of providing the potential buyers with adequate choice of selecting a suitable house type.

4.4. City Development Plan (CDP) 2006-12

4.4.1. Background:

As stated in the introduction, the city of Pimpri-Chinchwad receives funding under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for development of infrastructure. Under this scheme, it receives funding from the Central Government as well as state government to the extent of 70% for infrastructure projects sanctioned under JNNURM. For this purpose, PCMC has prepared a City Development Plan (CDP) for the period 2006-12.

4.4.2. Vision:

The Vision Statement mentioned in the CDP is, "Pimpri-Chinchwad will be place to live, spend and entertain. It will contribute towards maintaining and sustaining the vibrant economic growth of the region through modern and systematized administration, an optimal level of services and enriched environment."

4.4.3. Key Issues related to Traffic and Land Management:

- Lack of integrated traffic and transportation system.
- Lack of coordination between land use and transportation
- Lack of efficient public transport system

One of the important social points mentioned in the City Development Plan about social aspect is, "providing universal access to urban poor". The CDP also makes a mention of preparation of a "Comprehensive Mobility Plan". Accordingly, the Comprehensive Mobility Plan was prepared by PCMC in assistance with CRISIL in the year 2008.

4.5. Special Township Policy:

4.5.1. Introduction:

The Government of Maharashtra approved the Special Township Scheme in 2004. The idea was to promote private investments in housing sector to facilitate housing at reasonable prices and also create a hassle free atmosphere for investors. The new policy has to form a part of existing DCR of Municipal Corporation/ Councils and Development Control Regulations for regional plan areas.

4.5.2. Applicability:

Area under sanctioned Pune Regional Plan excluding area under jurisdiction of Municipal Corporations, Municipal Councils, Cantonment Boards, Pimpri-Chinchwad New Town Development Authority, Special Planning Authority if any.

4.5.3. Area Requirement:

Any suitable area preferably vacant having sufficiently wide means of access (not less than 18m) may be considered. The Area under Special Township Policy shall not be less than 40 ha (100 acres) at one plane excluding area under forest, water bodies, rivers, canals, dams, etc.

No development is to be allowed on hill tops and hill slopes.

4.5.4. Infrastructure facilities:

Township should be an integrated one with all infrastructures like roads, street lights, water supply and drainage. This shall be provided and maintained by the developer till urban local body is constituted in that area.

4.5.5. Environmental clearance:

An environmental clearance is required from Ministry of Environment & Forests, GOI as per directions issued by MOEF's notice dated 7th July, 2004. At least 20% of the total area should be reserved as parks, gardens, etc and made available free of cost to the residents.

4.5.6. Special Concessions:

i. As soon as the scheme is notified, NA permission will be automatic
ii. Any government land falling under the scheme shall be leased out to the developer
iii. Condition that only agriculturists will be able to buy agricultural land shall not be applicable
iv. Exemption from Urban Land Ceiling & Regulation Act, 1976

4.5.7. Transport and Communication:

The entire area of township shall be well knitted with proper road pattern, taking into consideration the linkages with existing roads within townships as well as outside areas. All such roads shall be developed by developers as per standard road widths.
Main road/ Ring road- 24m wide
Internal road- as per prescribed bye-laws in regional plan

4.5.8. FSI & No Development Zone:

Total FSI of entire gross area of Special Township excluding no development zone or hill tops will be 1. FSI for no development zone if included shall be 0.2 only in proportion to such area of zone. No limit for total built-up area/ FSI for development of individual plots. Development of Special Township in No Development Zone contained in Regional Plan shall be permissible subject to condition that 50% of gross area of project shall be kept open while the project of STP shall be executed on remaining 50% land with gross built up area with FSI of 0.2 worked out on entire gross area of project.

4.5.9. Sale:

It is obligatory on part of the developer to provide for basic infrastructure and no permission for sale of plot/ flat shall be allowed unless the basic infrastructure is completed to satisfaction of the Collector. The scheme will be finally approved by the collector.

4.5.10. Comments:

The main aim of the Government behind the policy was to provide reasonable affordable housing to people by encouraging private investment in housing. However, the policy has failed in its main objective. It can be observed in Pune that housing through Special Township Policy is so expensive that it is beyond the reach of common people.

Since, the policy allows for development on agricultural land by obtaining NA certificate, large quantity of fertile agricultural land in the outskirts of Pune is being utilized for housing purpose thereby giving rise to serious issues like food security.

[Former assistant director of town planning Ramchandra Gohad in an interview to Times of India, 16 Dec, 2010 said, "The ongoing change in purpose of the agriculture land is on an ad-hoc basis. The regional plan for Pune was prepared in 1993 after which the region has undergone immense change. The district collector has no mechanism to check if the land conversion is really required."]

The FSI has been kept same as in the city i.e. 1 for Special Townships. There is no mention about density in terms of number of persons per unit area. As a result, the townships loose the potential to become high density, compact settlements.

It is clearly mentioned in the policy that the sale of plots or flats shall not begin unless the infrastructure is developed properly taking into consideration the existing one. But, many plots are sold before hand to people prior to development of basic infrastructure like roads, water, etc

4.6. PCMC Transport:

4.6.1. Plans and Policies:

There are various plans, policies that have been formulated for betterment of traffic conditions in the city. All these plans mention certain objectives for having an integrated approach towards traffic and land management. The proposal for TOD can be framed within this broad framework of traffic and land management visions.

4.6.2. Comprehensive Transport Policy for Pune Metropolitan Region (PMR)

Bhure Lal Committee of EPCA[2] had issued directives to all city corporations for improving the traffic and transportation situation. The comprehensive transport policy for Pune Metropolitan Region (PMR) has been prepared in line with those directives. The Comprehensive Mobility Plan for PCMC has been prepared under the broad framework of this comprehensive transport policy.

[2] As a preventive measure against the increasing vehicular pollution in Delhi, the Hon'ble Supreme Court of India ordered the constitution of EPCA- Environmental Pollution (Prevention and Control) Authority in 1998. It is popularly known as Bhure Lal Committee after the name of its chairperson Mr. Bhure Lal. (Mathur, 2001)

One of the vision statements of Comprehensive Transport Policy aims at creating an integrated urban transport system which enables effective patterns of land use, equitable development of city, boosts economic activity, supports social development of its people and puts them on the path to sustainability.

The policy stresses on the need to create an integrated public transport system. Such an integrated public transport system would aim at linking the existing modes of travel like commuter rail, buses and para-transit services. Such a system would be in the form of a multi-modal transport system which would enable the commuters to have smooth transitions between different modes of public transport.

4.6.3. Comprehensive Mobility Plan (CMP) 2008

Introduction:

The Comprehensive Mobility Plan aims at overall improvement in the movement of people within the city as well as into and out of the city. The plan analyzes the existing land use, traffic characteristics through a number of surveys. It then identifies the current problems as well as predicts the probable problems that might be faced in the future. It also mentions the various proposals recommended by different traffic organizations. At the end, it strongly recommends a Bus Rapid Transit System for solving the traffic problems.

Observations:

The following observations about traffic and land use are made in the plan:

- Commercial zone and mixed uses are distributed mostly along major corridors and around nodes.
- Many commercial districts are yet to come up due to lack of proper road system.
- A lot of residences have come up along the rivers Mula, Mutha and Pavana.
- Health facilities like hospitals and educational facilities like schools and colleges have come up based upon market values rather than specified in Development Plan.
- Current growth of the city is in North-South Direction. However, the future growth of the city will be in the east-west direction mainly due to the development of information technology sector at Hinjewadi in the west.

Suggestions made:

Based upon the observations, certain suggestions have been made in the plan which are as follows:

- Adopt a pattern of mixed land use
- Take into consideration the future commercial districts which would come up
- Future transport network to take into account that the city will grow in perpendicular direction to the current growth pattern
- Have separate lanes for Non-Motorized Vehicles (NMV) and promote their usage
- Para- transit to be organized so that each mode complements the other.
- A BRTS system is suitable for current growth trend of the city.

4.6.4. Road Network:

PCMC has fairly good road network & most of the area has been developed in a planned manner. The road network in PCMC area functionally comprises arterial roads, sub-arterial roads, collector streets and local streets. Total length of road network is 757 km. The hierarchy of existing road network in the PCMC is as follows:

Table 4-5: Hierarchy of Road Network

Hierarchical Class	Percentage of total length of roads (%)
Up to 12m	90.89%
12m to 24m	8.17%
Above 24m	0.94%
Total	100%

Source: (PCMC C. , 2008, p. 35)

From the above table, it is clear that almost 91% of the roads have width less than 12m. Thus, there are number of plans for road-widening and improvement of overall road network.

4.6.5. Public Transport: Buses

Pune Mahanagar Parivahan Mahamandal (PMPML) is the sole public transport provider in PMR. It was created in 2007 through the merger of Pune Municipal

Transport (PMT) and Pimpri-Chinchwad Municipal Transport (PCMT), the two independent transport operators of PMC and PCMC.

There are a total of 10 bus depots in operation in the PMR region from which a total of 1454 buses are operated on 271 main routes and 60 shuttle routes. The existing PMPML network consists of 331 routes covering a network of 1900 km of streets in the Pune Metropolitan Region (PMR).

As per the norms of Central Institute of Road Transport (CIRT), 37 buses are required for a population of one lakh. However, in 2005 there were only 21 buses per lakh of population in PCMC.

4.6.6. Para transit services:

Auto- rickshaws:

Besides buses, auto rickshaws are the major mode of transport. Autos are mostly preferred by people since the existing fleet of buses is not efficient and the waiting time for auto-rickshaws is very less. The number of registered auto-rickshaws in March 2010 was 6273.

Local Trains:

The travel by local trains accounts very less. There are 17 pairs of trains between Pune and Lonavla. However, travelling by local train is neither common nor preferable as in Mumbai.

4.6.7. Private vehicles:

Two-wheelers:

There were 537,920 two-wheelers within the PCMC limits in March, 2010. The extensive usage of two-wheelers is mainly due to lack of a sound public transport. The number of two-wheelers per thousand persons is about 312.

Four-wheelers:

There were 76,246 cars within the PCMC in March, 2010. Compared to the number of two-wheelers this number is less. The number of cars per thousand persons is about 44. However, with the availability of small cars within the range of Rs 100,000, this number is increasing rapidly. (Motor Transport Statistics of Maharahtra, 2010)

Sources:

1 PMPML Bus
www.punesite.com
accessed on Feb20,2012

2. Two-wheelers
Author: June30, 2011

3. Three seater auto-rickshaw: article.vm.com
accessed on Feb20,2012

4. Six seater auto-rickshaw
article.vm.com
accessed on Feb20,2012

Figure 4-6: PCMC modes of transport

4.6.8. Trip Distribution:

A household survey was conducted by PCMC to study some of the traffic and transportation characteristics. In this survey, 4860 households were interviewed. The average household size was 2.84. The Per Capita Trip Rate (PCTR) was 0.83 while the Vehicular Trip Rate was 0.78. The average trip length considering walking as the mode is 1.75km while the average trip length excluding walking as the mode is 6.86km.

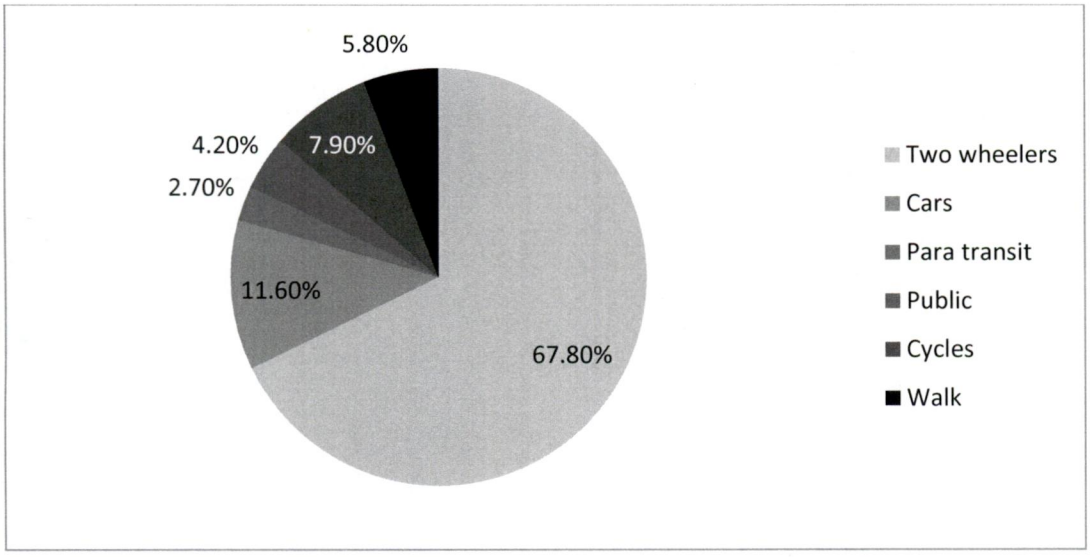


Chart 4-6: PCMC mode wise trip distribution
Source: (PCMC C. , 2008, pp. 81-82)

The survey reveals that almost 80% people use their own private vehicles for commuting. This is primarily due to lack of efficient public transport system.

However, significant numbers of people (about 13%) either walk or use bicycles for travelling. The survey also reveals that most of the people travel from their residences to their work places and back. This is evident from the Trip Rate Distribution.

Table 4-6: Trip rates distribution

Person in Household	1 trip in a day	2 trips in a day	3 trips in a day	4 trips in a day	Total trips in a day
1	2	4456	3	37	9071
2	37	812	0	4	1677
3	14	309	0	2	640
4	0	5	0	0	10
5	0	2	0	0	4
6	0	2	0	0	0

Source: (PCMC C. , 2008, p. 81)

It is clear from the above table that mainly the working persons in a house make two trips in a day from their house to the work place and back. Since, there is absence of a good public transport; most of these trips are made by the people using their own private vehicles. The modal split indicates that two-wheelers and cars together constitute for 95% of total vehicular traffic.

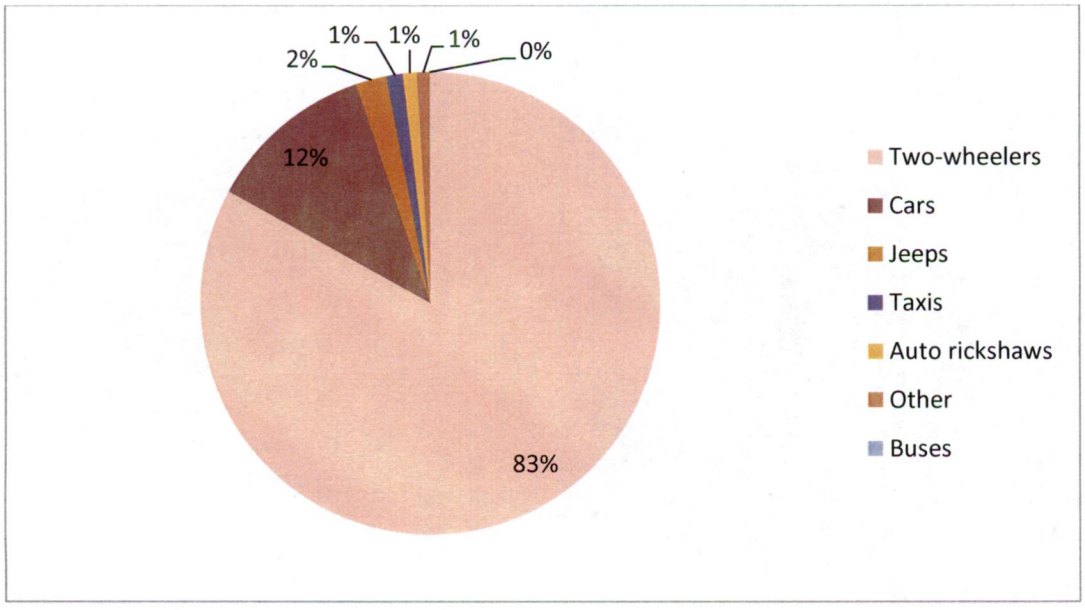


Chart 4-7: PCMC Modal split for motorized vehicles
Source: Author Ref: (Motor Transport Statistics of Maharahtra, 2010)

It is possible to convert the trips made using private transport into trips made by walking, cycling or by using public transport. Appropriate land use planning and an

effective public transport system is a prerequisite for reducing the trips using private vehicles.

4.6.9. Bus Rapid Transit System (BRTS):

After analyzing the existing conditions, PCMC has proposed the improvement of overall network and has also provided a public transportation system in the form of BRT. The proposed BRT network consists of 10 major corridors and 4 feeder routes. The corridors have been selected based on travel demand, hierarchy of roads and existing bus routes. Following are the identified BRT Corridors:

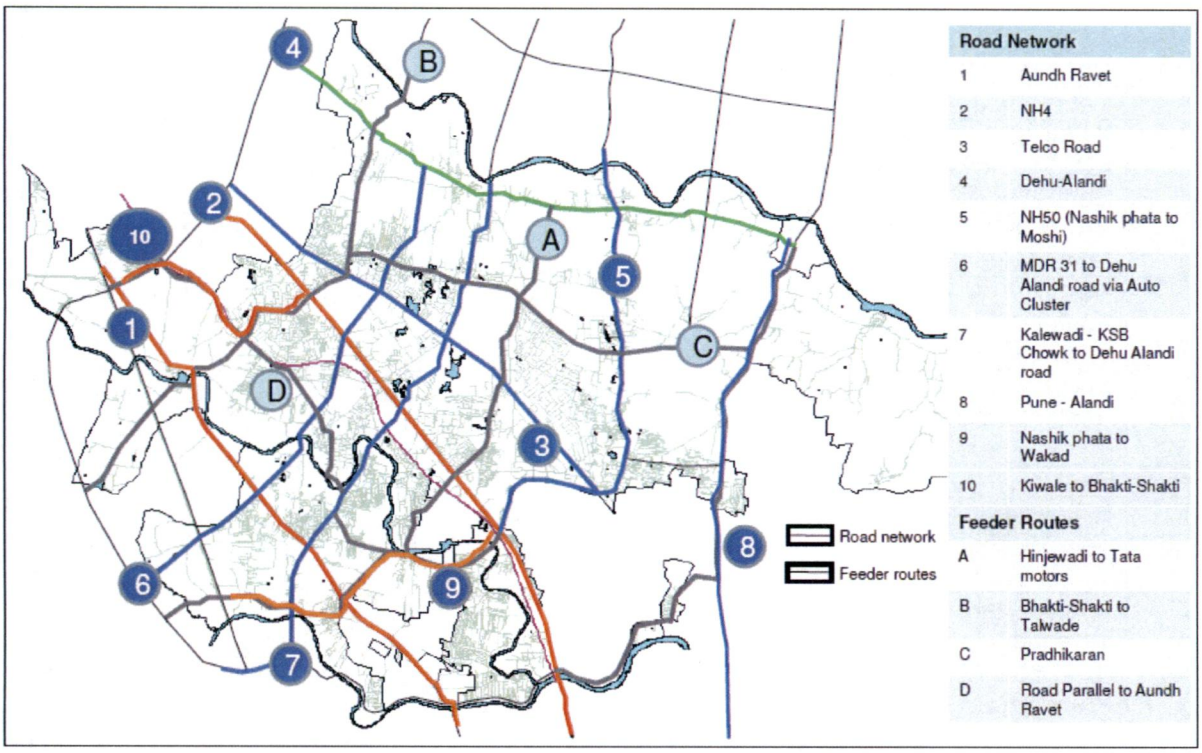


Figure 4-7: Proposed Road Improvement and BRTS Routes:
Source: (PCMC C. , 2008, p. 131)

For the purpose of road improvement and BRT implementation, the following project phasing as well as cost estimation has been done:

Table 4-7: Proposed BRTS

S.No	Name of Corridor	Proposed Length (km)	Width (m)	Cost (crore Rs)*	Year of Commissioning	Expected Year of completion	Current Status
Main Routes							
1	Aundh-Rawet	14.4	45	194.4	2009	2012	Road clearance completed. Tendering process to start (delayed)

2	Old NH4	14.6	61	197.1	2008	2011	Construction of 16 BRT stations ongoing, land improvement going (delayed)
3	Telco Road	12.0	61	180.0	2009	2012	Ongoing (delayed)
4	Dehu- Alandi	14.5	45	128.7	2011	2014	Yet to start
5	NH-50	10.4	61	280.2	2010	2013	Ongoing, flyover rail over bridge, etc under construction (behind schedule)
6	Hinjewadi to Dehu-Alandi	13.3	60	197.6	2011	2014	Yet to start
7	Kalewadi KSB Chowk-Dehu Alandi	11.2	45	218.9	2010	2013	Yet to start
8	Vishrantwadi-Pune Alandi	11.6	45	187.4	2011	2014	Yet to start
9	Nashik Phata-Wakad	8.04	60	205.6	2010	2013	Yet to start
10	Kiwale-Bhakti Shakti	11.18	30	144.9	2011	2014	Yet to start
Feeder Routes							
11	Hinjewadi-Tata Motors	10.3	45	92.7	2013	-	
12	Bhakti-Shakti Talwade	11.3	30	101.7	2013	-	
13	Pradhikaran	10.6	30	95.4	2012	-	
14	Road parallel to Aundh-Rawet	8.4	30	75.6	2014	-	

*Only road improvement cost

Source: (PCMC C. , 2008, pp. 129,161,173,174)), ITDP

The CMP of PCMC also mentions that NH4 and Aundh-Rawet are the two important roads connecting Pune and Pimpri-Chinchwad. Hence, it is important to execute the BRTS on these roads as early as possible. Accordingly, work has started along both these corridors as a part of Phase I of BRTS.

4.6.10. Expected increase in bus ridership due to BRT:

After successful implementation of BRT, the bus ridership is expected to rise by 23% in first 10 years till 2016 and by 45% in the next 10 years up to 2026. After developing cycle tracks in the city, the bicycle ridership is expected to increase by 2% in first 10 years and another 2% till 2026. However, the walk trips are expected to decrease by 6% (BRT Pilot Project: Aundh Rawet, 2007).

Comment:

The BRT project is running behind schedule. Hence, the expected increase in bus ridership would not be achieved till 2016. The expected increase in bicycle ridership is only 2%. But, the plan projects a decrease in walk trips by 6%. This decrease in walk trips is not favorable for TOD. Along with increase in bus and bicycle ridership, the BRT corridors and areas around the corridor should be planned in such a way as to increase the walk trips.

4.6.11. Land Use and Transport Integration:

The CMP mentions the concept of integrating land use with transport by "Transit-oriented development." It says, "The idea behind land use and transportation integration is to enable large sections of people to travel efficiently from one place to another and as far as possible reduce travel time. In coherence with this, is the concept of transit oriented development. Higher order and higher density uses are located around transit nodes and transportation corridor. This in turn improves ridership of the public transport over time". Accordingly, it proposes the following model for TOD.

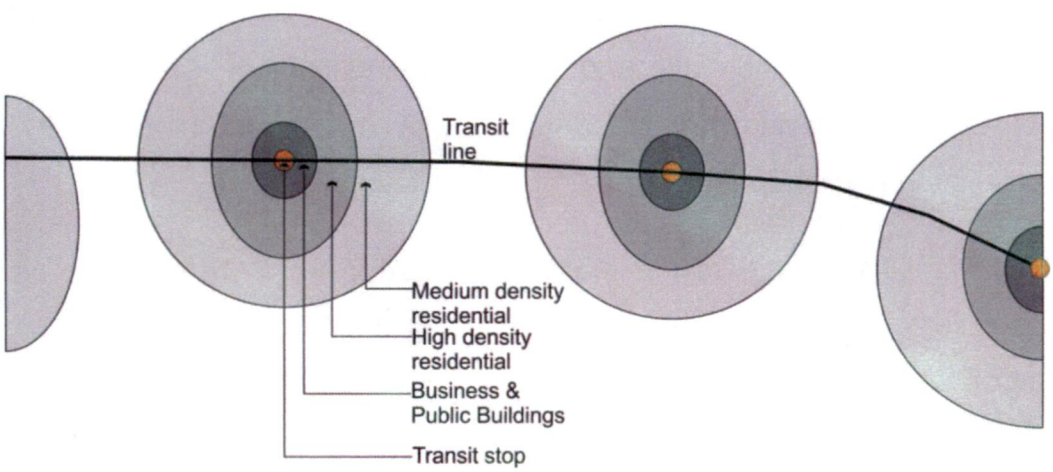


Figure 4-8: Proposed TOD Model in CMP
Source: Retraced by Author, Ref: (PCMC C. , 2008, p. 164)

The BRT planning guide mentions the following benefits of TOD:

Table 4-8: TOD benefits given by ITDP

Transit User Benefits:	*Transit Operators Benefits:*	*Benefits to society:*
• More destinations near transit stations • Better walking conditions • Increased security near transit stations	• Increased ridership • Lower costs per rider • Better image	• Reduced traffic problems • Reduced public infrastructure and service costs • Community livability • Increased property values, business activity & tax revenues

Source: (PCMC C. , 2008, p. 164)

The CMP also proposes a high FAR of 2 along the 500m corridor of BRT. The development charges collected from the development along the BRT Corridors will be used for strengthening of service delivery and infrastructure facilities along the corridor.

4.7. Conclusion:

The data on population growth shows that the population in Pimpri-Chinchwad area has grown at an alarming rate of 71% in the decade 2001-2010. It is currently 1.73 million and is expected to grow at a decadal rate of 59% and reach 2.75 million by 2021. (Ref: Table 4-2). Also, the number of private vehicles in PCMC is increasing at an alarming rate of 13% annually. Around 390 vehicles are registered every day in PMR region (Dastane, 2010). The administrative limits of Pimpri-Chinchwad are expanding and many adjoining villages are getting merged in the city area.

To prevent the urban sprawl of PCMC Area, it is absolutely essential to have an integrated approach towards land use and transportation planning. Some of the proposed BRT Corridors provide this opportunity to plan a compact, high density, mix-use and mix-income development around the BRT stations.

The concept of 'Transit-Oriented Development' mentioned in the CMP needs to be explored to its fullest potential. The development along the BRT corridors can be planned based on the TOD model.

The following chapter analyzes the Aundh-Rawet BRT Corridor and Punawale Area around the BRT Corridor regarding its potential for TOD.

5. Analysis of Selected BRT Corridor:

5.1. Aundh-Rawet BRT Corridor Study:

5.1.1. Introduction:

The Aundh-Rawet BRT Corridor is 14.4 km long, connecting the areas of Pune and Pimpri Chinchwad. It also serves as a connecting link to the Mumbai-Pune Expressway. There are total 22 BRT Stations along the stretch of the corridor. The selected stretch of corridor up to Punawale-Tathavde Area contains 16 BRT Stations.

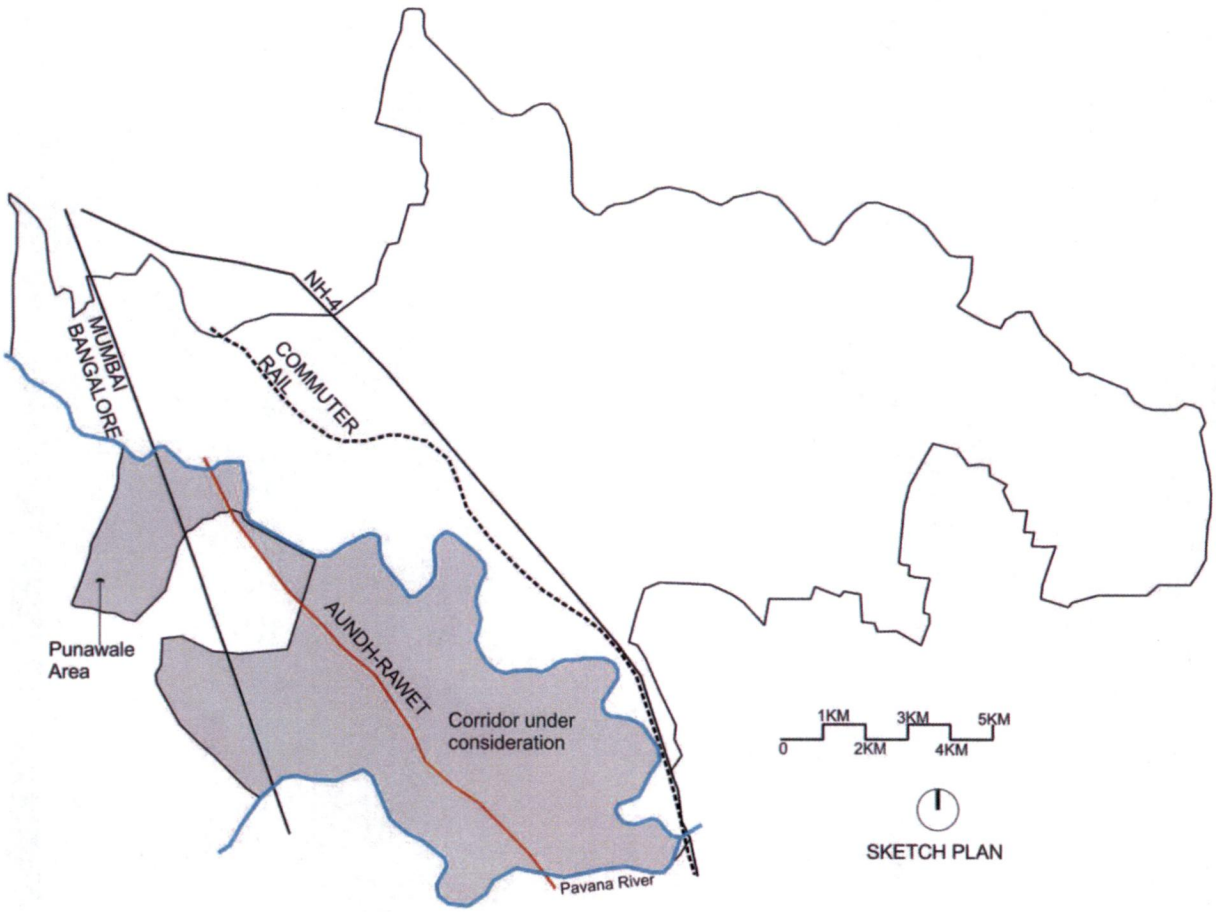


Figure 5-1: Aundh-Rawet Corridor location
Source: Traced by Author Ref: (PCMC C. , 2008)

As stated in Table 4-7, road clearance work is going on along the corridor. There are substantial parcels of vacant land around this corridor. This is the appropriate stage to plan a TOD model for the corridor, before the areas around the corridor get developed.

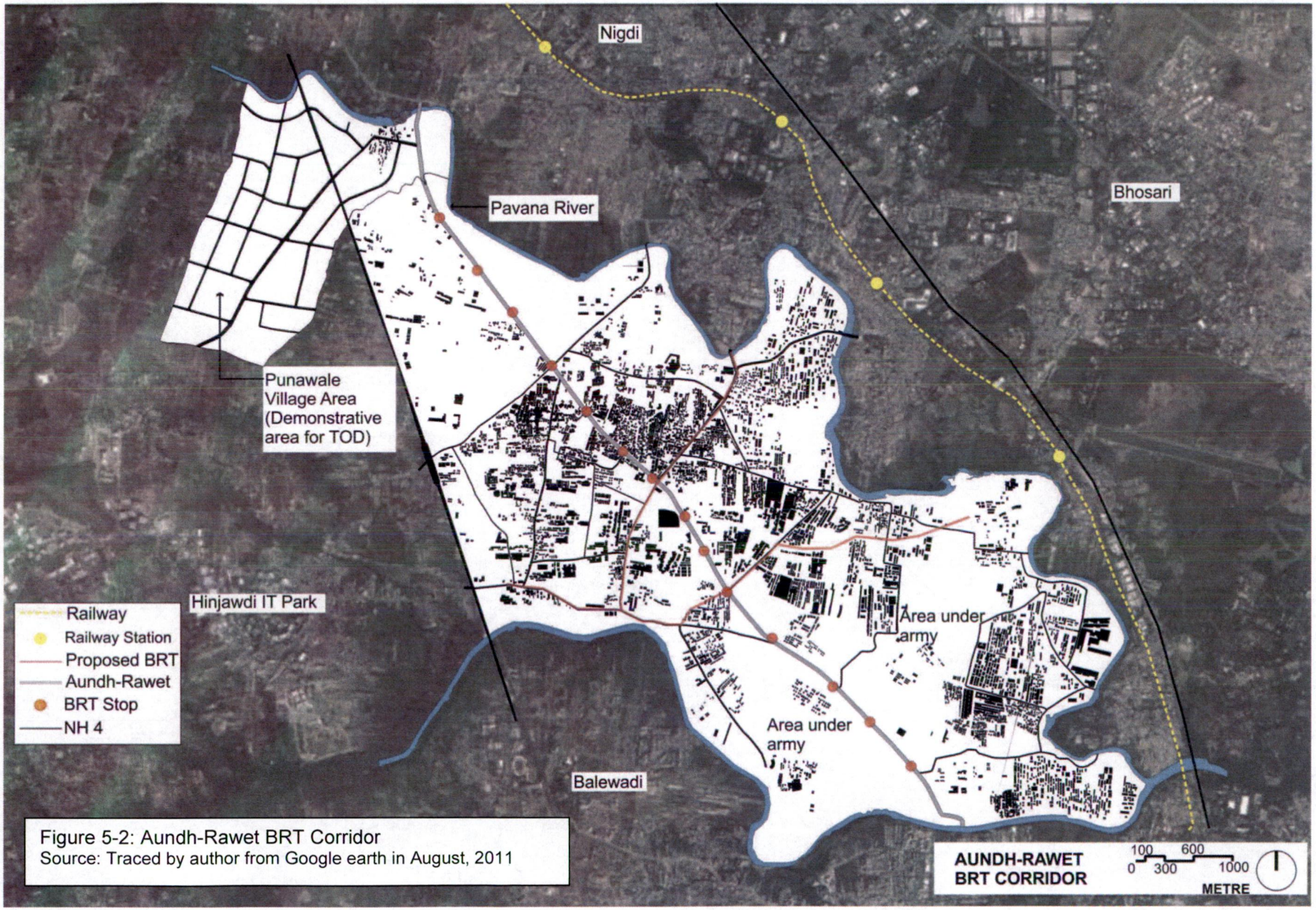
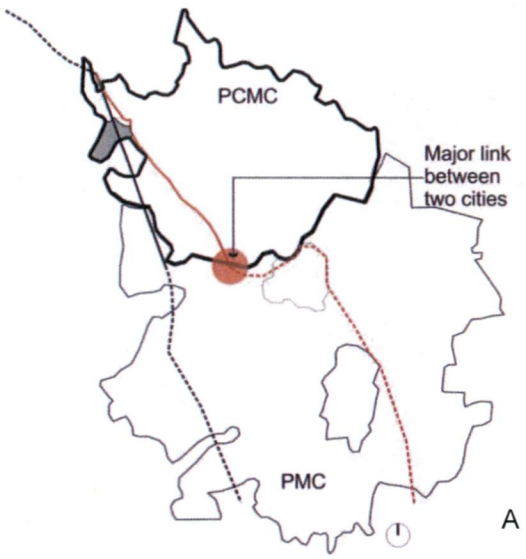


Figure 5-2: Aundh-Rawet BRT Corridor
Source: Traced by author from Google earth in August, 2011

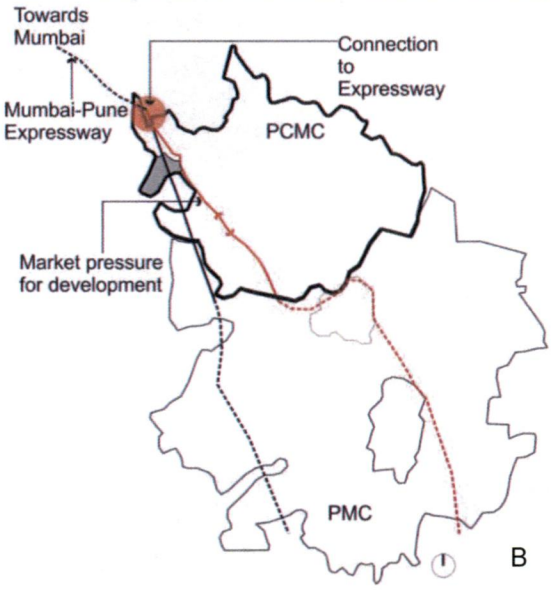
5.1.2. Reasons for selecting the Corridor:

The Aundh-Rawet Corridor has been selected for TOD demonstration for the following reasons:

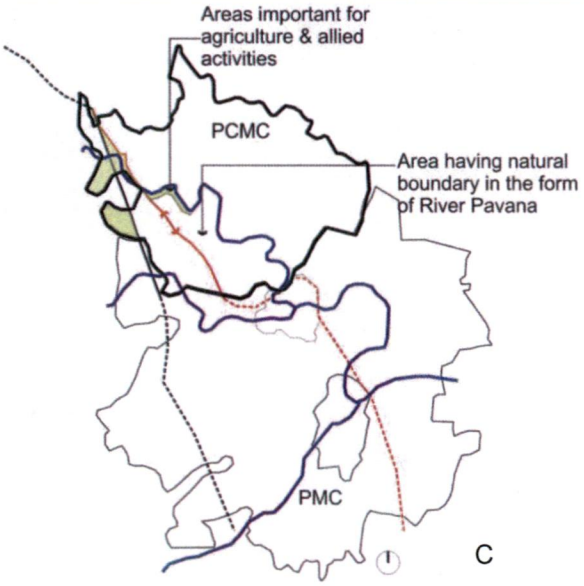
1. The corridor is a major link connecting the cities of Pune and Pimpri-Chinchwad



2. The road is the shortest link for residents of PMC & PCMC to reach the Mumbai-Pune Expressway



3. The corridor area has a natural edge in the form of Pavana River. It is also important to protect the patches of fertile agricultural land along the corridor



4. The corridor has potential for commercial and residential development which would also serve adjoining Hinjewadi IT Park

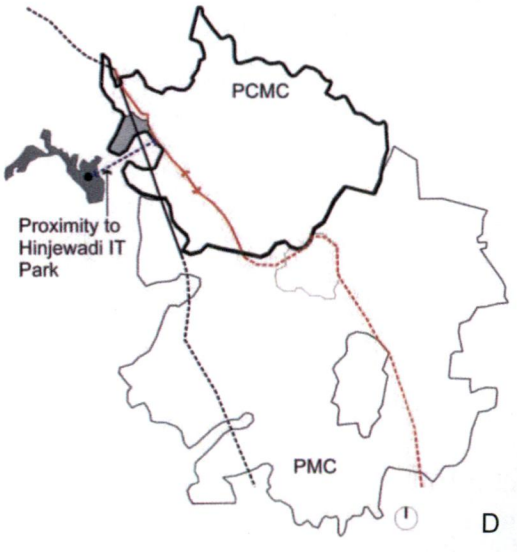


Figure 5-3: [A-D] Criteria for selection of Aundh-Rawet BRT Corridor
Source: Traced by author Ref: (PCMC C. , 2008)

5.1.3. Development along the corridor:

Personal investigation was carried out to understand the existing land uses and type of development along the corridor. This was done through photographic documentation and noting down the observations:

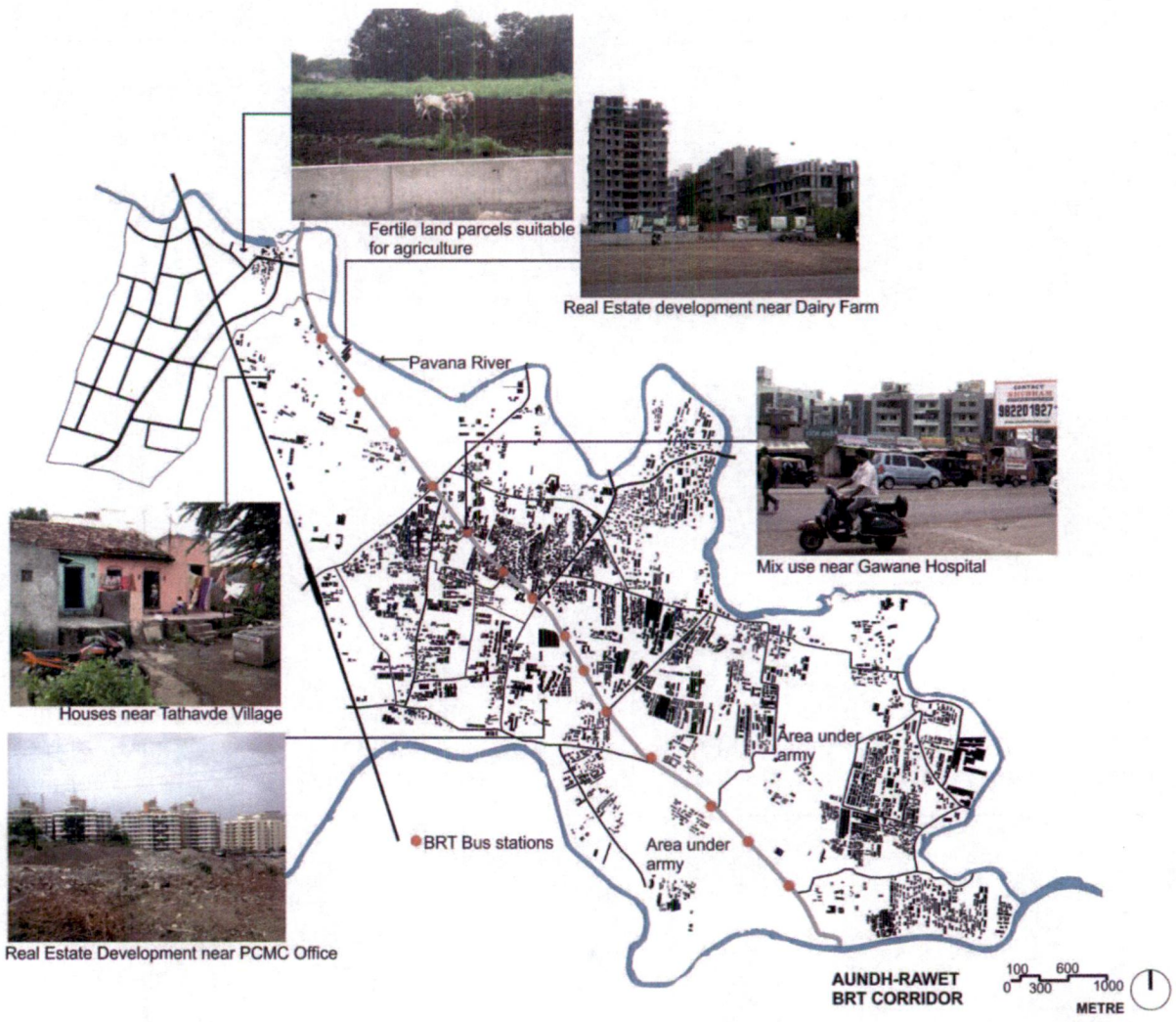


Figure 5-4: Type of development around Aundh-Rawet BRT Corridor
Source: Author (Photographs: June, 2011)

Observations:

From the personal investigation, it was evident that the land ownership varies along the length of the corridor. The land is owned by Central Government, State Government or private parties.

The development around the Aundh-Rawet BRT Corridor has taken place in a very haphazard manner. There are many small and big settlements around the corridor

which have already come up. In spite of this there are significant patches of vacant land around the corridor. There are certain land parcels along the corridor where agriculture and animal husbandry is still being carried out. It is therefore important to take all these aspects into consideration before planning any development along the corridor.

5.1.4. Population:

The area around the BRT Corridor enclosed within the boundary of River Pavana is composed of 16 electoral wards which had a population of 2,45,318 in 2001 ((PCMC, 2012). Considering the population growth rate of 71% for the past decade, the current population around the corridor would be around 4,20,000. The ward of Punawale is expected to have a population of around 25,000.

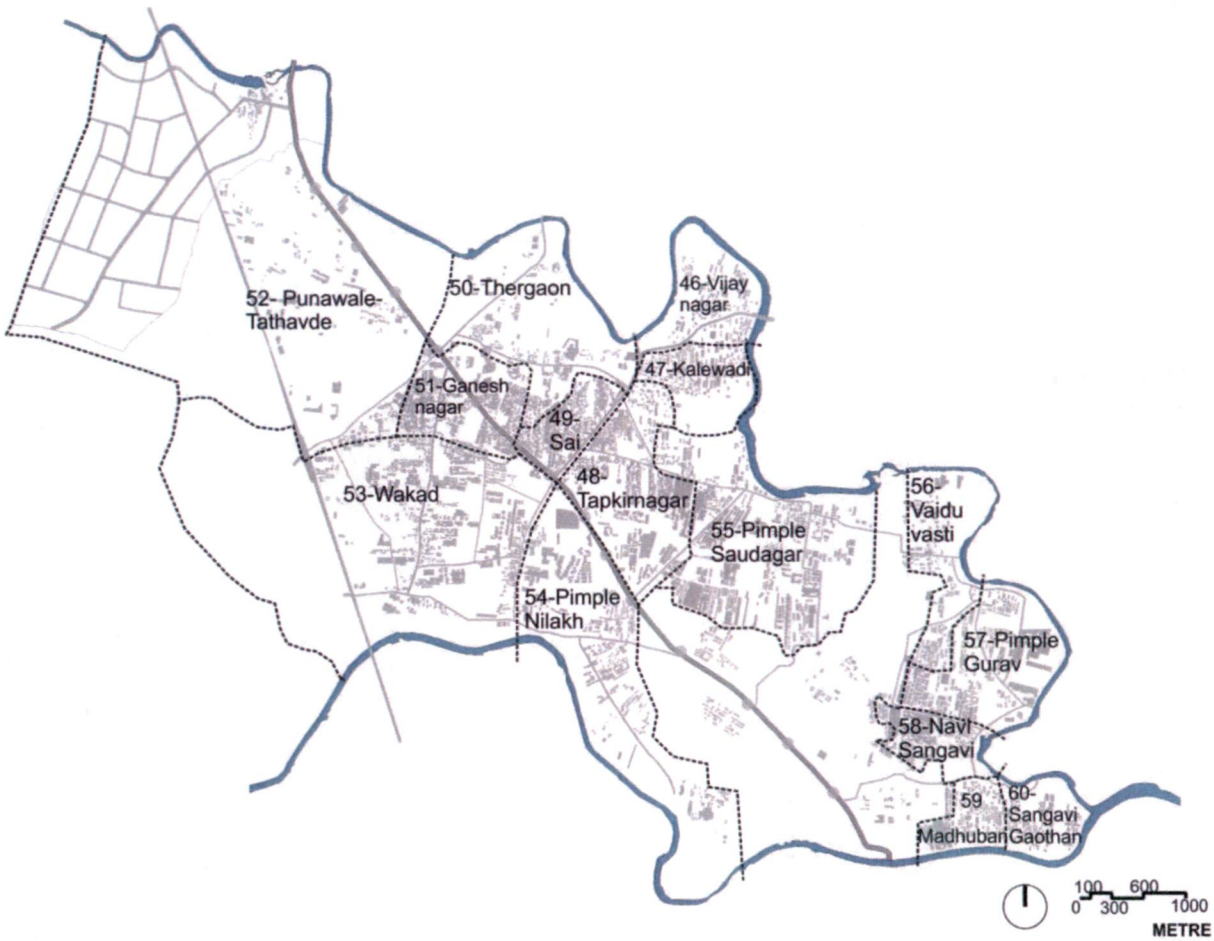


Figure 5-5: Electoral wards around Aundh-Rawet BRT
Source: Author Ref: (PCMC, 2012)

The current and the projected population for the wards around the Aundh-Rawet BRT Corridor shown in Fig 5-5 is as follows:

Table 5-1: Population of wards around Aundh-Rawet BRT Corridor

Ward No	Name	Area of Ward (hectares)	Population		Density (persons/ hectare)		Density (persons/ sq.km)		Projected Population
			2001	2011	2001	2011	2001	2011	2021
46	Vijaynagar	108	16945	28976	157	268	15690	26830	46072
47	Kalewadi	88	16899	28897	192	328	19203	32838	45947
48	Tapkirnagar	193	17076	29200	88	151	8848	15130	46428
49	Sai Mandir	66	17104	29248	259	443	25915	44315	46504
50	Thergaon	251	17100	29241	68	116	6813	11650	46493
51	Ganeshnagar	127	16530	28266	130	223	13016	22257	44943
52	Punawale-Tathavde	1300	14973	25604	12	20	1152	1970	40710
53	Wakad (Area beyond Highway not considered)	430	17042	29142	40	68	3963	6777	46335
54	Pimpale Nilakh	357	16556	28311	46	79	4638	7930	45014
55	Pimple Saudagar	357	15969	27307	45	76	4473	7649	43418
56	Vaidu Vasti	123	14335	24513	117	199	11654	19929	38975
57	Pimple Gurav	168	17154	29333	102	175	10211	17460	46640
58	Navi Sangavi	63	15793	27006	251	429	25068	42867	42940
59	Madhuban	53	15645	26753	295	505	29519	50477	42537
60	Sangavi Gaothan	64	16197	27697	253	433	25308	43276	44038
	TOTAL	**3748**	**245318**	**419494**	**65**	**112**	**6545**	**11192**	**666995**

Source: (PCMC General Elections 2012)

Observations:

Approximately 24% of the overall population of PCMC stays within the BRT Corridor area under consideration. The population density of 11,192 persons/ sq.km for the selected corridor area is higher as compared to the overall population density of PCMC, i.e. 10,142 persons/ sq.km. Out of the total 15 wards, the wards of Vijaynagar, Kalewadi, Tapkirnagar, Sai Mandir, Ganeshnagar, Vaidu Vasti, Pimple Gurav, Navi Sangavi, Madhuban and Sangavi Gaothan have a population density exceeding the average overall density of the corridor. As a result, these wards will

more or less reach a level of saturation until 2021beyond which it would be difficult for them to hold additional population.

On the other hand, the remaining 5 wards of Thergaon, Punawale-Tathavde, Wakad, Pimpale Nilakh and Pimpale Saudagar have a potential for densification. The area of Punawale-Tathavde has the lowest population density of 1970 persons/ sq.km. As a result, a part of this area has been considered for TOD demonstration.

5.1.5. Limit for holding additional population:

The UDPFI Guidelines specify an average urban population density in the range of 125pph-175pph for a metropolitan area. As seen in Table 5-1, the wards of Thergaon, Punawale-Tathavde, Wakad, Pimpale Nilakh and Pimpale Saudagar have population density far less than the prescribed range in UDPFI Guidelines. This is partly because of the reason that these wards are not fully developed to their optimum potential. Therefore, considering an average population density of 150 pph for the wards mentioned above, they would be able to hold additional population.

Table 5-2: Capacity of wards to hold additional population

Ward	Area (hectares)	Current population	Current density (pph)	Assumed density (pph)	Additional population
Thergaon	251	29241	116	150	8570
Punawale-Tathavde	1300	25604	20	150	166426
Wakad	430	29142	68	150	35141
Pimpale Nilakh	357	28311	79	150	25444
Pimpale Saudagar	357	27307	76	150	26588
TOTAL					262170
Total Population that can be accommodated including current population					681664 **680000** approx

Source: Referred by author Ref: (PCMC, 2012)

Thus, the 5 wards shown in the Table 5-2 have the capacity to hold the projected population of 2021 i.e. 666,995; beyond which the wards will be incapable to accommodate any additional population.

5.1.6. Distribution of Infrastructure facilities along the corridor:

Ease of accessibility to various infrastructure facilities is a pre-requisite for the success of TOD. A survey was carried to study the location of various infrastructure facilities.

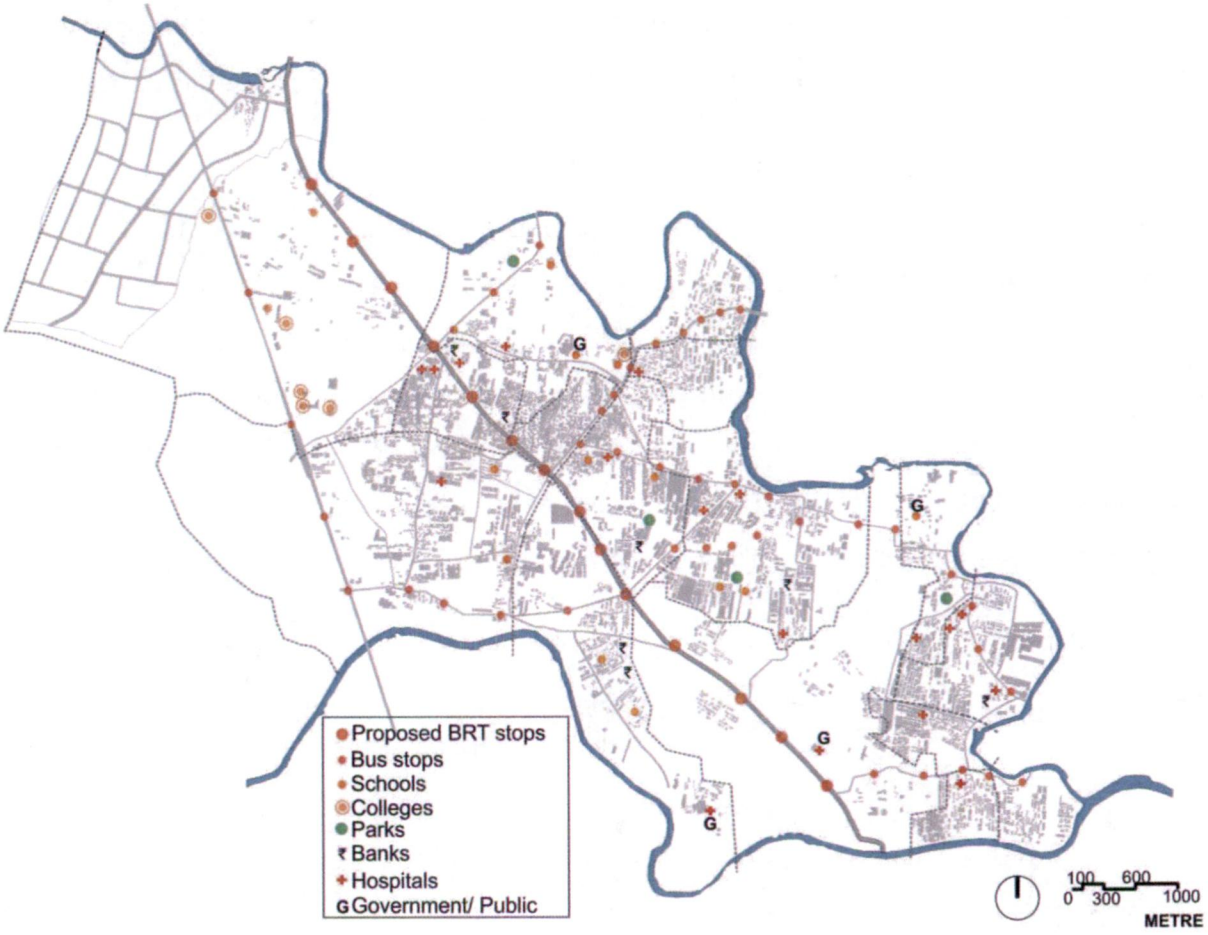


Figure 5-6: Infrastructure facilities along Aundh-Rawet BRT Corridor:
Source: Author

Observation:

BRT Stations:

The location of BRT stations has been finalized by expert bodies in transportation planning like ITDP after a thorough analysis of the current travel pattern. These stations therefore serve as guiding nodes to plan other infrastructure facilities around them so that the infrastructure facilities are easily accessible from the BRT stations.

Schools and colleges:

The corridor area has only two schools run by the municipal corporation while the remaining schools are run by private organizations. Besides, there are around five to six colleges offering higher education. As seen in the plan (Fig 5-6), most of the colleges are concentrated near the Punawale Area adjacent to the Mumbai-Bangalore Highway. All the schools need to be distributed in such a way that every neighbourhood has a school located within five minutes of walking distance. Also, the colleges need to be easily accessible by walking, cycling and use of public transport.

Parks:

The area has four major public parks. But, these parks are not easily visible to the people from the main access roads as they are located in the interior of the neighbourhood. From the literature review it is evident that the green areas need to be clearly visible to the people so that they are used in a proper way.

Banks and ATM's:

Though people may not visit the bank on a daily purpose, easily accessible ATM booths within a neighbourhood are important. The location of ATM booths adjacent to BRT station is beneficial to the people.

Medical Facilities:

The Aundh Chest hospital is a government hospital while the others are private hospitals. The extensive area of Punawale, Tathavade does not have a medical facility that is easily accessible. It is important that every ward has a basic medical facility like a polyclinic for emergency purposes.

Inference:

For the success of TOD, it is important that the location of daily infrastructure facilities is linked with the location of BRT stops.

Accessibility to various infrastructure facilities:

As discussed in the previous section, it is important to locate the daily required infrastructure facilities within easy accessibility distance. Apart from a planner's judgment, it is vital to understand how the users in reality access the various infrastructure facilities. This data has been gathered through a questionnaire. (Refer Appendix). However, the data collected is only to gather a very rough estimate about the travel characteristics. The survey carried out is not scientific and represents the opinion of a particular class of people belonging to the area.

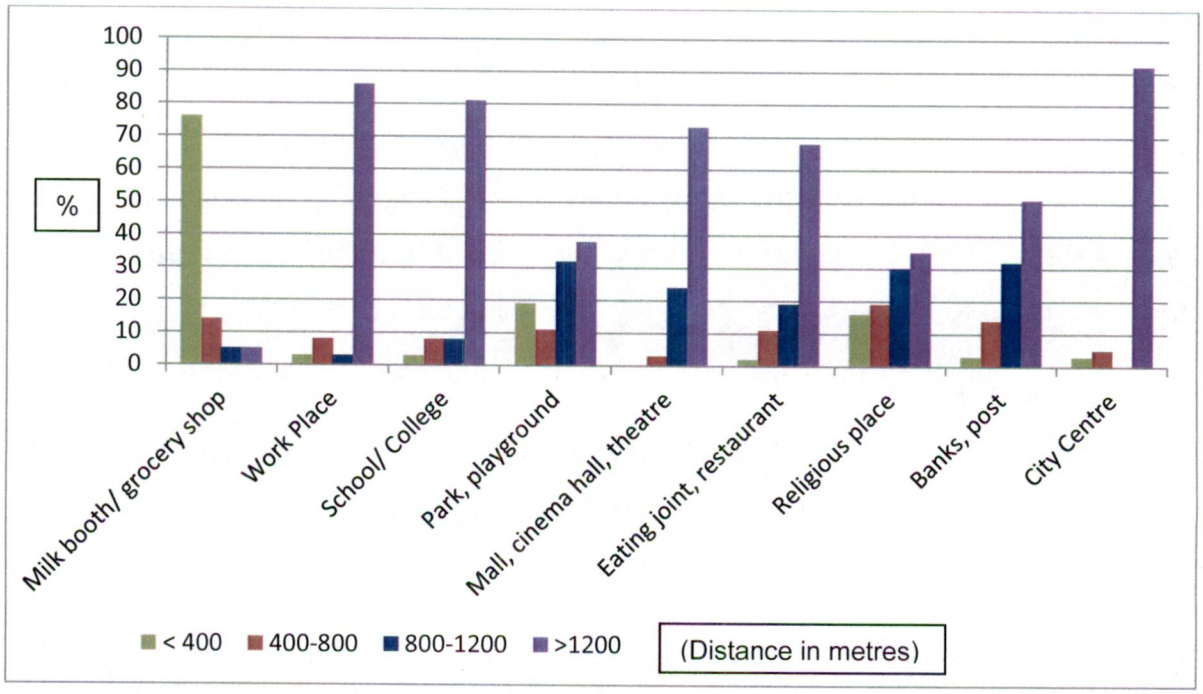


Chart 5-1: Survey: location of infrastructure facilities
Source: Survey questionnaire by author

Observation:

The graph above shows that the nearest infrastructure facility from residential area is the corner shop or the milk booth. In almost 75% of the cases, the milk booth or the grocery shop is located within a 5 minute walking distance of less than 400m. The remaining infrastructure facilities are located at a distance of more than 1200m, i.e. more than 1.2 km. One of the significant aspects revealed through the questionnaire is that 85% of the work places and 80% of educational facilities where people commute daily, are located at more than 1.2 km from the residential areas.

The questionnaire also gives information about people's travel pattern. It investigates how frequently people access a particular infrastructure facility.

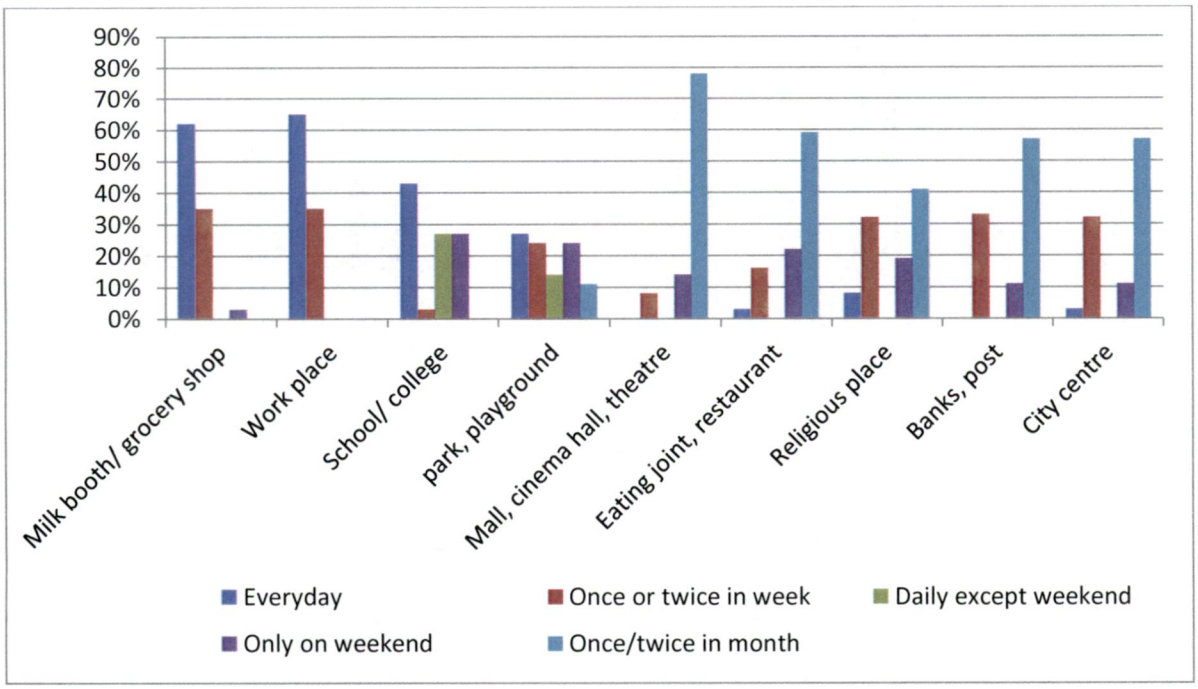


Chart 5-2: Survey: frequency of travel
Source: Survey questionnaire by author

Observation:

The chart above shows that people access the facilities like a corner grocery shop or milk booth, work place and educational facilities like school and colleges almost daily. People visit recreational places like a park and religious places on certain days throughout the week. Most people visit a cinema hall, restaurant, commercial centres like banks less frequently; only occasionally in a week or in a month.

It is evident from this travel pattern that the facilities which are accessed by people on a daily basis should be located as close as possible from the residential area. In many cases where these facilities are located far away from the residential area, they should be well connected by a good public transport system.

An investigation has been carried out about the mode of travel used by people to reach to the various infrastructure facilities.

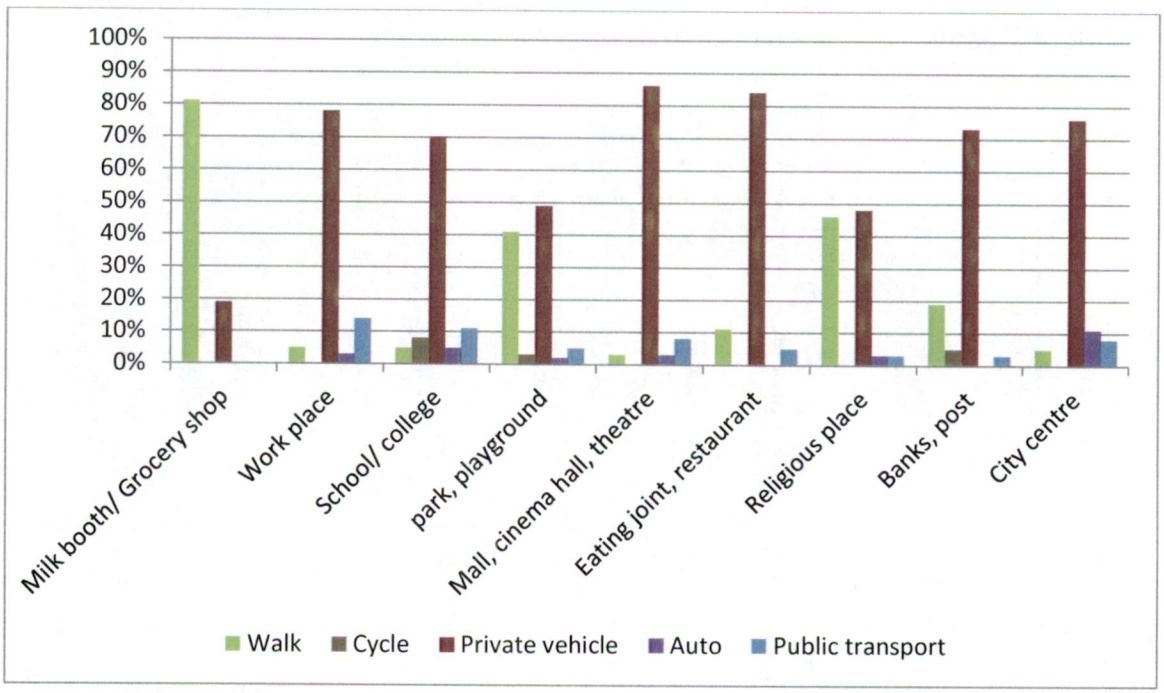


Chart 5-3: Survey: mode of travel
Source: Survey questionnaire by author

Observation:

Chart 5-3 shows that people prefer to walk to a corner shop, a park or playground and religious places. The percentage of commuters travelling by using public transport is almost negligible and less than 10% in most of the cases. 11% people use auto rickshaws to travel to the city centre. There are certain auto rickshaws which drop and pick up the children from their schools. But for commuting to majority of the facilities, people travel using their own private vehicles. Around 65% of trips are using private vehicles. Most of these trips are daily trips to travel to work place or to schools and colleges. The recommendations of this dissertation aim to reduce these trips done by private vehicles.

Inference:

Charts 5-1, 5-2 and 5-3 indicate the travel pattern of people and give information about the accessibility of various infrastructure facilities. The table below represents the interdependence between the locations of infrastructure facilities, the frequency of visiting these facilities and the modes of travel for accessing the facilities.

Table 5-3: Suggested criteria for accessibility

	Preferable distance	Expected frequency of travel	Suggested mode of travel
Milk booth/ grocery shop	Less than 400m	Daily	Walking, cycling
Work place	Less than 1200m for newly planned	Daily	Cycling, public transport
School/ college	Primary school less than 400m, high school, college 400m-800m	Daily	Walking, cycling, public transport
Park	400m-800m	Selected days in week	Walking, cycling
Cinema hall, theatre, mall	Less than 1200 preferable	Weekends, holidays	Walking, Public transport, private vehicles, auto rickshaw
Eating joints, restaurant	Less than 1200 preferable	Weekends, holidays	Walking, Public transport, private vehicles, auto rickshaw
Religious places	400m-800m	Selected days in week	Walking, cycling
Post/ bank	800m-1200m	Once, twice in month	Walking, cycling Public transport
City centre	Less than 1200 preferable	Once, twice in month	Walking, cycling Public transport

Source: Survey questionnaire by author

5.1.7. Cost estimate for the BRT Corridor:

As per the Draft Report on Master Plan for BRTS integrated with cycle network for PCMC, prepared by IIT Delhi on 21st July, 2007; the cost of entire Aundh-Rawet BRT project was estimated to be Rs. 310.87 crores i.e. Rs. 3108.7 million. This cost includes the costs for laying of road, construction of flyovers, foot over- bridges, drainage, lighting, traffic signage and other utility services.

5.1.8. BRT Ridership:

After, the Aundh-Rawet BRT is fully functional, the current ridership is expected to increase. The expected increase in ridership is as follows:

Table 5-4: Expected increase in BRT Ridership after implementation of BRT

	Current Status of Buses	Expected increase after implementation of BRT.
Trips between 5am to 11pm in one direction	542	714
Passengers Per Direction (PPD)	32,520	57,381
Peak Hour Peak Direction Traffic	3240	3682

Source: (BRT Pilot Project: Aundh Rawet, 2007)

The BRT report estimates to have daily 100,000 passenger trips with a bus frequency of 4.5 minutes. 50 buses having carrying capacity of 70 persons would be used for this purpose. (BRT Pilot Project: Aundh Rawet, 2007). With 100,000 people travelling daily, nearly 15% of the 2021 population would be using the BRT. With an integrated transport system, compact and transit oriented development; there is a definite scope to further increase this bus ridership and reduce the usage of private vehicles.

5.2. Conditions to be met for Aundh-Rawet Corridor:

Integrated transport system:

Having a well-integrated public transport system is a pre-requisite for the success of TOD. Different modes of transit existing currently like the commuter rail, proposed BRT, para-transit need to be well linked and well integrated to encourage the use of public transport amongst the residents.

Housing Requirement:

The vacant areas in the 5 wards of Thergaon, Punawale-Tathavde, Wakad, Pimpale Nilakh and Pimpale Saudagar need to be utilized cautiously to accommodate the 2021 projected population of 666,995. At the same time, infrastructure facilities need to be improved in the other wards that already accommodate population beyond their holding capacity.

Creation of jobs within 500m corridor distance of BRT:

The CMP proposes a high density commercial development along the BRT Corridor considering a FAR of 2. This opportunity can be utilized for planning a high density mixed use development along the corridor comprising offices and residences. This will also generate a lot of job opportunities for the current as well as future residents of the area.

Planning land uses around BRT Stations:

The locations of infrastructure facilities need to be coordinated with the location of BRT stations as per the inference of travel pattern survey (**Table 5-3**) so that the facilities become easily accessible to the people by using the BRT.

Restricting the spread of development up to the river edge:

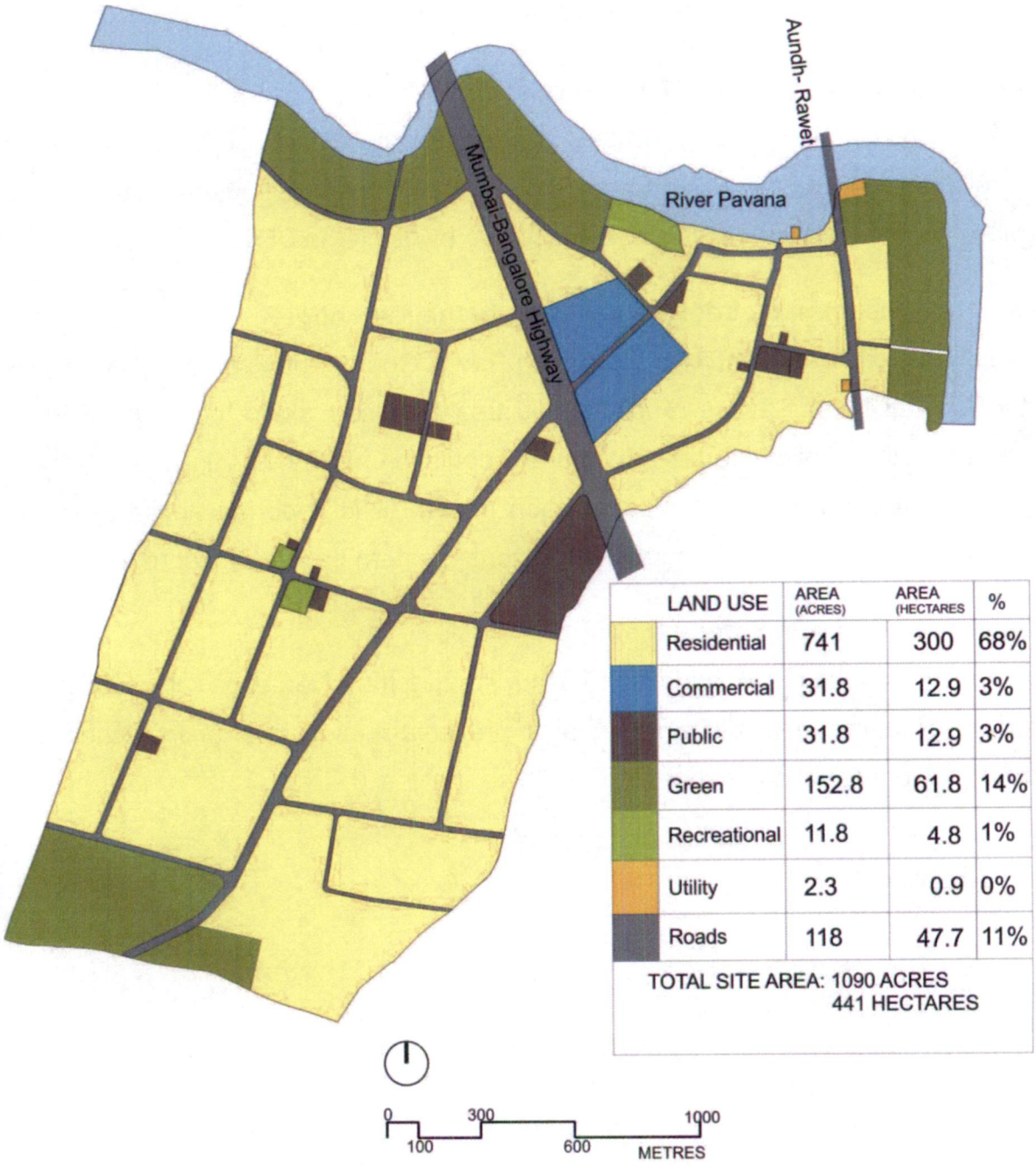
The administrative wards around the Aundh-Rawet Corridor have a natural boundary in the form of River Pavana. The present area enclosed within the edge of River Pavana has the capacity to hold additional population of 262,170 up to 2021-2025. (Table 5-2). During this period of population growth, it is important to prevent any urban sprawl towards the northern and the north-western parts of the corridor.

Protect the fertile agricultural land:

Certain patches of fertile agricultural land around the river edge are facing the pressure of rapid urbanization. It is vital to preserve these fertile land patches and prevent any construction on them.

5.3. Punawale Village Area:

The 441 hectare (1090 acre) Punawale Village Area has been merged to the planning boundaries of Pimpri-Chinchwad. A draft development plan for this extended area of PCMC has been prepared in October, 2009.



LAND USE	AREA (ACRES)	AREA (HECTARES	%
Residential	741	300	68%
Commercial	31.8	12.9	3%
Public	31.8	12.9	3%
Green	152.8	61.8	14%
Recreational	11.8	4.8	1%
Utility	2.3	0.9	0%
Roads	118	47.7	11%

TOTAL SITE AREA: 1090 ACRES
441 HECTARES

Figure 5-7: Punawale-Draft Development Plan
Source: (PCMC C. , 2006)

5.3.1. SWOT Analysis of Punawale Draft Development Plan:

Table 5-5: SWOT Analysis of Punawale Area

Strengths:	**Weaknesses:**
i. The development plan has proposal to reserve the bank of Pavana River as an ecologically sensitive zone. ii. 14% of the total site area is under green zone iii. A good hierarchical road network has been established.	i. Most of the land under the planning area is fertile agricultural land. All this land is proposed as residential development. ii. No consideration has been made about the Mumbai-Bangalore Highway cutting through the site. iii. The plan follows a very strict zoning pattern.
Opportunities:	**Threats:**
i. The planning area provides an opportunity to follow a sustainable pattern of development incorporating concepts like urban and peri-urban agriculture. ii. The Mumbai- Bangalore Highway and BRT route cutting through the site provide a chance to plan a high density mixed use development along their length. iii. Utilize the grid of roads for TOD with emphasis on walking and cycling. iv. Plan a self-contained and self-sustainable development. v. The area can serve as residential area for employees of Hinjewadi IT Park.	i. The pressure of real estate and housing demand can exploit the capacity of the planning area beyond its sustainable limit. ii. Since the site does not have a definite boundary earmarked by any physical features; the development may sprawl into adjoining areas. iii. Proximity to the Mumbai-Pune Expressway will result in heavy traffic. This traffic needs to be properly channelized.

5.3.2. Conditions to be met for Punawale Village Area:

The initial assumptions for average population density, population, land use structure have been made based upon the UDPFI Guidelines.

Density:

For the purpose of starting with initial calculations for planning, an average density of 150 pph is assumed.

Population:

Assuming the average population density of 150 pph and the development area to be 441 hectares, the projected population for the planning area works out to be 66,150. Thus, out of the projected additional population of 2,62,170; $1/4^{th}$ of the population i.e. 25% can be accommodated in the Punawale Village Area.

Land Use Structure:

The assumed land use breakup for the area is as follows:

Table 5-6: Assumption for Land use structure

Land use category	**Percentage Range** (%)	**Area (hectares)**
Residential	35-40	154 - 176
Commercial	4-5	18 - 22
Industrial	10-12	44 - 53
Public & Semi-Public	12-14	53 - 62
Recreational	18-20	79 - 88
Transport & Communication	12-14	53 - 62
Agriculture & Water bodies	As per plan	
	TOTAL	400 - 463
	TOTAL AREA AVAILABLE	441
• Around 400 hectares of land needs to be developed keeping the available balance of 41 hectares for agriculture and water bodies.		

Source: Prepared by author by referring UDPFI Guidelines

5.3.3. Social Infrastructure:

The following social infrastructure facilities are required for Punawale Village Area assuming a population of 66,150. The recommendations of accessibility criteria have been used to determine the maximum distance of facilities from the farthest point in any residential area.

Table 5-7: Social Infrastructure requirements:

Facility	Standard (Numbers required per unit population)	Area (hectares)	Area (sq.m)	Facilities required (number)	Total area (hectares)	Accessibility Distance (m) from the farthest point
Educational						
Pre-primary, nursery school	1 for 2500	0.08	800	27	2.16	400
Primary school	1 for 2500	0.4	4000	27	10.8	400
Senior secondary school	1 for 7500	1.60	16000	9	14.4	400-800
Integrated school with hostel facility	1 for 90000	3.50	35000	1	3.5	400-800
School for handicapped	1 for 45000	0.50	5000	2	1.0	400
Medical						
Intermediate hospital Category B	1 for 100000	1.0	10000	1	1.0	1200
Nursing home, child welfare	1 for 45000 to 100000	0.30	3000	1	0.3	1200
Dispensary	1 for 15000	0.12	1200	5	0.6	400-800
Socio- cultural						
Community room	1 for 5000	0.06	660	14	0.98 (9240 sq.m)	400
Library	1 for 15000	0.2	2000	5	1.0	800-1200
Recreational club	1 for 100000	1.0	10000	1	1.0	1200

Facility	Standard (Numbers required per unit population)	Area (hectares)	Area (sq.m)	Facilities required (number)	Total area (hectares)	Accessibility Distance (m) from the farthest point
Music, dance, Drama centre	1 for 100000	0.1	1000	1	0.1	1200
Meditation & spiritual centre	1 for 100000	0.5	5000	1	0.5	1200
Distribution services						
Petrol pump	1 for 150 ha gross residential area	0.2	2000	3	0.6	1200
Milk booth	1 for 5000		50	14	0.07	400
LPG Godown	1	0.2	2000	1	0.2	1200
Police						
Police posts	1 for 40000-50000	0.16	1600	2	0.32	1200
Fire station						
Fire station	Within 3-4 km access range	0.6	6000	1	0.6	3000-4000
Commercial centre						
Commercial Centre	1 (500 sq.m area per 1000 persons)	3.3	33000	1	3.3	400-800
Open space/ parks						
Community parks	2-3 (area 10 sq.m/ person)	66.15			66.5	400
Religious						
Religious buildings	2 for 15000	0.3	5000	5	2.5	400-800
Other services						
Postal service	1 for 15000 population	0.2	2000	5	1	400-800
Internet cafes, telephone booths as per design. The maximum distance of taxi, rickshaw stands and bus stops should not exceed 0.5 km from the farthest point in any residential area.						

Source: Prepared by author by referring UDPFI Guidelines & Survey

6. Proposal for BRT Corridor

All the previous chapters have provided the necessary background and direction to frame a TOD Proposal. The proposal is based on inferences drawn through literature review, case studies, detailed analysis of planning area and the BRT Corridor. This chapter attempts to explain the design envisioned for a Transit- Oriented Development.

6.1. Conceptual Plan for Transport Integration:

From the literature review and case studies, it is evident that the main point of argument is not whether to have a BRT, metro but to have a well-connected and well integrated transport system enabling the commuters to easily choose different modes of transit suiting their requirement.

For the city of Pimpri-Chinchwad and the Aundh-Rawet BRT Corridor, it is important that the bus system is well connected to other modes of travel like the commuter train or a proposed metro in the future.

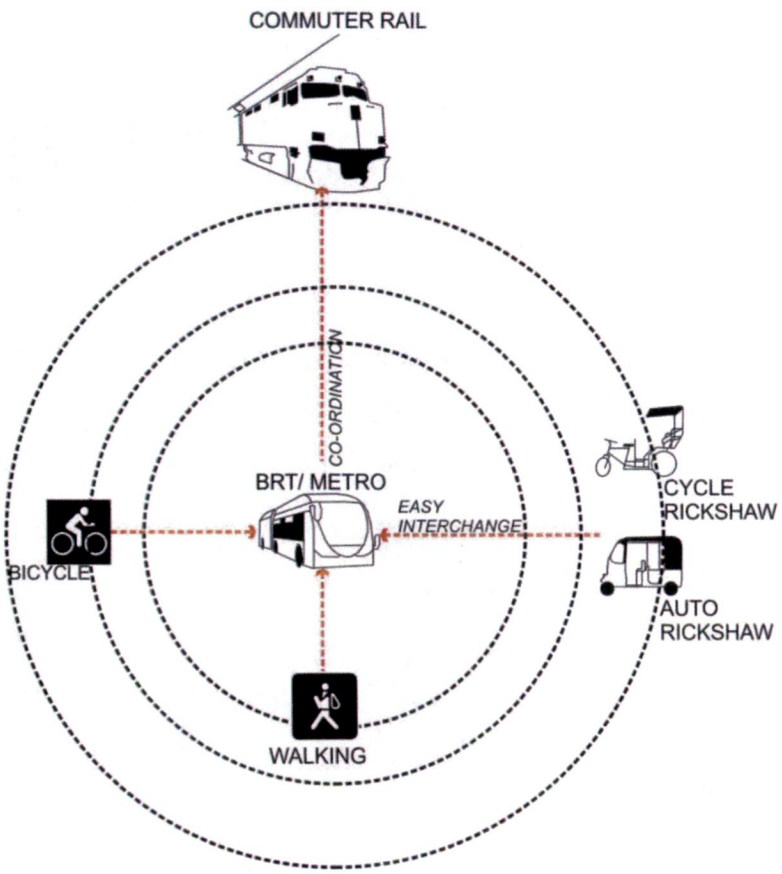


Figure 6-1: Proposed Travel Model
Source: Author

6.2. Conceptual TOD Model:

The main aim of the proposed TOD model is to reduce the auto dependency and encourage walking, cycling and use of public transit in the form of currently proposed BRTS. The BRT stations act as important nodes for the neighborhoods which contain all the day-to-day facilities within 5-10 min walking distances.

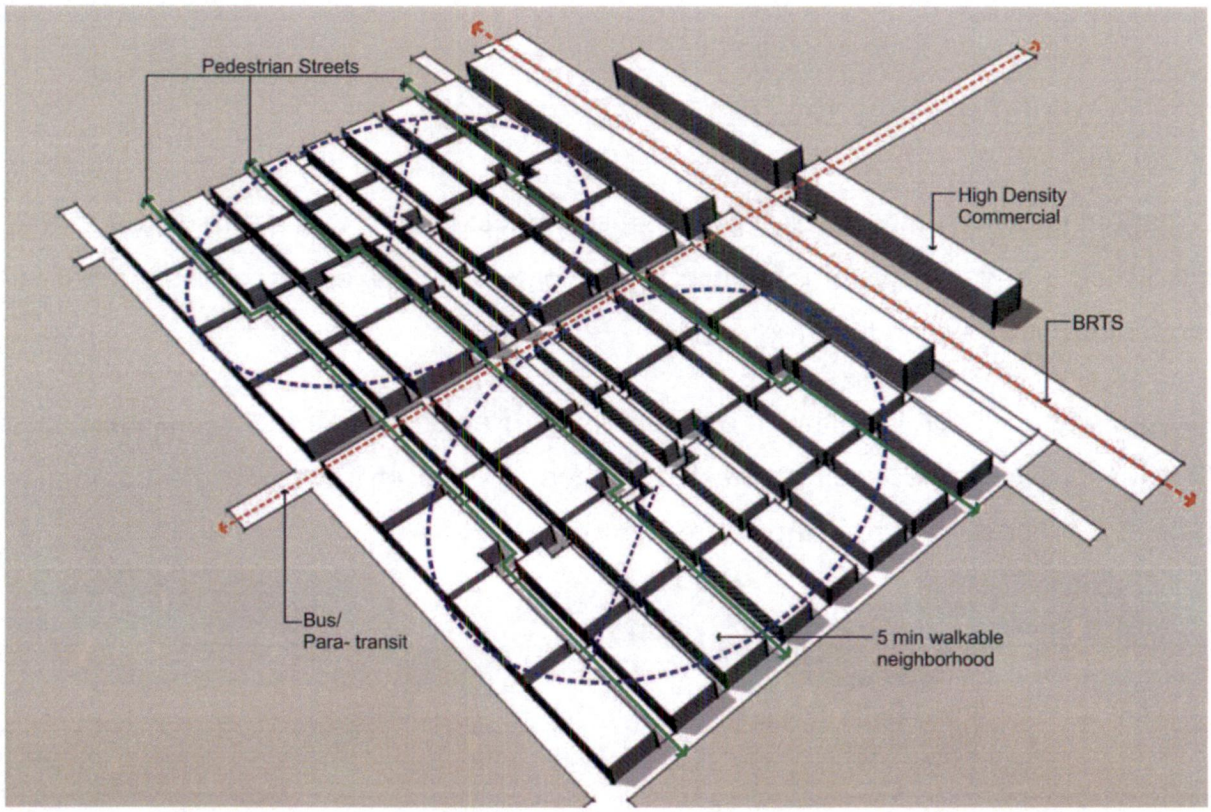


Figure 6-2: Proposed Conceptual TOD Model
Source: Author

The proposed model takes the superficial concept of TOD mentioned in the CMP one step ahead. In addition to proposing a high density development along the corridor, the model incorporates the criteria of easy accessibility to various day-to-day facilities within a neighborhood. Thus, the proposed development immediately adjacent to the BRT line will consist of high density structures housing offices and some residences. Located at some buffer distance from the work places, will be mixed density, mixed-use and mixed income settlements. These settlements will be self-sustainable containing all the facilities required for daily use within walkable distance.

6.3. Proposed TOD for Aundh-Rawet BRT Corridor:

Based on the TOD Model, a conceptual plan is prepared for the selected BRT Corridor Area. The plan illustrates the various planning concepts for the corridor to enable a TOD.

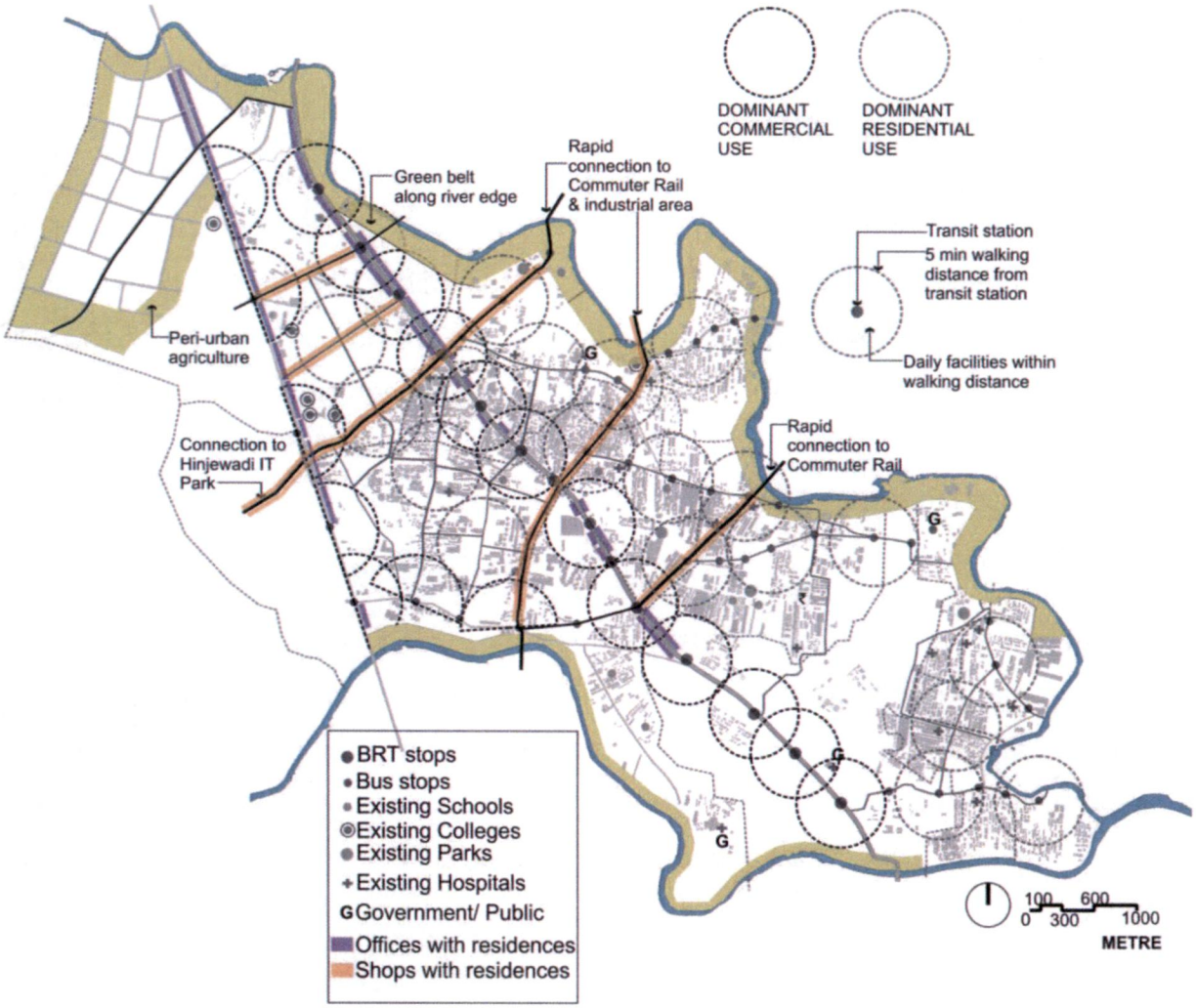


Figure 6-3: TOD Conceptual Proposal for Aundh Rawet Corridor
Source: Author

Recommendations in the conceptual proposal:

i. Work places along Aundh-Rawet BRT :

The development along the Aundh-Rawet BRT route running from south to north will be in the form of high rise office spaces, commercial establishments and some residences. These work places will be connected by rapid BRT network. Every work place will have a BRT station within a 5 minute walking distance.

ii. Commercial development along the perpendicular feeder routes to Aundh-Rawet

The development along the routes running east-west, perpendicular to the main BRT route running south- north will consist mainly of commercial establishments with some residences on the upper floors. These feeder routes will have special hi-speed buses that will run east-west connecting the residences to the commuter rail.

iii. Five minute walkable neighbourhoods

The Aundh-Rawet BRT stations will act as the central nodes for 5 minute walkable neighbourhoods which will consist mainly of high rise work places. The bus stations along the east-west feeder routes will act as central nodes for 5 minute walkable mixed-use neighbourhoods. The mixed-use neighborhoods will have dominant residential use. Commercial establishments shall be located along the public transport routes. Every neighborhood shall be a self-sustainable neighborhood containing all the facilities of daily requirement and appropriate open space.

iv. Green-edge along the River Pavana:

The selected Aundh-Rawet corridor area has a natural boundary in the form of River Pavana. The soil along the river bank is very fertile and needs to be reserved for forests and agriculture. The plan proposes to protect this fertile area along the edge of River Pavana by permitting no construction along the river edge.

7. TOD Proposal for Punawale Area

This chapter attempts to explain the TOD details worked out for the Punawale Village Area which can be used as a model for planning similar TOD projects.

7.1. Planning Concept for the Punawale Area:

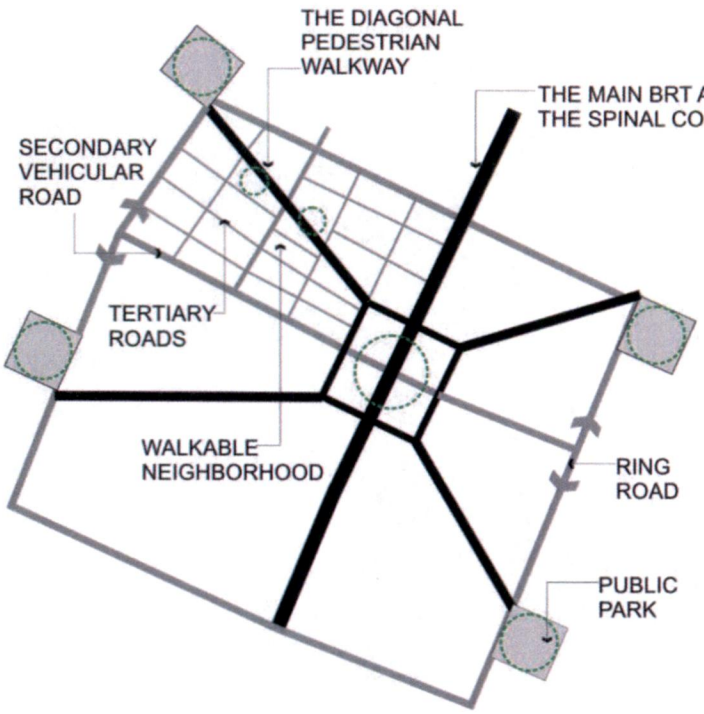


Figure 7-1: Conceptual Planning Diagram

As indicated in the figure alongside, the central BRT Line acts as the backbone of entire mobility network. The pedestrian walkways connecting the central commercial square to the peripheral parks act like the nerves of mobility system.

The vehicular grid acts like the skeletal network, inter-connecting the entire mobility network.

7.2. Sequential evolution of plan:

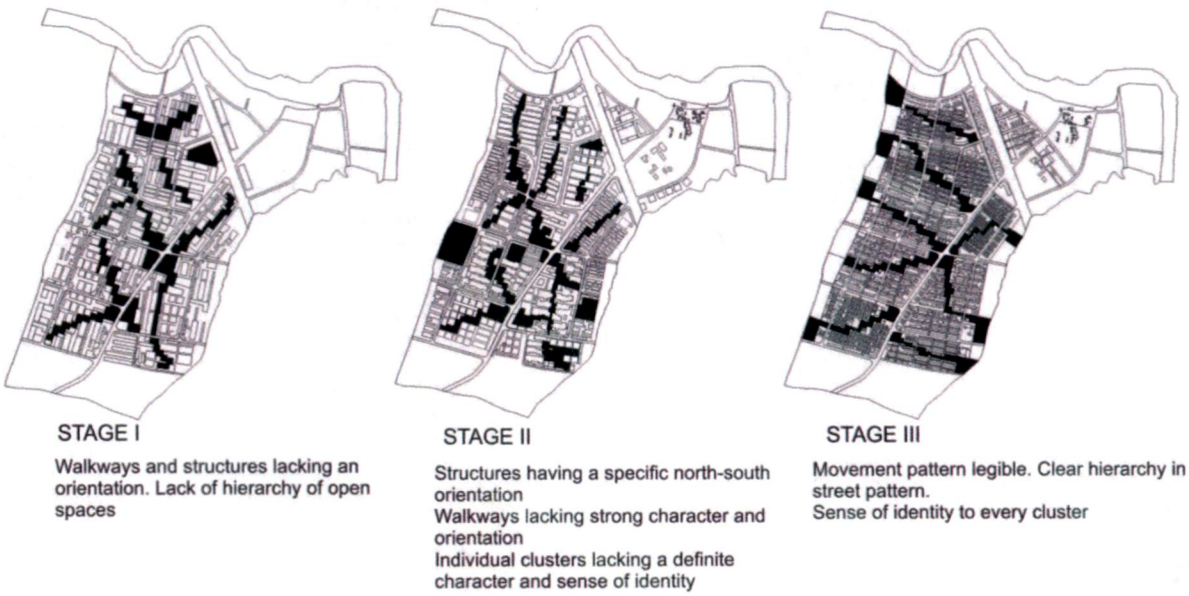


Figure 7-2: Punawale: Plan evolution

*All diagrams, drawings and calculations have been done by author as a part of proposal

7.3. Punawale Layout Plan:

Figure 7-3: Punawale Layout Plan

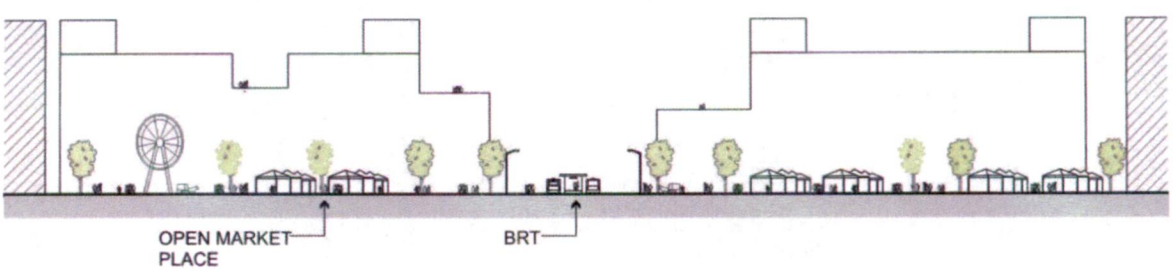


Figure 7-4: Section through central public square

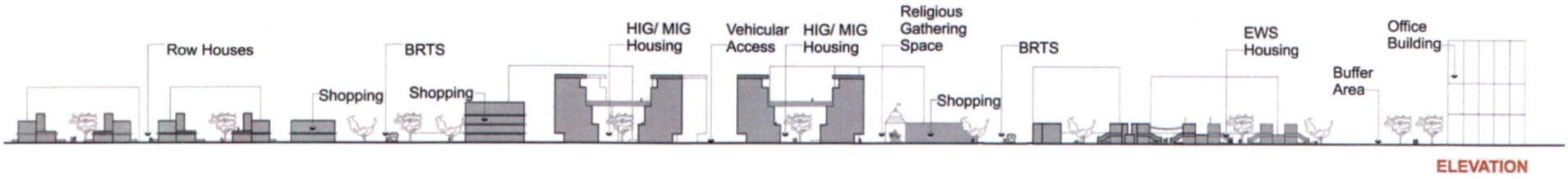


Figure 7-5: Housing Elevation

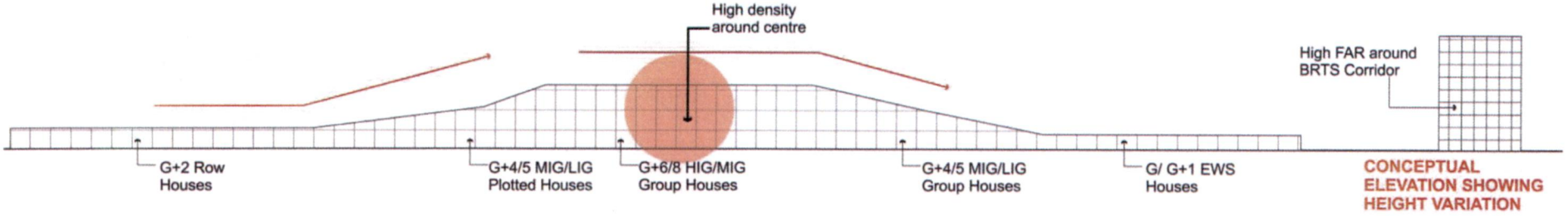


Figure 7-6: Conceptual Housing Elevation

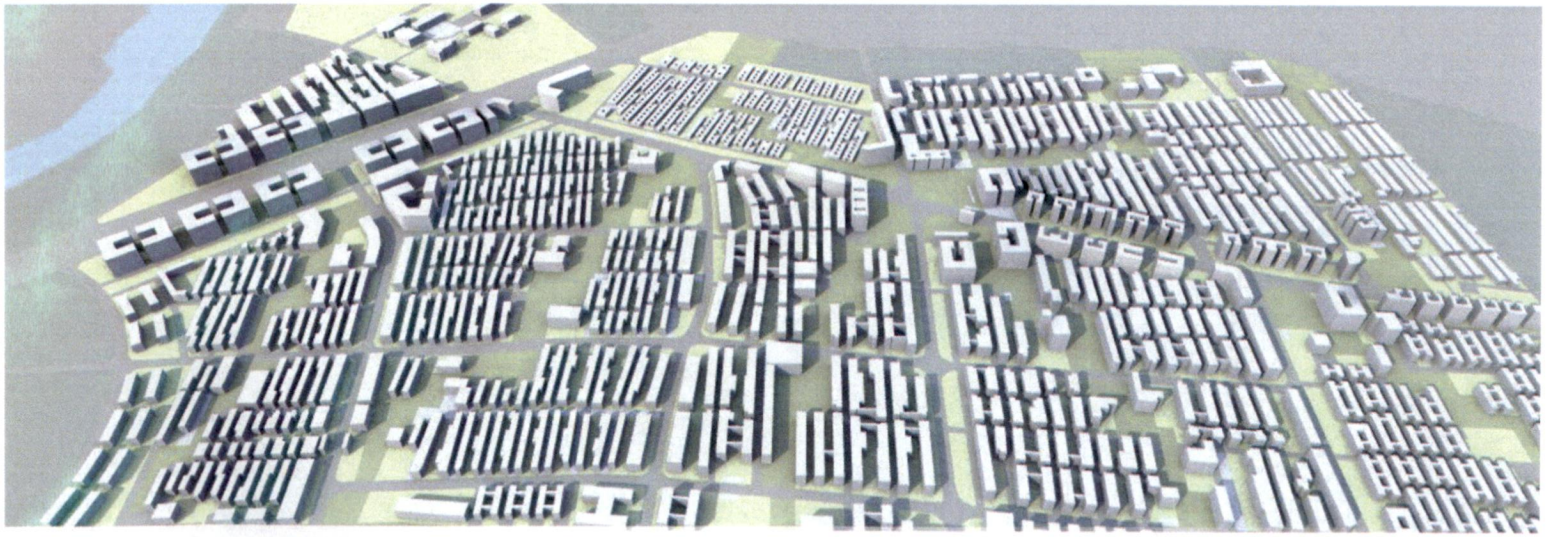


Figure 7-7: Housing View

7.3.1. Land Use:

The proposal uses the draft land use plan for Punawale Village as the base map and works out the various land uses in detail.

Table 7-1: Land use break-up for Punawale Area

LAND USE	AREA (HECTARES)	PERCENTAGE
MIXED USE (RESIDENTIAL+COMMERCIAL+ PUBLIC)	133.15	30.2
GAOTHAN (VILLAGE)	11	2.5
WORKPLACES	16.33	3.7
INDUSTRY	7.25	1.6
INSTITUTIONAL	1.04	0.2
ROADS	80.7	18.3
PEDESTRIAN WALKWAY	25.04	5.7
UTILITY	28.3	6.4
PARKS/PLAYGROUND	16	3.6
RIVER SIDE RECREATIONAL	29.24	6.6
FOREST	32.85	7.4
AGRICULTURE	60.1	13.6
TOTAL	**441**	**100.0**

In the proposed land use plan, 18% of total area has been reserved as open space. In addition to this, 7.4% and 13.6% of total area has been reserved as forest land and agriculture land respectively.

42.1% of the total land has been utilized for mixed- use housing.

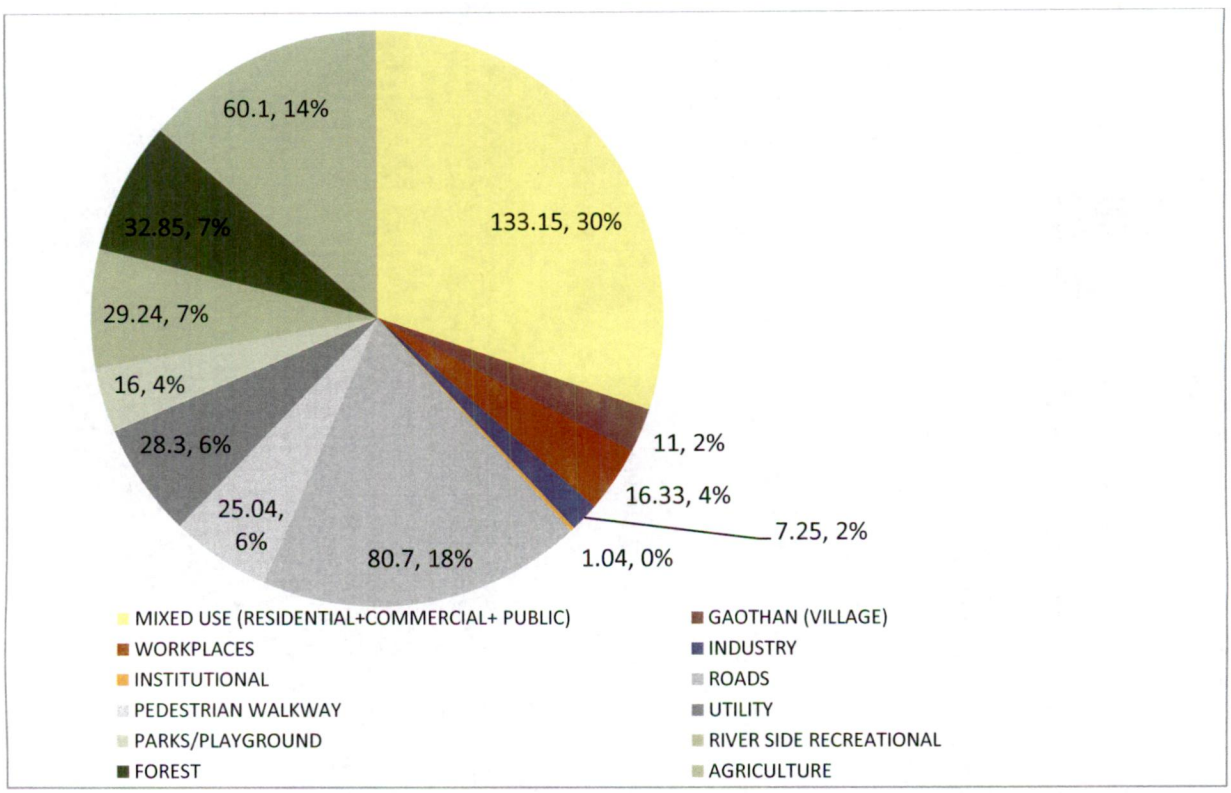


Chart 7-1: Punawale proposed land use break-up

Figure 7-8: Punawale Proposed Land use Plan

The proposed land-use plan for Punawale is a detailed version of the existing land-use plan. The existing land use plan has 68% residential land use. The proposed land use plan attempts to promote a mixed use development; which consists of peripheral ground floor commercial areas with residential use on upper floors and public use along the pedestrian walkway.

*All diagrams, drawings and calculations have been done by author as a part of proposal

7.4. Road Layout:

From literature review and case studies, it is evident that an inter-connected road system is better as compared to a cul-de-sac road system as the former system offers better connectivity and helps to keep the trips as short as possible. The road system adopted for Punawale area is an interconnected road system. However, some of the local 10m wide roads are cul-de-sacs terminating at the junction with pedestrian walkways.

Figure 7-9: Punawale Road Layout

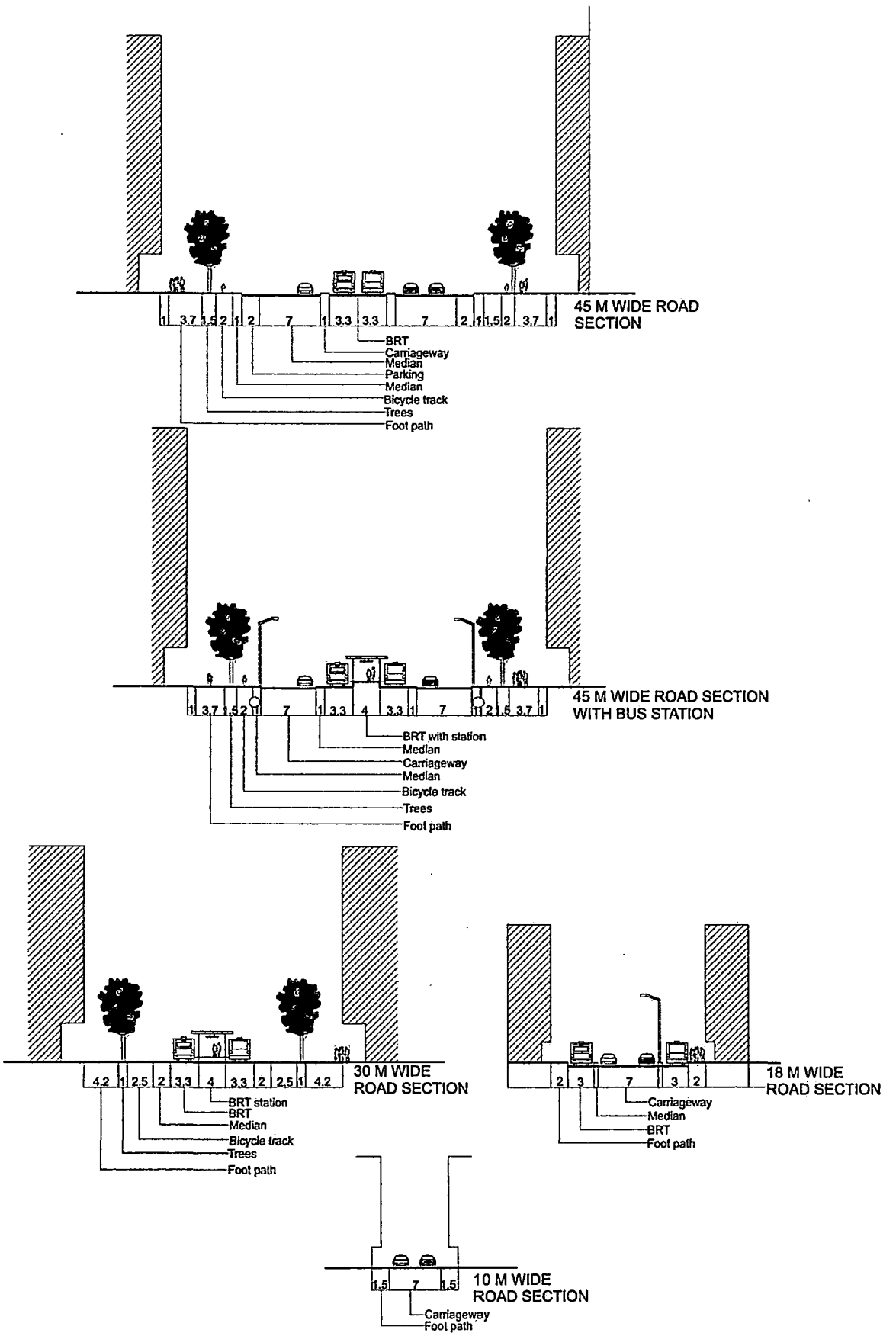


Figure 7-10: Punawale Proposed Road Sections

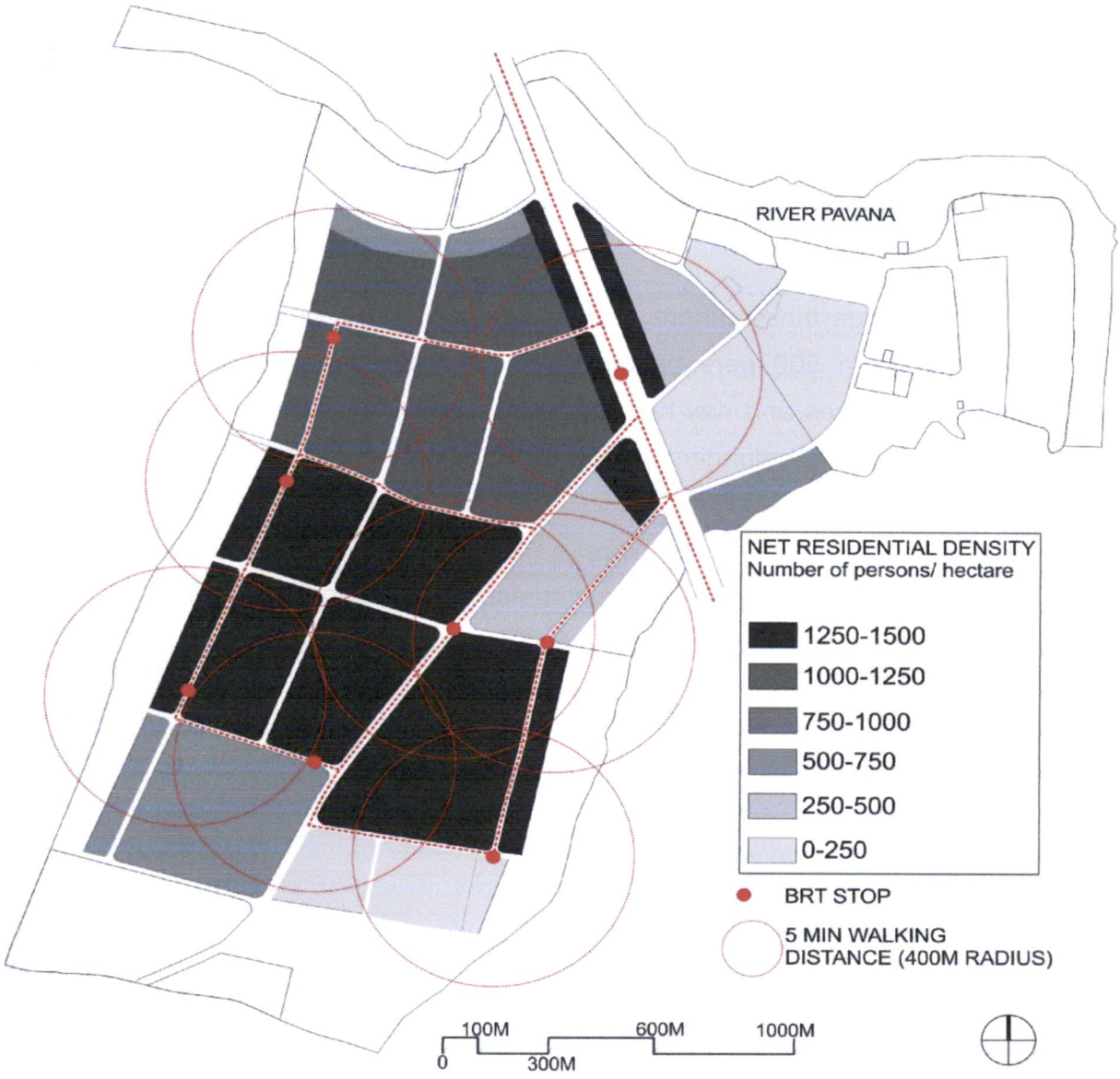
7.5. Built and Open Spaces:

The open spaces within the planned area are well connected and follow a hierarchy. The central commercial area and the central shopping street is the main public place. From this spectral open square, the diagonal pedestrian walkways spring out which connect the commercial area to the public parks on the periphery. School buildings, temples, public buildings serve as distinguishing edges to the pedestrian walkways.

Figure 7-11: Punawale Figure Ground Plan

Density distribution:

The following plan represents the net residential density distribution across the Punawale Area.



The population of 77,770 has been distributed across the planning area in such a manner that the central core area has a net residential density between 1250-1500 persons/ hectare. This area consists of 5-6 storeyed group housing apartments. This density gradually decreases from the area surrounding the central core towards the periphery.

The area along the length of main BRT Corridor has a density between 1000-1250 persons/ hectare. This area contains office buildings along the edge of the main BRT Corridor surrounded by Low Income Group (LIG) and Medium Group (MIG) Housing so that the residents of this income group are located in close proximity to the main express BRT station.

The area towards the southern part of the site consists of plotted housing having density less than 500 persons per hectare. The plotted housing consists of 3-4 storeyed residences and row houses, targeted mainly at High Income Group (HIG) housing. The people belonging to this category are expected to use their own private vehicles in spite of a good public transit system. As a result these residences are located slightly away from the express BRT station. Still, these settlements have a BRT station located within a walking distance of less than five minutes.

Thus, the entire settlement has been planned as a mixed-density settlement wherein the average net residential density is 395 persons per hectare as against the proposed density of 221 persons/ hectare

7.6. Housing:

7.6.1. Population and Density:

As per the result of population projection, the population to be accommodated in Punawale village area is 66,150. The planning proposal is able to accommodate a permanent residential population of 77,770 and a temporary working population of 21,472. Thus, the total population that can be accommodated in Punawale Area is 99,242

Table 7-2: Permanent population of Punawale

TYPE	NO OF UNITS	%	% TO TOTAL	HOUSE HOLD SIZE	POPULATION	NET AREA (Ha)	NET DENSITY (NO OF PERSONS/Ha)	GROSS AREA (Ha)	GROSS DENSITY (NO OF PERSONS/ Ha)	GROSS DENSITY (NO OF PERSONS/ SQ.KM)	TOTAL BUILT UP (Ha)	GROUND COVERAGE	FAR
GROUP HOUSING													
EWS	1025	9	78	4.5	4613	10.3	397						
MIG/LIG	4885	42		4.5	21983	17.5	1118						
HIG/MIG	5845	50		4.5	26301	16.7	1400						
TOTAL	11755	100		4.5	52898	44.5	1057						
PLOTTED HOUSING													
MIG/LIG	2306	72	22	4.5	9686	16.3	566						
HIG	406	13		4.5	1827	3	541	**441**	**176**	**17600**	**319.2**	**32%**	**1.8**
ROW HOUSES	510	16		4.5	2295	15.6	131						
TOTAL	3222	100		4.5	14499	34.8	370						
OFFICES	1925	100		4.5	8663	16.3	472						
MISC	380	100		4.5	1710								
TOTAL	**32259**			**4.5**	**77770**	**175**	**395**						

Table 7-3: Temporary population of Punawale Area

TYPE	UNITS	POPULATION
SCHOOLS	66	10000
HOSPITALS (CONSIDERING 100 BEDS)	2	100
CINEMA HALL (500 SEATS)	1	500
FACTORY	2	
OFFICES		6000
COMMERCIAL CENTRE	818	1272
SHOPS	1200	3000
INFORMAL SHOPS	400	600
TOTAL	**2489**	**21472**

The school children and the working population who reside outside the planned area constitute the floating population. School and college going children account for 47% of the total floating population of 21,472 and do not require any accommodation facility except the schools with attached hostel facility. A temporary housing facility has been provided for occasional visiting staff of offices.

7.6.2. Housing types:

Group Housing:

The group housing consists of four clusters of mixed-income housing as follows:

1. Economically Weaker Section (EWS)
2. Medium Income Group and Low Income Group (MIG/ LIG)
3. Higher Income Group and Medium Income Group (HIG/

Figure 7-12: Punawale group housing

The various mixed-income clusters of group housing are planned based upon the travel pattern characteristics of each group. Every cluster has a central pedestrian spine joining the central commercial street to the peripheral community parks. Commuters of EWS, LIG and MIG are dependent on the public transport for their daily travel to workplaces. Therefore, these groups are placed in close proximity to the main BRT route. People belonging to HIG tend to use their own private vehicle for travelling. As a result, the residences of these people are located slightly away from the main BRT line. However, the layout is such that the HIG commuters would reach their destinations faster either by walking or by the use of public transport. Thus, the main aim of the layout is to reduce the travel time, make trips as short as possible and slowly reduce the number of daily trips made by using private vehicles.

Table 7-4: Punawale group housing area calculation

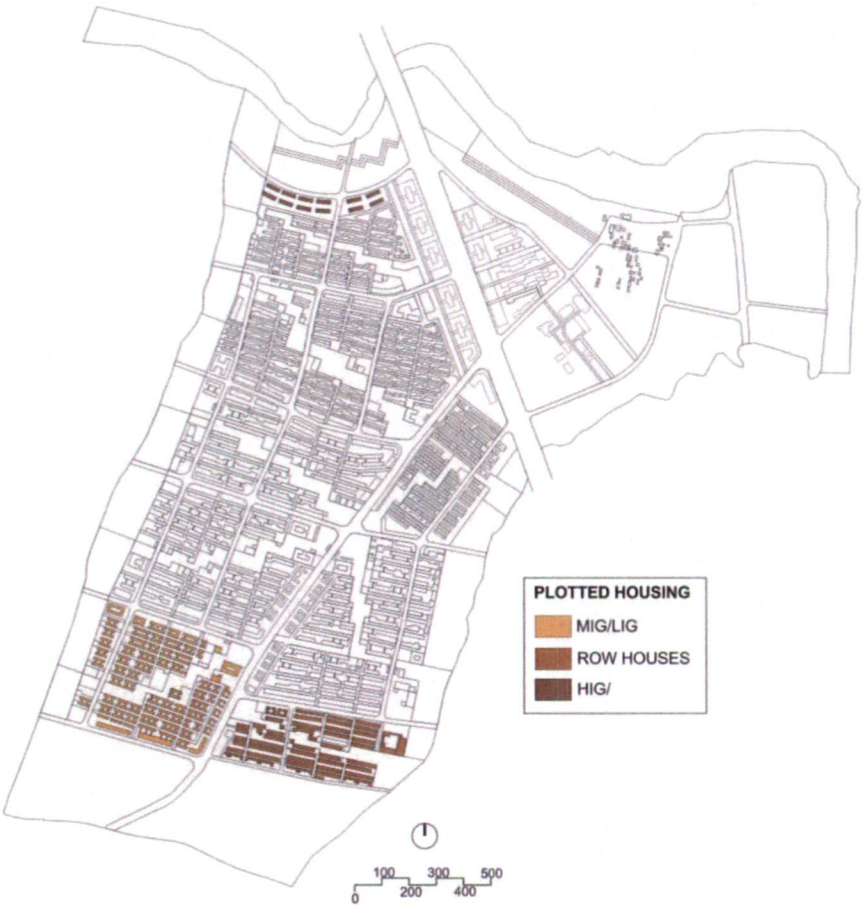
TYPE	UNITS PROVIDED	AREA OF SINGLE UNIT (SQ.M)	TOTAL AREA (SQ.M)	OTHER (SQ.M)	MIXED USE %	TOTAL BUIT UP (SQ.M)	PLOT AREA (SQ.M)	GROUND COVERAGE (SQ.M)	GROUND COVERAGE	FAR	NO OF FLOORS
EWS GROUP HOUSING											
EWS	1025	60	123000	2565	42%	125565	103204	47882	0.5	1.2	2
MIG/LIG GROUP HOUSING											
MIG1	1885	130	245050	260635	53%	751160	312104	174760	0.6	2.4	4
LIG1	1365	90	122850								
LIG2	1635	75	122625								
TOTAL	4885		490525								
HIG/MIG COMBINED GROUP HOUSING											
HIG	1670	200	334000	505730	55%	1424230	616868	167000	0.3	2.3	7
MIG2	4175	140	584500								
TOTAL	5845		918500								
	11755		**1532025**	**768930**	**50%**	**2300955**	**1032176**	**389642**	**0.4**	**2.2**	

Table 7-5: Punawale office housing area calculation

TYPE	TOTAL AREA (SQ.M)	PLOT AREA (SQ.M)	GROUND COVERAGE	GROUND COVERAGE	FAR	NO OF FLOORS
OFFICE AREA						
OFFICES	165640	163287	38206	0.2	2.1	8
HOUSING	173136					
INSTITUTIONAL						
INSTITUTE	62238	127016	10373	0.1	0.5	6

Group housing constitutes for 78% of the total housing provided. Group housing will be in the form of apartments. None of the cluster is a purely residential cluster. Every cluster is a mixed-use cluster consisting of residences, shops, schools and other day to day facilities. The percentage of other uses to residential use in every cluster is around 50%. The mixed-use pattern of planning enables the residents to access various day-to-day facilities easily by walking.

Plotted Housing:



The plotted housing consists of three major clusters:

1. Medium Income Group and Lower Income Group (MIG/ LIG)
2. Row Houses
3. High Income Group (HIG)

Figure 7-13: Punawale plotted housing

Table 7-6: Punawale plotted Housing area calculation

TYPE	UNITS PROVIDED	AREA OF SINGLE UNIT (SQ.M)	TOTAL AREA (SQ.M)	OTHER (SQ.M)	MIXED USE %	TOTAL BUIT UP (SQ.M)	PLOT AREA (SQ.M)	GROUND COVERAGE	GROUND COVERAGE	FAR	NO OF FLOORS
MIG/LIG PLOTTED											
MIG	922	90	82980	86496	46%	273276	162953	55906	0.3	1.7	5
LIG	1384	75	103800								
	2306		186780								
HIG PLOTTED											
HIG	406	150	60900	0	0	60900	30236	8700	0.3	2.0	7
ROW HOUSES											
ROW	510	250	127500	28035	22%	155535	106140	51845	0.5	1.5	3
	2874		**314280**	**114531**	**36%**	**489711**	**299329**	**116451**	**0.4**	**1.6**	

7.7. Planning of Infrastructure facilities:

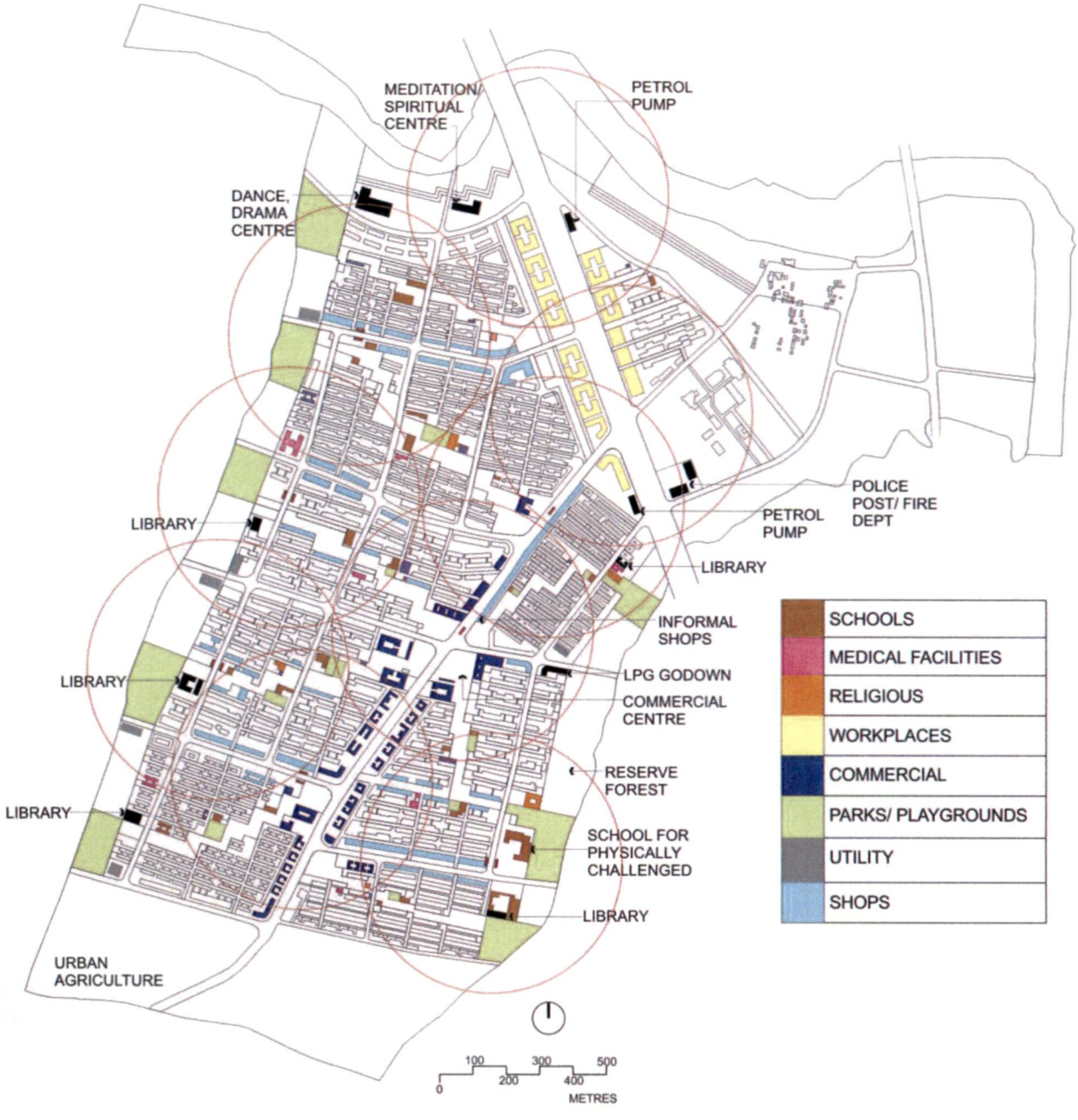


Figure 7-14: Punawale location of infrastructure facilities

In the above figure, circumference of the red circle denotes 5 minute walking distance from the BRT station. While locating the infrastructure facilities, this walking distance is taken into consideration to ensure that a corner shop, school, dispensary are located within the accessible limit of 400m (5 minute walking distance). The infrastructure facilities required for the planning area were decided based upon the

UDPFI Guidelines. (Ref Table 5-7) These facilities have been distributed across different neighbourhoods based upon the population of every neighborhood.

Table 7-7: Punawale location of infrastructure facilities

NUMBERS LOCATED IN PARTICULAR AREA											
FACILITY	NOS REQ AS PER NORMS	EWS	MIG/LIG GROUP	HIG/MIG GROUP	MIG/LIG PLOTTED	HIG PLOTTED	ROW HOUSES	OFFICES	SPECIFIC LOCATION	TOTAL PROVIDED	MAX DIST (M)
Pre-primary, Nursery	27	2	8	9	4	1	1	3		28	350
Primary	27	2	8	9	4	1	1	3		28	400
Senior Secondary	9	0	3	3	1			1		8	400
Integrated school with hostel	1								1	1	800
School for Physically challenged	2								1	1	1500
Category B Hospital	1								1	1	1200
Nursing Home	1								1	1	600
Dispensary	5		1	1	1	1	1	1		6	400
Community Room	14		4	5	2	1	1	1		14	500
Library	5		1	1	1		1			4	600
Recreational Club	1								1	1	1500
Music, drama centre	1								1	1	1500
Spiritual Centre	1								1	1	1500
Petrol Pump	3								2	2	1200
Milk Booths	14	1	3	5	2	1	1	2		15	300
LPG Godown	1										1000
Police Post	2								2	2	1500
Fire station	1								1	2	1500
Commercial Centre	1								1	2	800
Community Parks	66 ha	1	2	3	1	1	1			70 ha	560
Religious Buildings	5	1	1	1	1			1		5	400

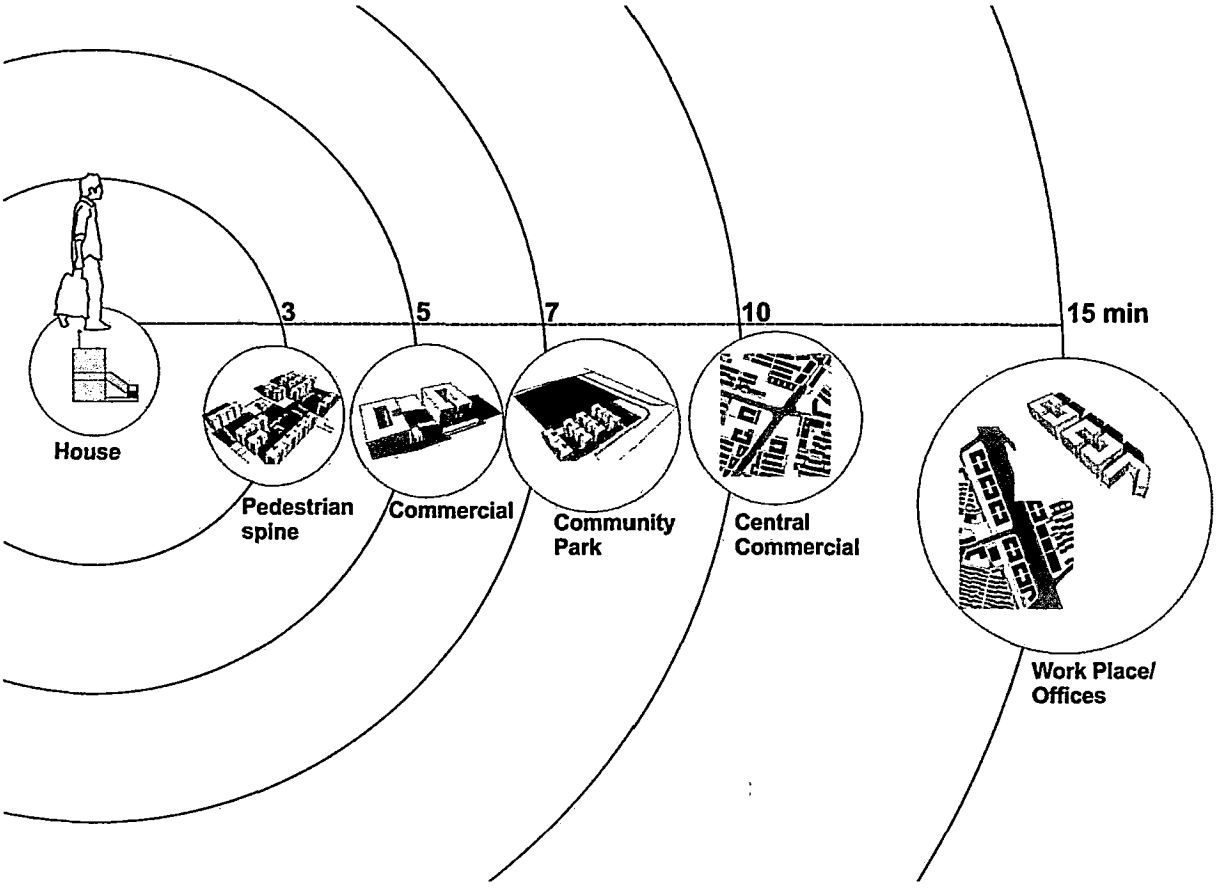


Figure 7-15: Punawale accessibility to infrastructure facilities

The above figure represents the accessibility to various infrastructure facilities in terms of maximum time required to reach a particular activity from a house by walking.

7.8. Services:

This sub-section consists of conceptual layouts for water supply, sewage disposal and firefighting. It also makes a rough estimate about the daily water requirement for the entire population, water that can be captured through rain water harvesting, quantity of generated sewage, and quantity of solid waste generated in the entire settlement area. Different standards like UDPFI Guidelines, WBDG Guidelines [1]and

[1] WBDG- Whole Building Design Guide is an online guide from the National Institute of Building Sciences, Washington DC, US which provides basic building and infrastructure designing guidelines to technical practitioners.

Solid waste Management Plan for Pune have been used for assuming the standard per capita requirements.

7.8.1. Water supply and sewage disposal

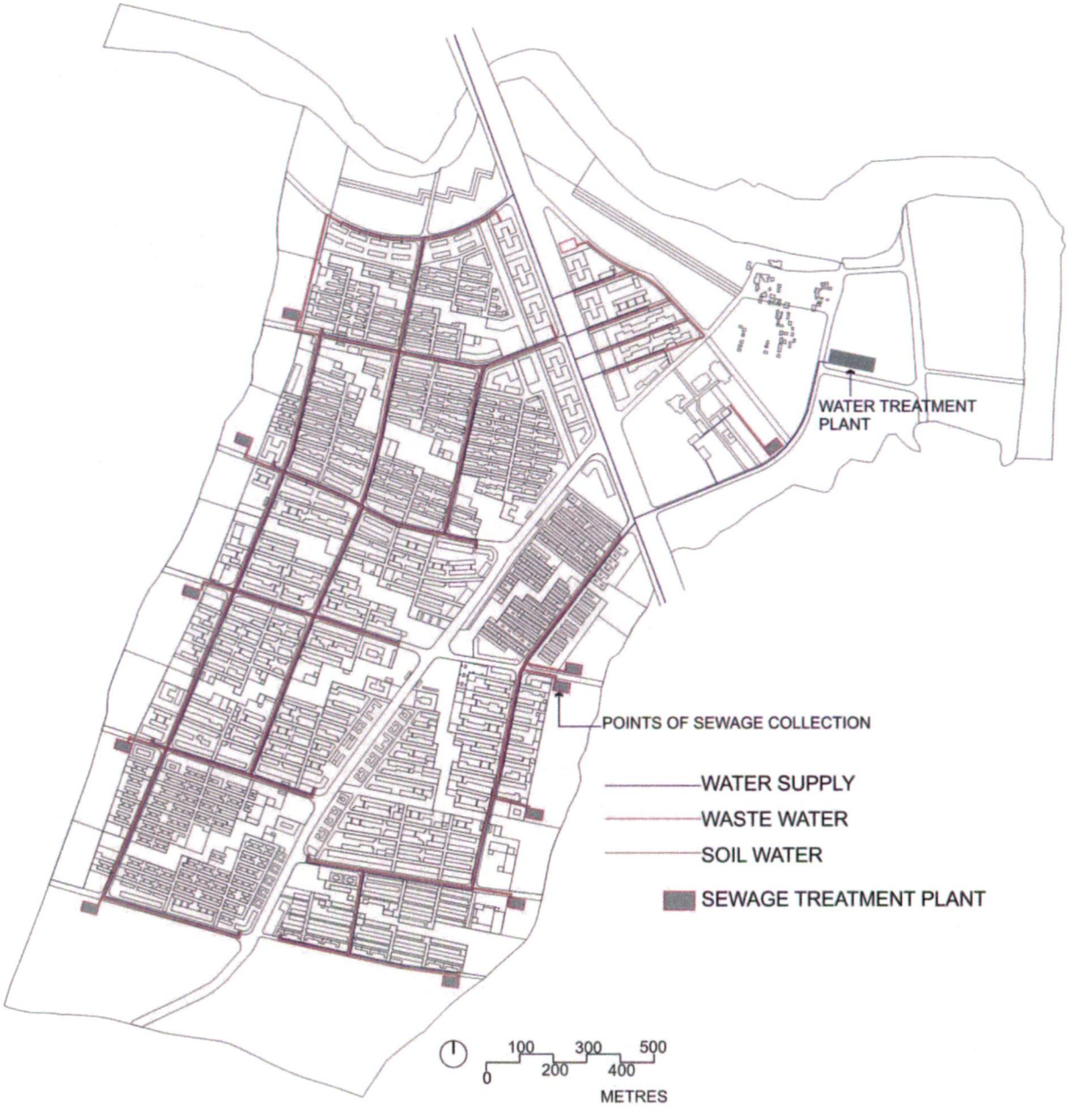


Figure 7-16: Punawale water supply and sewage network plan

The area shall receive potable water from the water treatment plant by a combined system of gravity supply and pumping. The resultant sewage water will be carried to the sewage treatment plants located at the periphery. This water will be treated and recycled for other secondary uses. Besides this, rain water that is collected on top of roofs and paved surfaces will also be recycled and used for secondary uses.

Table 7-8: Water Requirement for Punawale

GROUP	UNITS	POPULATION	NORM (UDPFI GUIDELINES) LITRES/PER CAPITA/ PER DAY	NORM WBDG LITRES/PER CAPITA/PER DAY	TOTAL WATER REQUIREMENT (MLD)		WASTE WATER GENERATED (80% OF CONSUMED) MLD	
					UDPFI	WBDG	UDPFI	WBDG
EWS GROUP	1025	4613	135	200	0.62	0.92	0.50	0.74
MIG/LIG GROUP	4885	21983	135	200	2.97	4.40	2.37	3.52
HIG/MIG GROUP	5845	26301	135	200	3.55	5.26	2.84	4.21
MIG/LIG PLOTTED	2306	9686	135	200	1.31	1.94	1.05	1.55
HIG PLOTTED	406	1827	135	200	0.25	0.37	0.20	0.29
ROW HOUSES	510	2295	135	200	0.31	0.46	0.25	0.37
HOUSING FOR OFFICES	1925	8663	135	200	1.17	1.73	0.94	1.39
SCHOOLS	66	10000	135	150	1.35	1.50	1.08	1.20
HOSPITALS (CONSIDERING 100 BEDS)	2	100	340	150	0.03	0.02	0.03	0.01
CINEMA HALL (500 SEATS)	1	500	15	45	0.01	0.02	0.01	0.02
FACTORY	2	500	45	45	0.02	0.02	0.02	0.02
OFFICES		6000	45	45	0.27	0.27	0.22	0.22
COMMERCIAL CENTRE	818	1272	45	45	0.06	0.06	0.05	0.05
SHOPS	1200	3000	45	45	0.14	0.14	0.11	0.11
INFORMAL SHOPS	400	600	75	75	0.05	0.05	0.04	0.04
TOTAL	**19391**	**97340**			**12.10**	**17.14**	**9.68**	**13.71**

The standard per capita per day water consumption quantity is different as per UDPFI and WBDG guidelines. Normally, for calculation purpose a standard figure of 135 litres/ person /day is considered to work out the total water requirement. However the per capita water consumption varies in summer and winter. In summer the daily water consumption may rise up to 200 litres/ person/ day. Therefore, the water tank capacity and the number of water tanks that are required for the total area have been worked out considering the WBDG figures.

Every overhead water tank will have an additional 200 litre capacity for firefighting purpose.

Table 7-9: Punawale requirement for water tanks

GROUP	WATER REQ MLD	CU.M	UG TANK CAPACITY (70%)	NOS REQ (30 CU.M CAPACITY)	OVERHEAD TANK (30%)	NOS REQ (10 CU.M CAPACITY)
EWS GROUP	0.92	920	644	19	276	28
MIG/LIG GROUP	4.40	4400	3080	91	1320	132
HIG/MIG GROUP	5.26	5260	3682	108	1578	158
MIG/LIG PLOTTED	1.94	1940	1358	40	582	58
HIG PLOTTED	0.37	370	259	8	111	11
ROW HOUSES	0.46	460	322	9	138	14
HOUSING FOR OFFICES	1.73	1730	1211	36	519	52
SCHOOLS	1.50	1500	1050	31	450	45
HOSPITALS (CONSIDERING 100 BEDS)	0.02	20	14	1	6	1
CINEMA HALL (500 SEATS)	0.02	20	14	1	6	1
FACTORY	0.02	20	14		6	1
OFFICES	0.27	270	189	6	81	8
COMMERCIAL CENTRE	0.06	60	42	1	18	2
SHOPS	0.14	140	98	3	42	4
INFORMAL SHOPS	0.05	50	35	1	15	2
TOTAL	**17.16**					

7.8.2. Rain water harvesting

The water from the roof surfaces as well as paved and open areas will be collected and used for secondary water requirement.

Table 7-10: Punawale rain water harvesting

RAINWATER HARVESTING		Units
Average Annual Rainfall of Pune considered	722	mm
For roof/ terrace/ paved areas		
Average run-off co-efficient for terraces, paved areas	0.85	
Area considered	**352578**	sq.m

Value of water available for rain-water harvesting = (Total area x 0.8 x .85 x 722/1000)	**173102**	cu.m
Peak one hour intensity of water	50	mm/hr
Infiltration well capacity period	15	min
Net rate of recharge required		
	12.5	mm/hr
Theoretical Volume of infiltration wells required (total area x 0.8 x 0.0125)	**3526**	cu.m
Landscape green & open areas	160000	sq.m
Average run-off co-efficient for green, open areas	0.4	
Value of water available for rain-water harvesting = (Total area x 0.8 x .4 x 722/1000)	**36966**	cu.m
Peak one hour intensity of water	50	mm/hr
Infiltration well capacity period	15	min
Net rate of recharge required	12.5	mm/hr
Theoretical Volume of infiltration wells required (total area x 0.8 x 0.0125)	**1600**	cu.m
Total rain water available		cu.m
Total water required for entire year	**5697650**	cu.m
% of harvested rain-water	**7%**	

From the calculations, it is clear that for such a massive water requirement, it is essential to close the loop in the cycle of water supply. Currently, in Pune and Pimpri-Chinchwad, waste water is not recycled and re-circulated in the water supply system. The waste water is left in the Rivers Mula Mutha without any treatment. This not only causes pollution of the rivers but also leads to wastage of a precious resource like water.

Therefore, in the proposal for Punawale area, the waste water shall be treated and circulated back for secondary uses like gardening, washing, etc. Potable water supply shall be used only for drinking and recycled water for all other secondary purposes as mentioned above. Provision shall also be made for rain water harvesting. From table 7-10, it is clear that 7% of total water requirement can be met through rain water harvesting.

7.8.3. Fire fighting

A firefighting layout has been prepared taking into consideration that every residential area can be accessed by a fire brigade in case of emergency.

Figure 7-17: Punawale firefighting layout

7.8.4. Solid waste management:

The cities of Pune and Pimpri-Chinchwad are facing a grave problem of solid waste disposal. The solid waste from the urban areas is transported away from the city and dumped in remote villages. As a result, the villagers are facing serious health problems. Out of the total quantity of solid waste generated, 55% is in the form of organic waste and can be treated at the source itself.

Table 7-11: Punawale Quantity of solid waste generated

GROUP	POPULATION	SOILD WASTE/PERSON/DAY	WASTE GENERATED PER DAY (KG)	WASTE GENERATED PER DAY (TON)	COMPOSTABLE (55% OF TOTAL)	WASTE GENERATED PER WEEK (TON)	COMPOSTABLE (55% OF TOTAL)
EWS GROUP	4613	0.312	1439	1.4	0.8	10.1	5.5
MIG/LIG GROUP	21983	0.312	6859	6.9	3.8	48.0	26.4
HIG/MIG GROUP	26301	0.312	8206	8.2	4.5	57.4	31.6
MIG/LIG PLOTTED	9686	0.312	3022	3.0	1.7	21.2	11.6
HIG PLOTTED	1827	0.312	570	0.6	0.3	4.0	2.2
ROW HOUSES	2295	0.312	716	0.7	0.4	5.0	2.8
HOUSING FOR OFFICES	8663	0.312	2703	2.7	1.5	18.9	10.4
SCHOOLS	10000	0.312	3120	3.1	1.7	21.8	12.0
HOSPITALS (CONSIDERING 100 BEDS)	100	0.312	31	0.0	0.0	0.2	0.1
CINEMA HALL (500 SEATS)	500	0.312	156	0.2	0.1	1.1	0.6
FACTORY	500	0.312	156	0.2	0.1	1.1	0.6
OFFICES	6000	0.312	1872	1.9	1.0	13.1	7.2
COMMERCIAL CENTRE	1272	0.312	397	0.4	0.2	2.8	1.5
SHOPS	3000	0.312	936	0.9	0.5	6.6	3.6
INFORMAL SHOPS	600	0.312	187	0.2	0.1	1.3	0.7
TOTAL	**97340**		**30370**	**30.4**	**16.7**	**212.6**	**116.9**

From the above table it is evident that out of the 28 ton of daily solid waste, 15.4 ton is in the form of organic waste and can be easily treated at the source point itself and converted into manure. This manure can then be used in agricultural fields.

7.9. Housing Cluster:

The figure below illustrates the details of a housing cluster. The main idea of every cluster is to encourage people to use the central pedestrian walkway as the main thoroughfare to reach out various places. The walkway has been designed in such a way so as to enhance the walking experience of every pedestrian.

7.8.4. Solid waste management:

The cities of Pune and Pimpri-Chinchwad are facing a grave problem of solid waste disposal. The solid waste from the urban areas is transported away from the city and dumped in remote villages. As a result, the villagers are facing serious health problems. Out of the total quantity of solid waste generated, 55% is in the form of organic waste and can be treated at the source itself.

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CINEMA HALL (500 SEATS)	500	0.312	156	0.2	0.1	1.1	0.6
FACTORY	500	0.312	156	0.2	0.1	1.1	0.6
OFFICES	6000	0.312	1872	1.9	1.0	13.1	7.2
COMMERCIAL CENTRE	1272	0.312	397	0.4	0.2	2.8	1.5
SHOPS	3000	0.312	936	0.9	0.5	6.6	3.6
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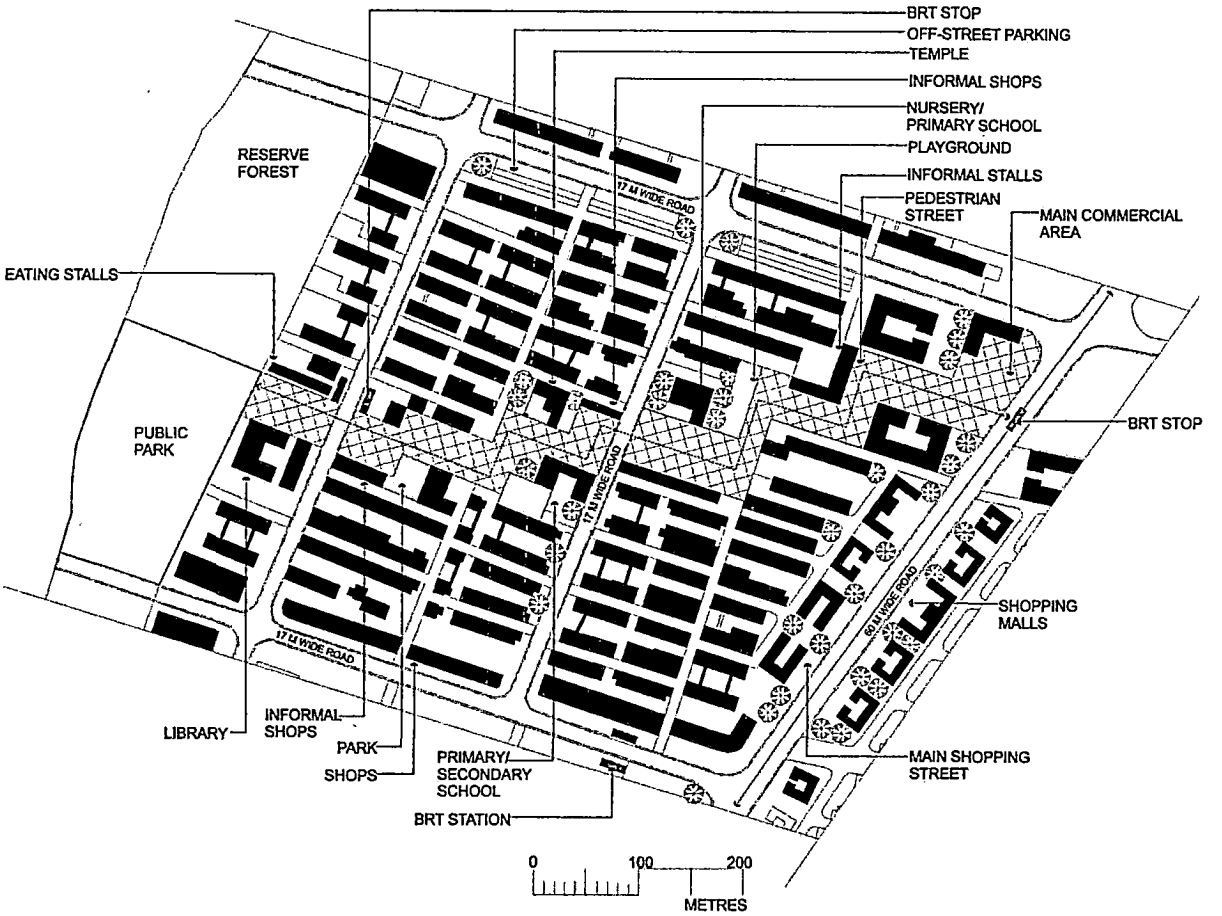


Figure 7-18: Punawale HIG/MIG Cluster Plan

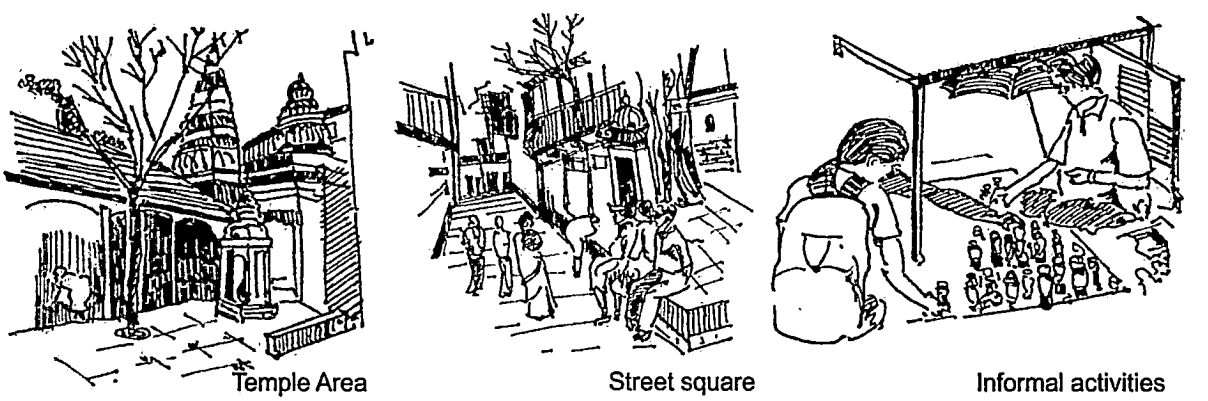


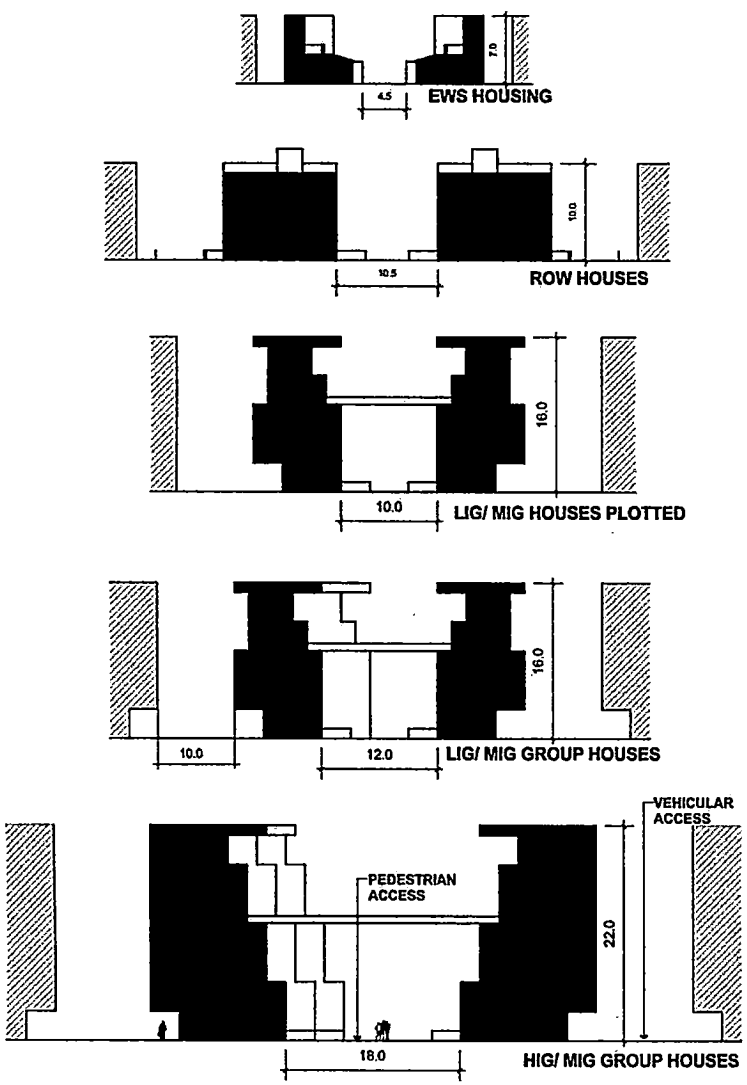
Figure 7-19: Activities along pedestrian walkway

Figure 7-20: Punawale Cluster physical models

7.10. Housing Units:

The various housing clusters are formed not only based on income criteria but also based on density and height of individual structures. The commercial centre consists of 8-10 storied structures. This commercial centre is surrounded by 4-5 storeyed housing for medium and low income groups. Some of these apartments are in the form of walk-up apartments to reduce the costs of infrastructure like elevators. The housing for EWS is in the form of low rise high density housing to suit the living pattern of these people. Thus as per Figure 7-6, the height of housing reduces from the centre towards periphery. The office buildings are in the form of high rise structures along the main 60 metre BRT route.

Characteristics of individual housing units:



EWS: G+ 1 structure. Low rise structures.

Row Houses: G+1/ G+2 structures. Low rise structures

LIG/ MIG Plotted Houses: G+3/ G+4 structures. Walk-up apartments

LIG/ MIG Group Houses: G+3/ G+4 structures. Floors at various levels connected by bridges in between

HIG/ MIG Group Houses: G+7/ G+6 structures. Floors at various levels connected by bridges in between

Figure 7-21: Punawale characteristics of housing structures

7.10.1. Planning for EWS:

Most of the EWS housing schemes fail in India, because they fail to understand the social background of the poor people. Most of the structures in a slum rehabilitation scheme are planned as medium-rise or high rise structures. The poor people are not accustomed to this lifestyle. Also, due to financial constraints, it becomes almost impossible for the poor people to maintain these structures.

This proposal suggests for a low rise high density G+1 incremental development for EWS. The structures are planned in such a way that the people can add an upper floor in the near future based upon their financial capability.

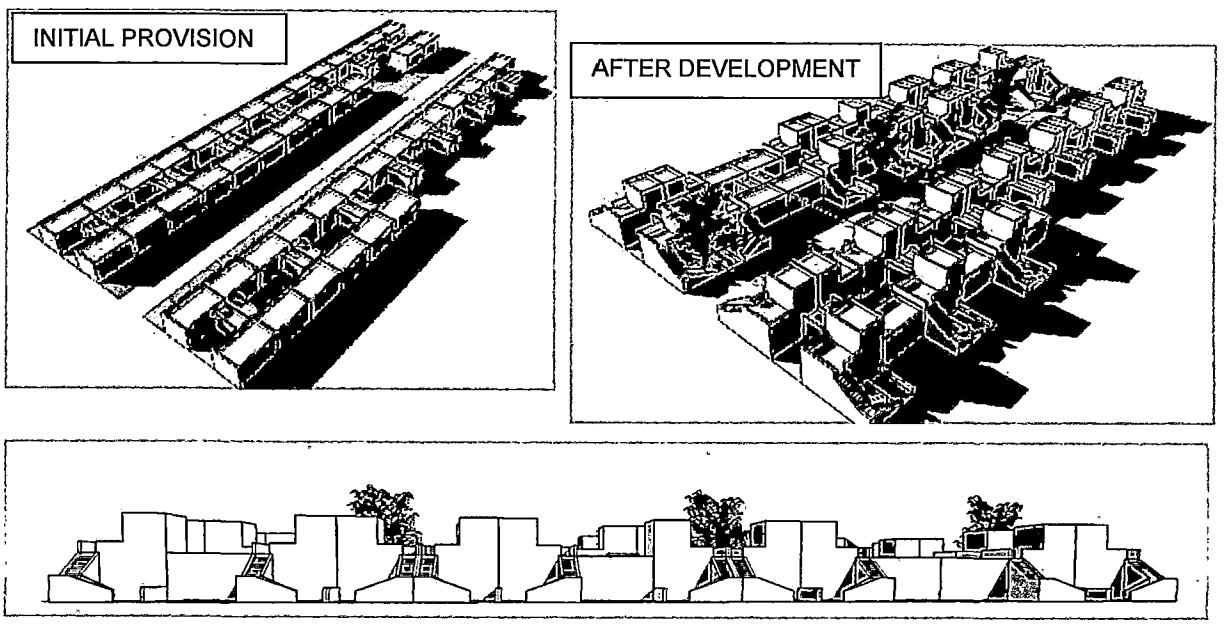
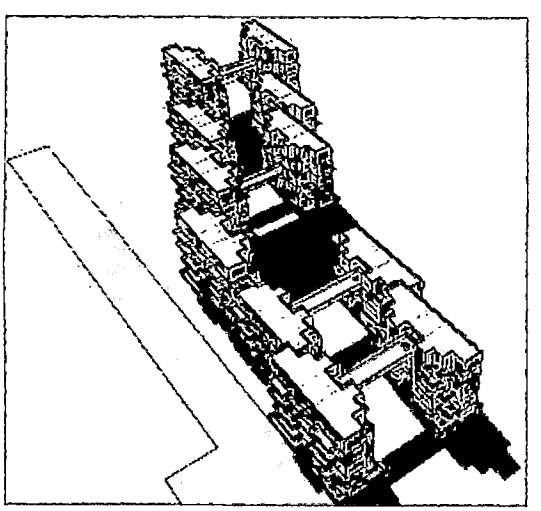


Figure 7-22: Punawale EWS Housing

7.10.2. MIG/LIG



Housing for MIG/ LIG is in the form of G+3, G+4 medium rise structures. Every floor has an open to sky terrace. The space between two opposite buildings is a big shaded public place for carrying out various activities. Intermediate floors on opposite ends are connected by means of a bridge.

Figure 7-23: Punawale MIG/ LIG houses

7.11. Scope for densifying the core:

The overall density for Punawale village is 175 persons/ hectare. Though this density is higher than the prescribed density of 150 persons/ hectare; it is still possible to densify the core area of the settlement. It is possible to add floors on top of existing structures in such a way that the density gradually increases from 175 persons/ hectare to 200 persons/ hectare. This density can be achieved without compromising on the quality of open spaces and availability of infrastructure facilities.

Figure 7-24: Punawale: densified central core area
Source: Author

The figure above shows the area wherein the density can be increased from 175 persons/ hectare to 200 persons/ hectare.

Viewing Punawale area as a part of Aundh-Rawet BRT Corridor:

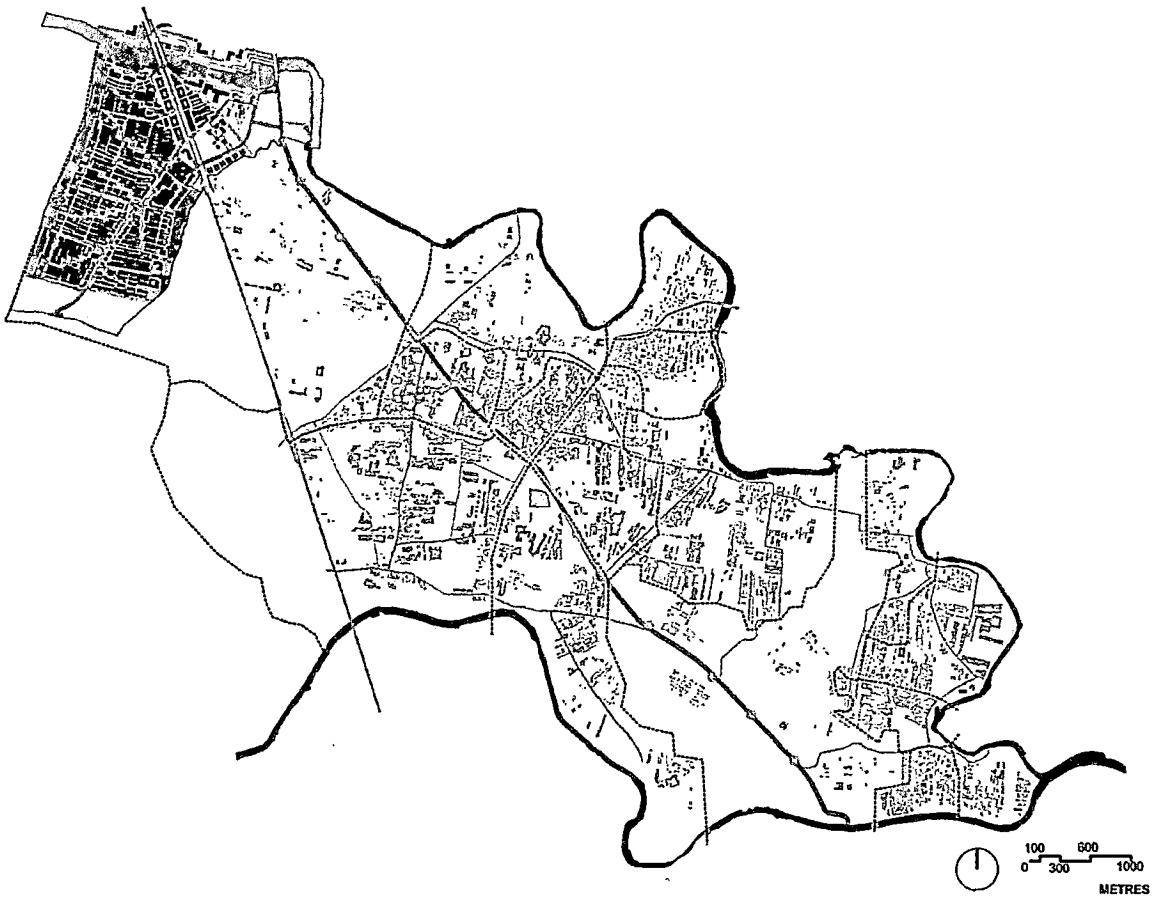


Figure 7-25: Punawale proposal in the context of Aundh-Rawet Corridor

The Punawale area along the Aundh-Rawet BRT Corridor has been considered as a demonstrative model for TOD. From the above figure, it can be seen that while other areas along the BRT Corridor have been developed haphazardly in an unplanned manner; Punawale village demonstrates a compact, high density, mixed-use settlement. The other areas along the corridor lack useable recreational and green spaces. This issue has been catered to while planning the Punawale area where a peripheral green belt has been planned which enables to have various recreational activities within the green areas and at the same time it prevents the settlement from sprawling.

7.12. Achievements:

Population:

The planning area was supposed to accommodate a population of 66,150. However, the achieved figure for total population is 77770 with an additional capacity to hold a floating population of 21,472.

Conservation of land:

The CMP of Pune expects a development of 4.6 million sq.km in an area of 2.3 million sq.km. However, by planning as per the proposed TOD model; only 1.8 million sq.km area will be required for the same development. Thus, 0.5 million sq.km area can be conserved.

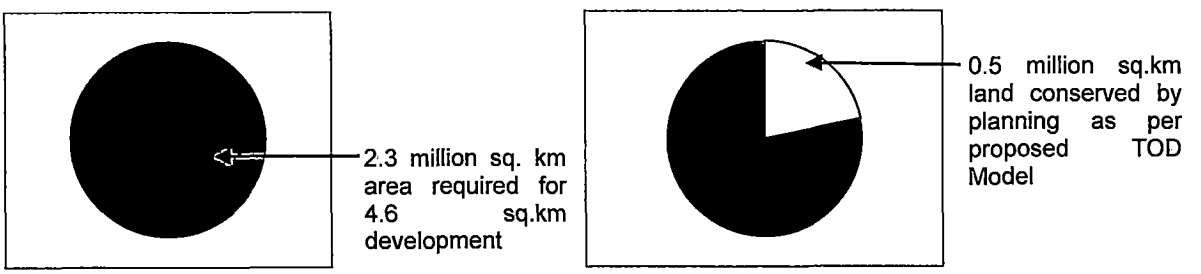


Chart 7-2: Conservation in land if planned as per TOD

Achievement of high density through balanced sustainable development:

The proposal manages to achieve a higher population density of 176 persons/ ha than the existing population density of 112 persons/ ha in the area. This high density has been achieved along with a total green area of 32% which includes parks, playgrounds, forests and agricultural fields.

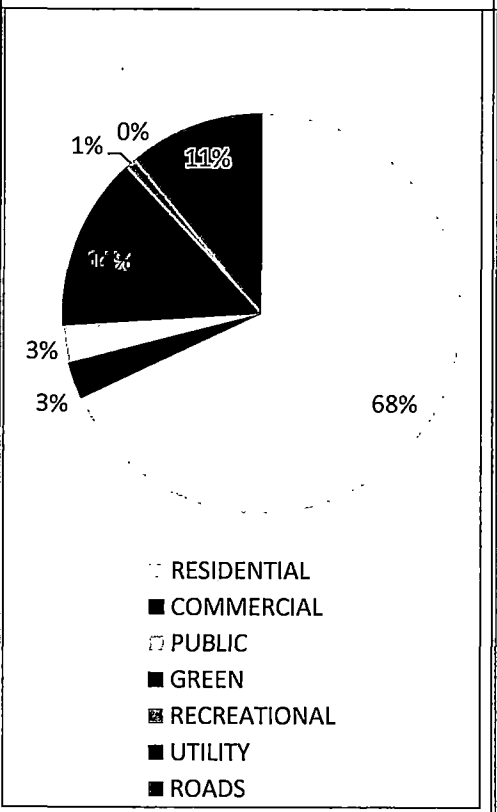
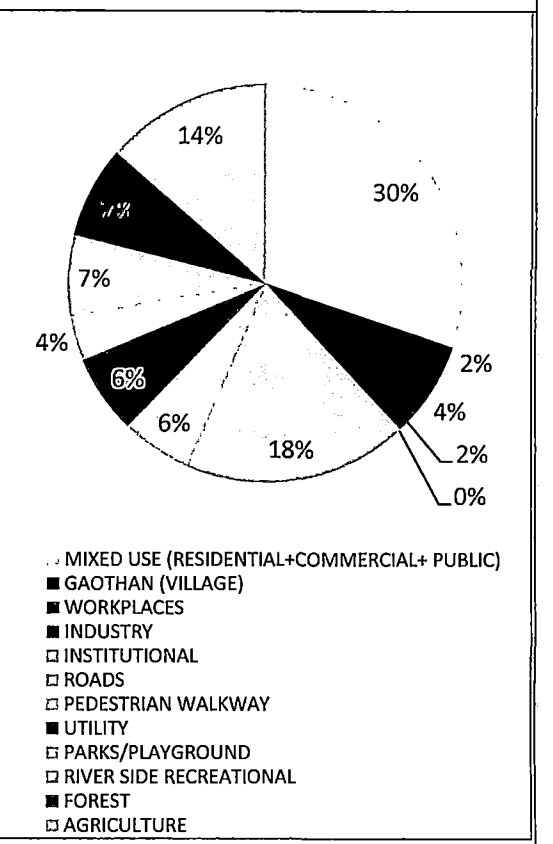
Reserving land for agricultural:

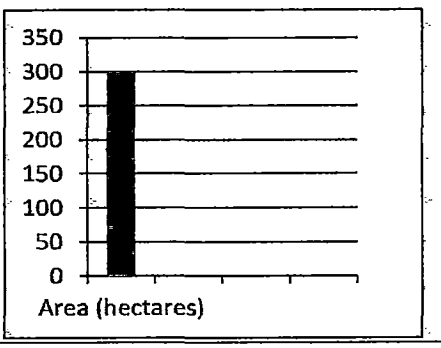
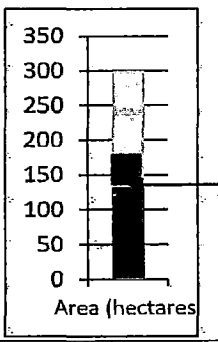
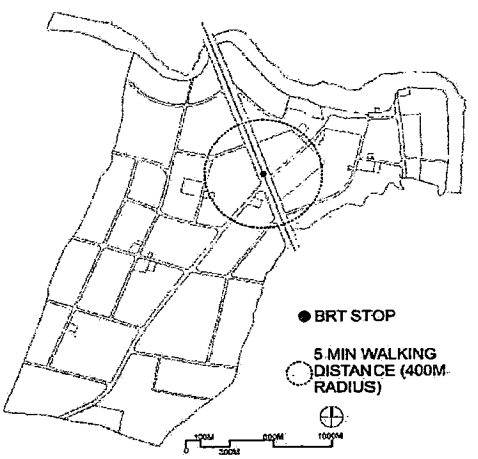
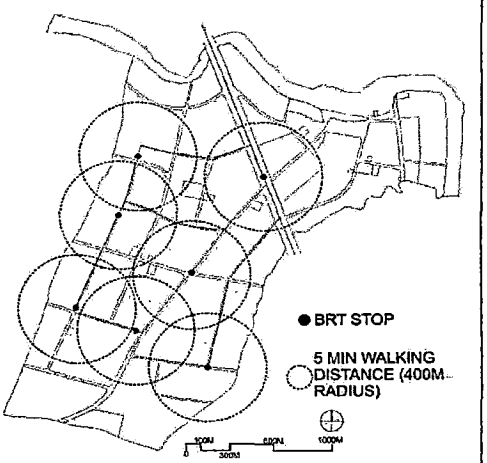
Out of the total area of 441 hectares, 14% land has been reserved as agricultural land. This land will be allocated to the farmers in the area who have lost their land due to haphazard development along the BRT Corridor.

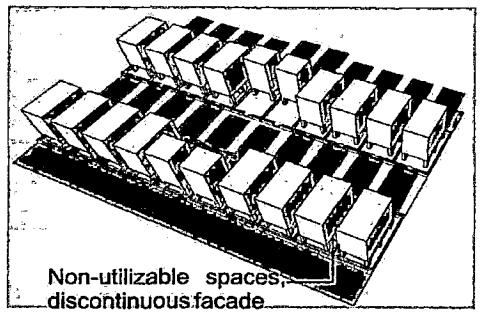
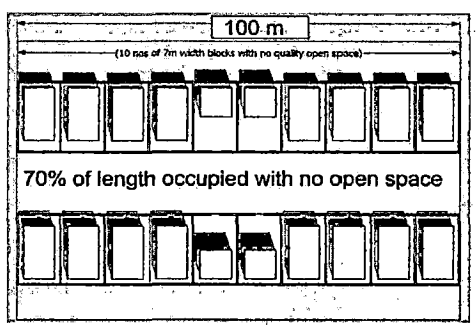
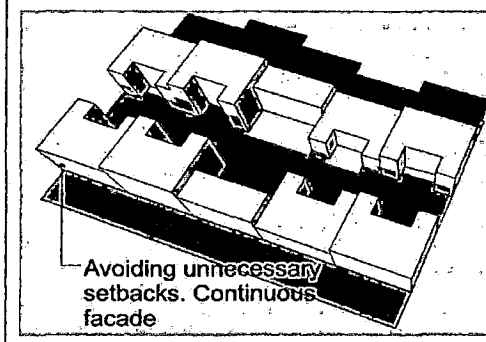
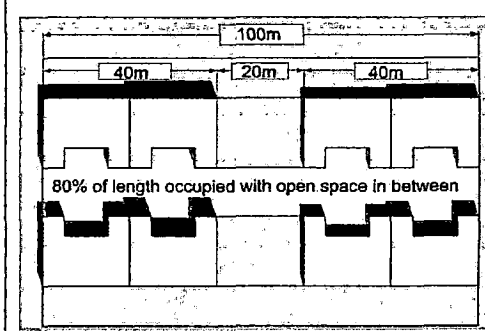
Mixed-use walkable clusters:

The planned settlement discourages the formation of strict zones based upon different land uses. Every cluster in the settlement is planned in the form of mixed use cluster wherein all facilities of daily requirement can be easily accessed by walking.

Table 7-12: Comparative analysis between existing planning practice and TOD

Aspect	Planning as per existing regulations	TOD Proposal by author
Population	66,150	Permanent: 77,770 Floating: 21,472 Total: 99,242
Density	150 persons/hectare	175 persons/ hectare 200 persons/hectare in core area
FAR	1	1.8
Land use		
Land requirement	2.3 sq.km land for 4.6 sq.km of development	1.8 sq.km land for 4.6 sq.km of development
Land for agriculture	Nil	14%
Accessibility to day-to-day facilities	Not defined	Within maximum walking distance of 15 min.
Workplaces/ jobs	Not defined	16.3 hectares (4% of total) of office space within 15 min walking

Aspect	Planning as per existing regulations	TOD Proposal by author
Planning Area (a)	441 hectares	441 hectares
Population considered (p)	66,150	77,770
Gross density (gd)	= p/a = 150 persons/ hectare	= p/a = 176 persons/ hectare
Net Residential area (nra)	= 300 hectares 	= 175 hectares  Area consumed for housing (58% of actual planning proposal)
Net residential density (nr)	= p / nra = 221 persons/ hectare	= p / nra = 395 persons/ hectare
Accessibility	Location of BRT Stops.  The existing proposal lacks a worked out BRT network for the interior roads. There is only one proposed BRT stop which would effectively serve the nearby offices located along the length of the main road.	Location of BRT Stops.  In the proposed TOD Model, the BRT stops have been located in such a manner that the people living in a particular area can access the bus stop in less than 5 minutes of walking distance. Thus the 7 stops can serve the entire population of 77,770.

Aspect	Planning as per existing regulations	TOD Proposal by author
Development Control Regulations	<u>Setbacks</u>  Pimpri- Chinchwad development control regulations specify the minimum front, rear and side margins to be left from the site boundary. Leaving such narrow setbacks (min 1.5m as side and rear margins & 3m as front margins) results in non-utilizable spaces. Such type of planning results in individual isolated blocks and there is an absence of a continuous façade.  	<u>Setbacks</u>  Unnecessary setbacks have been avoided in the TOD proposal. This results in a continuous façade, quality open spaces that can be well utilized for public activities. 

8. Reframing of Planning Guidelines

Various planning guidelines like the UDPFI Guidelines, Special Township Policy and Development Control Regulations for Pimpri-Chinchwad Municipal Corporation were referred to assume certain planning standards for initiating the preparation of TOD Model. However, from the achievements of the proposal, it is evident that these guidelines need to be modified with time to enable sustainable development in different parts of India. This section suggests some broad modifications that are required to be made in the planning guidelines.

8.1. UDPFI Guidelines:

The UDPFI Guidelines were prepared in August, 1996. Since sixteen years from their formulation, conditions in urban areas have changed drastically and some of the guidelines need to be modified as follows.

8.1.1. Classification of Urban Centres

The classification describes only 3 types of centres for plain areas and hilly areas based on population: Small Town, Medium Town and Large City (Page xiii). However cities like Pimpri-Chinchwad which have population more than a million and mega cities like Mumbai, New Delhi, Pune need a separate category in the classification. It is also important to decide upon the upper limit of expansion for every city and thereby prevent surrounding areas to be merged into the main city.

8.1.2. Appendix B: Norms and standards:

Land use (pg 145)

With more than a million farmers quitting agriculture and taking into consideration serious threats like food security, it is vital to consider agriculture as a land use and reserve land for agriculture purpose.

Infrastructure:

The requirement of infrastructure facilities should be contextual and the minimum number of facilities that are needed to support a certain number of people have no meaning unless the criteria of accessibility is taken into consideration.

Water Requirements:

The amount of water required per capita per day has no relationship with the size of the town. Also the amount of water needed in summer and winter varies considerably which needs to be taken into consideration.

8.2. Special Township Policy:

As per the policy, any developer wishing to carry out a continuous development on more than 100 hectares of land, is entitled to get a NA (non-agricultural land) certificate. This policy is extremely unsustainable. It is important to curb the practice of carrying out development on fertile agricultural land.

8.3. Pimpri-Chinchwad Development Control Regulations:

FAR:

The proposed FAR for new areas is only 1. This needs to be revised to suit more high density development. On the other hand, an increased FAR in the core areas will lead to congestion as the areas are already crowded and lack basic infrastructure facilities and adequate open spaces.

Building Control Regulations:

The existing building control regulations are not conducive for high density development. They prescribe mandatory setbacks from all sides of a building. Setbacks as less as 1.5 m often result in unutilized spaces. Unnecessary setbacks also result in isolated blocks of buildings lacking a continuous façade.

9.4 Conclusion

The cities of Pune and Pimpri-Chinchwad showcase a small part of the unsustainable growth trend in Indian metropolitan cities. The issues of urban sprawl, depleting natural resources, decreased open spaces are very complicated and finding a solution to any one of these problems simply raises new problems. These problems are further aggregated with population explosion.

The various planning proposals for Indian cities have started looking at Transit-Oriented Development as a toolkit for planning sustainable urban development. But, the proposals fail to recognize the central theme behind TOD and consider it as a means to incur back the investment in transit projects by planning high density urban development along the public transit corridors. The aspects of accessibility and affordable housing to all the people are seldom taken into consideration. Many European and American city governments have been planning settlements as per the planning guidelines of TOD. The theory of TOD has been enriched over the past decade to such an extent that it not only focuses on planning along a public transit corridor but also stresses on the act of a better place making.

The theory of TOD can play a significant role in curbing the urban sprawl of Indian cities and providing guidelines for planning a compact, high density, mixed-use, and mixed-income urban development having a high degree of accessibility. In many Indian cities like Pune and Pimpri-Chinchwad where high budget transit projects like metro, bus rapid transit are being planned; TOD can be used as an effective tool for integrating transit and land use.

This dissertation has been an attempt to analyze the central principles of TOD and using these principles for planning a sprawling metropolis like Pimpri-Chinchwad. The outcome and recommendations of the dissertation would serve as guidelines for planning other metropolitan cities in India.

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Appendix

Travel Pattern Survey:

- Name:
- Number of family members in the house:
- Area where you stay:
- Number of bicycles in your house:
- Number of two-wheelers in your house:
- Number of cars in your house:
- Approximate distance of nearest bus stop from your house (in metres)
- Approximate distance of nearest auto rickshaw stand from your house:
- Places you or your family visit:

Kindly answer to the questions as 'Yes' or 'No'

1. Do you prefer to use your own vehicle than public transport
2. Have you attempted to use the bus system in Pune?
3. Is the bus system efficient?
4. If the roads were made pedestrian and bicycle friendly, would you walk or use a bicycle to access nearby places?
5. Do you think the increase in petrol and diesel prices has reduced your usage of private vehicles?
6. Would you advice school, college students to walk or use bicycles to reach their school, college, classes, if they are located nearby from their house?
7. Do you think Pune urgently needs an efficient public transport system like metro or bus rapid transit system?
8. Do you use your own vehicle only because it saves time than public transport?
9. How much percentage of your monthly income do you approximately spend on transport?
10. How much do you travel daily using your own private vehicle?
11. Approximately how much do you walk daily?

Kindly answer to the following questions:

Places you or your family members visit	***How frequently you or your family members visit the place***						***Approximate distace of the place from your house (in metres)***				***How do you travel to the place?***					
	Every day in week	Daily except weekends	Alternate day in week	Once or twice in a week	Only on weekend	Once/ twice in a month	less than 400 (0.4km)	400-800 (0.4-0.8km)	800-1200 (0.8-1.2km)	more than 1200 (>1.2km)	Walking	Bicycle	Public transport or office (bus, train)	Two-wheeler	Car	Auto rickshaw
Milk booth, small grocery shop to buy daily stuff like bread, vegetables																
Work Place/ Office/																
School/College/University																
Recreational activities (Playground, park, hillock, sport facilities, gymnasium)																
Entertainment (Cinema halls, theatre, malls)																
Eating joints, hotels, restaurants																
Religious (temples, church, mosque)																
Services like post office, banks, MSEB																
City centre like Mandai, Tulshi Baug, Laxmi Road, Peth areas																