LAND USE – TRANSPORT

INTEGRATION FOR SUSTAINABLE URBANISM

INPUTS FOR THE DEVELOPMENT PLANNING PROCESS

PROJECT REPORT

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

CEPT
UNIVERSITY
CENTRE
FOR URBAN LAND POLICY

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The project received funding from the Shakti Sustainable Energy Foundation (SSEF), New Delhi. The project aims at evolving a methodology for sustainable urban planning through the integration of land use and transport.

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Executive Summary

Need for the study: Urban India currently houses around 310 million people. The future growth estimates and other externalities have raised concerns regarding sustainable development of cities in India. The development planning process in India has been criticised for its failure at both comprehensively guiding the development and following the predict-and-provide model of planning effectively. The current development planning processes, recommended by the Urban and Regional Development Plan Formulation and Implementation (URDPFI) try to guide development without taking market forces into cognisance and following the predict-and-provide model of planning and failing at both. Urban planners have for years in India focussed on efforts to decongest urban areas by imposition of artificial limits on the amount of built-up area through building margins and Floor Area Ratio (FAR), whereas the negative externalities resulting from transportation cost in accessing land use activities, lower per-capita income in Indian cities and poor enforcement of Development Control Regulations (DCR), poor or no cognisance of the land market have ensured that cities have densities, far higher than those planned for; land use is mixed and heterogeneous as opposed to discrete zones proposed in the development plans. As HPEC (2011) and McKinsey Global India (2010) point out, conventional planning processes have proved to be inadequate leading to a massive deficit in infrastructure provision.

As a result, most of our cities continue to grow in a manner that best suits the agenda set by the market, often after subverting the development control regulations. In the recent past there have been several efforts to use land as a resource and adopt a fresh look at the capitalization of its market value to encourage development. The transfer of development rights in Mumbai and Floor Space Index (FSI) related policies in Hyderabad are examples of some of these initiatives. However there is a strong need to explore how urban planning can proceed in cognisance with land market so that the planned land use is closer to ground realities.

Additionally, cities in India have also seen a drastic increase in the ownership of private motorized vehicles. The resultant deterioration of air quality has not only resulted in serious health implications but also contributed to climate change. The National Action Plan on Climate Change (NAPCC) stresses that it is possible to reduce greenhouse gases (GHG) emission from transport by adopting a sustainable approach through a combination of measures. These measures can be from demand or supply sides. Demand side interventions rely on reducing the trips, retaining high modal shares of non-motorised transport, and shifting demand from private vehicles to public transport. These can be achieved by developing plans centred on built form interventions. This approach to reduce GHG emissions is based on a large body of empirical evidence, which confirms that significant shift in travel behaviour of residents towards public transport and non-motorized modes can be achieved by altering the urban built form. The morphology of Indian cities

favours a higher use of non-motorized and public transport modes. However adequate supply of enabling infrastructure to support these is missing. This order of urban morphology will only remain if Indian cities stay economically stagnant.

The average per-capita income in India is likely to grow four times in the coming decades, thereby changing the travel elasticity with individuals willing to travel longer distances using private motorized modes while spending more on travel and residential space. Thus, in the business as usual scenario, Indian cities are likely to sprawl with a very high use of motorized vehicles. Therefore, given that transport sector alone account for countries 13% energy-related CO_2 emissions the difficult challenge for urban and transport planners and policy makers in India in the coming years will be to maintain the per-capita emission at the current level. Land use policies and how land markets react to these policies play an important role in managing transport demand. Therefore, it becomes important to review land polices in different states of India, compare them, and study how the land market and thereby urban development respond to these policies. From sustainable transport point of view, one can look at the effect of these resulting urban development scenarios on travel demand and thereby its impact on the environment.

The study: This research report argues for integrating land use and transportation for achieving sustainable urbanism. It presents how urban planning in India has exacerbated development that disincentivizes sustainable travel behaviour. Jobs have continued to be concentrated in the traditional Central Business District (CBD) while residences have shifted outwards causing sprawl owing to faulty regulatory processes as part of the development planning mechanism. The report presents existing literature on urban development control through urban growth limits, floor space index limits, cost increasing regulations and State control. From the sustainable urbanism point of view discussed in Munshi et al. (2013), it is important to note that urban growth limits are going to encourage greater densities which are bound to encourage the implementation of mass transit projects subject to interventions such as higher motor vehicle taxes, higher fuel costs and rationing parking spaces at a premium that would disincentivize use of private modes. Similarly, a city with newly higher regulation costs would result in a compact urban form again resulting in lower travel distances. Both these situations are desirable from the sustainability point of view. In case of FSI limits and State influences, the city expands spatially which is bound to result in higher travel distances and trip rates. This may not be desirable from the sustainability point of view on account of higher emissions, accident related deaths and pollution.

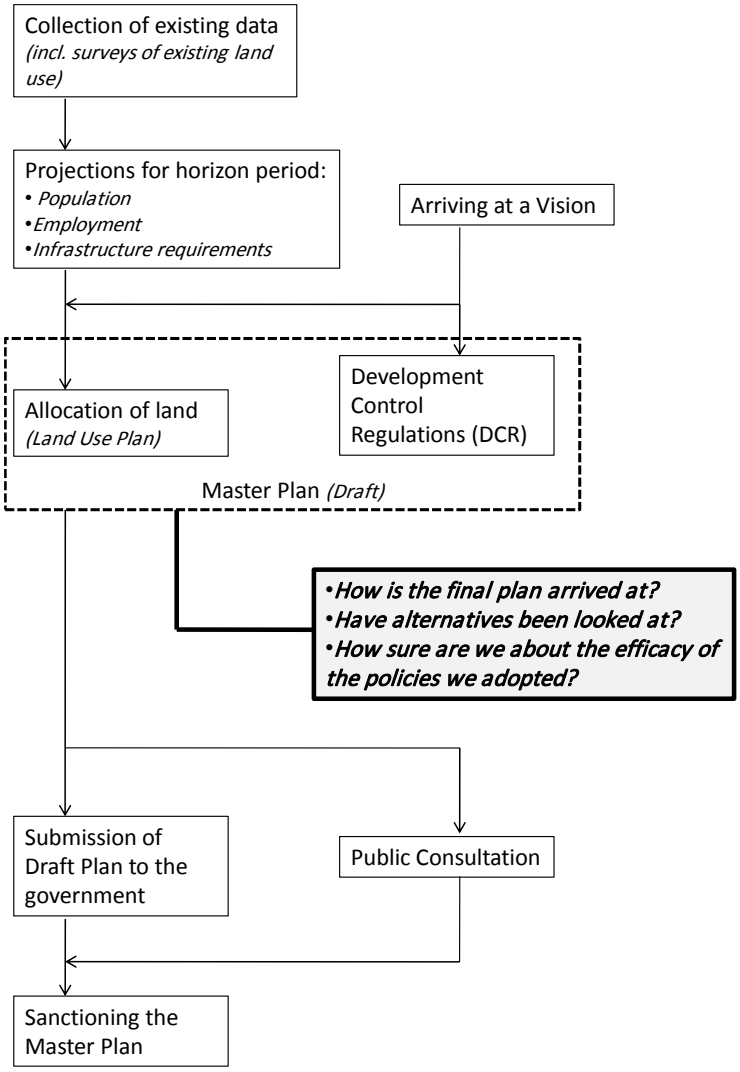

Figure E1: The planning process in India
Source: Authors

Further, case cities of Pune, Hyderabad, Bengaluru, Ahmedabad and National Capital Territory (NCT) of Delhi are evaluated for their development control measures and conclusions are drawn regarding the sustainability of their proposed built-form implications.

A comparison of the development plan preparation processes in various cities is shown in the following table. The comparison is on the basis of several parameters including periodicity of plan preparation, adoption of land suitability analysis, environmental zoning, land use transport integration, compactness and development control regulations like floor space index, transferable development rights, building height regulations, margins, coverage and transport demand management. Bengaluru has the least average age of a development plan (15 years) followed by Ahmedabad, Delhi and Pune. Hyderabad has the highest average age of development plan at 35 years. Ahmedabad scores on the adoption of land suitability analysis, environmental zoning and attempts towards aligning land use allocation with the bus-based transit system. Most cities have used FSI as a

mechanism to control built floor space. Base FSIs are low in most cities, especially so in Pune. However, it must be pointed out that even this FSI is not completely utilized in these cities. Ahmedabad has high FSI of 4 along transit corridors while the proposed central business district has a proposed upper cap of 5.4 FSI. Hyderabad has chosen to do away with FSI, instead relying on building height regulations, setbacks and market measures to control development. Most cities with the exception of Ahmedabad have not thought of traffic demand management as a measure towards sustainable development. Instead the approach seems to be of building and expanding road infrastructure. When seen in conjunction with proposals for mass rapid transit systems in these cities, it conveys a sense of confusion with regards to the direction in which the development plans appear to be taking. Interaction with town planners, consultants and architects in these cities confirmed that the development plans are often prepared in a manner that is not based on scientific evaluation of various directions that the city's growth could take. Allocation of land use and planning for infrastructure is often based on ad hoc decisions and inflated population projections. This calls for the use of scientific models for evaluating one approach against the other and arriving at a suitable direction by involving informed decision-making.

The LUTI approach: Planners have developed various scientific LUTI modelling techniques and utilized them in the plan making process. LUTI models catch all these various factors constituting the urban processes (housing, employment, transport, pollution, social segregation, etc.) together when analysing the cities and predicting outcomes. The simulations made by the LUTI models forecasts the city's growth scenarios under alternative planning policies, thus facilitating public consultation process as well as helping planners make informed decisions that are based on scientifically rigorous methodologies and empirical evidences regarding the various urban processes. And hence, LUTI modelling can be a very effective decision making tool for developing policies that help achieve sustainability.

The proposed 'LUTI model' is inspired by Adhvaryu & Echenique (2012) SIMPLAN modelling suite. Speaking specifically, it adopts the math for its simulations from the econometric Residential Location Module (RLM) of the SIMPLAN and is a comparatively technologically-improved version. Allocation of activities is made by the model on the premise that individuals (household) tend to choose their places of residence as near as possible to the place of their jobs. However the decision of location also includes other factors such as the prevalent housing prices (rents) as well as the cost of travel. Certain desirable factors such as accessibility to amenities, public transportation etc. also explain the choice of locating at places that may or may not necessarily be borne out of the tendency to keep nearer to places of work. Additionally, the factor of time involved in travelling to participate in activities, is also considered in terms of cost of time.

Table E1: Evaluation of development planning processes in case cities

City	Pune	Hyderabad	Bengaluru	Ahmedabad	NCT Delhi
Plan making authority	PMC	HMDA	BDA	AUDA	DDA
ULB or parastatal	ULB	Parastatal	Parastatal	Parastatal	Parastatal
Constituted in	1950	2008	1961	1978	1957
Enabling legislation	MR&TP Act, 1966	HMDA Act, 2008	BDA Act, 1976	GTPUDA, 1976	DD Act, 1957
Previous plan	1987 Development Plan	1975 Master Plan for MCH	Revised Master Plan for Bangalore, 1995	2002 Development Plan	Master Plan for Delhi, 2001
Current plan in force	2027 Development Plan for Pune City (Old Limits)	Revised Development Plan of erstwhile MCH Area	2015 Revised Master Plan for Bangalore	2021 Comprehensive Development Plan (Second Revised)	2021 Master Plan for Delhi
Horizon period	20 years	20 years	20 years	20^ years	20 years
Periodicity					
Year of preparation of first DP^	1952	1975	1971	1965	1956
Year of preparation of current DP	2007	2010	2007	2013	2007
No. of DPs prepared before current DP	3	1	3	3	3
Average age of DPs	18 years	35 years	15 years	16 years	17 years
Other factors					
Adoption of land suitability analysis	No	Yes	Yes	Yes	No
Adherence to environmental zoning	Partly	Yes	Yes	Yes	Yes
Land use transport integration	Partly	No	No	Yes	No
Compactness	Yes	Yes	Yes	Partly	No

City	Pune	Hyderabad	Bengaluru	Ahmedabad	NCT Delhi
Development control					
Use of FSI as a tool	Yes	No	Yes	Yes	Yes
Base FSI	1.50	Not applicable	1.75	1.80	1.20
Upper limit (including premium FSI)	4.00	Not applicable	3.75	5.40	3.50
Higher FSI along transit corridors	Yes	No	No	Yes	Yes
Use of TDR as a tool	Yes	Yes	Yes	Yes	No
Building height restrictions	Yes	Yes	No	Yes	Yes
Maximum permissible building height	150 m	Unlimited[1]	Unlimited	70 m	17.5 m
Setbacks / Margins	Yes	Yes	Yes	No	Yes
Coverage	50 %	No	70 %	No	90 %
Transport demand management	No	No	No	Yes	No

^ Revised every 10 years

Source: Compiled by authors from various aforementioned sources

[1] Above 30 m wide abutting roads

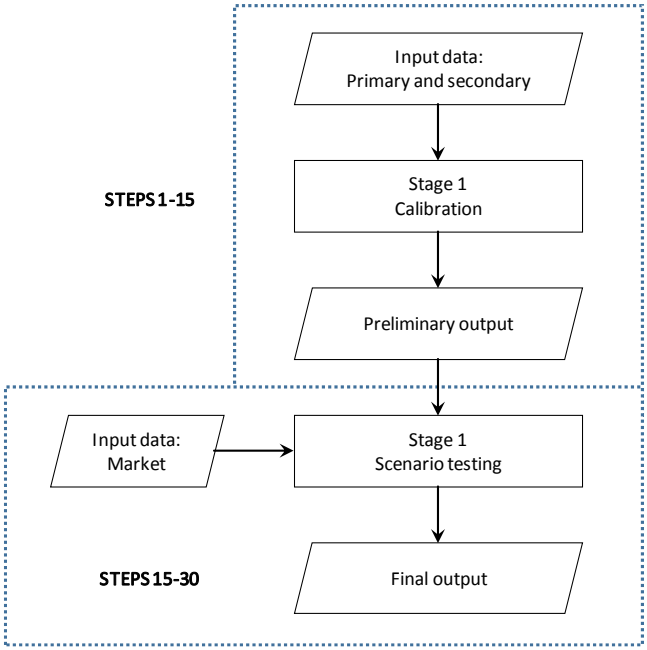

Figure E2: Schematic representation of the processing of the LUTI model

Source: Authors

The outputs of the model through calibration and scenario testing (business-as-usual, compact city and dispersed city) are produced in terms of the average trip lengths (ATL), average rents and average dwelling unit (DU) sizes for each socio-economic groups. Also projections of population in each zone and the FSI that would be consumed for all the different scenarios are also made during the simulations towards the final outcomes. While allocation of activities and the concomitant values of the average trip lengths help to go further in estimation of carbon emissions incurred in each scenarios, the consumption of FSI in each zone helps the planner to get an idea as to the kind of FSI regime and its distribution across the city that would facilitate market forces rather than stifling it. So simply put, the outputs give a better understanding during the decision making process as to which type of development front the city should adopt.

The case of Rajkot: Rajkot was chosen as the case city for the application of the proposed LUTI model as the investigators of this research are very well versed with the city, having worked extensively on it over various other research projects; and also because of a reasonably comprehensive amount of data was already available for the city. Rajkot is a city of 1.5 million people spread across an area of 684.77 square kilometres of the urban agglomeration while the municipal corporation area, however, covers an area of 98.24 square kilometres with a population of 1.28 million people (2011). It has been regarded as one of the fastest growing cities in the country. The model as shown in Figure E2 is run by dividing the city into 75 zones for disaggregated data on employment, population and rents. Local stakeholder inputs were also considered in the model to determine direction of growth. The model gave outputs for various scenarios mentioned above as shown in the following maps:

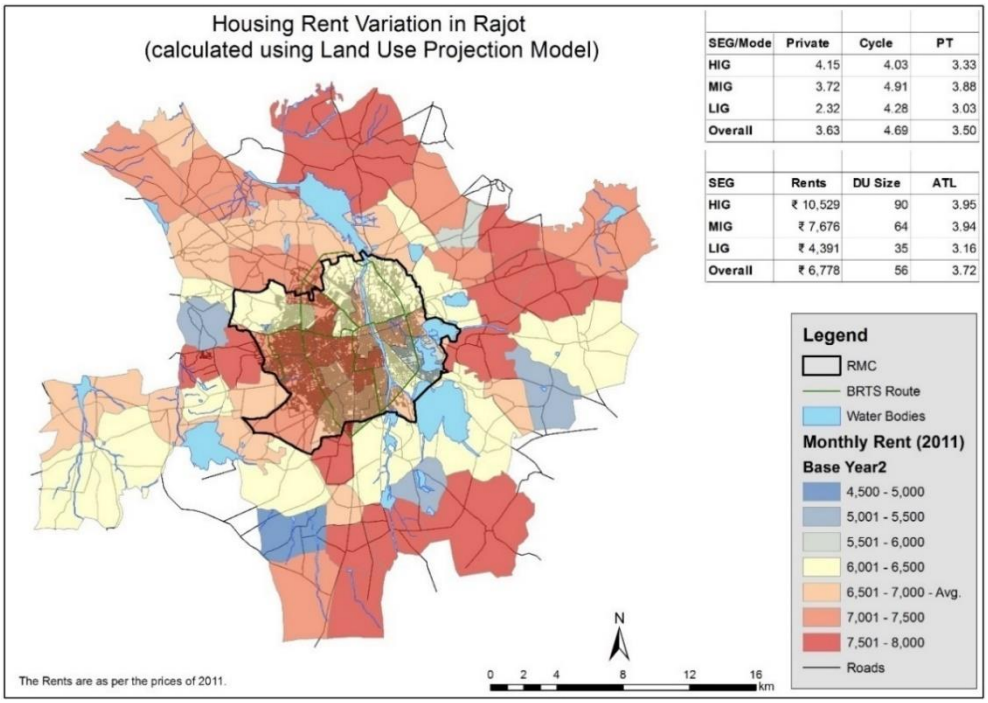

Figure E3: Modelled values of housing rents in 2011
Source: Authors

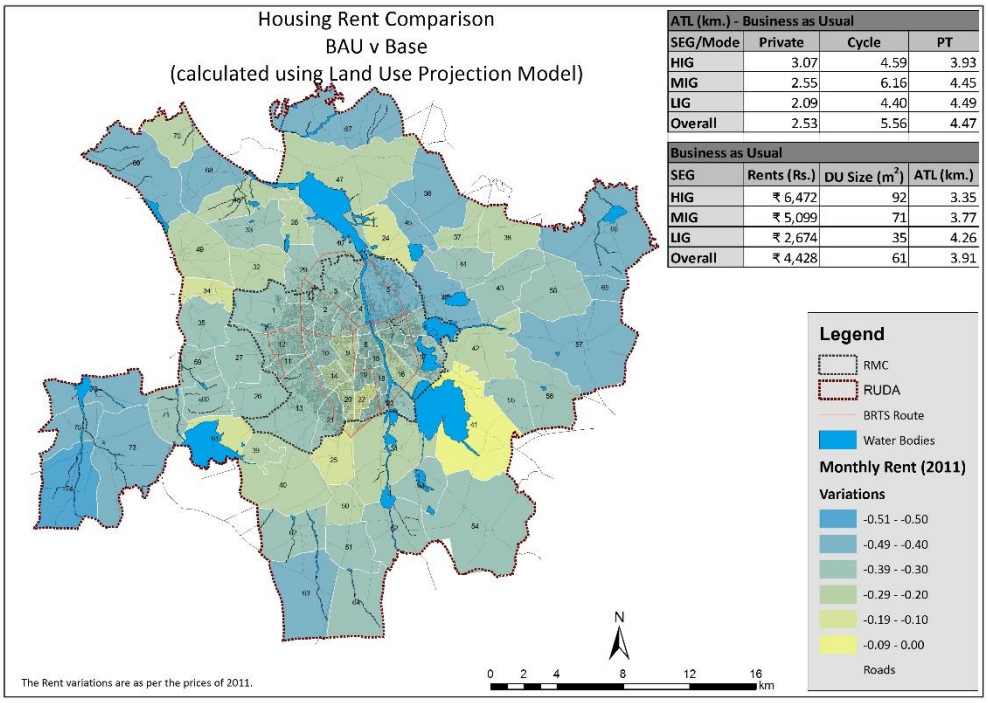

Figure E4: Rent variation of BAU scenario (base year)
Source: Authors

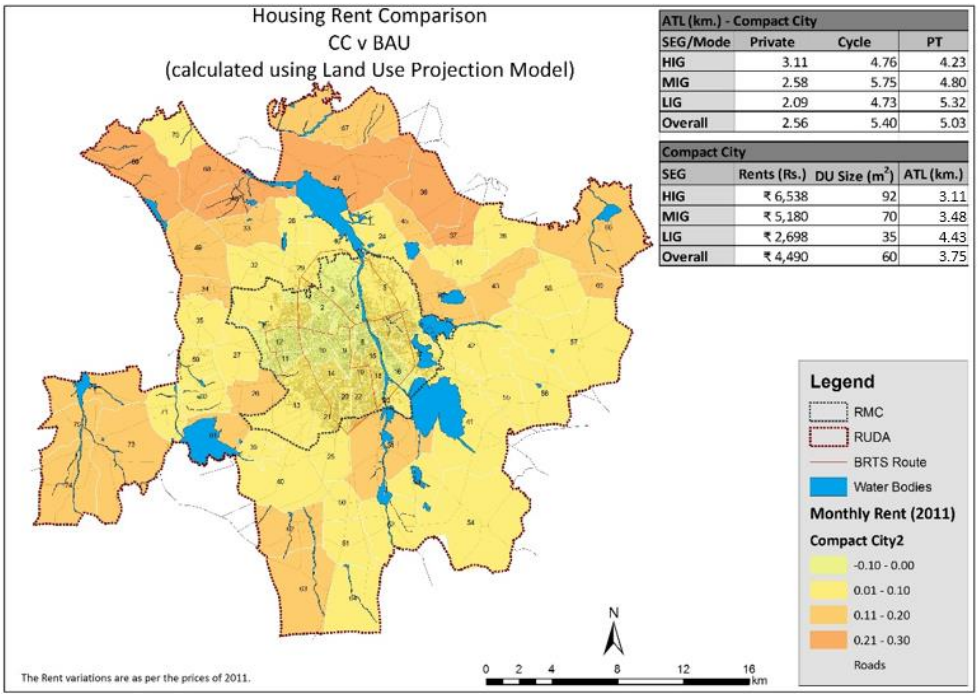

Figure E5: Rent variations of compact city scenario (base year)
Source: Authors

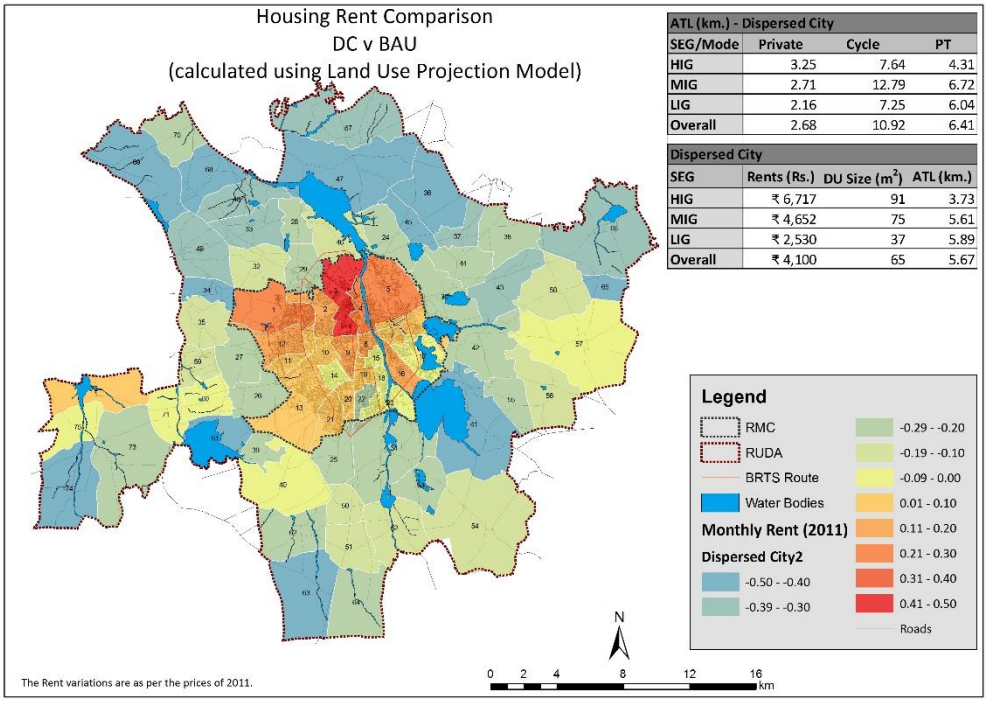

Figure E6: Rent variations of dispersed city scenario (base year)
Source: Authors

Table E2: Comparison of various scenarios

Particulars	Base 2011	BAU 2031	BAU vs Base	CC 2031	CC vs BAU	DC 2031	DC vs BAU
Population (Lakhs)							
Municipal Area (MA)	12.9	20.0	55.3%	21.2	6.1%	11.2	-43.9%
Outside MA	2.2	3.6	61.0%	2.5	-30.4%	14.0	289.5%
Overall	15.1	23.6	56.2%	23.7	0.5%	25.3	7.0%
Population densities (Persons per Ha)							
Municipal Area (MA)	131.0	203.4	55.3%	215.9	6.1%	114.2	-43.9%
Outside MA	3.8	10.0	161.0%	4.3	-57.1%	23.9	140.2%
Overall	22.1	34.4	56.2%	34.6	0.5%	33.2	-3.6%
Additional land consumption (Ha)							
Municipal Area (MA)	As is	5,872	N.A	6,562	11.8%	345	-94.1%
Outside MA	As is	3,983	N.A	1,328	-66.7%	25,227	533.3%
Overall	As is	9,855	N.A	7,890	-19.9%	25,573	159.5%
Citizens' cost of living (in terms of Money, Time and Distance)							
[A] Housing Rents	₹ 6,778	₹ 4,428	-34.7%	₹ 4,490	1.4%	₹ 4,100	₹ 4,428
[B] Transport Costs	₹ 405	₹ 770	90.0%	₹ 620	-19.5%	₹ 858	₹ 770
Cost of Living - [A] + [B]	₹ 7,183	₹ 5,198	-27.6%	₹ 5,110	-1.7%	₹ 4,958	₹ 5,198
ATL (km)	3.72	3.91	5.3%	3.75	-4.1%	5.67	3.91
ATL (min)	10.7	11.2	4.0%	10.7	-4.5%	18.9	11.2

Particulars	Base 2011	BAU 2031	BAU vs Base	CC 2031	CC vs BAU	DC 2031	DC vs BAU
Emissions (Thousand Tons per Year)							
HIG	23.87	30.09	26.1%	20.80	-30.86%	31.80	5.7%
MIG	872.72	1,018.98	16.8%	703.07	-31.00%	1,080.27	6.0%
LIG	43.22	66.10	52.9%	45.12	-31.74%	68.49	3.6%
EWS	0.00	0.00	0.0%	0	0.00%	0.00	0.0%
Total	**939.81**	**1,115.17**	**18.7%**	**769.00**	**-31.04%**	**1,180.56**	**5.9%**

Note:
Base year: 2011
BAU: Business as Usual
CC: Compact city
DC: Dispersed city

Table E2 provides a comparison of various parameters across the chosen scenarios. Based on the values arrived as a result of the LUTI model, the planners can arrive at suitable growth pattern for the city. In the context of the argument that the current practices in master plan preparation process lack rationality in the decisions made regarding the choice of policies for development regulations, and the fact that since such an approach has no way of explaining or knowing how do urban processes actually get influenced with the chosen policies; LUTI model illustrates how they can effectively aid in understanding this relationship and help to ensure that our development policies are not prohibitive and non-conducive to the market based demands and hence help in making sustainable development decisions.

Suggestions and inputs to the planning process: The need to integrate transport and land use planning in the preparation of development plans has been emphasized in Chapter 5. In this context, the lack of a decision making tool that could guide the planners with growth directions, growth intensity was felt and emphasized in our interactions with planners at Pune, Hyderabad, Bengaluru, Ahmedabad and Delhi. As a result, major decisions in this regard were often made at the discretion of those in charge of plan-preparation. In the paragraphs below, the research team wishes to propose its inputs towards reforming the plan preparation process in its current form.

- **LUTI model as a decision-making tool for sustainable development:** This research positions the LUTI model as a useful decision-making tool to help the planners in plan preparation. The model itself can't replace planners from the planning process. Listed below are the positive impacts that adoption of the LUTI model. The primary objective of this land use transport integration model is to contribute towards rationalizing the planning process. It makes use of data available with municipal corporations and development authorities to first model the current (base scenario) and future (business-as-usual, compact city and dispersed development) scenarios. Inputs given by local stakeholders such as builders, architects, engineers and eminent sector experts are also considered. The model gives average trip lengths and housing rent values as outputs for each scenario. Once the planners have this information, they would be in a position to make informed decisions on matters such as growth directions, intensity of use and zoning regulations.

  Integrates land use with transport: The LUTI model uses transport systems as a major input in its operationalization. The transport angle guides the model by building up on existing demand rather than skewing the demands based on specific projects. The resulting integration of land use and transport results in positive outcomes for the city especially from the point of social (greater equity, lesser conflicts), economic (lower expenditure on travel, healthcare) and environmental (lesser emissions) sustainability.

  Establishes growth directions on the basis of macro-economic trends: The demand assessment that the LUTI model relies on is based on jobs (employment projections) derived larger macro-economic projections for the region. This method

is found to be far more accurate than the conventional methods. The resulting job-driven growth has spatio-temporal implications which are captured by the LUTI model as part of the various scenarios.

Guides the assignment of intensity of land use: Since the LUTI model helps with the growth directions and spatial spread of development, the intensity of land use can be easily determined and assigned on the basis of the outputs of the model. The model also considers the wider inputs given by various stakeholders including builders, architects, engineers and sector experts with regards to the probability of residential, commercial and industrial development occurring in a given location.

Provides base material for political deliberations: The information given by LUTI model can serve as the ideal base material for such political deliberations. Also, citizens can use such information to question the planners on their decisions. In that sense, adoption of scientific methods like the LUTI model can help further the case of deepening effective democracy.

- **Reforming development control regulations: I**n order for the LUTI model to contribute effectively towards a built form geared for sustainability, it would need to be combined with development control regulations that move away from the prohibitive manner that is followed in most Indian cities, with the exception of Hyderabad and now in parts, Ahmedabad.

  Define ideal land use intensity: The land use zoning must be informed by the outputs of the LUTI model. Given the global academic debates on whether FSI or density is a better means of regulation must also be addressed. This is especially important in India where factors like gentrification owing to higher utilities of living close to transit stations has replaced sustainable built form and communities with higher per-capita floor space consuming segments of the population.

  Simplify norms of FSI and land use intensity: From the experiences of Hyderabad, it appears that even with the liberalization of FSI, the market can only respond to the demand. Fears of over estimating demand and building large inventory of unsold floor space are as true of Ahmedabad as Hyderabad. Therefore, while the state needs to intervene in situations where reservations must be made for public housing, social amenities and allied infrastructure through zoning, a well-regulated market must be allowed to operate in the real estate sector.

  Encourage higher intensities of floor space consumption: Zoning regulations must be used to ensure that factors like gentrification can be controlled to ensure that people most likely to use public transit can afford to live closest to transit stations and are not bought out by higher spending capacity segments unwilling to travel by public transit.

  Adopt building envelope approach to built-form: The building regulations often adopt a highly prohibitive approach by stipulating all three among FSI, coverage (and margins) and building heights. This results in over-controlled built-form often

at the expense of the creativities of architects and engineers. As a result, there is no incentive to innovate with designs that could contribute to sustainability. Similarly, the front margins on busy streets could be done away with and people could be encouraged to do away with compound walls to have more space in the public realm.

Combine traffic demand management with TOD: There is a need to restrict parking especially in the TOD zone to disincentivize the use of private modes of transport and encourage the use public transport.

Conclusion: This research presents arguments for and demonstrates how the integration of land use and transport can contribute towards sustainable urbanism. It presents the various debates surrounding the idea of sustainable urban development through literature and previous studies. The planning process in India is critiqued through the case cities of Pune, Hyderabad, Bengaluru, Ahmedabad and NCT of Delhi. Visits to these cities helped inform the research of the various approaches taken by the planners in these cities towards preparation of development plans. The critique help lead the research to arrive at the need for a data-driven and rational decision-making tool to guide the planners in the preparation of the plan. Review of international literature helped the research understand the various attempts at developing land use transport interaction models. Indian attempts were also reviewed and a model was developed to the specific case city of Rajkot. The model was operationalized and various scenarios were developed including base year, business-as-usual, compact city and dispersed city scenarios. The model was informed of the ideas of the local stakeholders to make it receptive to the market. Based on these developments, the research proposes inputs to the planning process based on the LUTI model and reforming the development control regulations. □□□

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1. Introduction

Land use planning in India is often limited to prescriptive zoning that assigns permitted land uses to specific areas (zones) in the city while restricting other uses that may be considered unsuitable. Despite this, land use in Indian cities is generally seen to be of a mixed nature and very different from the rigid zoning proposed as part of the development plan (Brueckner and Sridhar 2013). The mixed nature of land use makes shorter trips possible which should ideally encourage non-motorized modes of transport such as walking and cycling. However, the infrastructure required to sustain and encourage such non-motorised means of transport is not yet in place (Munshi, T. 2013). Meanwhile, Indian cities have continued to sprawl far beyond their original boundaries in search of cheaper developable land in the hinterland. Bertaud (2004) argues that artificial scarcity of developable land (or buildable floor space) in Mumbai is a product of the city's 'draconian' land policies which has only led to more sprawl. Sassen credits rising aspirations and a tendency to 'cut away' from the congestion and filth of the core city for people moving out to live in 'exclusive' gated communities in the suburbs (Raje 2015). Such urban development has brought the public transport infrastructure under severe strain besides encouraging the proliferation of privately owned vehicles. Mckinsey Global Institute (2010) points out that rising household incomes would lead to a near quadrupling of vehicular stock in urban areas to about 200 million by 2030. Important questions are being raised on the sustainability of the current development planning processes in India. Debates rage on whether the present paradigm has helped in controlling or exacerbating the problem. A Ministry of Urban Development, Government of India study points out a steady decrease in public transport and non-motorized modes of transport across 30 cities in the past decade (Wilbur Smith Associates Ltd. 2008). Over a similar time-frame, Indian cities have exceeded World Health Organization's emission related limits and accident-related fatalities have peaked (Badami 2005). These pointers can be linked to the negative externalities of a development paradigm that is not in sync with the global debates on sustainability and sensitivity to the environment.

This research aims at undertaking a comparative study of development planning processes in five Indian cites namely Pune, Hyderabad, Bengaluru, Ahmedabad and National Capital Territory (NCT) of Delhi (Figure 1). Since there are no binding national level guidelines on the development planning process, each of these cities have adopted an approach that fits within the framework of the state level town planning and urban development statute[2]. Localised plan-making may become a preferred position as it allows for local expertise and knowledge to be used in reliably predicting land use trends (Staley and Scarlett 1998).

[2] For example, Gujarat follows Gujarat Town Planning and Urban Development Act (GTPUDA), 1976. Other states have modelled their town planning legislation on the Model Regional Planning and Development Law prepared by the Town and Country Planning Organization (TCPO) in the 1970s (Mahadevia et al., 2009).

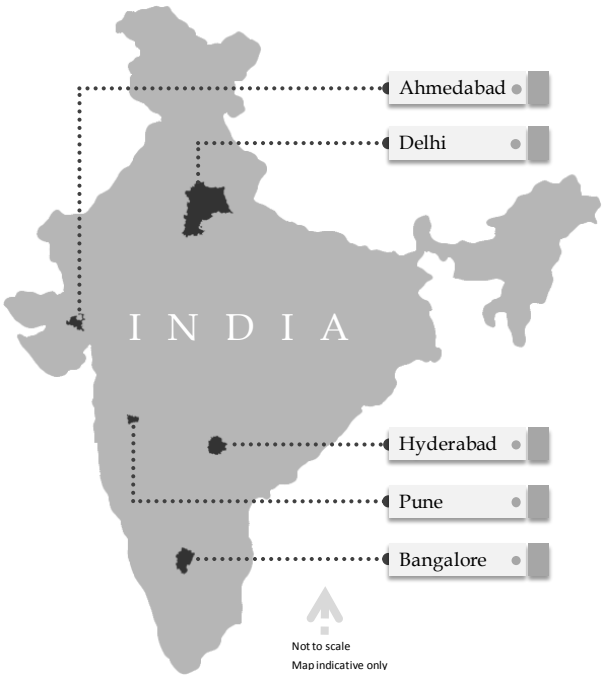


Figure 1: Location of the case cities
Source: Authors

Land redevelopment along mass transit corridors and sale of development rights are popular concepts being employed by most cities. These need to be seen in the context of several Indian cities adopting new mass transit systems in the last decade. For example, Pune's 2027 Draft Development Plan (old limits) (2013b) aims at economic vibrancy, sustainability, safety, liveability and connectivity. It proposes densification of land along the (built yet partially operational) BRTS and proposed metro-rail corridors[3]. The development plan - which is currently in the last phase of approval - also proposes Tradable Development Rights (TDR) as a means to control the supply of built space in the city. Hyderabad[4] on the other hand, has done away with Floor Space Index (FSI)[5] altogether, in areas other than the congested parts of the city under the erstwhile Municipal Corporation of Hyderabad (MCH) (Hyderabad Metropolitan Development Authority 2010: 34). The city also proposes a unique concept of 'extra floors for air rights'[6] as a means of compensating and incentivising land owners who surrender land for development projects (2010: 24).

[3] The Pune metro-rail project was approved by the Ministry of Environment, Government of India in December 2014. Construction is expected to start in 2015 in accordance with a Delhi Metro Rail Corporation (DMRC) report originally submitted in 2009 (Khape 2014; Umbrajkar 2014).

[4] Hyderabad's urban development scenario is complex with as many as five development plans being in force within the metropolitan area under the Hyderabad Metropolitan Development Authority. These are taken up for discussion later in this report.

[5] Floor Area Ratio (FAR) is used in place of FSI in some states like Delhi and Kerala. Delhi measures FAR in hundreds. For example, FAR of 350 in Delhi should be understood as 3.5 elsewhere.

[6] The revised development plan of erstwhile MCH (core) area (2010: 24) says that any land owner who surrenders land voluntarily for link roads between two critical roads by providing a minimum of 9 metres opening on site shall be allowed air rights to build over the road link, subject to compliance with relevant mandatory standards.

Ahmedabad has prepared a 2021 Draft Comprehensive Development Plan (second revised) (Ahmedabad Urban Development Authority 2013a, 2013b, 2013c) which has as its guiding principles, encouraging compact development, better coordination between land use and transport through transit oriented development and sustainable development. Along with other development control measures, it proposes Transit Oriented Zones (TOZs) along the city's Bus Rapid Transit System (BRTS) and proposed metro-rail corridors[7]. The development plans of NCT Delhi and Bengaluru have their own moot points which will be discussed in detail later as part of this report. Overall, this report attempts to understand the process of preparation of development plans in the selected cities with special emphasis on those best (or avoidable) practices that help (or foil) integration of land use and transport. Lastly, the report examines the application of these practices to plan-making for sustainable urban development.

[7] The proposed TOZs are envisioned as 'overlay zones' that would permit high-density mixed use along the transit corridors (Ahmedabad Urban Development Authority 2013c).

2. Sustainable urban development

Farr (2008: 34) defines sustainable urbanism as 'walkable and transit-served urbanism integrated with high performance buildings and high-performance infrastructure'. Compactness (density) and biophilia (human access to nature) are considered as core values of sustainable urbanism. Brundtland Commission (1987) defines sustainable development as that which 'meets the needs of the present without compromising the ability of future generations to meet their own needs'. The five core principles towards achieving and enhancing sustainability are development, efficiency, equity, safety and harmony. The recently revised Urban and Regional Development Plan Formulation and Implementation (URDPFI) guidelines (2014: 199) defines sustainable habitat development as that which aims at achieving a balance between economic and social development of human habitat together with the protection of environment, equity in employment, shelter, basic services, social infrastructure and transportation. The guidelines also advise controlling 'unplanned and un-organized' growth outside the development plans through integration of land use and transport. They recommend re-development and re-densification of existing habitat while promoting mixed land-use and shared social spaces to reduce trip generation. They also quote the National Mission on Sustainable Habitat (2011) while advocating low-rise high-density development with a view to reduce costs and travel demand[8].

A report on development of sustainable habitat parameters in the field of urban planning by the Town and Country Planning Organization (TCPO) (2011) indicates that planning for sustainability would need to address the planning process in general as well as land use (suitability, adequacy, optimality, balance and compliance), transport (integration with land use), environmental services (water supply, sewerage, solid waste management and storm water drainage), participation and decentralization (devolution of governance), local economic development (productivity, diversity and stability), social services (health, education, economic indicators, housing, urban services availability) and partnerships (private-community investments). Since this report is concerned only with the process of preparation of development plans, the following indicators recommended by the TCPO report on sustainable urban habitat (2011: 15) appear to be suitable.

a. Periodicity of plan preparation and revision (measured as average age of plans),
b. Adoption of land suitability analysis (including disaster risk assessment),
c. Adherence to environmental/land use zoning (adoption of environmental assessment as part of plan making), and

[8] In 2004, transport energy use amounted to 26 per cent of world energy use and the transport sector was responsible for about 23 per cent of the GHG emissions. According to a report prepared by the Ministry of Environment and Forests (MoEF) in 1994, the transport sector was responsible for 12 per cent of the country's total energy related CO_2 emissions.

d. Inclusion of features for land use transport integration, compact city planning, risk mitigation and universal access to housing.

For the purpose of this project, we shall use the above framework as it fits the contextual location of this research. A detailed discussion on sustainability with regard to other sectors and parameters for evaluation is presented in a subsequent working report that investigates sustainability of land development mechanisms in India.

2.1. Previous research on urban development control

After Development control has been used by governments across the world as a tool to bring about welfare gains. In some contexts like South Africa, they have also been explicitly used as a tool of oppression against people of a particular race. Nevertheless, the typology of land use interventions is composed of a) urban growth limits, b) Floor Space Index (FSI) and building height limitations, c) cost increasing regulations, and d) State control over development decisions. These are discussed in detail below.

2.1.1. Urban growth limits

A city like Ahmedabad or Hyderabad which has a set urban growth limit in the form of a ring road or a major highway or even a green belt can be the case for this study. Suppose that the natural boundary of the city is at a distance x from the central business district. A new growth limit is set at a distance x_b is shown in Figure 2 such that $x_b < x_m$. Since the land between x_b and x_m should now return to rural land use the people already living there must theoretically shift inwards thereby causing a spike in demand and price per housing unit denoted as p.

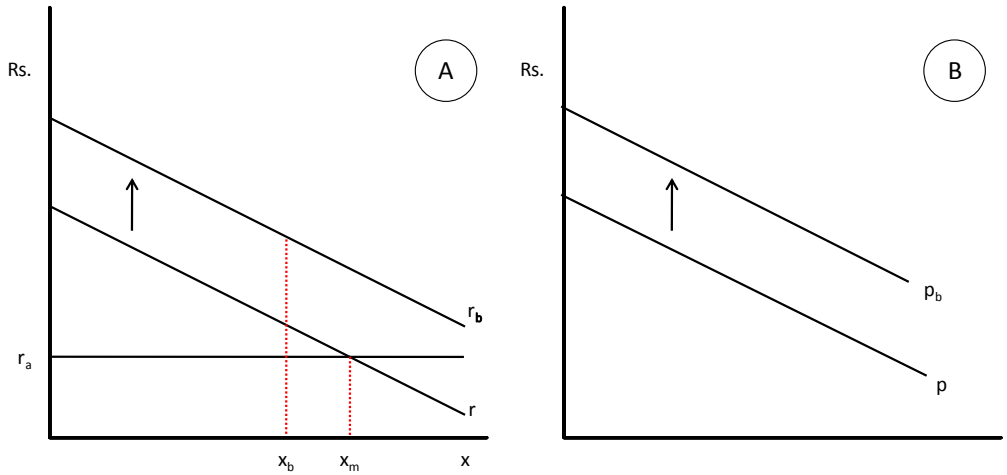


Figure 2: Effects of externally enforced urban growth limits
Source: Brueckner 2009

Since there is a decrease in the amount of developable land within the city, stiffer competition emerges between developers leading to an even more increase in land prices. The developers also try and build taller buildings on the same plot than before. This causes a reduction in per capita consumption of floor space and higher

densities within the core city. Since no fresh investments are made in social infrastructure like parks, the availability of open spaces comes down as well. Therefore, it is observed that enforcement of limits on city growth leads to higher housing costs, higher land rents, taller buildings, greater densities and lower availability of social amenities per person. Hence it can be concluded that people's living standards drop in such a situation.

2.1.2. Floor Space Index limits

In the event of enforcement of FSI limits on a city that previously had none leads to a declining building-height contour (H) as shown in Figure 3. Since the old buildings that were consuming more FSI than allowed are theoretically required demolishing the extra floors, demand for floor space rises causing a spike in the land prices and rents. As a result, dwellings downsize and the per capita consumption of floor space decreases. In the areas where the FSI limits have brought down building heights, the rents undergo a slight correction since developers are not able to make maximum use of the land potential. Higher housing prices raise developers' profits and stiffer competition emerges resulting in higher bids for land parcels. This encourages developers to build taller towers. Since taller towers can only be built in areas outside where the FSI limits apply, the city expands spatially. Therefore, imposing FSI limits adds to the worsening of the residents' situation.

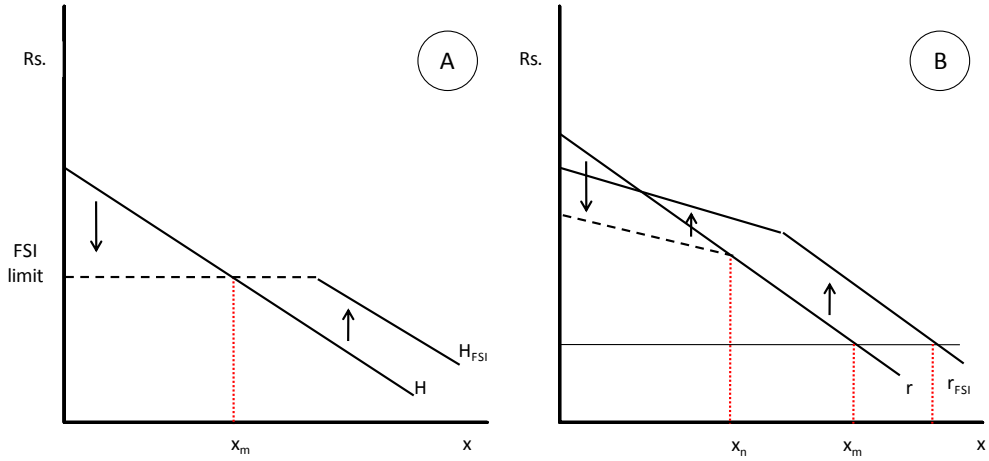


Figure 3: Effects of externally enforced FSI limits
Source: Brueckner 2009

2.1.3. Cost increasing regulations

In the event of the government imposing higher order building regulations that lead to higher costs, developer would be unwilling t invest more money on land. As a result, the land rents drop down to r' (Figure 4). As a result, builders are not able to outbid agricultural users in the outskirts of the city. This leads to some part of the city beyond x' theoretically returning to agricultural use. Due to the resulting shortage in land and housing, there is a surge in land prices and rents to r_{cost}. Also densities rise, building heights rise and per capita consumption of space reduces. The resulting city footprint reduces to x_{cost}. Thus a city that has higher cost inducing

regulations will be smaller, costlier (in terms of housing) and taller. The residents would still be worse off due to the higher costs of housing.

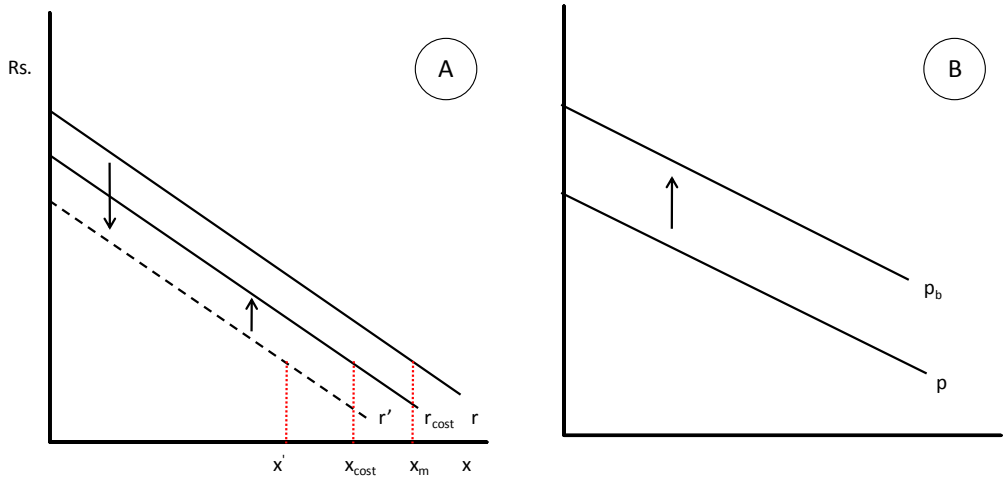


Figure 4: Effects of externally enforced cost increasing regulations
Source: Brueckner 2009

2.1.4. State control over development decisions

Suppose the government decides to build tall apartments on the outskirts of the city thereby playing a distorting role in the housing market. Since the residents have no choice but to move into the newly constructed housing and jobs continue to be concentrated in the core city, their travel time increases resulting in a deterioration of their standard of living. Needless to say, it also results in inefficient land use. In case housing was provided not by the government but by developers, then it is seen that absentee landlords suffer while the residents are not affected at all (Figure 5).

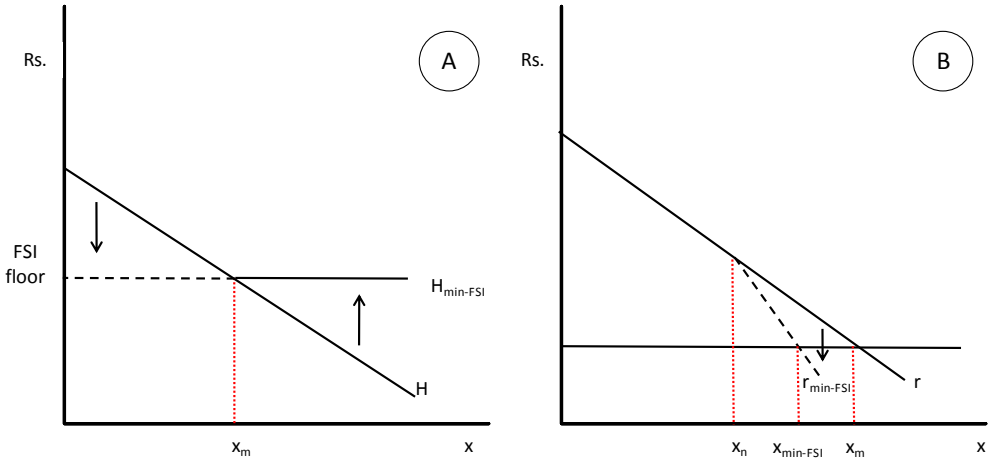


Figure 5: Effects of externally enforced cost increasing regulations
Source: Brueckner 2009

Brueckners' research in South Africa (1996) indicates positive welfare gains as a natural consequence of eliminating the distortion imposed by the apartheid system. Apart from the anomaly of apartheid, debates have been raging about the need for development control. Bertaud and Brueckner (2003) demonstrate how the imposition of building-height regulations in Bengaluru resulted in a welfare cost of

3-6 per cent on the residents of Bengaluru. Bertaud (2004) argues that draconian control of the government over FSI in Mumbai has led to net welfare losses for the city as the poor are squeezed on to the sidewalks in the highly competitive battle for floor space. Brueckner (2009) also demonstrates that from an economic point of view, governments should consider only moderate interventions in the land market as against draconian control since it seldom results in positive outcomes across contexts. Brueckner and Sridhar (2012) also demonstrate average savings in commute cost which is directly convertible into welfare gains in the case of Indian cities. The research discussed above clearly argue for the removal of development control altogether or its practice in moderation.

However, there is a contrarian view put forward by Patel (2013b) which finds fault with the monocentric model of the Indian city used by Brueckner and Sridhar (2012) and Bertaud and Brueckner (2003) for what the author calls a 'too-simplistic' representation of the Indian city. By doing so, Patel argues for continuation of development control by the government with the intention of conserving core city areas and provision of social amenities which may not be a priority for free-markets. Brueckner and Sridhar's response (2013) to Patel's defense of development control is based upon the observation that it is quite easy in Indian cities to circumvent the development control regulations anyway and it is better to do away with a restrictive framework than to have it and allow its subversion. From the sustainable urbanism point of view discussed in Munshi et al. (2015), it is important to note that urban growth limits are going to encourage greater densities which are bound to encourage the implementation of mass transit projects subject to interventions such as higher motor vehicle taxes, higher fule costs and rationing parking spaces at a premium that would disincentivize use of private modes. Similarly, a city with newly higher regulation costs would result in a compact urban form again resulting in lower travel distances (Giuliano and Narayan 2003). Both these situations are desirable from the sustainability point of view. In case of FSI limits and State influences, the city expands spatially which is bound to result in higher travel distances and trip rates. This may not be desirable from the sustainability point of view on account of higher emissions, accident related deaths and pollution. In the following section, the case cities identified in Munshi et al. (2015) are evaluated on the basis of the development control regulations discussed above.

3. Plan preparation in India

Planning in India is a highly centralized process owing to the Soviet-inspired approach chosen by the country after achieving independence in 1947. Economic planning is the prerogative of the Planning Commission of India chaired by the Prime Minister. Five-year plans were adopted on lines of the Soviet approach of centralized allocation of resources. Since land is a State subject in India, consequently, so is urban planning. The national government's role is, therefore, limited to laying down broad guidelines for urban development. The states are required to enact their own versions of urban and regional planning acts on the basis of model regional planning and development law prepared by TCPO in the 1970s (Mahadevia et al. 2009). There are several agencies that are connected directly or indirectly with urban planning at the state level. Key ones are Department of Urban Development and Urban Housing, Department of Roads and Buildings or Public Works Department, and Revenue Department.

With the 74th Constitutional Amendment Act (CAA) in place, the Urban Local Bodies (ULBs) such as Ahmedabad Municipal Corporation (AMC) have also been given the mandate to prepare spatial plans for areas within their mandate. In addition, there are urban development authorities like Ahmedabad Urban Development Authority (AUDA), that are engaged in producing spatial plans for the wider city-region incorporating areas that are likely to experience potential urban development over a couple of decades. Generally, plans are prepared at several scales including metropolitan region, city and ward levels. In India regional plans are rarely prepared for areas that may be bigger than a city, as big as a state, or occasionally even bigger than a state. They are aimed at identifying broad sectors of growth, centres of economic activity and hierarchy of settlements. Often prepared with a horizon of twenty years, revisions are not generally undertaken. Development plans, are statutory documents - prepared with a horizon period of twenty years - that identify and propose direction of growth, land-use, transportation network and several other projects for an area comprising the core city and its periphery. However, since there are often no capital investment plans linked to the development plan, they remain mere proposals on report, far from implementation (Mahadevia and Joshi 2009). It must also be said that although a ten year revision period is suggested, the development plan is hardly revised or updated thoroughly in most cases.

The development plan is often followed by an approach termed 'laissez-faire' where the developers take control and develop land on the periphery of the city for urban use. Such land is then divided into plots and sold, often for a premium, to people unable to afford shelter in the city centre. Provision of essential services such as water supply and sewerage take a long time. In another model of peripheral development, the city may extend major service lines till the periphery for the developers to take-over and distribute to the individual plots. Developers may also make use of the township policies enacted in several states to develop integrated facilities for work, shelter and entertainment in the newly earmarked areas as part of the development plan (Ballaney and Patel 2009).

Town Planning Schemes (TPS), take off from where the development plan process ends. It is a techno-legal method of developing serviced urban land from agricultural use. Having evolved in the twentieth century in erstwhile Presidency of Bombay, TPS came to be used in the states of Maharashtra, Gujarat, Andhra Pradesh and Kerala (Nallathiga 2010). The new areas identified for growth in the development plan are divided into workable smaller areas of 100-200 hectares. Land is pooled from all the owners and after making deductions for transport and social infrastructure, it is divided equally among the owners (in proportion to their original plot sizes). The rise in land values as a result of TPS makes up for the deduction. Besides, the original landowners may also be required to pay betterment charges, depending on the improvements carried out.

As per the Gujarat Town Planning and Urban Development Act (GTPUDA), 1976, it involves, a) delimiting an area, b) reconstituting properties, c) levying charges for infrastructure provision, d) levying betterment charges, e) informing landowners of proposed plans, f) compensating dispossessed landowners, g) seeking consent and recording suggestions, and h) empowering quasi-judicial officers for grievance redressal (Ballaney 2008). Ballaney & Patel (2009) opine that the perceived merits of the TPS in the Gujarat context-its image of being fair, equitable and relatively respectful of individual property rights--goes hand-in-hand with the presence of a robust enabling legislation that facilitates the relative success of supply of serviced urban land in Gujarat. However, as Gurumukhi (2003) reveals, too much is at the whim of the Town Planning Officer (TPO) appointed for each TPS under the provisions of the GTPUDA, 1976. The landowners are merely consulted--for their objections and suggestions, which may ultimately be ignored even—and not made participants in the process of selection of sites for social infrastructure. The process of planning at the local level therefore becomes consultative in nature rather than participatory, as might be expected in a country that embarked on the path of decentralization with a view to devolving power to the citizens.

In addition to those aforementioned urban land use planning approaches, local area planning initiatives have also been taken up in some cities. Most of these initiatives, especially in cities like Pune and Bengaluru have resulted due to constant efforts by civil society organizations like Centre for Environmental Education, Parisar (both Pune) and Janaagraha (Bengaluru). It is relevant to note that a methodology for local area planning has been developed as part of a previous project by the authors

4. Case cities

In the following section, the case cities selected for study under this project are introduced. Table 1 presents the population, area and densities of the case cities. Clearly, Pune and Ahmedabad are denser whereas NCT Delhi and Bengaluru are the more populous ones among the selected cities.

Table 1: Population, area and density of case cities in 2011

City	Population (millions)		Area (square kilometres)		Density (ppHa)	
	Core city	Metropl.	Core city	Metropl.	Core city	Metropl.
Pune	3.12	5.05	224	1,340	139	38
Hyderabad	6.81	7.75	650	7,228	105	11
Bengaluru	8.43	10.70	741	8,005	134	11
Ahmedabad	5.57	6.35	450	2,433	124	26
NCT Delhi	16.32	45.20	1,483	33,578	110	13

Source: Registrar General of India, 2011

4.1. Pune

Pune is the second largest city in Maharashtra with a population of 3.12 million (Registrar General of India 2011)[9]. It forms part of the Pune Metropolitan Region (PMR) which has an area of 1,340 square kilometres. Efforts to form a development body for PMR in the form of Pune Metropolitan Region Development Authority (PMRDA) have been unsuccessful (Jadhav 2013; Khape 2009; Times News Network 2013). Other urban bodies within the limits of PMR are Pimpri-Chinchwad Municipal Corporation (PCMC), Khadki and Pune cantonments (Figure 6). Of these, PCMC is most significant as it has an area of 171 square kilometres which forms around 13 percent of the area of PMR. Its population of 1.7 million forms 28 percent of the population of PMR. Urban planning in Pune is taken care of by the planning division of the urban local body using the provisions of the Maharashtra Regional and Town Planning Act, 1966. As of today, 2007–2027 Development Plan for Pune City (old limit)[10] (2013b) is in force within Pune city limits. In areas that fall under the PMR but not within the limits of PMC, PCMC or Khadki and Pune cantonments, Development Control and Promotion Regulations for Regional Plan Areas in Maharashtra (2013) are in force.

[9] Mumbai city accommodates 12.48 million people in an area of 603 square kilometres governed by the Brihanmumbai Municipal Corporation (BMC). At 206 ppHa, it is the densest city in India. It forms part of the Mumbai Metropolitan Region (MMR) which accommodates 20.99 million people in an area of 4,764 square kilometres (Registrar General of India 2011).

[10] Twenty three peripheral villages were added to Pune city in 1997. These villages have a separate development plan and development control regulations. The 'old limit' part in the name of the current development plan for Pune city stands for the areas that were under the PMC before 1997. Another 34 villages were recently added to Pune city by a government order.

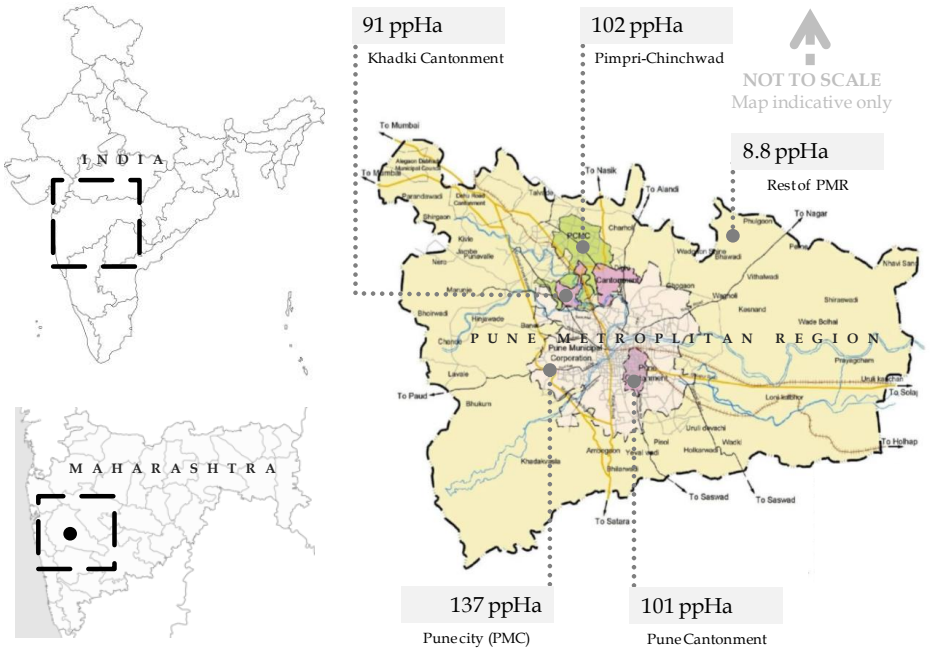


Figure 6: Location of Pune city

Source: Pune Municipal Corporation, 2013

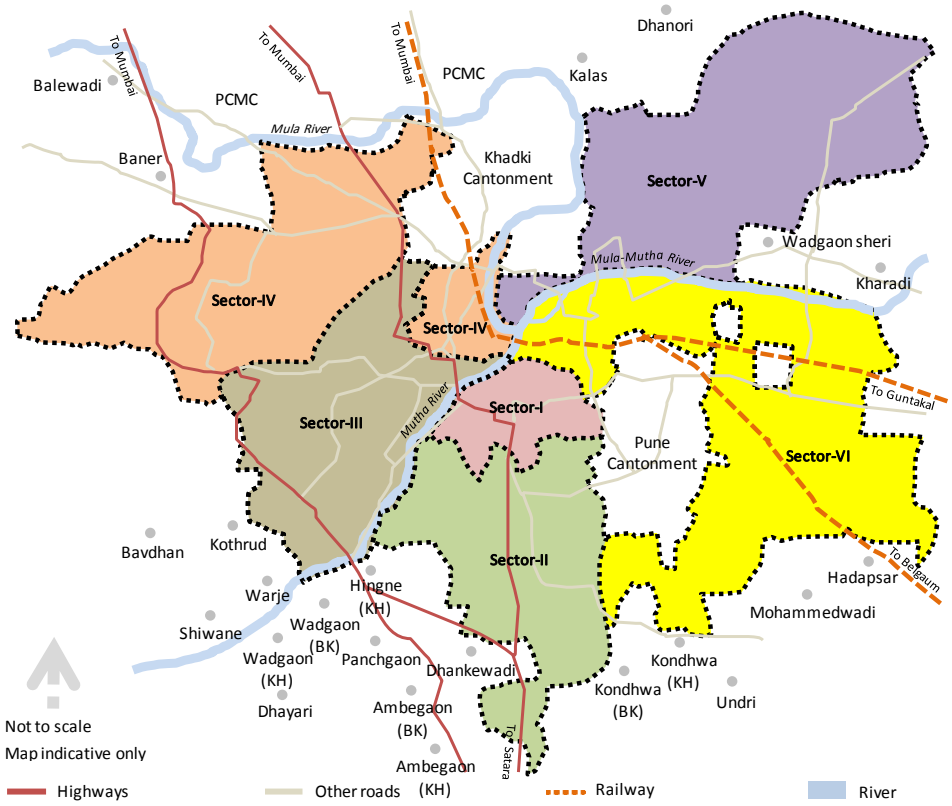


Figure 7: Map showing sectors in Pune city (old limit)

Source: Pune Municipal Corporation, 2013b

Development control in Pune city is made through a combination of margins, coverage and FSI. In addition, Transferable Development Rights (TDR), developmental TDR, heritage TDR, accommodation reservation and incentive FSI are other means that have been used in order to regulate development in that city.

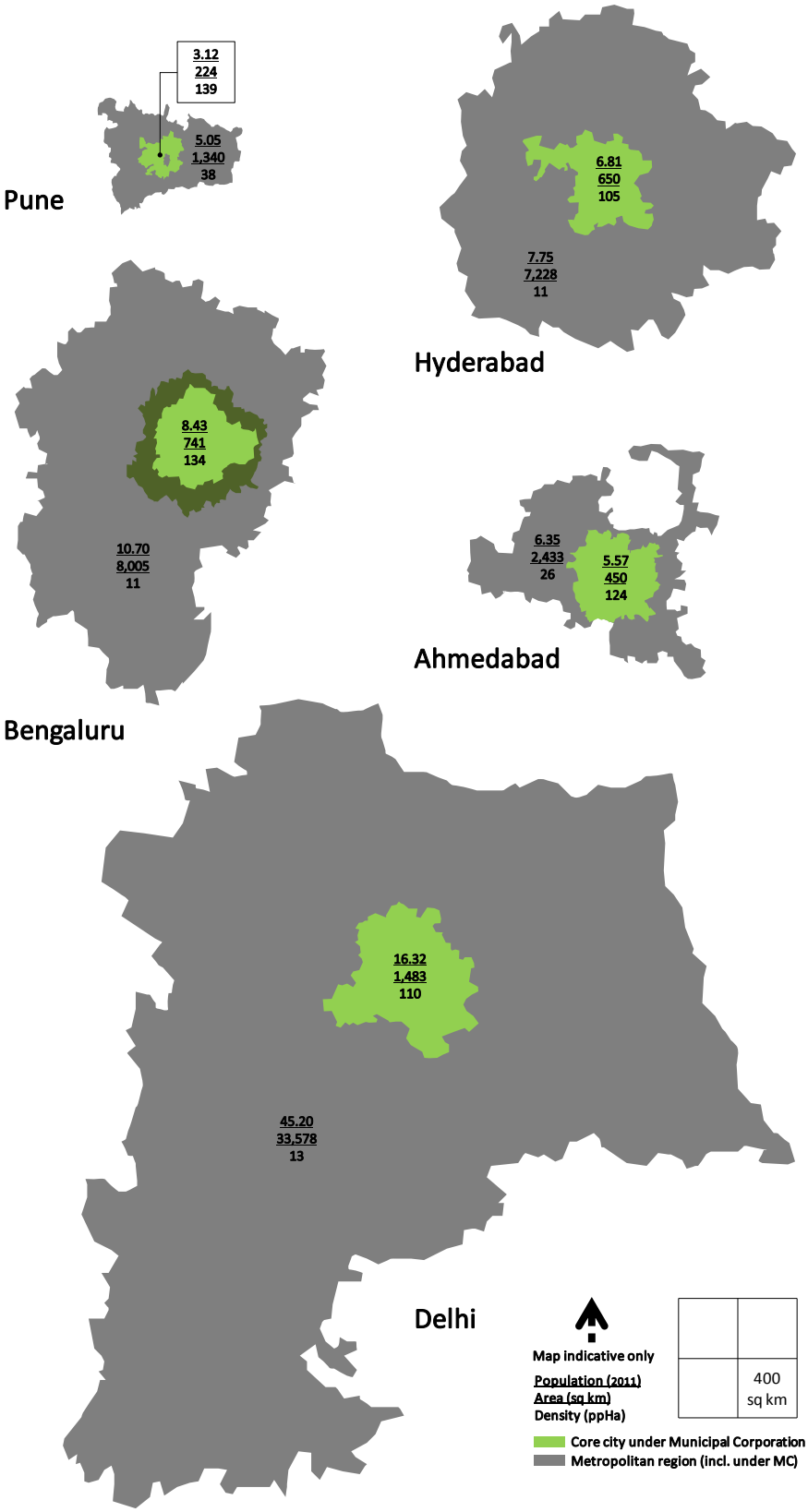


Figure 8: An illustration showing the population, area and densities of case cities
Source: Authors

There are two development plans in force within the Pune Municipal Corporation (PMC) limits. The 2027 Development Plan for Pune City (2013b) applies to areas that

were part of the Corporation limits prior to 1997[11]. These areas are part of the 'old limit'. The old limit areas are perceived as congested and non-congested areas. Figure 7 shows Pune city old limits divided into sectors. The PMC appears to discourage development in the congested areas. These areas are listed below: all of Sector-I, Parvati, Bibwewadi (Sector-I), Kothrud, Erandwana, Pulachiwadi (Sector-III), Pashan, Aundh, Bopodi, Bhamburda, Sutarwadi, Narvir Tanajiwadi (Sector-IV), Yerawada, New Kirkee, Ramwadi, Ladkat Wadi (Sector-V), Mundhwa, Hadapsar, Wanawadi, Kondhwa, Somwar-Mangalwar Peth (part), Kavadewadi (Sector-VI) (Pune Municipal Corporation 2013a). In areas that fall within the Pimpri-Chinchwad Municipal Corporation (PCMC), the 2016 Development Plan of Pimpri-Chinchwad Municipal Corporation Area (1995) is in force. In all other areas within the Pune Metropolitan Region (PMR), standardised development control and promotion regulations for regional plan areas in Maharashtra (2013) comes into force. In the following section, we shall discuss the development regulations in areas that fall in the Pune city (old limits).

FSI: For residential use in congested areas, an FSI of 1.5 is permitted subject to maximum tenement density of 375 tenements per hectare. In a mixed use building, commercial use shall be permitted only on the ground floor. Minimum setback from existing roads of 4.5 m width shall be 1.5 m. For roads narrower than 4.5 m, a setback of 2.25 m from the centreline of the road is prescribed. Building heights shall not exceed 70 m and coverage shall not exceed 2/3 of the plot area. FSI and margins permitted in non-congested areas are shown in Table 2 below. It is interesting to note that while the FSI in the core city (old limit) is only 1 in the non-congested areas, an FSI of 1.5 for residential development (with an additional premium FSI of up to 0.5 in case of mixed use) is allowed in the areas other than those within Corporation limits (Urban Development Department 2013: 80).

Cluster[12] development policy for congested areas: The owners of properties in residential zone of congested areas older than 30 years with an area not less than 1,000 square metres can apply for cluster development provided they have no-objection certificates (NOCs) of 70 per cent of tenants of the cluster. A maximum FSI of 3 is permitted of which 2.5 must be used for rehabilitation of tenants, subject to a minimum size of 25 square metres. The remaining FSI may be used as commercial space. The ratio between FSI used for rehabilitation of tenants and FSI used for free sale shall be 1:2. This is done with a view to subsidize the rehabilitation process.

[11] Twenty three villages were added to Pune city in 1997. These are: Balewadi, Baner, Bavdhan (Kh), Kothrud, Warje, Shiwane (P), Hingane (Kh), Wadgaon (Bk) , Wadgaon (Kh), Dhayari (P), Pachgaon (Kuran), Dhankawadi, Ambegaon (Bk), Ambegaon (Kh)(P), Kondhwa (Kh), Kondhwa (BK), Undri (P), Mohmmedwadi, Hadapsar (P), Wadagaon Sheri, Kharadi, Dhanori and Kalas (Figure 9). These villages have their own development plan (Pune Municipal Corporation 2005).

[12] A cluster is defined as the area bounded by roads/lanes from at least two sides with minimum width of access from either side being 9 m.

Incentive FSI: An extra FSI of 20 per cent, 30 per cent and 45 per cent of the rehabilitation FSI may be granted to cluster development initiatives where landlords jointly develop plots of 2,000 to 4,000 square metres, 4,000 to 10,000 square metres and above 10,000 square metres respectively. Educational institutions can use a maximum of 1.5 FSI while hospitals can use a maximum of 4 FSI.

Table 2: FAR, front, rear and side margins and heights in non-congested area

Description of abutting road	Min plot size (m^2)	Min frontage setback (m)	Min setback from road front (m)	Min side and rear margins (m)
36 m and above	750	18	6	Half the height of the building minus 3 m (min 3 m)
36 m > x > 24 m	600	18	6	
24 m > x > 15 m	500	15	4.5 m (R) 6 m (O)	
15 m > x > 12 m	250	12	4.5 m (R)	
12 m and below	250 > y > 125	12 > z > 8	3	2.25 m, 3 m
Row housing on 12 m and below	125 > y > 50	8 > z > 4	3	Side 2.25 m Rear 1.50 m
Row housing for EWS/LIG	50 > y > 125	4	1 m from path 2.25 m from road	Side 2.25 m Rear 1.50 m
Description of abutting road	**Max ground coverage (%)**	**Max permissible height (m)**	**FAR**	
36 m and above	50	21	1	
36 m > x > 24 m	50	21	1	
24 m > x > 15 m	50	21	1	
15 m > x > 12 m	50	18	1	
12 m and below	50	10	1	
Row housing on 12 m and below	50	10	1	
Row housing for EWS/LIG	Only margins	10	1	

Source: Pune Municipal Corporation, 2013b

Transport (Parking): Multi-storied parking lots are planned within 200 m from metro station and other bus rapid transit stations. The PMC proposes to acquire land, develop, operate and maintain parking plots. If plots reserved for parking under the development plan are under private occupancy, there are some options available to the owner. If the plot is below 1000 square metres, entire plot may be handed over to PMC. If the plot area is between 1000 and 6000 square metres or above 6000 square metres, then an area of 33 per cent or 25 per cent respectively may be handed over to PMC with parking constructed. The owner may continue to use the remaining part of the plot with FSI equal to that allowed for the whole plot prior to handing over of the parking lot. If the plot is not reserved for parking as part of the development plan but falls within 200 m from transit station, multi-storied parking lots may be developed and handed over to PMC free of cost subject the plot being

of required size (500 square metres in congested area and 1000 square metres elsewhere) with at least 50 car parking slots. In such a case, an additional incentive FSI of 30 per cent (Zone A), 40 per cent (Zone B) and 50 per cent (Zone C & D) shall be allowed on base FSI subject to a maximum of 4 in congested areas and 3 elsewhere. Single, two-tier and three-tier basements are permitted for plot area of 750 to 2000 square metres, 2000 to 4000 square metres and above 4000 square metres respectively. Ramps are allowed in marginal open spaces subject to the approval of the Pune Municipal Corporation.

Table 3: Parking related provisions as part of 2027 development plan

One parking space for every	Non-congested			Congested			Remarks
	C	Sc	Cy	C	Sc	Cy	
Multi-family residential							
Tenement (carpet area > 150 m^2)	3	2	1	3	2	1	5 % visitor parking extra
Carpet area* 80 to 150 m^2	1	2	2	1	2	2	
Carpet area 40 to 80 m^2	1	4	4	1	4	4	
Carpet area 25 to 40 m^2	1	6	4	0	6	8	
Plot area less than 200 m^2	-	-	-	0	2	4	-
Plot area more than 200 m^2 and road frontage less than 5 m	-	-	-	0	2	4	-
Tourist homes (every 5 rooms)	3	4	4	3	4	4	-
4 & 5 star hotels (every 5 rooms)	3	6	4	3	6	4	Additional parking for banquet
Restaurants (every 50 m^2)	2	8	4	0	8	8	-
Hospitals							
Every 10 beds	3	10	20	3	10	20	5 % visitor parking extra
Assembly							
Multiplex (for 40 seats)	6	20	10	6	20	10	-
Community hall (every 100 m^2)	1	4	2	1	4	2	-
Educational							
Schools (every 100 m^2 admin)	1	2	8	1	2	8	Parking can be shown on playgrounds
Schools (every 100 students)	2	0	60	2	0	60	
Colleges (every 100 m^2 admin)	2	20	10	2	20	10	
Colleges (every 100 students)	0	90	30	0	90	30	
Mercantile							
Malls, Offices (every 100 m^2)	4	12	4	3	6	4	-
IT buildings (every 200 m^2)	5	12	4	5	12	4	-

Note: C - Car, Sc- Scooter, Cy-Cycle; * carpet area is approximately 15 % of built-up area
Source: Pune Municipal Corporation, 2013b

Maharashtra Housing and Area Development Authority (MHADA) colonies: With a view to encourage low cost housing schemes in MHADA owned vacant lands, FSI of

2.5 shall be allowed. An incentive FSI towards rehabilitation of existing occupants shall be admissible as 50 per cent (congested areas) and 60 per cent (elsewhere) for plots up to 4000 square metres and 60 per cent (congested areas) and 75 per cent (elsewhere) for plots larger than 4000 square metres.

Rental housing: To facilitate immigrants to find affordable housing FSI up to 4 shall be allowed. Out of 4 FSI, rental housing can be constructed on minimum 30 per cent of land using a maximum of 1 FSI and handed over to PMC. Convenience shopping could be built to the tune of 15 per cent of the total built-up area of rental housing of 1 FSI. On the remaining (up to 70 per cent) land, the land owner can construct housing units using the remaining 3 FSI which can be sold in the open market to subsidize the rental housing component. Commercial/convenience shopping units could be built to the tune of 15 per cent of the total built-up area of housing units for open market of 3 FSI. A rental housing unit is a 180 square feet carpet area self-contained residential unit. A density of 1,500 rental housing units per hectare and 750 tenements (housing sold in open market) per hectare would be allowed. Minimum plot size of 4,000 square metres is required unless decided so by PMC. Allottees of rental houses must satisfy the following conditions namely a) the allottee must have employment within PMC limits, b) the allottee and his family member shall not own any house in PMC area, c) the allottees must preferably be domiciles of Maharashtra, d) the allotment of rental housing unit shall be made in joint name of spouse, if married, and e) the maximum lease rent agreement should be not exceed 11 months. Exclusion from FSI computation a) areas covered by staircase rooms, lift rooms, lift wells, chimneys and passages, b) area of fire escape stairways, fire escape passages, c) basements, d) covered parking spaces, e) area of one office room of co-operative housing society, f) area of sanitary blocks for the use of domestic servants for each wing of each floor, g) refuge area, h) areas covered by lofts, meter rooms, porches, canopies, air conditioning plant rooms, electric sub-stations, i) area of balconies (not more than 15 per cent of floor area), and j) area under effluent treatment plants, service ducts, pump rooms.

Transferable Development Rights (TDR) is applicable for cities having a population greater than 2 lakhs. If land owner hands over possession of reserved land to the Corporation without any encumbrance, a Development Rights Certificate (DRC) is granted to him. The DRC can be used to construct a built up area equivalent to the permissible FSI of land handed over to the FSI. The accumulated TDR can be used in one or more plots in specified zones.

Heritage TDR: An incentive mentioned in the development plan that is to be decided on the basis of statement of significance. The FSI of a receiving plot can't be allowed to be exceeded by more than 0.05 as a result of heritage TDR.

Accommodation reservation: Land owners can develop sites reserved for an amenity in the development plan using full permissible FSI on the plot. They must then hand over the amenity (parking, shopping centre and dispensary) to the local authority

and accept full FSI as compensation. It saves the Corporation the cost of acquisition and development.

Developmental TDR: It is the TDR that is made available to land owners who turn over their developed site (under reservation for amenities) to the Corporation.

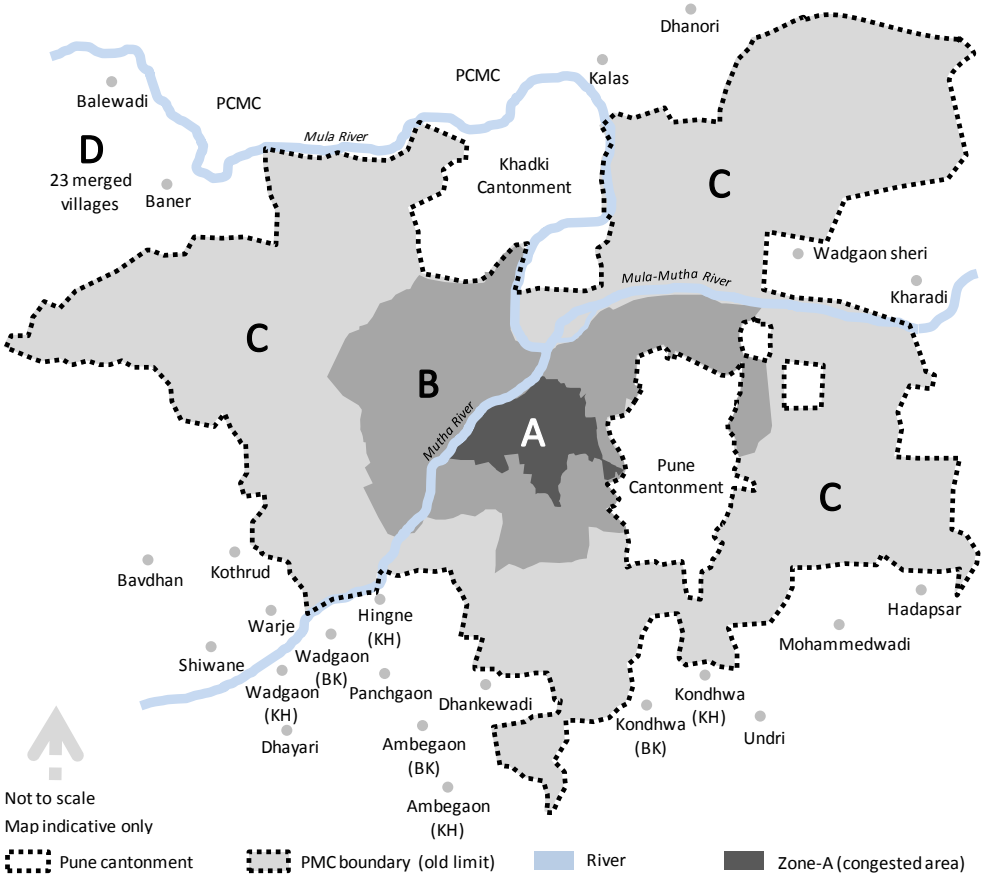


Figure 9: Map showing TDR zones in Pune city
Source: Authors, Pune Municipal Corporation, 2013b

Table 4: Multiplication factors for TDR generated and utilised in various zones

DRC Generating zone	DRC Utilization Zone			
	Zone A	Zone B	Zone C	Zone D
Zone A	1.00	1.00	1.00	1.00
Zone B	0.00	1.00	1.00	1.00
Zone C	0.00	0.62	1.00	1.00
Zone D	0.00	0.00	0.67	1.00

Source: Pune Municipal Corporation, 2013b

Figure 10: Map showing Pune metro rail corridors
Source: Authors, Delhi Metro Rail Corporation, 2013

Densification along metro influence zone[13]: The 2027 development plan has a proposal to densify the public transport corridor to a distance of about 500 m on both sides of metro corridor. Minimum plot size of 0.2 hectares is a precondition. While a base FSI of 1 would be available, another 3 FSI can be purchased as premium FSI. The premium shall cost 1.5 times of the ready reckoner for the concerned property. Some part of this 2 (premium) FSI can be TDR, subject to a maximum of 40 percent. Coverage of 2/3 for building heights up to 21 m and 50 percent for the buildings those are taller than 21 m. All uses already allowed under residential and commercial zones will be permitted. People who give up their plots voluntarily for the metro rail project will be given TDR that is twice of permissible limits. FSI less than 4 will not be allowed. No vacant land allowed in Metro Influence Zone after 5

[13] The Detailed Project Report (DPR) for 31.5 km Pune metro rail project was submitted to PMC in 2008. It has two corridors namely PCMC-Swargate (16.6 km) and Vanaz-Ramwadi (14.9 km). It is scheduled to commence construction by 2015.

years from commencement of metro-rail project related work. Figure 10 shows the proposed metro rail corridor in Pune city.

Premium/paid FSI: Premium FSI up to 0.4 may be bought in all areas of the city by paying a premium of 1 times the ready reckoner rates for open plot of that area. Premium FSI can't be used in congested areas (except in metro influence zones). Premium FSI can't be used for slum dwellers' housing schemes and in areas where permissible FSI is less than 1.

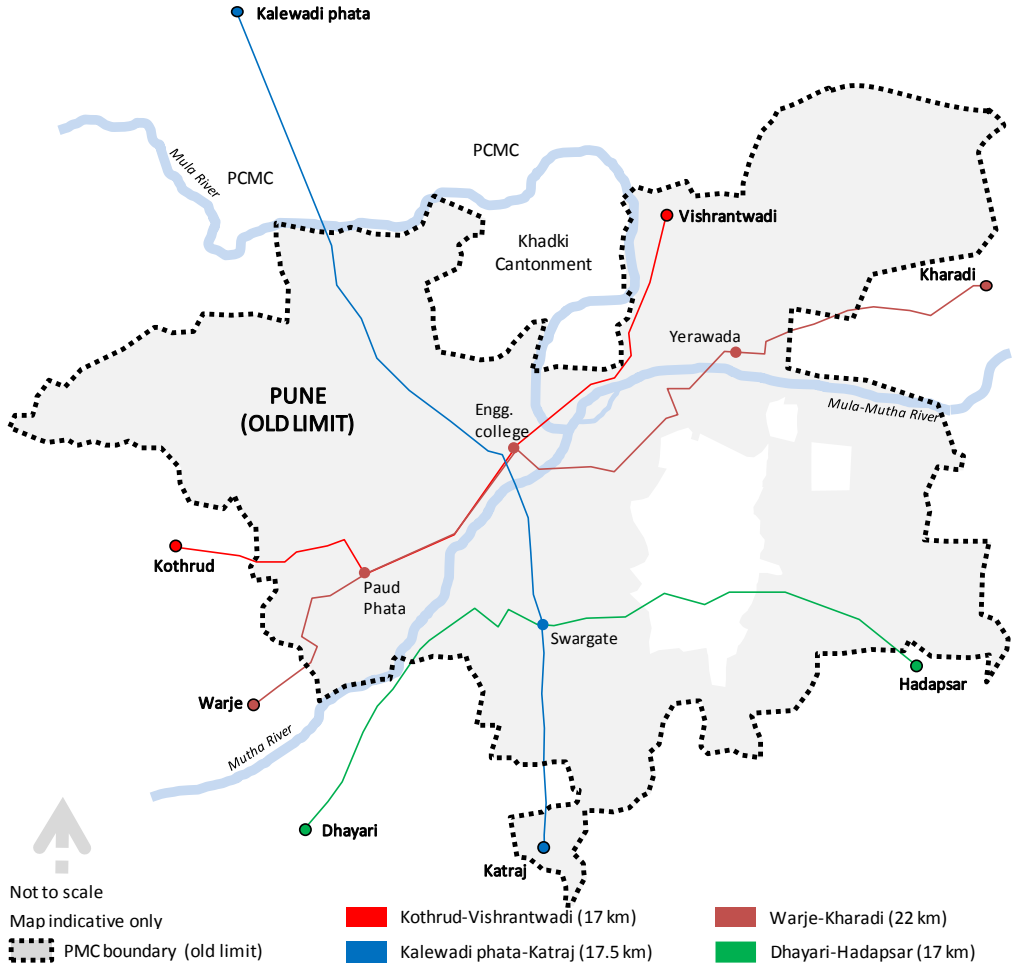


Figure 11: Map showing Pune BRTS corridors
Source: Authors

Experts' view: As part of site visits made as part of the project in November 2014, discussions were held with experts in order to further our understanding of the development planning process in the city. A formal discussion with various civil society members including sector experts like retired town planning department officials, academicians and civil activists was conducted at College of Engineering Pune on November 1st, 2014. A detailed list of participants is presented in Appendix- An individual discussion was held with Mr. Kunal Kelkar[14] an architect with his own practice in Pune for the past five years. Mr. Kelkar citing his experience in the field

[14] Kunal Kelkar is Principal Architect at des.K, an architecture and urban design practice based in Pune. He can be reached at http://goo.gl/9KM6RV.

notes that an FSI of 1 in the PMC area usually adds up to an actual FSI of 1.2 to 1.4 effectively since there are areas that do not get counted for FSI calculations such as staircase rooms, balconies, terraces etc. Also Mr. Kelkar argues that premium FSI (amounting to 0.5) can be claimed for what was called 'enclosable' balconies. Builders often used this to build larger bedrooms than those shown in the approval plans.

Figure 12: Image showing the project team discussing with Ar. Kelkar
Source: Authors

Citing the number of development control regulations that are currently in force in Pune metropolitan region, Mr. Kelkar felt that that there is too much confusion with regards to what regulation applies where. He illustrated this by saying that while PMC development control regulations apply in the city (old limits), another set of regulations apply to the 23 villages added to Pune city in 1997. In Pimpri-Chinchwad Municipal Corporation administered area, there are a separate set of regulations (Urban Development Department 1999) while in areas other than those mentioned above standardised development control and promotion regulations for regional plan areas in Maharashtra (Urban Development Department 2013) is applicable. However, for practical purposes in areas within the old limits, the stringent of the development plan and the regional plan development regulations is put into force, often at the discretion of the concerned official. In some cases, he had come across FSI regulation of one set of regulations being combined with the margins of another set of regulations. This, he felt, had made understanding the development planning process impossible for common man. Even architects had to resort to liaise with 'experts' to get their plans ready for approval. He also thought that the differential regulation of development in the old limit and newly merged areas and the fact that

two separate development plans were made for these areas are meant to benefit developers who stand to gain from the less stringent regulation in the newly merged areas. Overall, Mr. Kelkar recommended that a uniform set of regulations be applied across the city.

Figure 13: Image showing the project team discussing with civil society at CoE Pune
Source: Authors

A formal discussion was organized with several civil society actors, sector experts and retired government officials at the College of Engineering Pune on November 1st, 2014. A list of participants in the discussion is presented in Appendix-A. A range of issues related to Pune's development planning processes were discussed. Some of the issues that the delegates came to debate and agree/disagree upon are presented below:

- The development planning process in Pune has been influenced to varying degrees by the civil society and media campaigns. There is a strong relationship between the civil society and the executive.

- An integrated perspective plan for PMR is needed. Even in Pune there are two development plans. These two plans have nothing to do with each other and are independent of each other. Even PMC and PCMC don't have coordinated plans. This has led to uncoordinated growth.

- Development planning in Pune has gone backwards instead of forward in terms of processes. The 2007 development plan (1987) was prepared after a detailed transportation study. The present 2027 development plan (2007) has only a traffic forecast for the proposed metro rail project in Pune Metropolitan Area (2008) report as its base. Transportation studies do not seem to have enjoyed much attention this time. Even the comprehensive mobility plan (Wilbur Smith Associates

Ltd. and IL&FS Urban Infrastructure Services 2008) was not considered for major inputs during the development plan preparation.

- The development planning processes, by making people shift outwards, have only incentivised people to shift from public modes of transport to private modes as the public transit system has failed to grow in sufficient measure to areas with new demand.

- No studies on threshold (carrying capacity) analysis have been carried out apparently during the preparation of the plan.

- The metro-rail corridor appears to have been thrust upon the city. The delegates expressed concern at the argument for planning to meet the ridership expectations for the metro rail project when it does not exist. It was felt that areas that had good latent demand like Hadapsar (see Figure 14) were not being considered.

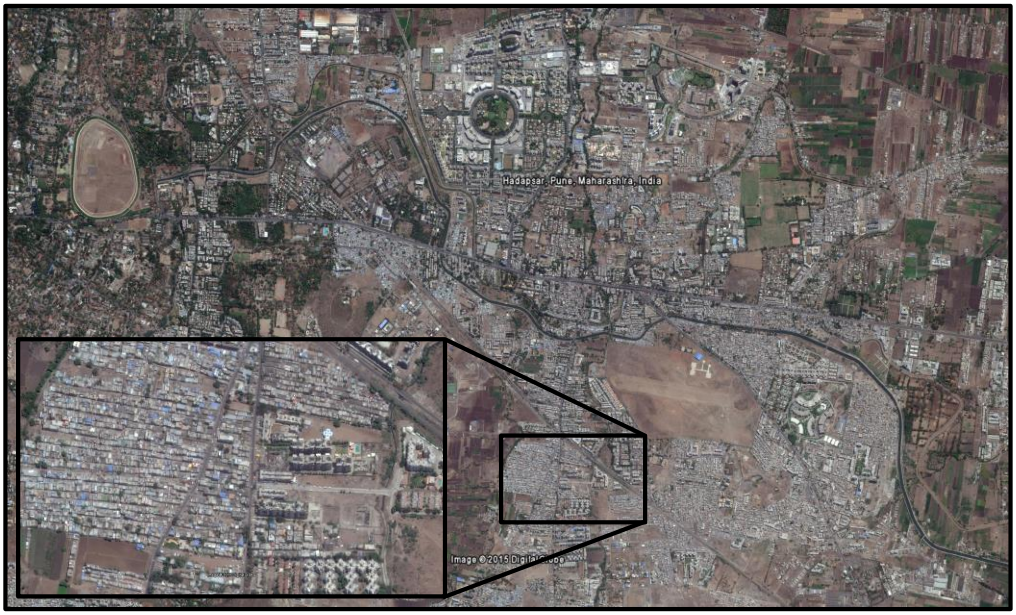


Figure 14: Satellite image showing Hadapsar – an emerging housing hub in Pune
Source: Authors

- The metro densification approach is not consistent with the direction in which development planning is moving in Pune. In fact they are at cross purposes. The TDR policy aims at moving people outwards from Zone-A (see Table 4). Metro corridor passes through all zones and has 4 FSI. It was therefore felt that a new TDR policy was needed to incentivise consumption of FSI only in metro densification zone.

- Parking provisions in the development plan are only encouraging for those that wish to own vehicles instead of the recommendations contained in the National Urban Transport Policy (2006) which advocated for paid parking and congestion charges in order to disincentivise use of private vehicles.

- Private sector controls housing provision in Pune. MHADA itself has invited private parties to help develop housing. The state has effectively left the field open for

private parties to take over. The 2027 development plan provides incentives for private parties to redevelop public housing by MHADA.

- The BRTS project in Pune is compromised with the addition of flyovers over BRTS corridors with visible importance given to motorized traffic than buses. Debates on the type of BRTS (Ahmedabad versus Delhi i.e. central versus side stations), open versus closed system have dragged the basic idea down[15]. Ultimately it has been decided to have a hybrid system.

- Interventions on the sustainability part with respect to cycle tracks and footpaths have largely remained token in nature. Most expenditure has been made on construction of roads. The street edges are ignored. Footpaths are part of multi-utility zone and pedestrians continue to suffer. Vendors are not even considered in street design.

- No coordination between city road plans and BRTS infrastructure plans. Feeder services are not sufficient as people like point-to-point services. Metro on top of BRTS on Nagar road will cannibalize each other.

- Overall, there were demands for the need to have a more comprehensive view of planning with a perspective plan for PMR guiding the development plans for the corporations and municipalities in PMR. Uniform development control regulations would go a long way in reducing confusion and help people in understanding the development plan. Also, the need to look at densities as against FSI as the determinant of development was felt.

Summary: Overall, the approach in Pune has been traditionally to move people from the inner parts of the city to the outer areas with a view to decongest the core area. This is evident in the way the consumption of TDR is regulated in Pune where only development rights generated in the core area can be consumed in the core area. TDR generated in the core area can be consumed in other outer zones as well. However, TDR generated in zones other than the core area can't be consumed in the core area. As is evident from Table 4, even the multiplication factors for TDR are in a manner that incentivises people to move away from the core area. For a certain amount of TDR generated in Zone-C, none can be consumed in Zone-A while 0.62 times the TDR generated and equal amount of TDR can be consumed in zones B and D. With the metro-rail project, there is a slight skewing of this logic as there is a proposal to have 4 FSI uniformly across the area through which the metro line passes through PMC area. This is done with the intention of bringing in more people to live near the transit line and thereby increase the ridership. However, it is debatable if such a sudden increase in FSI from the current 1 FSI (partially utilised)

[15] Pune Mahanagar Parivahan Mahamandal Limited (PMPNL) operates BRTS buses in Pune and Pimpri Chinchwad. The experts felt that 'open system' of BRTS was most suitable for Pune. They felt that the 'closed system' was imposed on Pune. Since it did not work well, the hybrid system became the compromise.

is going to result in higher density, since FSI and density are rarely seen to be in a proportional relationship (Bertaud 2004; Patel 2013a, 2013b).

There are also debates about how real estate development along the transit lines are bound to be costly thereby excluding the poor and the lower middle classes from being able to afford residential space in these areas. People belonging to upper middle class and the high income groups that are going to be able to afford floor space in these areas are seldom going to be using transit as they already (or plan to) own vehicles. In the light of the prevalent easy means of automobile ownership and absence of tight parking regulations, their patronage of transit is bound to be low thereby debunking the logic of transit corridor densification to increase ridership. At a basic level, there are other debates about the need to have a highly expensive metro-rail corridor supposed to cater to 20,000-40,000 peak hour peak direction traffic (PHPDT) when even the detailed project report for the project (Delhi Metro Rail Corporation 2013) predicts that the lower limit of such traffic would be achieved only in 2031.

The other takeaway from the study of Pune is that most new development is happening only on the outskirts of the city. Areas like Kothrud, Hadapsar and Warje are outside of the old limits of the PMC. Due to locational advantages, easier availability of developable land and slightly more lenient development control in these areas, developers tend to prefer to start new projects in these locations. Given that the public transit connection to these areas from the core city has not kept pace with that of development, people tend to aspire for personal vehicular ownership. This puts even more pressure on the limited road infrastructure and adds to congestion, pollution and impact on health. To sum up the Pune approach to local area development control is based on core de-densification while encouraging new development on the outskirts with a transit corridor planned with higher densities running through the city.

4.2. Hyderabad

Hyderabad city is governed by the Greater Hyderabad Municipal Corporation (GHMC) [16] and accommodates 6.81 million people in an area of 650 square kilometres as of 2011 (Table 1). The city is located within the larger metropolitan area under the Hyderabad Metropolitan Development Authority (HMDA) which covers an area of 7,228 square kilometres (Hyderabad Metropolitan Development Authority 2013).

[16] The GHMC was formed in 2007 by merging the areas under the erstwhile Municipal Corporation of Hyderabad (MCH) and 12 municipalities and 8 village councils (panchayats) in Ranga Reddy and Medak districts. The MCH itself was formed in 1960 by combining the Municipal Corporations of Hyderabad and Secunderabad under the Hyderabad Municipal Corporation Act, 1955.

HMDA is the planning authority for the entire metropolitan area comprising areas under the GHMC, the Buddha Purnima Project Authority (BPPA)[17], the Cyberabad Development Authority (CDA)[18], the Hyderabad Urban Development Authority (HUDA)[19] and Hyderabad Airport Development Authority (HADA)[20] along with the extended area of HMDA. Except for the GHMC, all the other administrative authorities have been dissolved into HMDA. The GHMC exercises civic administration in the entire corporation area that includes the erstwhile MCH.

Since in Hyderabad there has been constitution of separate development authorities over the period of time, separate master plans have followed for each of these authorities. As a result, the metropolitan region has multiple Master Plans[21]. The following master plans are in force currently in Hyderabad: a) 2031 Metropolitan Development Plan 2031, for the extended Metropolitan Region (Hyderabad Metropolitan Development Authority 2013), b) Revised Development Plan 2031, for the erstwhile MCH Area (HMDA core area), c) HUDA's Revised Master plan 2020, d) HADA's Master Plan 2021, and e) CDA's Master Plan 2021. Also, the master plans for the municipal towns of Bhongiri and Sangareddy, prepared in 1989 and 1988 respectively, have been revised by the HMDA in its current Metropolitan Development Plan as these towns were included in the extended Metropolitan region.

The 2031 Metropolitan Development Plan for HMR is applicable to an area of 5,960 square kilometres comprising the extended area of HMDA including the municipal towns of Bhongiri and Sangareddy, and those areas outside and including the Outer Ring Road Growth Corridor (ORRGC) that were earlier part of the erstwhile HUDA and HADA. The HUDA, HADA and CDA master plans continue to be applicable in their erstwhile jurisdictions within the ORRGC (Figure 15). The 650 square kilometres of GHMC has the 'Revised Development Plan 2031' for the 172 square kilometres of the erstwhile MCH area, and the 'Revised Development Plan 2020' prepared by HUDA in 2003 for the remaining corporation area[22].

[17] The BPPA was formed in 2000 as a special development authority under the Andhra Pradesh Urban Areas Development Act of 1975 to develop areas around the Hussain Sagar Lake that lies in the centre of the city. It covered an area of 902 hectares under its jurisdiction.

[18] The CDA was formed in 2001 for development of areas around the HITEC city with a jurisdictional area of 52 square kilometres.

[19] HUDA was formed in 1975 under the Andhra Pradesh Urban Areas Development Act, 1975. It covered 10 municipalities in Ranga Reddy and Medak districts along with several villages making up an area of 1,348 square kilometres prior to its dissolution in 2008 when it was merged into the newly formed HMDA.

[20] HADA was formed in 2001 as a statutory body to promote development in the areas around the proposed Shamshabad international airport. It covered 70 revenue villages and 19 hamlets in the Ranga Reddy District making up an area of 458 square kilometres prior to its dissolution in 2008 when it was merged into the newly formed HMDA.

[21] Talks for a single Integrated Master Plan have been doing rounds lately (Singh 2015).

[22] The Secundrabad Cantonment area (Figure 15) is separately administered by the Secundrabad Cantonment Board (SCB).

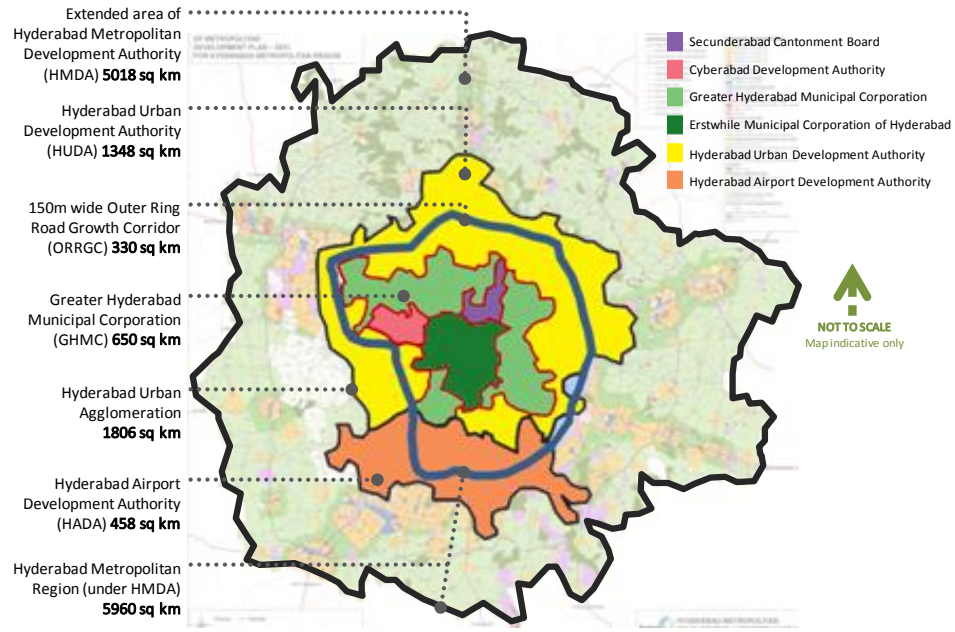


Figure 15: Hyderabad Metropolitan Region (HMR) and its constituents

Source: Hyderabad Metropolitan Development Authority, 2013

Development Plans have been prepared under the Andhra Pradesh Urban Areas Development Act 1975; however, concurrent to the creation of HMDA was enactment of a separate HMDA Act 2008 that provides as the statutory framework for the preparation of Metropolitan Development Plans by the HMDA for the metropolitan region. Meanwhile, the existing notified master plans continue to be in force.

In the urban agglomeration of the larger metropolitan region in Hyderabad, the master plans in force are- the Revised Master Plan (RMP) 2031 for MCH prevailing over the corporation area (erstwhile MCH), HUDA's2020 Master Plan over portions of HUDA inside of the ORRGC and over the GHMC area, the CDA Master Plan 2021, and HADA's 2021 Master Plan. The Metropolitan Development Plan 2031 prevails over the extended portions of the HMR[23].

Master Plans in Hyderabad aim to bring about balanced growth by discouraging growth in the already congested areas, focussing developments in newer areas and intensifying them in areas on major transport corridors(Munshi, T., Joshi, et al. 2014). At the same time, they also aim at rejuvenating the core city and at developing self-reliant growth centres in the larger metropolitan region. The major micro-planning tools employed for implementation of the development plans in Hyderabad are height regulations, TDR incentives, apart from of course, shift to zoning new land-uses.

[23] The extent of various master plans in Hyderabad are discussed in (Munshi, T., Joshi, et al. 2014). For the purpose of this study, the focus is largely kept on the master plans governing areas covering the urban agglomeration including the core city.

It has to be however noted that FSI as a parameter for building regulations was done away with in 2006 through a state legislation (G.O.Ms.No.86) whereby also, single building regulationscalled as 'Andhra Pradesh Building Rules, 2012'for the entire statewaspromulgated.Though due to this all cities in the state now have same building regulations, the DCR of the master plans in different cities can be still different in terms of strategies and implementation mechanism adopted apart from these common building rules.

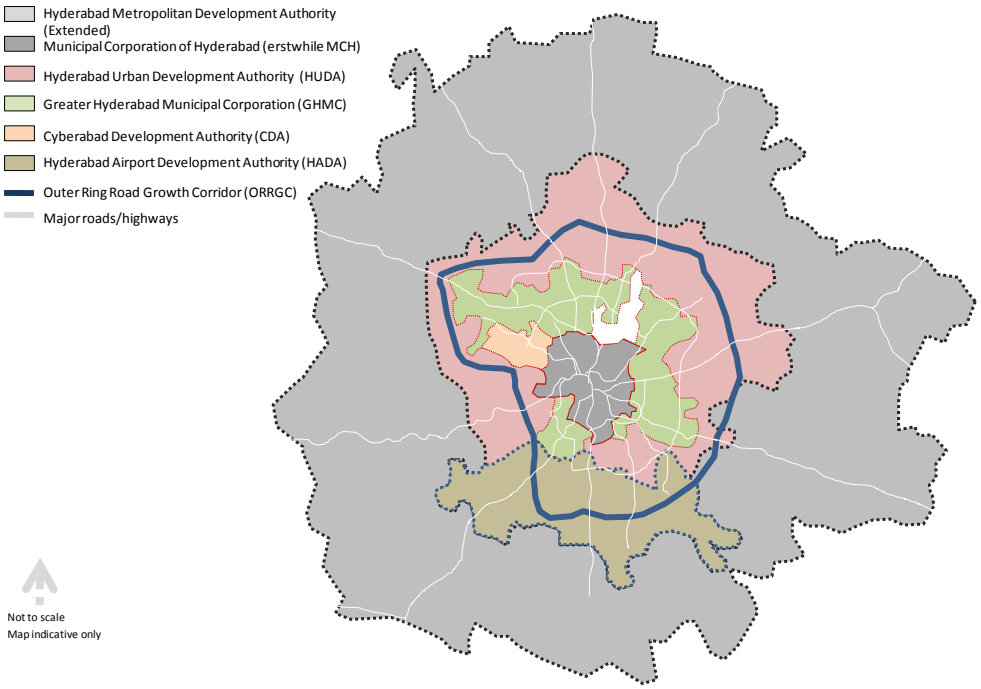


Figure 16: Image showing constituents of Hyderabad Metropolitan Region
Source: Authors

Table 5: Height regulations in Hyderabad core area

Type/Use of building plots	Abutting Road width
[A] Old/Existing Built-up areas/Congested areas/settlements	
Residential up to **10m** height Non-Residential up to **12m** height	6m
Residential up to 15m height Non-Residential up to **18m** height	9m
[B] New approved areas	
Non-high rise residential, Commercial only up to GF, basic social amenities, all up to **15m** height	≤9m
All of previous, and educational, commercial and public uses up to **24m** height	12.2m
All of previous with high level educational institutions, hospitals, shopping complexes up to **30m** height	18m
All of above with **30m- 45m** height	≥ 24m*
All of the above with building heights above **45m**	30m*

* From section 5 (table II) and section 9.6 (table IV) of Part III of the RMP 2031 for MCH area)
Source: (Hyderabad Metropolitan Development Authority 2010)

Height regulations: Following the 2012 Andhra Pradesh Building Rules, the current DCR does not consider FSI as a tool for development control but, restrictions on building height are put on the basis of plot sizes and abutting road widths(refer Table 5 and Table 6). These restrictions allow limited building in the core city as compared to the 'new development areas'[24], subject to approval from the airport authority. For the *congested* core area, a maximum building height of 15m for residential purposes and 18m for non-residential uses is allowed. However, the amalgamation provisions in the DCR for the city lead to increased plot sizes and with provision of stipulated width of approach roads, higher order of development may take place.

For high rises[25] in the entire city, the minimum plot area should be 2000sq m. For the congested areas in the city core, high rises are allowed only where the access is through an at least 30m wide road.

Table 6: Building controls based on plot sizes and road widths in Hyderabad

Sr. No.	Plot Size (sq m)	Parking provision	Permissible Height (m)	Building line or Min. front setback (m)					Min. setbacks on other sides (m)
				Abutting road width					
				Up to 12m	12m to 18m	18m to 24m	24m to 30m	Above 30m	
1	<50	-	7	1.5	1.5	3.0	3.0	3.0	-
2	50-100	-	7	1.5	1.5	3.0	3.0	3.0	-
			10						0.5
3	100-200	-	10	1.5	1.5	3.0	3.0	3.0	1.0
4	200-300	Stilt Floor	7	2.0	3.0	3.0	4.0	5.0	1.0
			10	2.0	3.0	3.0	4.0	6.0	1.5
5	300-400	Stilt Floor	7	3.0	4.0	5.0	6.0	7.5	1.5
			12	3.0	4.0	5.0	6.0	7.5	2.0
6	400-500	Stilt Floor	7	3.0	4.0	5.0	6.0	7.5	2.0
			12	3.0	4.0	5.0	6.0	7.5	2.5
7	500-750	Stilt Floor	7	3.0	4.0	5.0	6.0	7.5	2.5
			12	3.0	4.0	5.0	6.0	7.5	3.0
			15	3.0	4.0	5.0	6.0	7.5	3.5
8	750-1000	Stilt+ 1 Cellar Floor	7	3.0	4.0	5.0	6.0	7.5	3.0
			12	3.0	4.0	5.0	6.0	7.5	3.5
			15	3.0	4.0	5.0	6.0	7.5	4.0
9	1000-1500	Stilt+ 2 Cellar Floors	7	3.0	4.0	5.0	6.0	7.5	3.5
			12	3.0	4.0	5.0	6.0	7.5	4.0

[24]These are areas that do not fall into the already congested core city area. They include the newly approved layouts and undeveloped areas.

[25] In Hyderabad, a buildingwith height greater than 18m is considered asa 'High Rise'.

Sr. No.	Plot Size (sq m)	Parking provision	Permissible Height (m)	Building line or Min. front setback (m)					Min. setbacks on other sides (m)
				Abutting road width					
				Up to 12m	12m to 18m	18m to 24m	24m to 30m	Above 30m	
			15	3.0	4.0	5.0	6.0	7.5	5.0
			18	3.0	4.0	5.0	6.0	7.5	6.0
10	1500-2500	Stilt+ 2 Cellar Floors	7	3.0	4.0	5.0	6.0	7.5	4.0
			15	3.0	4.0	5.0	6.0	7.5	5.0
			18	3.0	4.0	5.0	6.0	7.5	6.0
11	Above 2500	Stilt+ 2 or more Cellar Floors	7	3.0	4.0	5.0	6.0	7.5	5.0
			15	3.0	4.0	5.0	6.0	7.5	6.0
			18	3.0	4.0	5.0	6.0	7.5	7.0

Source: Andhra Pradesh Building Rules, 2012

Additionally, the DCR has a provision of levying what is called 'City level Impact Fees' on buildings with height greater than 15m. Rates of these fees could be seen in Table 7 below.

Table 7: City level Impact Fees in Hyderabad

Areas	Height (No. of floors), Building Use and Rate (Rs. Per sq. m. of built-up area)							
	Above 15m up to 7 floors		Above 7 floors up to 10 floors		Above 10 floors up to 17 floors		Above 17 floors	
	Residential	Commercial, Offices, ITES, Institutional Educational & Others (except industrial)	Residential	Commercial, Offices, ITES, Institutional Educational & Others (except industrial)	Residential	Commercial, Offices, ITES, Institutional Educational & Others (except industrial)	Residential	Commercial, Offices, ITES, Institutional Educational & Others (except industrial)
HMDA area								
GHMC	500	1000	750	1500	1500	2500	3000	5000
Municipalities	250	500	500	1000	1000	2000	2000	4000
G.P. areas	175	250	350	500	750	1000	1500	2000
UDA areas								
Municipal Corporations	350	500	500	1000	1000	2000	2000	3000
Rest of UDAs	175	350	350	500	750	1000	1500	2000
Other than UDA area								
Municipal Corporations	350	500	500	800	1000	1500	2000	2000
Municipalities Sel/Spl/1st grade	150	350	250	500	400	1000	800	1500
2nd/3rd/N.Ps/G.Ps	100	200	200	300	300	500	500	1000

Source: Andhra Pradesh Building Rules, 2012

In HADA's 2021 Master Plan area, as discussed in (Munshi, T., Joshi, et al. 2014), High Promotion Zone (HPZ), Medium Promotion Zone (MPZ) and Low Promotion Zone (LPZ) also dictate permissible building heights (referTable 8).Here, premium on additional floors is applicable and allowed through trading of Transfer of TDR from elsewhere. Along with this, various types of uses are regulated by permitting them only on certain road widths, mandating a minimum road width of 12.2m in most cases, and allowing majority of uses up to roads 36m wide. For instance, in HPZ, while general residential developments can come up anywhere, apartment complexes are allowed only on roads with more than 12.2m access. Schools, colleges and other educational institutions, as well as service establishments, garages, workshops, dispensaries and other medical facilities are all allowed on at least 12.2m roads but not on roads more than 36m. Regulations for MPZ and LPZ are designed in similar fashion. In fact, for LPZ, the DCR for HADA spells out minimum plot area requirements at 1000sqm for all developments with a cap of 20% ground coverage, where the remaining area should be developed as green landscapes. Minimum plot area specifications are also given for various uses, in the DCR.

Table 8: Height restrictions in erstwhile HADA area

Zone	Free Height	Total Height
HPZ	10m	No restriction
MPZ	10m	15m
LPZ	6m	N.A.

Source: (Hyderabad Urban Development Authority 2003)

Multiple land-uses along major transport corridors: The Development plan for MCH eyes at having intensive use of land along major public transit routes and at transit stations. For this, the DCR allows for multiple land-uses within 300m on either side of the MRTS routes as well as around major public transit stations. However, multiple uses are allowed only on plots with access of at least 12m wide roads and with certain a minimum area (500sq m for GHMC circles IV & V, 1000sq m for circles VIII, IX & XVIII); with which a 6m building line will have to be maintained along the routes. Multiple uses are also made permissible at transit/transport stations such as Bus depots and bus stations, subject to a proportion (5% of the total built up area or, 10% of the plot area) of land being handed over free of cost to GHMC for facilitating area-level public facilities.

However, this plan apparently limits itself to allowing for intensive use of land along the corridor and remains silent on further levels of planning provisions required to make its approach to transit oriented development successful, something that can be seen in the LAP efforts for the TOD development in Ahmedabad. The entire stretch of the ORRGC, a strip of 1km on either side of the Outer Ring Road (ORR),

amounting to an area of almost 330sq.km, more or less[26], is a mixed-use zone that develops as a transit-oriented zone. The HMR Metropolitan Development Plan 2031 also plans a dedicated public (rapid) transit along this road with feeder services to the interiors of the larger metropolitan area.

Amalgamation/Subdivision strategies: Under the amalgamation strategy of the current master plan, owners of smaller sized plots that lay adjacent can come together to create larger plot sizes that can allow for higher build forms, where of course, appropriate approach widths will also have to be provided.

Amalgamations of plots is allowed at all places in the city provided they have access with a minimum width of 6m for 500sq m plots, 9m for 1000sq m plots and 12m for the larger plots. Amalgamation of plots leading to sizes greater than 4000sq m, and with a minimum access of 18m is, in fact, promoted[27], allowing multiple uses in such plots.

Subdivision of plots is regulated according to which part in the city it lays. In the congested areas is allowed up to 50sq m sizes, provided a minimum access of 3.6m is maintained. For other areas, plots can be subdivided up to 80sq.m sizes but they will be required to have an access of at least 6m.

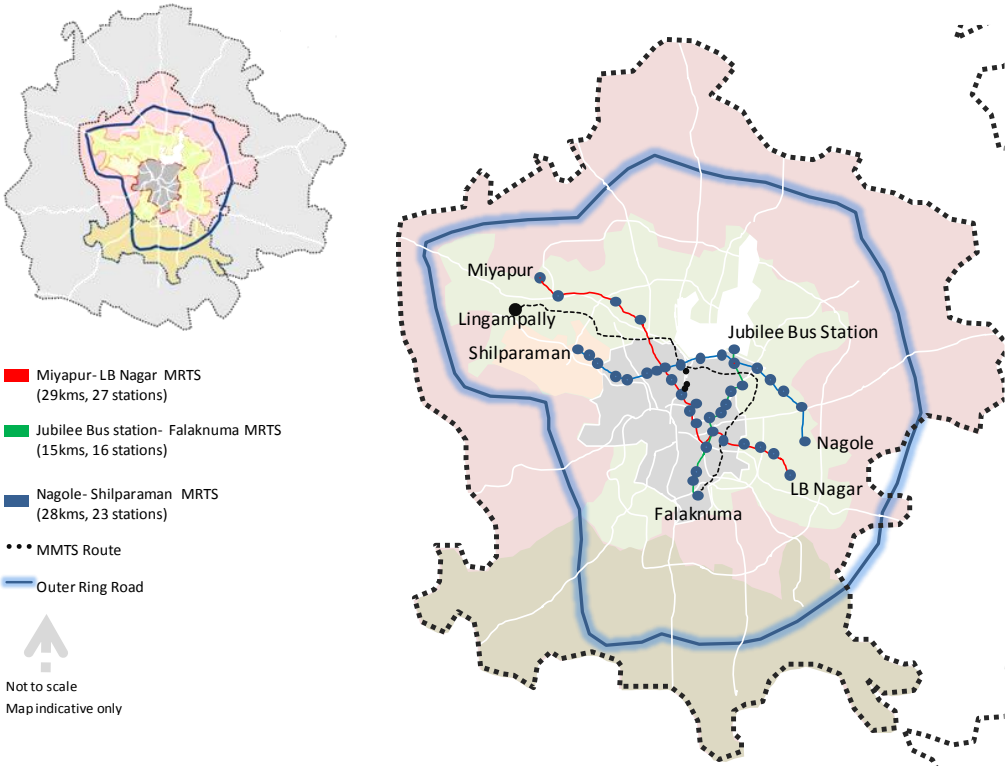


Figure 17: Major transit corridors in Hyderabad for Integrated Land Use Transport
Source: Authors

[26]Excluding area under land-uses for transit and conservation, most of the land-use in the ORRGC is mixed-use and is called Multipurpose-use zone. This zone is also called Special Development Zone.
[27]GHMC gives concession on fees for approval of layouts for mixed use developments in such plots.

TDR incentives for development as well as conservation: The TDR mechanism for road-widening purposes has been in accordance with the state's 2012 building rules and it has been the primary mode of implementation for the road-widening agenda in the city even before the current master plan. However, the current master plan adopts the TDR-mechanism for additional purposes of heritage conservation.

In the core city (read: GHMC area), plots surrendering portions of their land for road widening purposes free of cost get a permission to build an extra floor or can even choose to otherwise get a TDR of 150% and rebuild the building structure.

The current master plan adopts TDR mechanism for its policy of ecology and heritage conservation by granting a TDR of 50% of the built-up area to developers/owners who maintain heritage precincts and recreational buffer areas.

The HADA Master Plan 2021, on the other hand uses TDR to implement the area level infrastructure and other amenities proposed in the master plan. It grants a TDR of 25% of built up area to the developer for undertaking the proposed roads, 5% for undertaking sector level amenities and open spaces, and 10% for developing recreational buffer spaces along the recreation-cum-afforestation tracts earmarked along the HimayatSagar foreshores in the Master Plan. A TDR of 5% of the built-up area is also granted for development of corporate farming, horticulture, floriculture, biotechnology and other such non-polluting recreation-based activities in the Bio-Conservation zone earmarked in the Master Plan.

Restriction on development for Ecological Conservation: No development activities are allowed in the ecologically fragile zones in the city. The RMP for MCH identifies such areas as hillocks and rocks and notifies them for conservation. The DCR for HADA allows no developments except for agriculture, hi-tech agriculture and allied activities in the Bio-Conservation zone laid down in its Master Plan.

Encouragement for provision of parking complexes: Parking requirements are kept 10% higher for the MCH area as compared to the rest of the urban areas. Parking complexes, enclaves and lots are encouraged by giving a TDR incentive of an equivalent built-up area to the developer, apart from incentivizing them in terms of development fees and charges. This applies also to the HADA area.

Micro-level area planning: The RMP 2031 for MCH envisages Special Area Development Projects (SADP) at various locations spread across the city for detailed planning and urban renewal focussing on heritage, infrastructure upgradation and environmental aspects [28] .On a micro-level, Infrastructure and Facility Nodes (InFANS) are also identified by this master plan at various locations across the city (HMDA core area). These locations are to function primarily as nodes for public facilities, parking lots, bus terminus, police stations, fire stations, emergency service centres and other multipurpose public facilities for the city. The plan also talks about

[28]Details into the workings on SADP can be known only after they are prepared and published by the local authority.

separate preparation of architectural and façade control regulations for certain heritage zones.

Land Pooling mechanism as a micro-planning tool has been adopted by the master plans of both HADA (for its entire area), as well as HUDA (new areas). However they differ from the land-pooling mechanisms practiced in, say, Ahmedabad, in terms of the planning process as well as the statutory standing[29]. They can be proposed by either the authority itself or by a private (empanelled) developer. In HUDA, Land Pooling schemes need to have a minimum area of 20ha whereas the HADA Master Plan requires them to be at least 40 ha in size.

Experts' views: A visit to the city was made as a part of this research project in April 2015 during which planning professionals from the authorities, academicians, civil society representatives and private architects were talked to for a better understanding of the master plans in the city. The list of people that were met in the city could be seen in Annexure-A (Table A2) at the end of this report.

The salient issues/view-points coming forth from these meetings are discussed below:

- **Implementation of Master Plan and the influence of the state government**: It has been said that, generally, only around 10% of what a city's Master Plan proposes gets implemented. Of the various reasons that this happens, one of the concerns is the extent of influence that the (state) government has in the city; particularly when its proposals are beyond what the city's master plan proposes. The present state government in Telangana, it was informed, has proposed to spend Rs.16000 crores to build multi-level fly-overs at various locations in the city as a part of their urban development expenditure from the annual budget[30]. These fly-overs are neither proposed in the Master plan nor are suggested by the Comprehensive Transportation Study (CTS) that the authority undertakes to inform its master plan. Experts say that there have also been talks about developing portions of the green areas surrounding the HussainSagar Lake for building purposes which, if done, would be in clear defiance of the Master Plan's policy of conserving areas around the city's lakes. It was pointed out that since the Chief Minister is the President and the Minister for Urban Development, the Vice President of the HMDA, they will continue to have influence over what happens in the city.

  The influence of the state government on what happens to plans in the city can also be seen in the vigorous push for the metro rail amidst presentations by the civil society in Hyderabad against it. The existing MMTS was doing quite well; and even a BRTS, which had been supported by the CTS revealing it to be cheaper and more

[29]Land Pooling mechanism, used for planning Town Planning Schemes in, say Ahmedabad, goes through a process of being sanctioned from the state government and public consultation whereas in Hyderabad, the authority sanctions the schemes.

[30]Though a separate issue in the present context, it was also pointed out that the urban development expenditure in the newly formed state was proposed only for Hyderabad, ignoring other cities in the state.

suitable for the city, could have been worked out for the city, a prominent academician shared. He opined that the metro rail has been thrust upon the city in an undemocratic manner and a more cost-effective MMTS is being ignored completely with only phase-I of the project completed till now.

- **Finances and implementation:** The 2008 HMDA Act mandates preparation of a Metropolitan Investment Plan which has to be submitted along with the main DP document during the sanctioning process. It spells out the investment to be made for the implementation of the development plan and phases it out across the entire plan period. Since this would be a statutory document too, implementation could be ensured. However, the current MDP was submitted and sanctioned without the investment plan. An official who had worked on the development plan revealed that the recent talks about a single unified development plan for the entire HMDA area was spurred after the new state government recently requested the total investment cost for the entire HMDA area.

  So while there's a statutory investment plan in Hyderabad, there's also another innovation regarding augmenting revenues for the city infrastructure in the form of 'city-level impact fees' discussed earlier. Experts unanimously say, this has increased the capacity of the city to fund the infrastructure. According to the Building Rules, the income generated from these fees should be put into an escrow account and 50% of the amount has to be used for infrastructure expenditure of the area from which the fees are collected. However, it is said, this is not strictly followed by the authority.

- **Preparation of Master Plan and public consultation:** Even though, under the 1975 Andhra Pradesh Urban Areas Development Act as well as under the new 2008 HMDA Act, a master plan has to be put for public consultation before being submitted to the government for approval, the process of public consultation followed is, as planning professionals suggested, weak and not of much consequence. However the view from the authority is that the plan preparation process mandated under the 2008 HMDA Act has definitely given due attention to public views on the plans prepared by HMDA, which they describe as comprehensive with the period of consultation extending over a few months[31].

  Also, it was added that even while a Community Participation Law was incorporated in the corporation act in Hyderabad[32], something that the city takes pride in for being one of the earliest to do it, it doesn't have any significant consequence on the Master Plans in the city.

[31]The 2008 HMDA Act mandates a period of one month for keeping the draft Development Plan open to public scrutiny.

[32]Community Participation Law was introduced into the Hyderabad Municipal Corporation Act, 1955 through an amendment by the Andhra Pradesh Municipal Laws Act in 2008.

Figure 18: Image showing the project team at various meetings in Hyderabad
Source: Authors

- **The push for metro-rail**: More than 20 cities in the country are currently either building or planning to build metro-rail systems(Rahul and Geetam 2014). While debates questioning the validity of making huge sums of investment of metro-rail in the city in favour of more efficient modes of public transport prevail, a leading transport-planner in the city postulated that metro-rail system is inevitable and required in any large city owing to the fact that a city can have only limited amount of space for public transport on the ground after which providing additional space for public modes for transportation could only be either under-ground and/or over the ground.

- **Removal of FSI regulations:** Removing FSI regulations has made housing affordable in the city. One key informant who had been pivotal to creation of the new state-wide building rules, initially referred to as G.O. No.86, that did away with considering FSI as a tool for development control said, Hyderabad is today one of the cheapest cities to buy house[33]. This, he explained, is owing to the removal of FSI

[33]("Buying a house? Look beyond the top four metro cities" 2014) could also be referred.

regulations and due to the new building height regime under which taller buildings could be built, augmenting supply and hence bringing the prices down[34].

- **Sustainability and energy efficient buildings**: From sustainability point of view, the otherwise voluntary Energy Conservation Building Code (ECBC) for energy-efficient buildings promulgated by the Union government has been made mandatory to obtain development permission for all non-residential buildings with plot areas more than 1000sqm or with built-up areas more than 2000sqm in the city. With this, building plans will now have to be certified by any architect/environment professional who is empanelled in the authority for this purpose.

Summary: Master Plans view 'sustainability' mainly as about conserving the natural heritage/ environment viz. lakes, forests etc. Focus on other aspects such as efficient transit oriented mixed land-use has come up in the recent master plans, like in many other city master plans in the country. Both of these approaches can be seen in Hyderabad's current master plans. Although introducing the ECBC guidelines for building regulations was not a proposal made in the master plans, it is an additional measure towards sustainability that Hyderabad is taking now.

With regards to spatial growth, the approach of the master plans in Hyderabad, as admitted in the plan documents, is to encourage development, but away from the core city. However the current development control regulations with a liberalized building height regime are not clear as to how this strategy can be implemented to produce the desired result. Moreover the practice of road-widening through TDR incentive, coupled with provisions enabling amalgamation, will lead to redevelopment resulting in higher order built-forms even in the central parts of the city. Hence, with this there is a potential for increase in density in the same areas which the master plan wants to de-congest, or at least not further congest. Also, the said push for growth on the outside, especially along the outer ring road can very well induce sprawl. Plans to build multiple over-bridges in the city indicates impractical approach to easing traffic congestion despite a now widely known fact that it such measures only foster more traffic.

However, amidst these issues, there have been a few urban planning innovations that have been adopted towards implementing their plans, which have been working well in the city. The TDR mechanism for road-widening has been very successful in Hyderabad. With no FSI regulations and a liberal building height regime, the real-estate market is the cheapest in the city among all the metros in India. Acquiring land worth 5% of the plot area or 10% of the built-up area for every mixed-use development has made it easier for the authority to have spaces in the public realm for public utilities, thus supporting the intensive use of land in

[34]The lowering down of the housing market rates was also additionally attributed to the recession of 2008 when the demand nose-dived creating a hugely over-supplied real-estate market that time. However, prices have since then more-or-less normalized and they're still lower than any other city in the country.

those areas. Such innovations could be very-well studied for adoption by other cities.

4.3. Bengaluru

Bengaluru is the largest city in Karnataka and is the fourth most populous city in India with a population of 8.43 million and area of 741 square kilometres. It is administered by the Bruhat Bengaluru Mahanagara Palike (BBMP). It forms part of the Bangalore Metropolitan Area (BMA) which has a combined population of 8.49 million and area of 1,320 square kilometres. The Bangalore Development Authority (BDA) is responsible for planning and development functions in BMA. Its stated vision is to 'plan, regulate, control, monitor and facilitate urban development in BMA, to ensure sustainable and orderly growth' (Bangalore Development Authority 2015). The BDA uses the 2015 Revised Master Plan for Bangalore (2007b) to regulate and facilitate urban development in the area under its jurisdiction. In addition, the Bengaluru Metropolitan Region Development Authority[35] (BMRDA) plans and coordinates development in the Bengaluru Metropolitan Region (BMR) measuring 8,005 square kilometres comprised of Bengaluru urban, Bengaluru rural and Ramanagara districts (Table 9). As of 2011, some 10.70 million people live in the BMR. The BMRDA aims at integrating development in the BMR through the 2031 Revised Structure Plan[36] (2013). Planning in areas outside the BMA (but within the BMR as shown in Figure 19) is undertaken in accordance with the provisions of the Karnataka Town & Country Planning Act, 1961.

The master plan for Bengaluru (2007a) has set its objectives towards urban integration, promotion of mixed use, creation of adequate housing stock, and development of a 'networked' city among others. The urban form of Bengaluru is characterised by a radio-concentric system formed of ring roads, five major radial roads and five secondary radial roads (Figure 20). Along these roads is located Bengaluru's major industrial and commercial development. Major developments in the context of Bengaluru include the international airport, Bengaluru-Mysuru corridor; Information Technology Enabled Services (ITES) based development along Hosur road and large-scale manufacturing in the east and north of the city. Various institutions involved in the realm of urban planning and service provision include the Bruhat Bangalore Mahanagara Palike (BBMP), Bangalore Development Authority (BDA), Bangalore Metropolitan Region Development Authority (BMRDA), Bangalore Water Supply and Sewerage Board (BWSSB), Bangalore Electricity Supply Company (BESCOM), Bangalore Metropolitan Transport Corporation (BMTC) and Karnataka Industrial Area Development Board (KIADB) among others. For a comprehensive listing of various agencies and their roles, please refer to Table B-1

[35] The BMRDA was created in 1985 by the Government of Karnataka through the BMRDA Act, 1985 as an autonomous body for coordinating the development of the metropolitan region. It is therefore a contemporary of the National Capital Region Planning Board (NCRPB) constituted in the same year.

[36] A structure plan is a regional level perspective plan supporting a long term vision for development and related spatial perspective for integrated development in the area. The 2031 Revised Structure Plan for BMR aims at achieving synergy between socio-economic and spatial planning in the region.

(Appendix-B). A discussion on the roles of BBMP, BDA and BMRDA are presented in Munshi et al. (2015) as well as Sudhira et al. (2007). The 2015 master plan (Bangalore Development Authority 2007a, 2007b) was prepared by BDA and uses tools like zoning, FAR (same as FSI), setbacks, coverage and TDR towards regulating urban development in the Bengaluru Metropolitan Area (BMA).

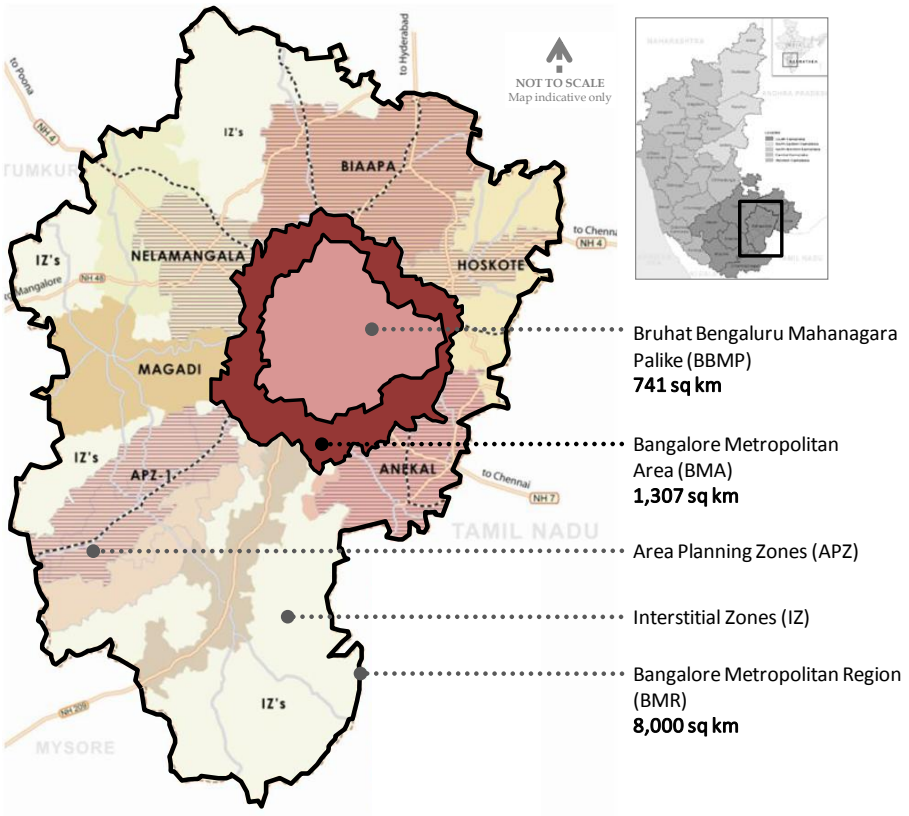


Figure 19: Bengaluru Metropolitan Region and its Constituents

Source: Groupe SCE India Pvt. Ltd. 2013

Table 9: Authorities functioning in Bengaluru Metropolitan Region

Sl. No.	Authority	Area (sq km)
1.	Bangalore Development Authority	1,220
2.	Bangalore-Mysore Infrastructure Corridor Area Planning Authority	426
3.	Ramanagar-Channapatna Urban Development Authority	63
4.	Anekal Planning Authority	402
5.	Nelamangal Planning Authority	735
6.	Magadi Planning Authority	502
7.	Hosakote Planning Authority	535
8.	Kanakapura Planning Authority	413
9.	Bangalore International Airport Area Planning Authority	792
10.	Area Planning Zone-1[37]	463

[37] Area Planning Zones (APZs) are where urban development is allowed subject to certain regulations.

Sl. No.	Authority	Area (sq km)
11	All Interstitial Zones in Bangalore Metropolitan Region[38]	2,455
	Total area under Bengaluru Metropolitan Region	8,005

Source: Bangalore Metropolitan Region Development Authority 2015

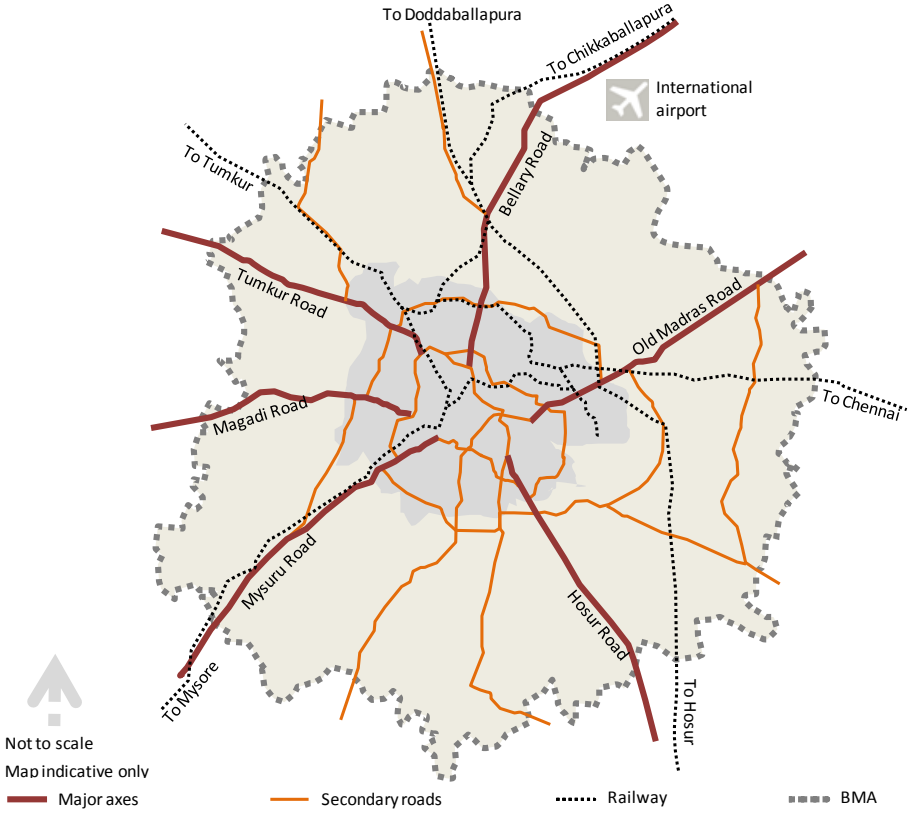


Figure 20: Existing major road and rail network in BDA area
Source: Authors

As part of the development control regulations, several codes have been used including residential [39] (R), commercial [40] (C-1 to C-6), Industrial [41] (I-1 to I-4), transportation[42] (T-1 to T-4) and public semi-public[43] (U-1 to U-4). Presented below

[38] The Interstitial Zones (IZs) are areas lying between APZ's where urban activities are restricted giving more emphasis to environmental issues like conservation of forest area, agriculture etc.

[39] Plotted residential development, villas and semi-detached houses, apartments and hostels, multi-dwelling housing and group housing form part of this category.

[40] C-1: petty shops, professional offices; C-2: eateries, banks, retail plus C-1; C-3: commercial and corporate offices plus C-1, C-2; C-4: warehouses, junkyards plus C-1, C-2, C-3; C-5: Heavy goods markets, *mandis* and C-1 to C-5.

[41] I-1: household industries; I-2: service industries plus I-1; I-3: light industries plus I-1, I-2; I-4: medium industries plus I-1, I-2, I-3; I-5 heavy industries plus I-1, I-2, I-3, I-4.

[42] T-1: bus bays, metro stations, filling stations; T-2: transport office, workshops plus T-1; T-3: bus terminals, godowns plus T-1, T-2; T-4: warehouses, railway stations plus T-1, T-2, T-3.

[43] U-1: police stations, post offices, parks, primary schools, religious worship places; U-2: burial grounds, nursery schools plus U-1; U-3: hospitals, residential schools, colleges plus U-1, U-2; U-4: meteorological observatories, airports plus U-1, U-2, U-3.

are the setbacks that are meant to be followed by buildings based upon their height irrespective of which land use or zone they fall under.

Table 10: Setbacks buildings with height up to 11.5 m and plot size up to 4000 m^2

Width/Depth	Front side	Rear side	Right side	Left side
6 m and below	1 m	0	1 m	0
9 m > x > 6 m	1 m	1 m	1 m	1 m
9 m and above	12 %	8 %	8 %	8 %

Source: (Bangalore Development Authority 2007b)

Table 11: Setbacks for buildings above 11.5 m height

Building height	Minimum setbacks on all sides
15.0 m > x > 11.5 m	5 m
18.0 m > x > 15.0 m	6 m
21.0 m > x > 18.0 m	7 m
24.0 m > x > 21.0 m	8 m
27.0 m > x > 24.0 m	9 m
30.0 m > x > 27.0 m	10 m
35.0 m > x > 30.0 m	11 m
40.0 m > x > 35.0 m	12 m
45.0 m > x > 40.0 m	13 m
50.0 m > x > 45.0 m	14 m
50 m and above	16 m

Source: (Bangalore Development Authority 2007b)

FAR: The FAR regulations in Bengaluru vary according to the zone the property falls under such as residential (main), residential (mixed), commercial (central), commercial (business), mutation corridors, commercial axes, industrial, public semi public and transportation.

Residential (main): The areas of the city which have predominantly residential land use pattern is considered for the residential (main) zone. This includes many old areas of the city such as parts of Malleswaram, Richmond Town, Vasant Nagar, Jayanagar, Vijayanagar, Visveswarapura, and Rajajinagar. The main land use in this zone is residential (R) and transportation (T-1). Ancillary land use permitted to tune of 20% of the total built up area or 50 m^2 whichever is higher include commercial (C-2), industrial (I-2) and public/semi-public (U-3). Parking provision is exempted for buildings with area less than 100 m^2. The FAR regulations in this zone are given below:

Table 12: FAR and ground coverage in residential (main)

Description of abutting road	Min plot size (m^2)	Max ground coverage (%)	FAR
30 m and above	4,000 to 20,000	50	3.25
30 m > x > 24 m	2,000 to 4,000	55	3.00
24 m > x > 18 m	1,000 to 2,000	60	2.50
18 m > x > 12 m	360 to 1,000	65	2.25
12 m and below	360 and below	75	1.75

Source: (Bangalore Development Authority 2007b)

Residential (mixed): Main features of mixed use areas are those where employment, shopping and residential land uses will be integrated in a compact urban form, at higher development intensities and will be pedestrian-oriented and highly accessible by public transit. The main land use in this zone is residential (R). Ancillary land use permitted to tune of 30% of the total built up area includes commercial (C-3), industrial (I-2), transportation (T-2) and public/semi-public (U-4). Parking provision is exempted for buildings with area less than 100 m^2. The FAR regulations in this zone are given below:

Table 13: FAR and ground coverage in residential (mixed)

Description of abutting road	Max ground coverage (%)	FAR
30 m and above	50	3.25
30 m > x > 24 m	55	3.00
24 m > x > 18 m	60	2.50
18 m > x > 12 m	65	2.25
12 m and below	70	1.75

Source: (Bangalore Development Authority 2007b)

Commercial (central): The historic commercial core comprising of Petta area such as Chickpet, Cubbonpet, Cotton pet, and parts of Shivajinagar around the Russell Market area forms this area. The main land use in this zone is commercial (C-4). Ancillary land use permitted to tune of 30% of the total built up area includes residential (R), industrial (I-3), transportation (T-3) and public/semi-public (U-4). A maximum FAR of 2.5 may be used with a ground coverage ceiling of 75 per cent. Parking provision is exempted for buildings with area less than 100 m^2. Setbacks are relaxed (except front) on plots with an area less than 150 m^2. For plots with an area between 150 $m^2$and 500 m^2 no setbacks are needed on the rear and sides.

Commercial (business): This zone comprises of areas in between MG Road, Brigade Road, Residency Road, Madras Bank Road and St Marks Road and also areas between the traffic island of Mayo hall, Magrath Road and Residency Road, Manipal Centre between MG Road and Ulsoor Road. The main land use in this zone is commercial (C-3). Ancillary land use permitted to tune of 30% of the total built up area includes residential (R), industrial (I-3), transportation (T-3) and public/semi-public (U-4). The FAR regulations in this zone are given below:

Table 14: FAR and ground coverage in commercial (business):

Description of abutting road	Max ground coverage (%)	FAR
30 m and above	40	3.25
30 m > x > 24 m	40	3.00
24 m > x > 18 m	45	2.50
18 m > x > 12 m	50	2.25
12 m > x > 9 m	50	1.75
9 m and below	55	1.50

Source: (Bangalore Development Authority 2007b)

Mutation corridors: The radial corridors and main arterial roads are designated as mutation corridors. Plots facing the mutation corridor must have a minimum frontage of 12 m. There is an incentive for smaller plots to amalgamate. The main land use in this zone is commercial (C-4). Ancillary land use permitted to tune of 30% of the total built up area includes residential (R), industrial (I-3), transportation (T-3) and public/semi-public (U-4). The FAR regulations in this zone are given below:

Table 15: FAR and ground coverage in mutation corridors

Description of abutting road	Max ground coverage (%)	FAR
Above 30 m	50	3.25
30 m and below	55	2.75

Source: (Bangalore Development Authority 2007b)

Commercial axes: The major and minor roads which have commercial activities along them are recognized as commercial axes. As these are part of the residential zone through which they pass and the regulations applicable shall be that of the main zone in which they are located with an exception to the permissible land uses of commercial axes. If the plot size is more than 240 m^2 and faces a road of width up to 15 m, C-2, I-2 and T-2 uses in addition to uses allowable in the respective zone are permissible. If the plot size is more than 240 m^2 and faces a road width 15 m and above, C-3, T-2 and I-2 uses in addition to uses allowable in the respective zone are permissible. The FAR and coverage for commercial axes will be same as that of the table for the surrounding zone that it passes through.

Industrial (general): The main land use in this zone is industrial (I-5). Ancillary land use permitted to tune of 10% of the total built up area includes residential (R), commercial (C-4), transportation (T-3) and public/semi-public (U-2). The FAR regulations in this zone are given below:

Table 16: FAR and ground coverage in industrial (general)

Min plot size (m^2)	Max ground coverage (%)	FAR	Front setback	Rear and side setback

Above 3000	45	1.00	10.0	8.0
1,000 to 3,000	50	1.00	6.0	6.0
500 to 1,000	60	1.25	4.5	4.5
500 and below	75	1.50	4.5	4.5

Source: (Bangalore Development Authority 2007b)

Industrial (hi-tech): This is a priority area for establishment of activities associated with new technologies: IT, IT Enabled Services, biotechnology, electronics, telecom and other emerging areas and as well as services sector. The main land use in this zone is industrial (I-3). Ancillary land use permitted to tune of 40% of the total built up area includes residential (R), commercial (C-3), transportation (T-2) and public/semi-public (U-4). The FAR regulations in this zone are given below:

Table 17: FAR and ground coverage in Industrial (hi-tech)

Description of abutting road	Min plot size (m^2)	Max ground coverage (%)	FAR
30 m and above	6,000 to 12,000	45	3.25
30 m > x > 24 m	4,000 to 6,000	45	3.00
24 m > x > 18 m	2,000 to 4,000	50	2.50
18 m > x > 12 m	1,000 to 2,000	50	2.25
12 m and below	1,000 and below	55	2.00

Source: (Bangalore Development Authority 2007b)

Table 18: FAR and ground coverage for flatted industries over 12,000 m^2

Description of abutting road	Max ground coverage (%)	FAR
30 m and above	45	3.25
30 m > x > 24 m	45	3.00
24 m > x > 18 m	50	2.50
18 m > x > 15 m	50	2.25
15 m > x > 12 m	55	2.00
12 m > x > 9 m	55	1.75
9 m and below	60	1.50

Source: (Bangalore Development Authority 2007b)

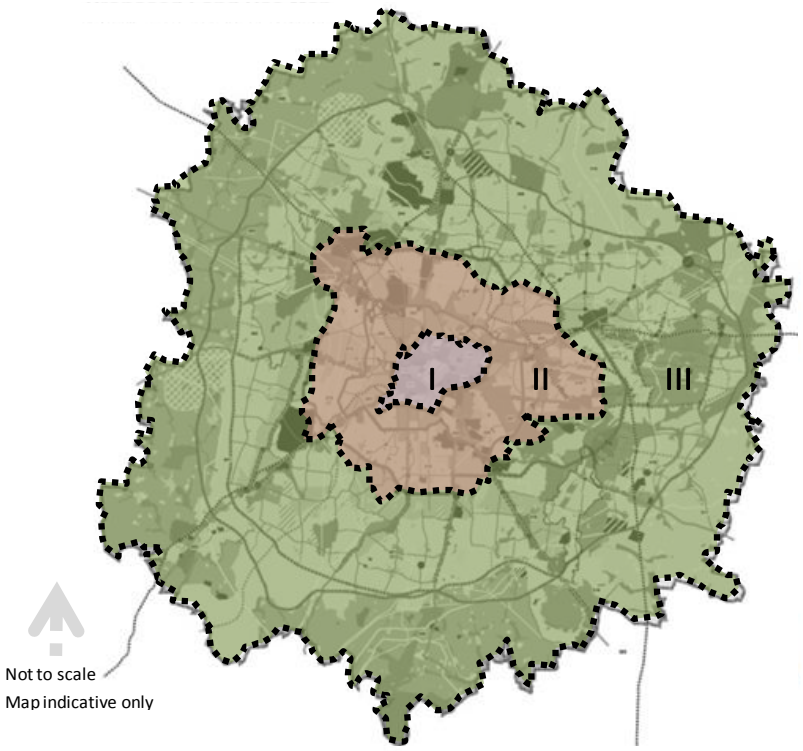


Figure 21: Development rings in Bangalore Development Authority area
Source: Authors

In addition to the FAR regulations above, the BDA incentivises development in the core area as per Figure 21 by providing for additional FSI as shown in Table 19.

Table 19: Additional FAR proposed to intensify development in core area

Ring	Up to 360 m^2	360 m^2 < x < 4000 m^2	Above 4000 m^2
Ring 1	As per existing FAR	0.25 additional FAR	0.50 additional FAR
Ring 2	As per existing FAR		0.25 additional FAR
Ring 3	As per existing FAR		

Source: (Bangalore Development Authority 2007b)

Areas which fall within 150 m radius from the metro terminals shall be eligible for a maximum FAR of 4 for all permissible uses, irrespective of the FAR applicable for the respective uses in the respective tables. However, this will be applied only after the completion of the metro stations.

TDR: As in Pune, when the local development authority would like to acquire a private property for public purposes such as road widening, an incentive is offered to the land owner to transfer the land free of cost to the authority free of all encumbrances. As part of this incentive, the land owner may be issued Development Rights Certificate (DRC)[44] to use development rights equal to the tune

[44] DRCs are valid for a period of five years and contain details of the floor area credit in square meter of built up area and the area to which the owner of the surrendered land is entitled shall be stated in figures and words. The description of the land from where development rights are generated and the land use zone of the same are also stated in DRC.

of one and a half times the surrendered area anywhere in the local planning authority's ambit. He/she may also sell these rights to anyone he wishes to. This incentive goes by the name of Transfer of Development Rights (TDR). In case of Bangalore LPA, if the additional floor area is transferred to another plot, FAR of the receiving plot is allowed to be exceeded by not more than 0.60 times of the existing FAR, provided the receiving plot abuts a road width of 12 m and above; if the receiving plot abuts a road width of 9 meters to 12 meters, then a maximum of 0.40 times the existing FAR is allowed. Contrary to Table 19, there is an incentive here to claim DRC from areas under Ring 1 and utilise them in the outer rings as shown in Table 20.

Table 20: Multiplication factors for TDR generated and utilised in various zones

DRC Generating zone	DRC Utilization Zone		
	Ring 1	Ring 2	Ring 3
Ring 1	1.00	1.50	2.00
Ring 2	0.67	1.00	1.33
Ring 3	0.50	0.67	1.00

Source: (Bangalore Development Authority 2007b)

Parking: The parking provisions prescribed by the master plan are liberal given the magnitude of the parking problem in Indian cities. All parking provided on the ground floor with the building on stilts is exempt from FAR calculation. Ramps and elevators built to the parking areas are also exempt from FAR calculation but have to be within plinth area of the building. Multi-Level Car Parking (MLCP) is exempt from FAR and height restrictions except when in conflict with airport and fire department restrictions. Table 21 shows parking requirements prescribed for various land use.

Table 21: Parking requirements for various uses

Description of abutting road	One ECS for every
Residential units	Dwelling unit measuring more than 50 m^2 up to 150 m^2 of floor area. Additional 1 car park for part thereof, when it is more than 50% of the prescribed limit. If area less than 50 m^2 one car parking for every two Dwelling units.
Retail business, office buildings	50 m^2
Multiplex and shopping mall	40 m^2
Restaurants	75 m^2
Star hotels	2 rooms. Additional 10 % for visitors.
Theatres and auditoriums	25 seats subject to a minimum of 20 parking spaces.
Industrial	100 m^2 plus 1 lorry space for every 1,000 m^2.
Hospitals	100 m^2
Nursing homes	50 m^2

Educational buildings	150 m^2
Other public semi-public buildings	100 m^2

Source: (Bangalore Development Authority 2007b)

Summary: The 2015 master plan for Bengaluru has taken some steps that appear to be aiding sustainable development. Opening up of more land in the western part of the city for IT related development is aimed at reducing the need for people to travel from various parts of the city to the IT hub in the south-east. Similarly, by encouraging mixed use development the master plan aims at reducing trip rates across the city. Recognizing that parking is a major issue, the master plan places the responsibility on the builders and developers to account for the parking spaces of the cars and other traffic that they might attract. However, no steps have been conceived that could disincentivise the use of private motorised modes themselves. The setbacks specified in the development control regulations are based on percentage parts of the width and depth of the site instead of the traditional slabs. This appears to make more sense from the point of rationality. The master plan also incentivises redevelopment of the core city by offering additional FAR for new projects in the core city. At the same time, TDR has been used as a method to acquire lands for public purposes without prolonged legal battles. There is an incentive for TDR users to move to the outer rings of the city. This is done with a view to de-densify the core city. The provision of extra FAR (up to 4) around metro stations is also aimed at intensifying development along the proposed metro rail project. The jury is still out on the equity aspects of such FAR provision. Literature points to the gentrifying aspects of transit oriented development. Overall, the master plan for Bengaluru follows the recently popular model of car-driven development which is expected given the status of Bengaluru as the IT capital of India.

4.4. Ahmedabad

Ahmedabad is the largest city in Gujarat with a population of 5.57 million in an area of 450 square kilometres (Registrar General of India 2011). The Ahmedabad Municipal Corporation (AMC) was established in 1950 under the Bombay Provincial Municipal Corporation (BPMC) Act, 1949. In the year 2008, around 180 square kilometres in the west and 80 square kilometres in the east were added to the city, bringing the total municipal corporation area of the city to 450 square kilometres. The AMC lies within the larger planning jurisdiction of Ahmedabad Urban Development Authority (AUDA) that covers 169 villages including the growth centres of Kalol, Dehgam, Sanand, Mehmedabad, and Bareja (see Figure 22)[45].

As of 2011, the area within AUDA's jurisdiction has a population of 6.35 million in an area of 2,433 square kilometres. It is the primary planning authority for the entire area while AMC deals with civic administration for the corporation area. Currently,

[45] AUDA was constituted by the Government of Gujarat in 1978 through the Gujarat Town Planning and Urban Development Act (GTPUDA), 1976 for carrying out sustained, planned development of the area beyond the AMC limits.

the '2021 Comprehensive Development Plan (Second Revised)' (Ahmedabad Urban Development Authority 2013a, 2013b, 2013c) is in force.

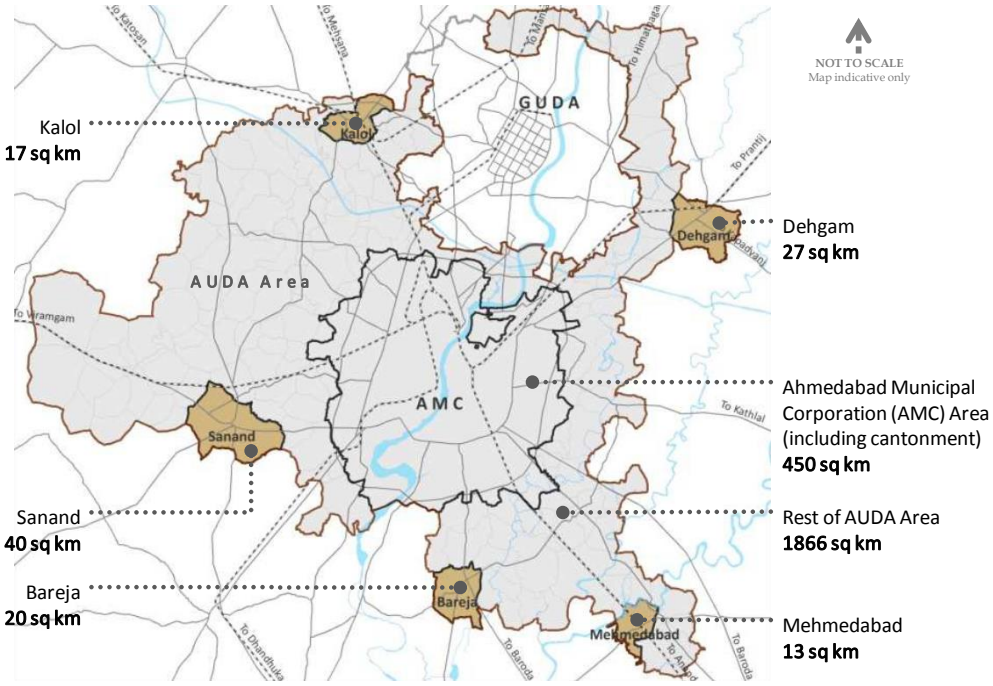


Figure 22: Constituents within AUDA boundary

Source: Ahmedabad Urban Development Authority 2013a

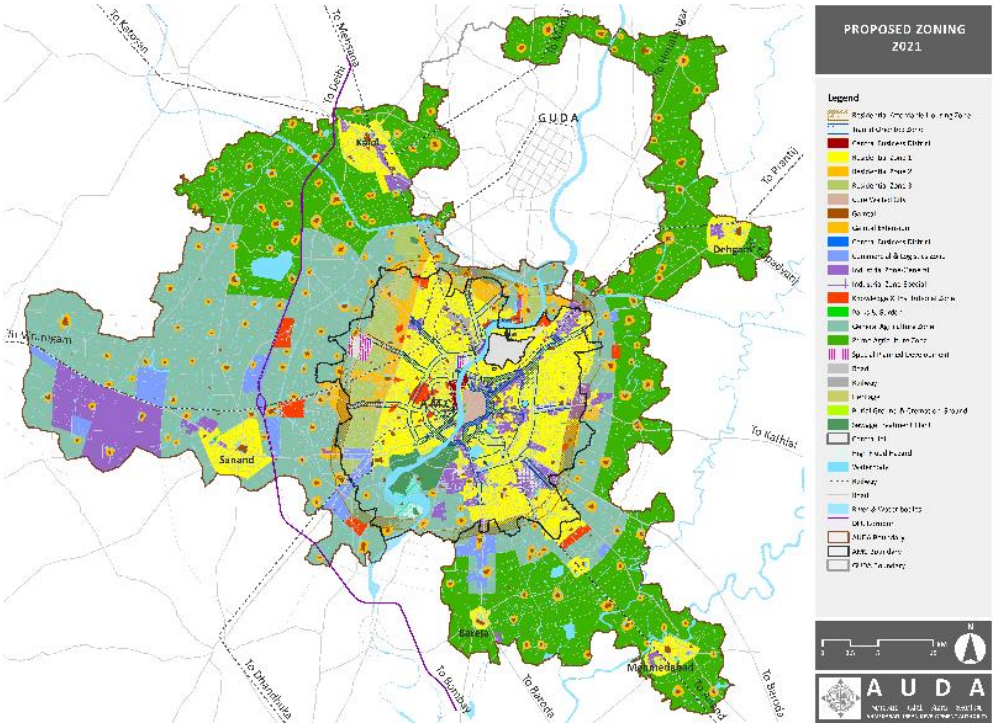


Figure 23: Land use zoning in Ahmedabad's Revised Development Plan 2021

Source: Ahmedabad Urban Development Authority 2013a

In Gujarat, traditionally, macro-planning for urban areas done through the Development Plan follows preparation of T.P. schemes. T.P. schemes are micro-

level plans that can be seen as essentially, segments of the DP, and are prepared in accordance with the statutory DP document. Over 122 TP schemes have been prepared in Ahmedabad alone over the years towards implementation of the development plans. The current DP, in aiming for a more compact urban form that is environment-friendly, has introduced innovative strategies to achieve the desired outcomes; and it has also adopted certain additional special micro-planning mechanisms. These are discussed here.

FSI relaxations: RDP 2021 for Ahmedabad looks at making the city compact. This is based on the findings of the study carried out during the preparation of the development plan- that nearly 109sqkms of lands zoned for development under the previous development plan still lie vacant and that some portion of the additional projected future growth could very well be accommodated by incentivizing development on these lands. This can also be viewed as a continuation of the policy of having a compact urban form taken during the previous development plan which had found a similar phenomenon of un-developed vacant lands within the city's spatial growth. However, this time the development plan tries to bring in more viable methods to implement this. The current DP has tried to incentivize additional growth in the existing zoned areas through an increase in permissible FSI values[46]; so while this may, in the long-term trigger redevelopment of the existing structures, it is seen as a move that would bring in development on the vacant undeveloped lands. Geographically speaking, the hike in permissible FSI is within the city limits and the increase has been made higher for areas within the SP Ring Road than in areas outside it (refer Table 22). The increment in the permissible FSI is however, chargeable and hence comes at a premium. Also, building heights are additionally governed by the road widths that a plot abuts. Given this and in the back drop of the trend of underutilization of FSI in the city, there may also be reservations against believing that such high FSI values could be actualized easily[47].

Table 22: Increase in permissible FSI for major land-use zones

Land Use Zone	DP 2011	RDP 2021	
	Max. permissible FSI	Base FSI *(free of charge)*	Maximum permissible FSI *(chargeable above the base FSI)*
Gamtal& Core Wall city	2	2	2
Gamtal extension (NGoG)	1.2	1.2	1.2
Residential (R1)	1.8	1.8	2.25 (outwards SP Ring Road)
			2.7 (inwards SP Ring Road)
Residential (R2)	1.2	1.2	1.2-1.8

[46](Munshi, T., Joshi, et al. 2014) explains the rationale behind promoting densification- vacant un-utilized spaces in existing zoned areas that have the capacity to accommodate additional population.

[47]Even with an FSI of 1.8, the net FSI in the CBD along Ashram Road is found to be about 0.72 (STP n.d.).

Land Use Zone	DP 2011	RDP 2021	
	Max. permissible FSI	Base FSI *(free of charge)*	Maximum permissible FSI *(chargeable above the base FSI)*
Residential (R3)	0.3	0.3	0.3
Commercial (C)	1.8	1.8	2.25 (outwards SP Ring Road)
			2.7 (inwards SP Ring Road)
Industrial (In)	1	1	1
Residential Affordable Zone (RAH)	-	1.8	2.7
Transit Oriented Zone (TOZ)	-	As per base zone	4.0
Central Business District (CBD)	-	1.8	5.4

Source: (Ahmedabad Urban Development Authority 2013b)

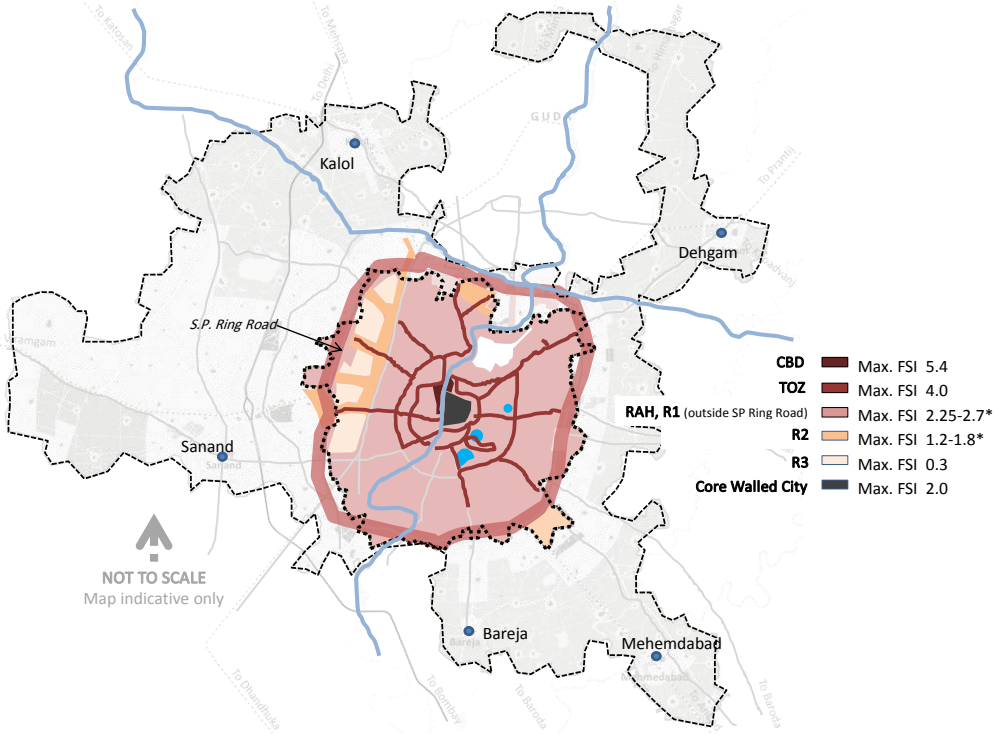


Figure 24: Distribution of FSI across major zones

Source: Compiled from Ahmedabad Urban Development Authority 2013a

*Higher value in RAH zone for areas outside the SP ring road; and lower value for other areas (R1 and R2) within the SP ring road.

Table 23: Height regulations in Ahmedabad*

Road width	Max. permissible building height
Less than 9m	10m
9m and less than 12m	15m
12m and less than 18m	25m
18m and less than 60m	45m
60m and above	70m

* Applies to these zones: Residential zones (R1,2,3), Commercial zone, Logistics zone, Industrial zones, Institutional/Knowledge zones, and Parks and Gardens
Source: (Ahmedabad Urban Development Authority 2013b)

Significant increase in permissible FSI can be seen for the newly created land-use zones that are discussed subsequently.

Table 24: Parking regulations in Ahmedabad

Sr. No.	Type of Use	Parking Requirement	
a.	Residential	<80sqm.	1 car parking, 10% for visitors
		80sqm – 300sqm.	
		Above 300sqm	At rate of 1car parking for every additional 100sqm.
b.	Residential Mixed Use	For residential as in (a) above and 50% of the utilized FSA for commercial area. For visitors' parking, 10% of parking area for residential and 20% for commercial	
c.	Mercantile, Business, Institutional and Assembly Buildings	50% of utilized FSA	20% of parking space for visitors
d.	Industrial	10% of the utilized FSA	Nil
e.	Educational	Primary schools	25% of total utilized FSI, 10% for visitors
		Secondary and Higher secondary	40% of total utilized FSI, 10% for visitors
		Colleges and coaching classes	
f.	Residential Affordable Housing (RAH) zone	10% of max. Permissible FSA and additional 10% for visitors	

Source: Compiled by the authors

New Land-use zones: Alongside increasing FSI in existing zoned areas, the revised development plan in Ahmedabad creates new zoned areas for specific purposes. These are (a) Central Business District (CBD), (b) Residential Affordable Housing (RAH) zone, (c) Transit Oriented Zone (TOZ). Of these, the latter two are overlay zones[48]. Detailed Local Area Plans are made for these zones since they are aimed at a different built form over its current existing one.

[48]An overlay zone has a different set of regulations over an established/existing base zone to regulate development in such a zone to achieve a specific set of goals defined in the Development Plan (Ahmedabad Urban Development Authority 2013a).

The CBD zone proposes to be predominantly commercial and business/mercantile in nature; however, it also allows residential, institutional, hospitality, religious and leisure uses. It has no restriction on building height provided the airport authority gives clearance to such developments. However it does restrict the building bulk through FSI regulations as indicated in Table 22. Additionally, buildings with height greater than 45m are allowed on plots having area at least 3500sqm. TOZ zone is a strip of 200m on either side of the BRT and the MRT routes in the city and is aimed at intensifying land uses along these major transit corridors. This overlaid zone takes precedence over the R1, R2, Commercial and Agricultural zones that it passes through. Height restrictions in TOD zone are simplified and are as shown in Table 25 below. Parking requirements in the TOZ are relaxed for commercial developments abutting the BRT corridor by reducing them by 10% over that required otherwise.

Table 25: Height regulations for TOZ in Ahmedabad

Road width	Max. permissible building height
Upto 60m	45m
60m and above	70m

Source: (Ahmedabad Urban Development Authority 2013b)

RAH zone is a strip of 1km outwards the S.P. Ring Road. It is overlaid over the existing zones mainly to incentivize affordable housing in this area; so this zone takes precedence over the different zones that it passes through. Additional FSI over the base FSI (refer Table 22) is chargeable but discounted by the authority for developments in affordable housing sector. While normally, developers going above the base FSI have to buy the commensurate FSI at 40% of the *Jantri*[49] rates, this premium is discounted by half to 20% of the *Jantri* rates for developments in affordable housing. To ensure that the benefits accrue to the target population only, these incentives are given only to those developments where individual dwelling units have a maximum built-up area of 80sqm. Additionally, commercial uses are allowed only up to 10% of the permissible FSI.

Additional Micro level area planning tools: Local Area Plans are made for CBD and the TOZ. These LAPs will provide comprehensive guidance and will account for the existing conditions at the local area level (Ahmedabad Urban Development Authority 2013a). Since these are made for areas where there is already existing development, they can be seen as micro-level planning for redevelopment and will thus also comprise of aspects such as road widening, plot rationalization, parking management and pedestrianization. Special Planned Area Development Zones (SPADs) are areas identified for focussed development around important structures in the city. These are, Sabarmati Riverfront Development Project (SRDP), Gandhi Ashram Special Area Development, and Science City and Science Park. SRDP is

[49] *Jantri* rates are land prices (often termed as ready-reckoner rates) for residential and commercial properties for any given area. These are published by the Revenue Dept. of the government every year.

completely managed by the SRDP Ltd. In fact DCR for this area will be prepared in consultation with the SRDP Ltd. With the area around Gandhi Ashram, the DCR enforces uniformity, of structures in this zone, in terms of aesthetics, and limits their heights to 10m.

Conservation measures: The development plan zones the core city, where most of the heritage sites are located, as 'Core Walled City', for which the DCR proposes an FSI of 2. TDR incentives are used for Heritage conservation. Tradable Right Certificates (TRC's) are given by the authority in form of FSI, for structures, buildings and precincts notified as Heritage Areas. These FSI values depend upon the classification of the heritage structures/building: Grade I (highest heritage value), for which an FSI of 0.5 is given, Grade II (moderate heritage value) and Grade III (low heritage value) with an FSI of 0.3 and, Non-graded non-listed heritage structures/buildings, for which there is no TDR.

Special parking management plan will also be made for the core walled city. Other development regulation strategies for heritage conservation include disallowing any amalgamation or sub-division in this zone and allowing non-residential uses only on roads with widths above 18m. The DCR encourages Energy efficient buildings that are certified by GRIHA (Green Rating for Integrated Habitat Assessment) by discount of 5% for chargeable FSI.

Summary:

Successive development plans have been finding the phenomena of underutilization of FSI as well as un-used vacant lands characteristic to spatial development in the city, leading to their focus on a compact form of urban development in each of the development plans. However, unlike the previous policy of a more-or-less blanket-FSI, FSI regulations in the current development plan are modified with an aim to develop a particular type of growth in specified areas towards the purpose of efficient land use and compact city. Over all, higher densities are allowed in the central business district and along a network of transit lines (BRTS and MRTS).

Permissible FSI has been increased in the CBD from 1.8 to 5.4. But, given the phenomena of low utilization of FSI, how such relatively high FSI would be realized should be observed. Planning professionals attribute the low-FSI utilization, in this business district, to the fact that an FSI of 1.8 under the previous DP as against an FSI of 1 earlier wasn't incentive enough to cause any redevelopment. However, the current FSI of 5.4 is very well an incentive for developers to cause redevelopment of the existing structures. Also along with this is the LAP[50] for the CBD that aims to rationalize urban design in this entire area and bring-in additional infrastructure which may increase the attractiveness for the place and help realize the increased FSI.

[50] As of now, the LAP has been submitted to the state government for sanction. It is opined that redevelopment can be seen getting started soon after it is sanctioned.

Attempts in the affordable housing sector are done by incentivizing private investments in low-cost housing on a 1km strip of lands along the outside of the SP ring road, amounting to around 75sqkm area of land. At the same time it is ensuring that the benefits of the incentives are utilized for the purpose of the targeted population are well-intentioned; however, it can also be seen as a move that essentially pushes the lower-income groups outwards on the periphery. This in context of having a business district at the centre of the city may result in longer travel distances for them. Residents of the EWSH-reservations in TP schemes within the city will be however better placed.

Again, even while there is an un-stated urban growth limit put around the SP ring road; going by (Brueckner and Sridhar 2013), the possibility that rising demand for lands that are made attractive for development will consequently increase in prices may also push for an urban sprawl on lands in the surrounding areas. A similar argument may be made over the outcomes of the proposed increase in FSI for the TOZ zone, where the intention is to have as many people live near public transit facilities; however, as prices will also rise in commensuration, these lands might not seem affordable to the income groups who could easily choose to shift to the public modes of transport. But since FSI has generally been hiked for most of the city, availability of housing will rise in more areas and so, markets may very well allow relevant income groups accessibility in the transit zone.

4.5. National Capital Territory of Delhi

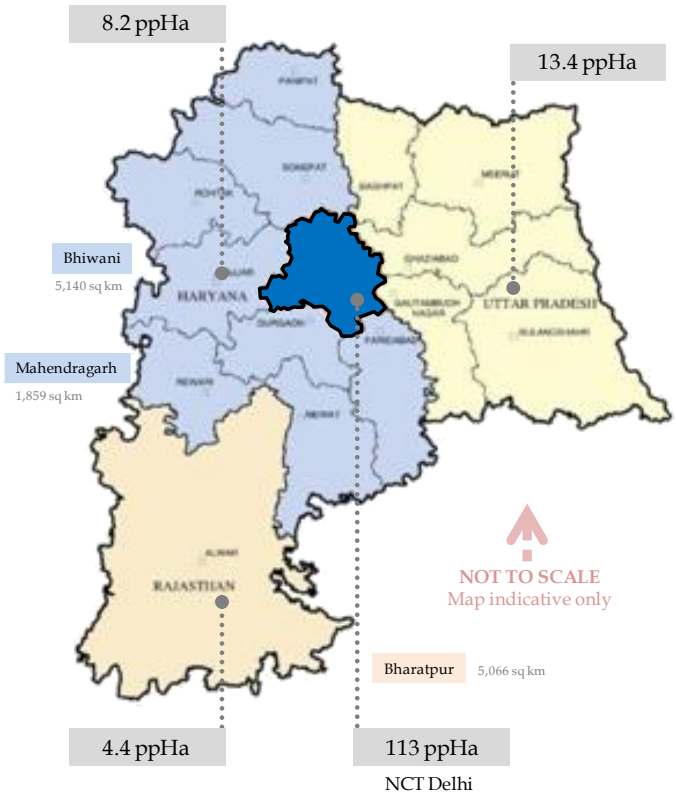


Figure 25: National Capital Territory of Delhi within the National Capital Region

Source: National Capital Region Planning Board 2013

The NCT is located at the core of the National Capital Region (NCR) (Figure 25). It has a population of 16.32 million within the NCR which has a population of 45.2 million (Registrar General of India 2011). NCT Delhi is highly urbanized with 93.18 percent of its population living in urban areas as against the national average of 27.81 percent. During 1991-2001, the urban population of Delhi increased at 3.87 percent annual growth rate. This rate of growth of population stabilized to around 1.8 percent in the next decade. The 2021 Master Plan for Delhi (2005) is currently in force. It was prepared by the Delhi Development Authority (DDA) under the provisions of the Delhi Development Act 1957. It sits within the larger context of the 2021 National Capital Region Plan (2013) prepared by the National Capital Region Planning Board (NCRPB) which was formed under the NCPRB act of 1985.

The National Capital Territory (NCT) of Delhi has an area of around 1,483 square kilometres which accommodates 16.32 million people according to the 2011 census. It sits within the larger context of the 2021 National Capital Region Plan (2013) prepared by the National Capital Region Planning Board (NCRPB) which was formed under the NCPRB act of 1985. The local government functions in Delhi are discharged by the North Delhi Municipal Corporation, East Delhi Municipal Corporation, South Delhi Municipal Corporation[51], New Delhi Municipal Council[52] and the Cantonment Board. The planning functions in the area under the NCT of Delhi are taken care of by the Delhi Development Authority – a parastatal body created in 1955 for planning activities in Delhi. As of today, the 2021 Master Plan for Delhi (2005) is in force. Table 26 and Figure 26 show the fifteen zones in the NCT of Delhi as given by the 2021 master plan.

Table 26: Zones in NCT as per Master Plan for Delhi, 2021

Zone	Name of zone	Area (km^2)
A	Old city	11.6
B	City extension (Karol Bagh)	23.0
C	Civil line	39.6
D	New Delhi	68.6
E	Trans Yamuna	88.0
F	South Delhi-I	119.6
G	West Delhi-I	118.7
H	North West Delhi-I	56.8
J	South Delhi-II	151.8
K	K-I West Delhi-II	57.8

[51] The North Delhi Municipal Corporation, East Delhi Municipal Corporation, South Delhi Municipal Corporation form part of the erstwhile Municipal Corporation of Delhi that was trifurcated in 2011 to aid better local governance. Together they form over 95 per cent of the area under NCT of Delhi.

[52] The New Delhi Municipal Council area comprises of the territory that has been described as Lutyen's Delhi and which has historically come to be regarded as the seat of central authority in Union of India. It comprises of buildings like Rashtrapati Bhawan, Parliament House, Supreme Court, North and South Blocks and buildings abutting Central Vista. It forms only 3 per cent of the area under NCT of Delhi.

	K-II Dwarka	64.1
L	West Delhi-III	228.4
M	North West Delhi-II	50.7
N	North West Delhi-III	139.8
O	River Yamuna / River Front	80.7
P	P-I Narela	98.7
	P-II North Delhi	85.3
	Total	**1,483.0**

Source: (Delhi Development Authority 2005)

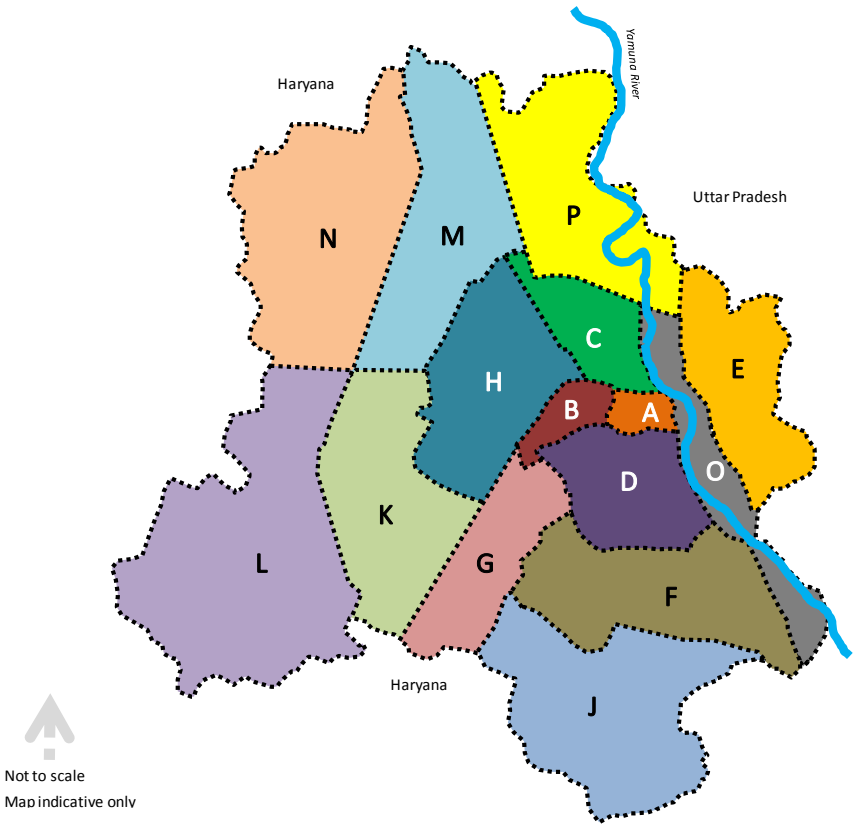


Figure 26: Zones in NCT as per Master Plan for Delhi, 2021
Source: http://www.dda.org.in/planning/narela_map_pop_up.htm

Prior to the 2021 master plan, three plans were sanctioned as 2001 master plan (1990), 1981 master plan[53] (1962) and interim master plan (1956). These planning efforts were meant to cater to the increasing primacy of Delhi as a city for people migrating from different parts of the country for administrative, manufacturing and service sector employment. As a result, the urban footprint of Delhi increased from 487 square kilometres in the 1981 master plan to 687 square kilometres in 2001 master plan to 978 square kilometres in 2021 master plan (Kushalappa et al. 2013). The early attempts were envisaged as public sector led efforts which started to change from the 2001 master plan. These plans could be seen as land use plans with

[53] According to School of Planning and Architecture (2011), the 1981 master plan for Delhi received assistance from Ford Foundation.

a three level hierarchy consisting of master plan, zonal plan and layout plans for specific development schemes. The master plan is a statutory instrument that guides planned development and spells out policies, guidelines for regulating the physical development of the city. Its focus is on land use planning. The master plan mechanism has often been criticised over its static, idealistic and advisory nature, insufficient coordination with economic plans, lack of linkage to outcomes, and limited consideration of the urban boundary (Nallathiga 2012; School of Planning and Architecture 2011). The zonal plans detail out the master plan pertaining to the areas coming within the zone. The layout plans and development schemes indicating various use premises conform to the zonal plans.

Figure 27: Zonal plan for Zone-A prepared as per Master Plan for Delhi, 2021
Source: http://goo.gl/dkooFK

In general, the FSI, coverage and margins are specified in the master plan document while the zonal plans only interpret the provisions in the master plan to the context of the zone. It proposes the number of schools, colleges and other social infrastructure that need to be added to the zone by the horizon period in order to satisfy the master plan. For this purpose, the zonal plans use the UDPFI guidelines (1996) in order to arrive at the number of amenities needed to cater to the population proposed as part of the master plan. Figure 27 presents the zonal plan prepared for zone-A as part of the 2021 master plan.

FSI: The 2021 master plan recognizes the need to intensify land utilization and therefore recommends FSIs of 1.2 to 3.5 for residential development depending on the plot size. Margins for residential development are given in Table 28. Depending upon the plot size, ground coverage varies from 40 to 90 per cent (Table 27). Although the permissible number of dwelling units has also been prescribed ranging from 3 to 21 in plot sizes 32 square metres to 3,750 square metres, it is not clear how this could be enforced. Building heights for residential purposes have been

capped at 17.5 metres. Infrastructure requirements have also been specified for residential neighbourhoods on the lines of those specified in UDPFI guidelines. However, it has often been seen that the parameters on which such standards are set are not sensitive to the actual densities prevailing on ground. Similarly, for buildings having an area of up to 250 square metres, there are no Equivalent Car Spaces (ECS) parking spaces provided. This is bound to encourage on-street parking. Detailed development control norms have been summarised in Table 27. Margins for development other than residential use are given in Table 29.

Table 27: A snapshot of development control norms in MPD 2021

<table>
<tr><th>Min plot size (m2)</th><th>FSI</th><th>Max ground coverage (%)</th><th>Max permissible height (m)</th><th>Equivalent Car Space (ECS)</th></tr>
<tr><td>Residential plot</td><td></td><td></td><td></td><td></td></tr>
<tr><td>32 to 50 m²</td><td>3.50</td><td>90</td><td rowspan="11">17.5 m</td><td rowspan="4">-</td></tr>
<tr><td>50 to 100 m²</td><td>3.50</td><td>90</td></tr>
<tr><td>100 to 250 m²</td><td>3.00</td><td>75</td></tr>
<tr><td>250 to 750 m²</td><td>2.25</td><td>75</td><td rowspan="7">2 ECS for plot size 250 to 300 m²

1 for every 100 m² over 300 m²</td></tr>
<tr><td>750 to 1,000 m²</td><td>1.50</td><td>50</td></tr>
<tr><td>1,000 to 1,500 m²</td><td rowspan="5">1.20</td><td rowspan="5">40</td></tr>
<tr><td>1,500 to 2,250 m²</td></tr>
<tr><td>2,250 to 3,000 m²</td></tr>
<tr><td>3,000 to 3,750 m²</td></tr>
<tr><td>Above 3,750 m²</td></tr>
<tr><td>Group housing</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3,000 m²</td><td rowspan="2">2.00</td><td>33.3</td><td rowspan="2">-</td><td rowspan="2">2</td></tr>
<tr><td>1,670 m²
For slum/JJ rehabilitation, redevelopment area/ lal dora</td><td>40</td></tr>
<tr><td>Cluster housing</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3,000 m²</td><td>1.75</td><td>-</td><td>15</td><td>2</td></tr>
<tr><td>Night shelter</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1,000 m²</td><td>1.20</td><td>30</td><td>26</td><td>-</td></tr>
<tr><td colspan="2">Convenience shopping centres</td><td></td><td></td><td></td></tr>
<tr><td>1,000 m²</td><td>1.50</td><td>40</td><td>15</td><td>2</td></tr>
<tr><td colspan="2">Community centre</td><td></td><td></td><td></td></tr>
<tr><td>4,00,000 m²</td><td>1.25</td><td>25</td><td>-</td><td>3</td></tr>
<tr><td>Primary school</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2,000 to 4000 m²</td><td>1.2</td><td>30</td><td>18</td><td>1.33</td></tr>
<tr><td colspan="2">Secondary/ senior secondary school</td><td></td><td></td><td></td></tr>
<tr><td>6,000 to 8,000 m²</td><td>1.50</td><td>35</td><td>18</td><td>1.33</td></tr>
</table>

College				
-	2.25	35	37	1.33
Industrial plot				
Up to 50 m^2	2.00	100	8	2
51 to 400 m^2	1.80	60	15	2
Above 400 m^2	1.50	50	15	2
Flatted group	1.50	30	26	2

Source: Delhi Development Authority 2014

Table 28: Minimum setbacks prescribed in residential development in MPD 2021

Plot size (m2)	Front margin (m)	Rear margin (m)	Side (1) margin (m)	Side (2) margin (m)
Up to 100 m^2	0	0	0	0
100 to 250 m^2	3	0	0	0
250 to 500 m^2	3	3	3	0
500 to 2,000 m^2	6	3	3	3
2,000 to 10,000 m^2	9	6	6	6
Above 10,000 m^2	15	9	9	9

Source: (Delhi Development Authority 2005)

Table 29: Minimum setbacks prescribed in other development in MPD 2021

Plot size (m2)	Front margin (m)	Rear margin (m)	Side (1) margin (m)	Side (2) margin (m)
Up to 60 m^2	0	0	0	0
60 to 150 m^2	3	1.5	-	-
150 to 300 m^2	4	2	-	-
300 to 500 m^2	4	3	3	-
500 to 2,000 m^2	6	3	3	3
2,000 to 10,000 m^2	9	6	6	6
Above 10,000 m^2	15	12	12	12

Source: (Delhi Development Authority 2005)

Transportation: The 2021 master plan for Delhi proposes a unified metro transport authority, greater synergy between land use and transport, private sector development of parking facilities, increase in parking space norms, multi-level parking spaces, integrated multi-modal public transport system to reduce personalised transport dependence, restructuring existing road network through expressways, elevated roads, and provision of cycle tracks, pedestrian and features for differently abled persons in arterial and sub-arterial roads. With regards to synergy between transport and land use, the master plan proposes selective redevelopment and redensification of existing land use along the metro rail corridor. The master plan proposes segregated cycle tracks on all arterial roads with safe parking and ride lots. Cycle tracks are also proposed along sub-arterial and local

level roads. In walled city areas, pedestrianizartion and cycling are encouraged. This includes removal of encroachments along footpaths. Overall, the master plan aims to transform the modal split from 70[54]:30[55] in 2011 to 80:20 in 2021. To this effect, Figure 28 shows the sub-regional transport network of NCT of Delhi.

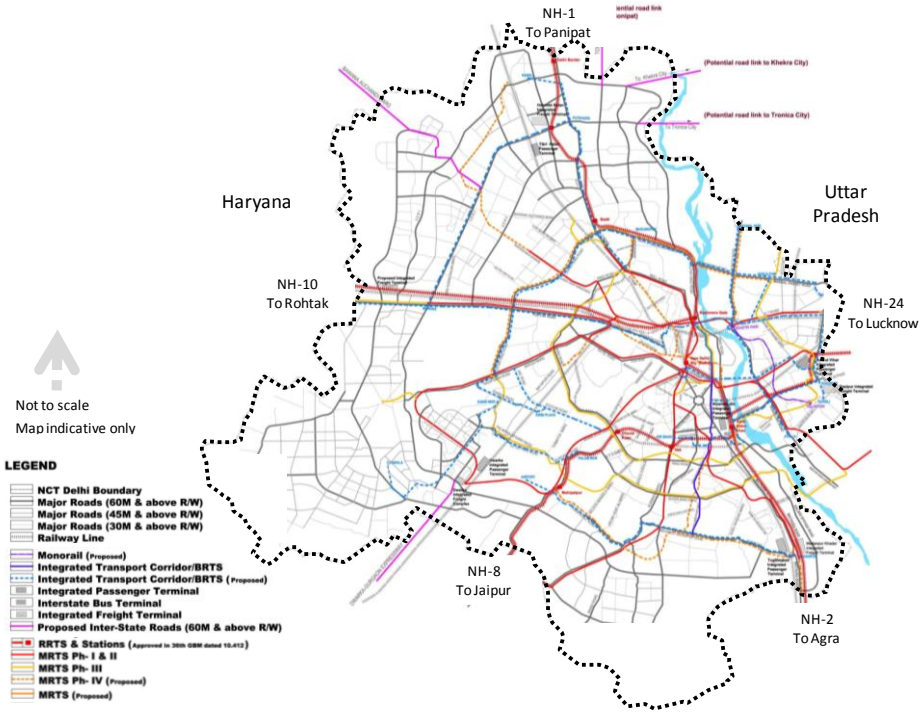


Figure 28: Sub-regional transport network of NCT of Delhi
Source: (High Powered Committee 2014)

Parking: The master plan recognises the acute shortage of parking space in Delhi. It also recognises that earlier norms were on the lower side as against the on ground situation. To this effect, more parking facilities are proposed in the form of park and ride facilities at metro stations, public parking, parking facilities in DTC depots, underground parking, and multi-level parking complexes. In general, more parking spaces have been provided.

Transit Oriented Development (TOD): The master plan looks at TOD as 'any development, macro or micro, that is focused around a transit node, and facilitates complete ease of access to the transit facility, thereby inducing people to prefer to walk and use public transportation over personal modes of transport' (Delhi Development Authority 2007: 2). The master plan aims at reduction of private vehicle dependency and inducement of public transport use. Also it aims at provision of easy public transport access to the maximum number of people within walking distance. The MRTS system in Delhi aims at: a) an enhanced level of accessibility by non-motorised modes, b) a reduced trip length to the average

[54] Public transport (including Rail/ Light Rail/ MRTS/ IRBT/ Bus/ Tram).

[55] Personal modes (including Personal Fast Modes / Hired Fast Modes/ Hired Slow Modes/ Bicycle).

commuter, and c) economic viability of the public transportation system through substantial non-fare box revenues.

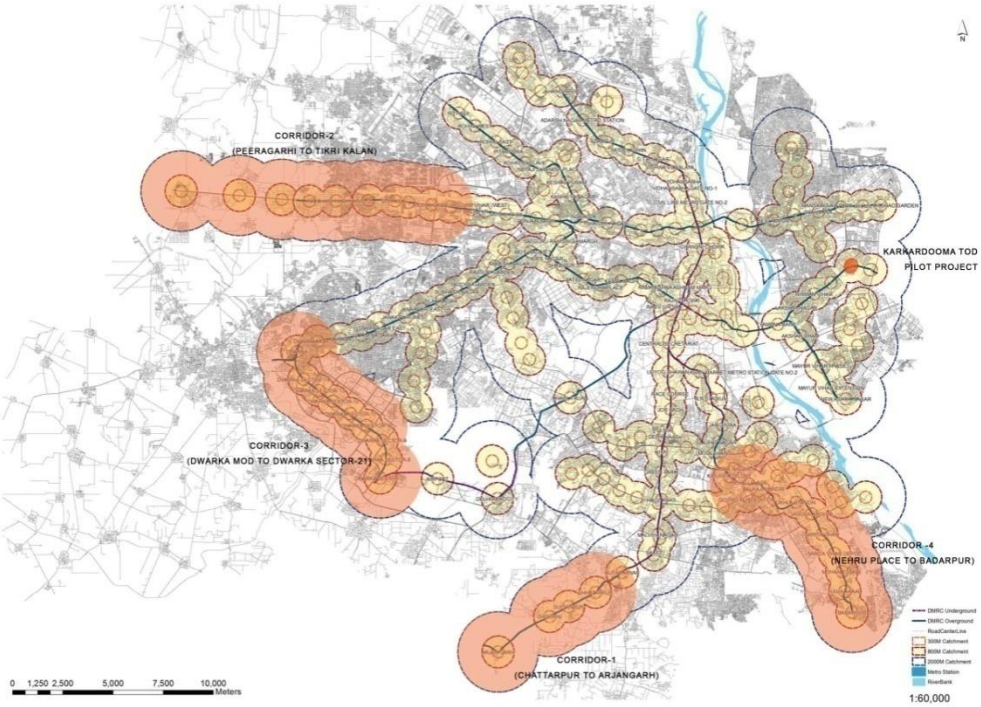


Figure 29: Influence zones along MRTS routes in Delhi
Source: (Delhi Development Authority 2005)

To this effect, a maximum of 2,000 m wide belt on both sides of the MRTS corridor is designated as TOD influence zone that has been identified as white zone. The development control in the white zone will be regulated by the competent authority as per the influence zone plans (Figure 29). Within the white zone, there are three zones based on the intensity of use namely, a) intense TOD zone[56], b) standard TOD zone[57], and c) TOD transition zone[58]. These zones are identified as part of the zonal development plans. Redevelopment, Greenfield and retrofitting projects are allowed in the TOD zones. The influence zone plans provide an urban design framework, transport impact assessment and mitigation strategies, decentralized infrastructure plan, and economic viability model. Similarly, TOD policy and development control; norms have evolved that aim at a) pedestrian, cycle and rickshaw friendly environment, b) connectivity, c) multi-modal interchange, d) modal shift measures, e) place-making and safety, and f) high density, mixed-income development.

Table 30: Permissible FSI and density in TOD influence zone

[56] 300 m influence zone of all MRTS stations and 800 m (10 minute walking distance) influence zone or regional interchange station.

[57] 800 m (10 minute walking distance) influence zone of all MRTS stations.

[58] 2000 m (10 minute cycling distance) influence zone of all MRTS stations and 300 m influence zone of BRT corridors and zones within standard and intense zones that are not allowed for redevelopment.

Gross FSI* (site)	Residential dominated project (Residential FSI>50 %) (DU/ha)	Residential dominated project (Residential FSI<30 %) (DU/ha)
Below 1.0	Underutilization not permitted	Underutilization not permitted
1.1 to 2.0	200 to 400	100 to 200
2.1 to 3.0	400 to 600	250 to 400
3.1 to 4.0	600 to 800	400 to 600

*Site level FSI as per approved TOD influence zone plan
Source: (Delhi Development Authority 2007)

Parking spaces near the metro stations are required to keep 40 per cent of spaces allocated to cycle-rickshaws within 300 m of MRTS stations. This is in line with the desired modal share in 2021. Similarly, accessibility standards for various services have been fixed. Motorized vehicle parking is discouraged in general. Another welcome development is the intent shown towards having mixed-use development. For example, at least 30 per cent residential and 20 per cent commercial and institutional use (minimum 5 per cent commercial and institutional use) is mandatory in every new development within the influence zone. Another initiative has been towards place-making and safety. Boundary walls are not permitted within the influence zones. Setbacks are kept capped at 4.5 m for residential use and even lower for commercial use. Active frontage with a view to have 'eyes on the street' is encouraged. Vendor zones, climatic control through trees, arcades, overhangs, artificial canopies, seating, dustbins, public conveniences, lighting and good design have been recognized as a factor towards creating better enjoyable spaces. Overall, there is a good intent and measures towards making the TOD work.

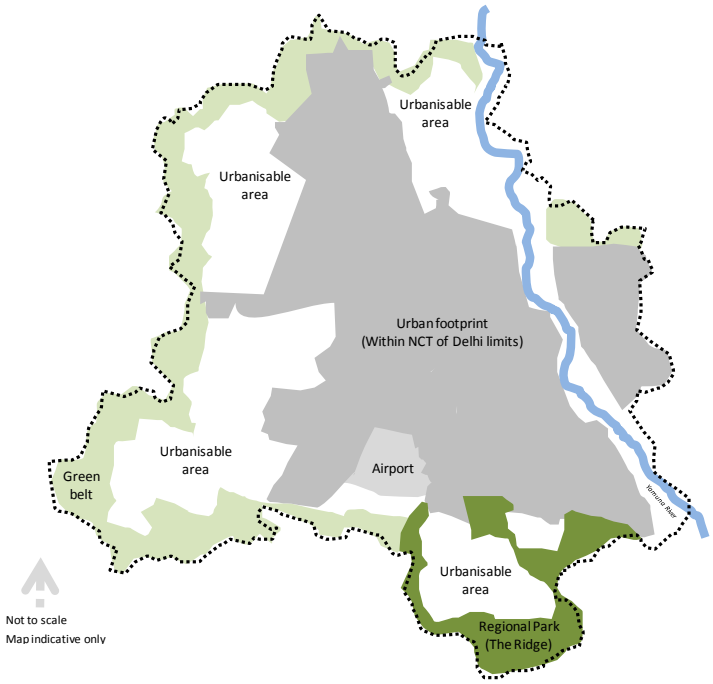


Figure 30: Extent of built area within the NCT of Delhi
Source: Authors

Summary: The NCT of Delhi suffers from chronic shortage of developable land. Going by Brueckner's framework of artificially enforced urban growth limits, the

enforcement of the green belt (Figure 30) as limit of urban growth in earlier plans resulted in increased housing costs, rents and a general dip in people's living standards. The spur of growth witnessed in neighbouring cities of Noida, Gurgaon, Faridabad and Ghaziabad are a result of the artificial scarcity of development in NCT of Delhi, on would argue. The resultant pressure on transport and travel time has had cascading effect on people's health and well-being (Badami 2005; Delhi Metro Rail Corporation 2013; The Energy and Resources Institute 2012). The 2021 master plan recognises this and through the TOD guidelines aims to make intense use of available land while promoting sustainable means of movement through walking, cycling and mass transit systems. Emphasis is on 5 Ds of density, diversity, design, destination accessibility and distance to transit station.

4.6. Comparison between the cities

The development control mechanisms in the cities of Pune, Hyderabad and NCT of Delhi have adapted themselves in ways that suit the local context. In Pune, the planning authority is the urban local body which has taken measures towards de-densification of the core city which is considered to be highly congested. At the same time, there are also attempts being made towards implementing the Pune metro project. With a view towards making the highly cost intensive metro project economically viable, efforts are being made to densify the areas through which the metro corridor passes through, thereby revealing a contradiction with the de-densification strategy. A similar strategy is also being employed by the NCT of Delhi by way of proposing transit oriented development along the metro corridors. The difference is however in the measures taken towards on-ground implementation of the same. Delhi has detailed norms for regulating development in what it calls the influence zone of the metro which extends up to 2 kilometres from the station. Major control is exerted through local influence zone plans prepared by the planning authority at the zonal level. Though the plan is being made at the zonal level, it must be conceded that people's stake in preparation of these plans would be limited as the planning authority is a para-statal body. Only consultations (as against participation) may be expected. In stark contrast, the Pune experience is characterised by a good level of participation from the civil society. However, the development plan for Pune has no concrete proposals for implementation and realization of the transit oriented development on ground. Hyderabad has no such mechanism to govern development at the local level along the proposed metro corridor. While the intention is clearly to decongest the erstwhile MCH areas, the absence of any FSI based regulations makes building heights the sole basis for regulation of built form. The building heights are more liberal in areas outside the MCH area, and no intensification of development is proposed along the metro rail corridors. The growth corridor along the proposed outer ring road meanwhile has regulations that incentivise taller buildings with a view to attract development away from the core areas.

When seen against the backdrop of literature available on development control interventions, it is evident that Pune is grappling with the issue of expansion of limits

leading to incentives for people to locate outside the city limits. In a counter current, there is also a proposal to intensify development along proposed metro rail corridor through the city. As a result the resultant urban form would appear to be highly dense in the core area and along the proposed metro corridor while it declines as we move outside towards the city boundary before seeing a sudden spike just outside the city limits. Delhi has a green belt as an inheritance from its previous master plans which imposed a natural limit on its outward growth. The metro corridor has a highly intensive influence zone being planned as transit oriented development. Also, within the core city, densities are high owing to the location of the traditional CBD. As we move southwards, the Lutyen's Delhi portion accommodating government offices and bungalows has very low densities. These densities keep on declining as we move towards the green belt where only motels and farmhouses are allowed. In Hyderabad, the core city features highly dense urban form and diverse land use that is most suited for shorter trips and therefore sustainable modes of transportation such as walking and cycling. No further densification is allowed in these areas. But in the newer areas such as those along the outer ring road growth corridor, taller buildings are encouraged. The urban form transforms into low rise as we move outwards from the ring road to the limits of the metropolitan region.

Figure 31: Picture showing change in urban form just outside city limits
Source: Mangesh Dighe (http://www.panoramio.com/photo/59887622)

The Delhi approach looks to be most likely towards reduction of private motorized trips as it sends clear signals through intensification of land use, diversity of land use and good design to encourage greater use of the public realm using sustainable modes of movement like walking, cycling and rickshaw. The Pune approach appears to encourage people to move out of the city which would in the absence of decentralization of job lead to greater travel times and lower comfort levels given

the current state of public transport in that city. This may lead to increase in private motorised trips leading to greater emissions. The Hyderabad experience of having only FSI as a limiting measure does not seem to make much of a difference. The city seems to be expanding beyond its limits continuously and even the current development plan seems to encourage such expansion. The proposed metro rail project is not accompanied by any regulations that would intensify development along the identified alignment.

Table 31: Evaluation of development planning processes in case cities

City	Pune	Hyderabad	Bengaluru	Ahmedabad	NCT Delhi
Plan making authority	PMC	HMDA	BDA	AUDA	DDA
ULB or parastatal	ULB	Parastatal	Parastatal	Parastatal	Parastatal
Constituted in	1950	2008	1961	1978	1957
Enabling legislation	MR&TP Act, 1966	HMDA Act, 2008	BDA Act, 1976	GTPUDA, 1976	DD Act, 1957
Previous plan	1987 Development Plan	1975 Master Plan for MCH	Revised Master Plan for Bangalore, 1995	2002 Development Plan	Master Plan for Delhi, 2001
Current plan in force	2027 Development Plan for Pune City (Old Limits)	Revised Development Plan of erstwhile MCH Area	2015 Revised Master Plan for Bangalore	2021 Comprehensive Development Plan (Second Revised)	2021 Master Plan for Delhi
Horizon period	20 years	20 years	20 years	20^ years	20 years
Periodicity					
Year of preparation of first DP^	1952	1975	1971	1965	1956
Year of preparation of current DP	2007	2010	2007	2013	2007
No. of DPs prepared before current DP	3	1	3	3	3
Average age of DPs	18 years	35 years	15 years	16 years	17 years
Other factors					
Adoption of land suitability analysis	No	Yes	Yes	Yes	No
Adherence to environmental zoning	Partly	Yes	Yes	Yes	Yes
Land use transport integration	Partly	Yes	No	Yes	No
Compactness	Yes	Yes	Yes	Partly	No

City	Pune	Hyderabad	Bengaluru	Ahmedabad	NCT Delhi
Development control					
Use of FSI as a tool	Yes	No	Yes	Yes	Yes
Base FSI	1.50	Not applicable	1.75	1.80	1.20
Upper limit (including premium FSI)	4.00	Not applicable	3.75	5.40	3.50
Higher FSI along transit corridors	Yes	No	No	Yes	Yes
Use of TDR as a tool	Yes	Yes	Yes	Yes	No
Building height restrictions	Yes	Yes	No	Yes	Yes
Maximum permissible building height	150 m	Unlimited[59]	Unlimited	70 m	17.5 m
Setbacks / Margins	Yes	Yes	Yes	No	Yes
Coverage	50 %	No	70 %	No	90 %
Transport demand management	No	No	No	Yes	No

Source: Compiled by authors from various aforementioned sources

[59] Along roads wider than 30 m.

5. Reforming the plan preparation process

The primary objective of the cities' master plans is to provide a framework for accommodating the anticipated growth including infrastructure. But, recent discourses on 'sustainable urbanism'- a debate that has developed mainly from the growing concerns about how urban development should take into account and address the larger issue of climate change, have led to investigation of how our master planning activities are oriented towards it. It has been realized that despite the good intentions, our master plans have failed at it. The general failure of our city-plans has been ascribed to a number of reasons that include institutional factors (mainly, delayed planning and implementation, poor public participation during plan preparation, reactive approach to infrastructure planning) as well as the inadequacies of the planning policies that are adopted(Jain, 2015; Nallathiga, 2009; Shivanandswamy H.M. et.al., 2013).

The master plans of all of our major cities indicate that the principles for sustainable urban development – 'land use transport integration' and 'mixed land use' that have been routinely propagated by various agencies, including by the government in form of tool kits, are adopted by these cities. But, the manner of growth in our cities reveals a scenario that doesn't quite reflect what would be considered as a 'sustainable urban development'. Despite being generally denser, and having always been characterized more by 'mixed land use' than by the monolithic zoning approaches actually prescribed by the previous plans, our cities exhibit sprawled growth and a steadily lowering share of public transportation(Wilbur Smith Associates Ltd. 2008)that corresponds to a burgeoning vehicle ownership. Mckinsey Global Institute (2010) points out that rising household incomes would lead to a near quadrupling of vehicular stock in India's urban areas to about 200 million by 2030. Meanwhile our cities have already exceeded World Health Organization's emission related limits in the past decade (Badami 2005). This raises alarming questions on the efficacy of our policies, which seem to be in good spirit but have been indicative of a *half-baked* approach and on the very practice of the current development planning process in India from the viewpoint of sustainability.

5.1. Current approach

5.1.1. The plan preparation process

The conventional plan preparation process in our cities mainly involves forecasting the population followed by calculation of area and infrastructure (roads, utilities and amenities) requirements which are then finally translated into land use allocations that are represented on a Development (Master) Plan map. Adhvaryu (2011) argues against such 'broad brush' approach to plan making, regarding the process of preparation of plan as 'intuitive', and especially arguing that the process is shrouded in lack of clarity of how the final plan is arrived at. This is to say that even when there are certain projections and rationale that goes into the decision of arriving at a certain kind of plan in the conventional method; but, the questions guiding it are more about 'how much population is to be accommodated?' and

'where is the land available?'. Adhvaryu(Adhvaryu 2010) makes another equally compelling argument against the current plan making process about what is found in the Indian context, and which may very well be the case for other places too- a process that entirely skips 'weighing between alternative policy proposals', which Southworth(1998) professes as being intrinsic to the plan preparation methodology (refer Figure 32).

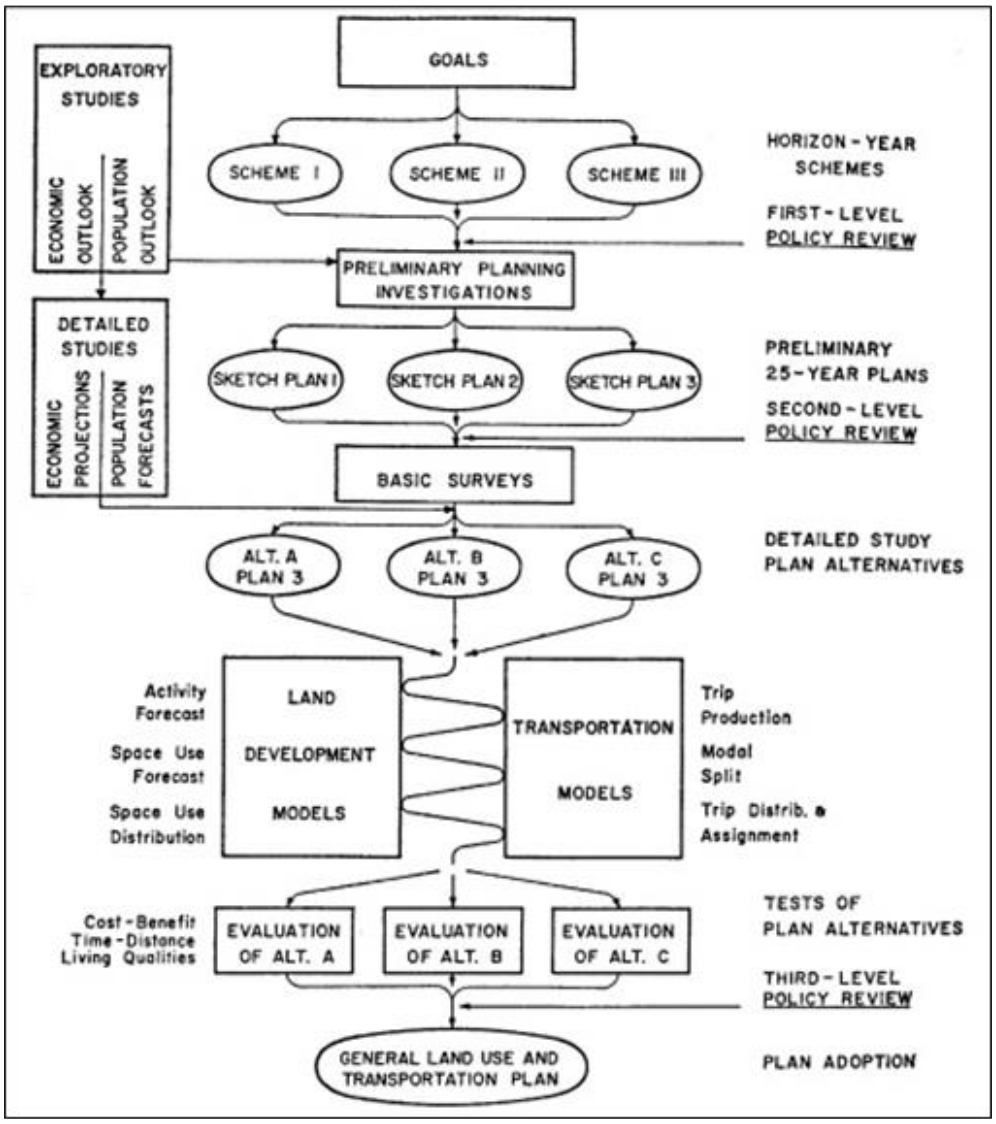


Figure 32: Schematic representation of the plan preparation process
Source: Chapin (1965, Figure 36, p. 458)

The legal fame-work that guides the plan preparation process is also similar across our cities: putting up a draft of the master plan for receiving public suggestions for a certain period of time (which is not more than a couple of months) alongside it's submission to the concerned government department, and making suitable changes wherever deemed plausible before it eventually gets sanctioned by the government under respective state town planning legislations (refer Figure 33). However the underlying significance of conducting such public consultations to the plan is more about their (land) being affected by such plan proposals rather than

also being about discussions regarding the alternative planning proposals for the city. But of course, one would concede that the alternatives to a certain planning proposal could be efficiently discussed when the implications of each of those proposals could be made explicable to the general public- showing how various policies such as say, congestion pricing, growth management, pollution mitigation schemes , etc. would lead to a certain kind of urban form, and making planning decisions more rational (Torrens 2000).

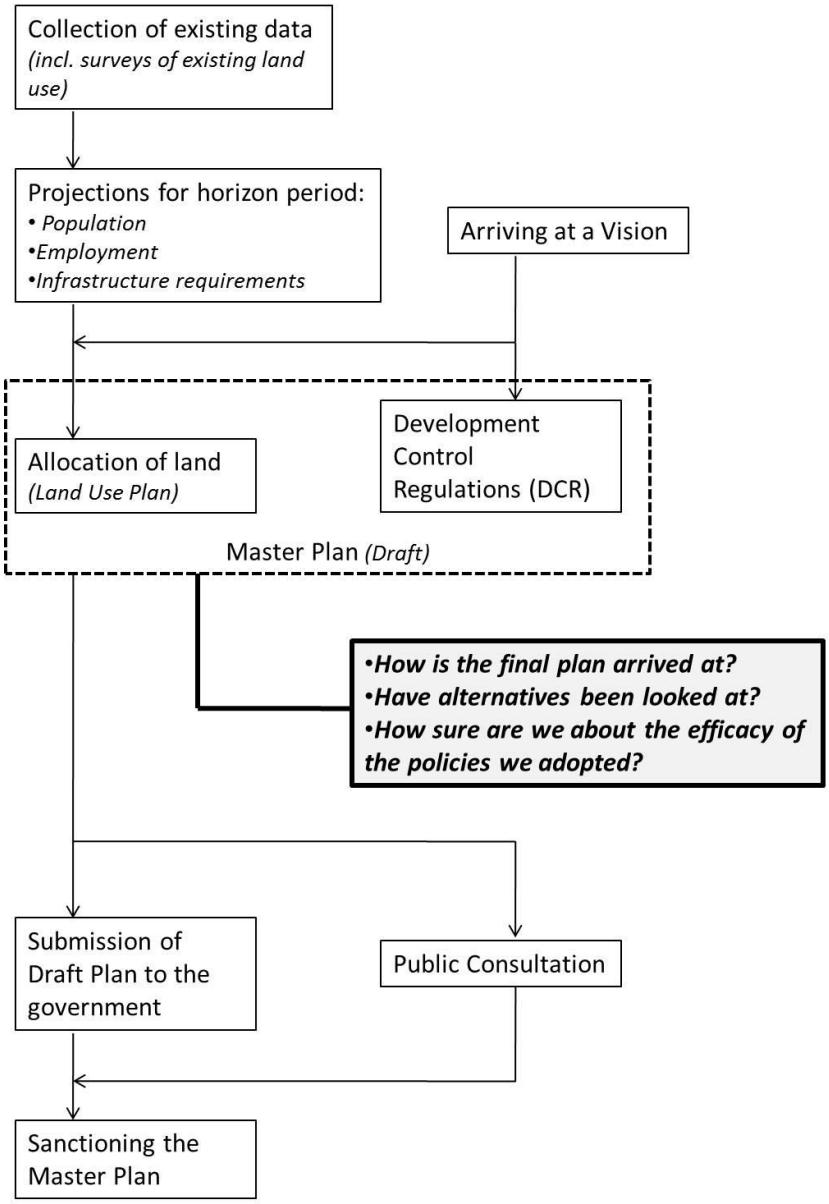


Figure 33: Master Plan preparation process in India
Source: Authors

Another significant point pertaining to our plan preparation process is the weak information base of our development plans, which is not only due to lack of practice of collecting wide ranging and comprehensive data historically, but also due to not fully utilizing the existing data available. For instance, only a broad over-view of selective data from the transportation studies, usually taken up separately in our

cities, inform the plan preparation in our cities. In most cases, such as in case of Hyderabad and Pune, the recommendations made by such studies are not always adopted in the development plans. This sits very well also with the fact stated by the ministry for urban development in the Government of India, in one of its studies on sustainable urban growth, conceding that while our master plans explain their output in form of future spatial growth, there is a very limited explanation of the transport network; and that they are not planned simultaneously, nor in complete view of the mutual impact they have, and that hence the current approach is not integrated (Shivanandswamy H.M. et al. 2013).

5.1.2. Policies for sustainable urban development

Traditionally, master planning in our cities has been an exercise usually limited to prescribing land use zones that are in form of large and more-or-less monolithic zones, but it has not worked because in reality land use in our cities has been generally mixed in nature. Now, mixed land use is a favourable urban form owing to the fact that it lowers down the trip lengths since options for general destinations of work and consumer activities could be easily found in the vicinity for an individual. Such an urban form promotes non-motorized travel modes like walking and cycling, and is inherently oriented towards making it work. And so for its inherent propensity to support integration of land use and the transportation networks, it has been seen as the most credible proposition during discourses on sustainable forms of urban development(Hunt et al. 2005). In India, even while travel in Indian cities takes place mostly through walking, cycling, and public transport, including intermediate public transport (IPT) modes (Tiwari 2007), the share of public transport use has been steadily coming down (Wilbur Smith Associates Ltd. 2008). This is because the infrastructure required for the use of non-motorized travel in our cities is found inadequate (Munshi, T., Joshi, et al. 2014), thus discouraging the use of such modes of travel. Also, exacerbating this is the development control regulation regime, which, in its present form, has failed to address the issue of sprawl in most of our cities, and has, in fact, fostered it through draconian land development regulation policies; not only putting severe strain on existing public transportation and in turn promoting the preference for private vehicles, but also having significant impact on the land markets in the city.

The recently revised Urban and Regional Development Plan Formulation and Implementation (URDPFI) guidelines (Ministry of Urban Development 2014)profess integrated land use and transport as the policy to achieve sustainable urban development. The master plans of most of our cities reveal that they have adopted this. But even then, the 'comparative study of plan preparation process of the five million-plus Indian cities'[60], as well as the evaluation of the master plans of these case cities[61] for their approach towards 'sustainable urbanism', done as a part of this research brings attention to the one of the structural reasons for the general failure of our plans at this approach. While all the cities spell out vision as that for a

[60](Munshi, T., Joshi, et al. 2014)
[61](Munshi, T. G., Joshi, Adhvaryu, Joseph, et al. 2015)

sustainable future growth, not only is there a confined understanding about what should a plan entail in order to achieve such a vision, but also, at many instances the plans are poised to go against the common principles of sustainability.

Of all cities, Pune explicitly identifies for itself, indicators for sustainability, which it says would be used to measure its performance in this regard. Other cities too invariably mention sustainability in their vision. There are more or less varying approaches to their plans though. For instance, while most of the case cities' planning approach has been to stop further congestion of their core areas, Ahmedabad and Bengaluru, despite having a relatively higher density in their core areas, speak of bringing more growth to the city-core[62]. Both of these cities aim to do this by permitting higher FAR as well as through redevelopment. The TDR policies of both Pune and Bangalore seem to be fostering further sprawl since it incentivizes development in their outer lying areas in lieu of restricting development at the core. This indicates that there is a lack of clarity regarding how compact can a city (or its regions) be sustainable enough. One of the common strategies in these case cities is to increase the ridership on public means of transport has been to either increase FSI along the public transit corridors, specifically in Ahmedabad and Pune, or to allow mixed-use activities in case of Hyderabad, albeit in a *no-FSI*[63] regime. But there is a general scepticism about it given how land and housing markets dynamics often pan out in our cities, often pricing the people out for whom public transport has a greater economic significance. With Hyderabad although the no-FSI regime seems to have increased housing-affordability, planning of infrastructure could quite possibly be a challenge unless a fair idea of how market forces would locate the population across the city could be known. These practices can be taken as fairly representative of all the cities in India.

This indicates that there are possible negative externalities of our planning policies or better put, our current approach to the policy of integration of land use transportation makes the capture of these benefits in our cities quite limited. And, there are questions raised over how appropriate our current practices in master planning. And, even while the need for rectification of the various institutional factors affecting the efficacy of our master planning seem to be equally compelling for the purpose; particularly with regards to the discourse on 'sustainable urbanism', there is indeed a pressing need for a reformed approach on how we decide upon our plans and how we integrate land use and transport.

5.1.3. Need for a decision making tool

It has been observed that cities have a thumb-rule approach to the two basic principles of sustainable urban development- 'land use and transport integration'

[62] The 2031 Bengaluru Master Plan seems to be conflicted in its purpose to bring development to the core city since its TDR regime is to incentivize growth towards the outer-ring road, which it says is to de-densify the core city.

[63] There are height restrictions on buildings depending upon the road-width they abut, and their plot sizes; however there are no height-restrictions on roads above 30m width (Munshi, T. G., Joshi, Adhvaryu, and Shah 2015).

and ‘mixed land use’. Various stakeholders in the planning profession, consulted during this research, have expressed their scepticism about the efficacy of certain policies that seem to have likely come out of a half-baked approach. Elaborating on the phenomenon of these thumb-rule policies for sustainability not having worked every time and in full-effect, Spiekermann & Wegener(2004) as well as Geertman et al. (2013) explain that sometimes ‘some policy adoptions may work against each other, whereas some may reinforce each other. Some policy options may improve the situation in parts of the region, whereas in other parts of the situation may get worse. Hence the design of policies to improve urban sustainability is anything but a straightforward task. Because the direct and indirect, the short-term and long-term effects have to be identified and measured in a transparent way, this calls for advanced methods of policy impact assessment and policy evaluation’. A deeper investigation into the impact of these policies will hence prompt realization that there is in fact a two-way relationship between the urban processes shaping up the city and the planning policies; and that there is there is a certain degree of case-specificity to these urban processes due to the socio-economic and spatial/geographic tendencies characteristic to the city. Thus, only a generalist adoption of these policies may not always result in a plan which truly benefits the city in achieving sustainable development. In order to assess the efficacy of the policies, planners will have to study their relationship with these urban processes, and ‘in order to get an idea of whether, and how far, the stated goals and objectives of the proposed plan (and its policies) can be met or not could be gauged only if one can forecast the implications of these plans and policy proposals’(Adhvaryu 2010). So, the approach to adoption of the principles of ‘integrated land use and transport’ and ‘mixed land use’ require to be supplemented with a sound understanding of the mutual relationship that these policies have with the urban processes in the city.

Now, urban processes, in their entirety, are quite complex and not simplistically linear. Southworth (Southworth 1998) depicts the complex functional linkages of various factors in the urban dynamics (see Figure 34). Handling such information requires a robust capacity that can weave-in the complexity into some framework that can then help simulate the urban processes and make projections based on the policy alternatives. This would improve the planning and policy decision making process by making it well-informed and rational. For this, planners have developed various scientific LUTI modelling techniques and utilized them in the plan making process. LUTI models catch all these various factors constituting the urban processes (housing, employment, transport, pollution, social segregation, etc.) together when analysing the cities and predicting outcomes. The simulations made by the LUTI models forecasts the city’s growth scenarios under alternative planning policies, thus facilitating public consultation process as well as helping planners make informed decisions that are based on scientifically rigorous methodologies and empirical evidences regarding the various urban processes. And hence, LUTI modelling can be a very effective decision making tool for developing policies that help achieve sustainability.

LUTI models simulate the interaction between land use (activities) and transportation network in city. The results of these simulations represent the scenarios under various planning policy alternatives. It has to be noted that the bases of these simulations are built from the established theories that have explained various urban processes in cities, and that the utility of these models is also self-corroborated by a process termed as 'back-casting'64 practiced at each modelling exercise. Since these models work upon a comprehensive collection of data (including social, physical and relevant data on economics), they mimic the real-life urban processes to represent not only the current urban interactions but also future scenarios possible under a given development regulation policy regime. Their employment to simulate forecasts also includes testing as well as comparing the outcomes of various policy alternatives, and thus helping make informed decisions in the plan preparation process.

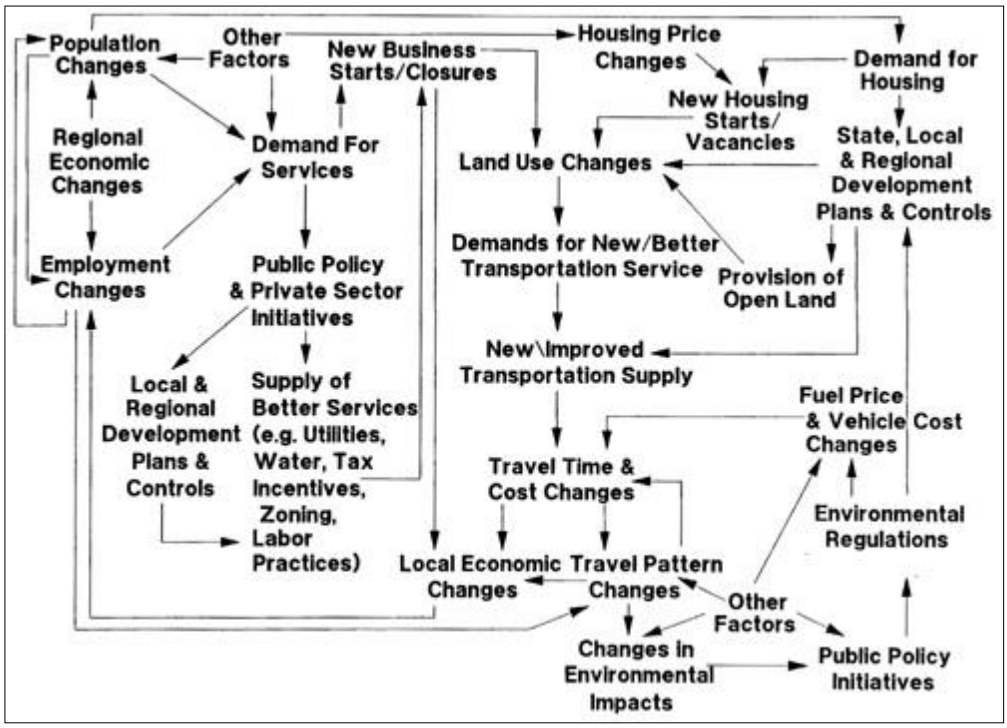


Figure 34: Complex functional linkages in an urban system dynamics
Source: (Southworth 1998)

However the role of LUTI models as an effective decision making tool is not only about helping to assess policies which could be shown can lead to sustainable urban development, but as EUNOIA(2012) explains, it extends significantly also to 'facilitating the participatory process for a collaborative decision making', apart from 'enhancing understanding of urban dynamics (explanatory role), and enabling virtual experimentation allowing prediction (predictive role)' of outcomes. Also, given that the enthusiasm about sustainable urban development comes from its role with regards to the larger issue of climate change, the fact that the

[64]In contrast to fore-casting, back-casting involves simulation using past data. If the output matches to a great extent with the prevalent scenario (data for which is of course, known), the model can be validated.

environmental impacts under various land use and transport scenarios could be quantified and represented using such modelling techniques makes it even more persuasive for adoption these techniques in our plan preparation process.

Saujot, et.al. (2015) list out the various uses of the LUTI models that they have been employed for different projects as:

- To make spatial distribution of jobs and population/households endogenous;
- To simulate the effect of transport on land use;
- To evaluate the effects of transport on land and housing prices;
- To assess environmental, social and economic impacts of urban dynamics and urban development scenarios;
- To test and recommend land use and transport policies to mitigate urban sprawl or improve sustainability;
- To perform over-all cost-benefit analysis of a transport project;
- To present projects and discuss them with the stakeholders- as a support for the debate and participatory process.

The idea that computer models of urban land use and transportation might contribute to a more rational planning was born in the 1950s with developments in the computing techniques. The significance of employing a rational scientific modelling methodology in mainstream urban planning has been realized long back in the west. For instance, some federal legislative acts in the US, such as the Clean Air Amendments Act, 1990 and the Intermodal Surface Transport Efficiency Act, 1991 make it necessary for certain designated metropolitan areas to employ such scientific simulation models for planning transportation management vis-à-vis the land-use (Quiroga 2000), which, it has been suggested, is also for the need to particularly quantify forecasts regarding possible emission scenarios under various plans, thus underlining their usefulness in making plans that help address the growing environmental concerns. In UK, the Department of Transport has issued a ‘Supplementary Guidance’ for the use of LUTI models in urban plan making.

Many LUTI models have been operational and in practical use in many cities across the world and their use must have proliferated to other regions too. The major urban modelling tools in use across various cities and urban regions are either developed by individual cities or group of cities such as VURCA, MUSCADE, NEDUM, or they employ the already available generic and commercially available modelling tools such as Tranus and UrbanSim(OECD Global Science Forum 2011).Wegener (1995)lists out some thirteen LUTI models that are operational:

- Projective Optimization Land Use Information System (POLIS) by Prastacos (1986) used for the San Francisco region
- California Urban Futures Model (CUFM), developed by the University of California (Landis 1992; 1993; 1994)
- BOYCE, developed by Boyce et al. (1992)
- KIM, an urban equilibrium model developed by Rho and Kim (1989)

- METROSIM, a micro-economic LU-T model developed by Anas (1994), for New York city region
- Integrated Land Use and Transport Package (ITLUP) developed by Putman 1983; 1991)
- Harvard Urban Development Simulation (HUDS) developed by Kain and Apgar (1985)
- TRANUS by de le Barra et al. (1984; 1989)
- 5-stage Land Use Transport Model (5-LUT) developed for Santiago city (Chile) by Martinez (1991; 1992)
- MEPLAN developed by Marcial Echenique& Partners
- Leeds Integrated Land-Use Transport Model (LILT) by Mackett (1983; 1990; 1991)
- IRPUD for the Dortmund region by Wegener (1985; 1986) and Wegener et al. (1991)
- Random-Utility URBAN (RURBAN) model developed by Miyamoto et al. (986) and, Miyamoto and Kitazume (1989)

Most of the operational models noted here are improvised and/or contextual variants of models that have been discussed in the following subsection.

5.1.4. LUTI models and their theoretical underpinnings

The modelling techniques employed for simulating various urban processes are premised on the established theories that have explained these processes and their evolution has been directly impacted through major developments in theoretical propositions as well as computing techniques. They were initially developed with an aim to solve the transportation specific problems, and later such techniques were converged with spatial (land use) allocations. Documentation of how various modelling techniques have evolved over time has been made earlier by Berechman & Small(Berechman and Small 1987), Southworth(Southworth 1998), Wegener(1995),Torrens(Torrens 2000), Hunt et al.(Hunt et al. 2005),Siva Kumar& Sivakumar(Sivakumar and Sivakumar 2008), Adhvaryu(Adhvaryu 2010), Waddell(Waddell 2011), amongst others.

i. Early spatial interaction models

The earliest LUTI models were based on the gravity model borrowed from the transportation sector. The premise of these gravity-modelling is that the number of flows between a pair of zones is a function of the sizes of these zones and the distances between them, directly proportional with the former and indirectly proportional with the latter. This was similar to the Newtonian law of gravity and hence called as Gravity models. This theory was used extensively in the transportation specific models and has been relevant to the LUTI models even today. 'Model of Metropolis' (known as the Lowry Model), developed by Ira S. Lowry (1964) for the Pittsburgh region in the US is very well considered as the stepping stone in the history of LUTI modelling. While flow of activities was based on gravity-models, the location of activity-centres was based on the economic base theory that

the basic sector[65]employment influences the population and the non-basic sector growth and hence these are endogenously modelled. Location allocation functions of these models also included factors such as travel costs, data on the trips, and attractiveness of various locations. These models worked with data aggregated at the zone[66] level.

Subsequent improvements included further disaggregation of population databy socio-economic groups (SEGs) to improve representation by Crecine (1964) in the Time Oriented Metropolitan Model (TOMM), matrix representation of the model by Garin (1966), known as Garin Lowry Model, and the Projective Land Use Model (PLUM) by Goldner (1971) in which allocation of activities was made based on 'intervening-opportunity' model as well as based on zone-specific activity rates and population-serving ratios(Berechman and Small 1987). Even then, these models could not account for the influence that housing-markets have on location decisions individuals make.Putman (1974; 1983)'s Integrated Transport and Land-Use Model Package (ITLUP) factored in traffic congestion on the basis of which the model wouldre-allocate activities during the iterations once such congested nodes could be encountered. This explicit attention to transportation network, was not given by the earlier Lowry-model types (Berechman and Small 1987). A later version of this model had an improvised land use model called Disaggregated Residential Allocation Model (DRAM). The land use sub-model had both the DRAM, as well as the Employment Allocation sub-model (EMPAL). Each iteration of the land use model produces a trip-matrix that is fed into the transport model producing a travel cost matrix that helped calculate new activity distributions. ITLUP has been regarded as the first fully operational Land-Use Transport software package with applications over a dozen places in the US. The model was made compatible with the Geographic Information System (GIS) technology for better representation of its outputs. It was called METROPILUS. The improvements included a land-supply sub-model with zonal constraints so as to limit land allocations where it has been saturated.

The Leeds Integrated Land Use Transport model (LILT) by Macket (1983; 1991) brought in the ability to handle demolition and changing occupancy rates, and had a sub-model that could estimate vehicle ownership (Iacono et al. 2008). IRPUD developed by Wegener (1982) allowed simulations that reflected changes in land-use over time. In fact, the model is a complex of seven different sub-models of aging, firm relocation, residential and non-residential construction, rehabilitation and demolition, change of residence and Travel-demand/Car-ownership. Therefore, all these early spatial interaction models are considered as 'first generation of models', and althought many of these have been tested and applied in numerous real life urban scenarios, apart from METROPILUS, not many are in use today(Iacono et al. 2008). The major shortcomings that chracterized these models were their

[65] The basic sector is one that caters to the non-local demands of goods and services.
[66] Delineation of these zones depends upon the lowest geographical unit for which population and other data would be available.

inability to factor in land-market with explicit prices, the spatial aggregation at which they worked, and the lack of 'theoretical justification to support the notion that urban systems operate in a fashion akin to Newtonian gravity' (Torrens 2000)

ii. **Random utility/ discrete choice models**

Lerman (1976) and McFadden (1978) illustrated how the 'Discrete Choice' theory could be applied to residential location problems. Wingo(1961)'s and Alonso(1964)'s explained the role of land markets in residential location, asserting that households trade-off higher site cost against lower commuting cost; whereas land-owners sell to the highest bidder. So, each household has its own bid-rent curve/function that described its tendency for location choice at given level of perceived utility. The 'Discrete Choice' theory was premised on this and explained that individuals decide upon a location that brings him/her maximum utility '(eg.: Cost, amenities, quality of school system, etc.)' from a given discrete set of choices (Torrens 2000). LUTI models that were already increasingly becoming more disaggregated in their approach and their data sets, adopted this. These models would seek equilibrium when the levels of utility of each of the households are adjusted, i.e. when they have occupied exactly one location in the city. Hence these models have a market-clearing mechanism, and they do this by endogenously determining prices in the land-markets. This way, they were significantly able to simulate how market forces govern residential location, making the modelling simulations closer to reality.

CATLAS, developed by Anas (1982; 1994; 1998) for simulating urban development in Chicago, captures the impact of improvement in transportation network on the land markets land markets using a discrete-choice framework that describes the demand as well as supply side of the housing markets. It takes in huge amount of data including construction costs, land prices, taxes, operating costs, expected future resale values, vacancy-occupancy, and construction-demolition. The supply side (developers) will assume locations and construction-type that maximizes profits; the same way the demand side (consumers) will choose a location that maximizes their utility given that their work-place locations[67] are fixed. Based on inputs on fixed number of firms (basic and service), fixed number of employed residents, prices of export commodity, congestion technology, floor space associated with each building type, the model makes endogenous calculations on spatial location of workplace as well as residence, housing types and their rental prices, wages and travel routes. CATLAS hence takes in a very comprehensive view of factors constituting the market forces to simulate location of activities, relying on a very large amount of data, which is at the same time seen as impracticable for data-deficient contexts. CATLAS was enhanced into METROSIM when it was applied to New York City metropolitan region in 1994, incorporating improvements with a sub-model for housing as well as commercial markets. Further improvements resulted in NYMTC-LUM model in 1998 to bring in the ability to evaluate various transit-policy changes in the city. Significant changes made were shrinking of the

[67] The model considers only two types of work-place locations- CBD and non-CBD

zone sizes, adding local-labour sub-model. 'An alternative framework for modelling land-markets in the LUT models was provided by Martinez (1992; 1996) by MUSSA for the city of Santiago' (Iacono et al. 2008), which was combined with the four-step transport model and known as 5-LUT model. MUSSA used a combined bid-rent and discrete choice approach to land-market. UrbanSim, developed by Waddell & colleagues (2000; 2002) was also developed with focus on simulating land-markets. Waddell and Borning (2004) added activity-based travel forecasting and Environment assessment modules. UrbanSim stands out from the preceding models of its times because it 'operates in disequilibrium from year to year, with no general equilibrium in land markets at the end of a time step. Since urban areas do not ever really reach a general equilibrium in land and travel markets' (Iacono et al. 2008), this model, in that respect, resembles the real world urban dynamics in a far better manner. Introduction of the decision theory where individual's decisions are based on their utility maximization in a given land market did bring in economic angle to urban simulations hence enabling them to make more realistic simulations on how urban processes function. However, these models were still the aggregate-based in their approach.

iii. Disaggregated/micro-simulation models

The theoretical validity of gravity-based four-step transport modelling was always questioned. These models failed to ground themselves onto the 'fundamental tenet that travel demand is derived from the demand for activity participation' (McNally and Rindt 2008). They also ignored the spatial and temporal relationships between trips and activity scheduling. So, these models could not simulate behavioural responses to different policy decisions such as 'traffic flow improvements, flexible working hours, and diversion of traffic to alternate modes' (Iacono et al. 2008). Improvements were made on these issues in the newer modelling techniques.

These improved models are further classified as Activity based and Agent based. Activity based models predict which activities take place when, where, for how long, and the travel choices they will make to complete them'(Travel Forecasting Resource n.d.). Some of the initial attempts at constructing such models included the one under the Travel Model Improvement Program (TMIP) of the Federal Highway Administration in the US, CARLA (Clarke, 1986), STARCHILD by (Recker et al., 1986). STARCHILD is considered as the first operational activity based model but it was designed for research and not for general application. It produces choices an individual may make regarding travel pattern for participating in an activity. This is done on the basis of 'exogenously available directory of activities along with duration, location and time window of participation'(Pinjari& Bhat, 1970). Feasible alternatives are identified which then establish pattern choice.

One of the stumbling-blocks of these models was that the data requirements were such that were difficult to obtain. Also, since activity-based models 'simulate travel behaviour within the limits of time and space, it cannot be modelled within a framework that treats trips as independent and generates trips at an aggregate level'(Iacono et al. 2008). In agent based models, each individual actor is modelled

as an autonomous agent, possessing an identity, attributes and capacity to make decisions. The agent maybe developers, individuals, state policy etc.

iv. Cellular models

The 'Complexity theory' suggested that systems, such as the urban systems, are too complex to be explained using closed system and predetermined mathematical formulations and that they actually arise from a 'collective interaction and self-organization of a large number of individual agents' (Iacono et al. 2008). Cellular models are considered as a variant of the Micro-simulation models, and also sometimes more specifically as agent-based micro-simulation models, due to the highly disaggregated way they segregate the urban space into during their simulation. The entire urban area is modelled as a lattice of cells which are the unit of operation in these models. Each cell is characterized by a state. These states can be qualitative data on land uses, quantitative data such as on population, density, degree of development, vector of several attributes, or even binary values such as whether the cell is urban or non-urban land(Santé et al. 2010). This modelling technique is based on the assumption that past urban development affects future patterns through local interactions among land uses. The state of each cell depends upon the previous state the cell has been in, as well as on the state of its neighbouring cells. Change of state in these cells is governed by predefined 'transition rules'.

The CA modelling technique is regarded for its high level of spatial detail as well as the capacity to link the results to the GIS system for a better visual of the spatial structure. It is also considered to improve upon the many earlier LUT models that were static in their explanation of evolution of the land-use pattern in a city over time, and could not explicitly consider the process changing or creating them. Also, one of the major, and rather compelling advantage for these models as pointed out by Rodrigue(Rodrigue 2013) is that conventional LUT models are based on the empirical evidences in the 'developed countries' in the west, which may not be able to truly represent the typical land use characteristics in the developing world. Since CA models premise their spatial evolution process based on 'transition rules' created according to the local context, they may have an edge over other models. However, it is felt that the CA models may be limited to explaining evolution of land use based on historical data and may not be too useful as an robust forecasting tool when land use and transportation are in togetherness (Iacono et al. 2008). Also, a cell based micro-simulation methodology is suitable when the data that the modeller deals with is sufficiently simple; and a more complex simulation would demand the agent-based modelling methodologies (Geertman et al. 2013)

Summary: Therefore, LUTI modelling has evolved over the time, weaving various established theories that explain the urban dynamics. Over time they have improved their methodologies by becoming more disaggregated with their data sets and by including factors that capture market forces to make simulations that are would represent the real situation in a better way. These models rely on a large

amount of data on various factors explaining urban processes- mainly concerning location of activities and the flow between them, to as complex as the impact of transportation network improvements and construction-demolition scenarios. However, it would not be appropriate to say that these models always require such comprehensive data on a very wide range of factors to make accurate forecasts. Most of the times, the required variety of data demanded in a particular modelling exercise depends upon the desired complexity and the objectives that are set out at the start of such modelling initiatives. So, a reasonable amount of data on factors concerning location of activities and their flows can very well give satisfying simulations for the purpose of studying the impact of various Land Use Transport integration policies in a city.

5.2. Attempts at LUTI modelling in the Indian context

The ability of scientific modelling techniques to make realistic predictions rests largely on them being fed with disaggregated data on a reasonably comprehensive amount of factors to truly capture and represent the influence of urban processes. Their rather tremendous proliferation in the west and in other parts of the developed world has been due to a history of comprehensive and reliable wealth of data too. Chances of such practices in cities of the developing countries, such as in India, are marred by constraints of the availability of such reliable and comprehensive data. Data availability is typically the reason that hinders the usage of complex and data-demanding mathematical methods. Speaking specifically of the Indian context, despite the fact that 'no visible attempt is being made to collect relevant land use and transport data in this regard' (Srinivasan, 2005), there have been attempts to develop some methodology that may be adopted even with the kind of data availability our cities have.

Attempts at understanding and explaining the urban growth processes using modelling techniques have been made, albeit fewer in number. Sudhira, Ramchandra, & Jagadish (2003), amongst others, have explained sprawl using GIS and Remote Sensing techniques for historical data and predicted it under various scenarios.Their work however relates more exclusively to the realm of geographical studies with a very limited overlapping onto the context of land use transport integration. In fact there are fairly considerable attempts at utlizing the GIS and remote sensing techniques to study urban form, but speaking parituclarly of LUTI modeling in the Indian context, we have only a handful of examples. Moghadam & Helich (2013) and Munshi, et al. (2014) have used the Cellular Automata model to forecast urban growth in Mumbai and Ahmedabad respectively. The former is a 'Markov Chains' CA model, and the latter has used 'Logistic Regression' to make it's projections.Moghadam & Helich (2013)examines past urban land use data and how it has changed over the years. The model simulates growth depicting the growth patterns across the city, areas of infill and redevelopment.

Attempt at illustrating how LUTI modelling can be done in the Indian context has been done by Adhvaryu & Echenique (2012)for Ahmedabad with their model-

SIMPLAN[68], which is a simpler Lowry-based version of the MEPLAN model. It has simulated allocation of activities in a based on available data on employment locations and socio-economic characteristics of the population[69]. Their model had four different modules (Trend Analysis Module (TAM), Residential Location Module (RLM), Modal Split Module (MSM) and Assessment Module (ASM)) that simulate different types of results, although connected. The TSM analyses spatial growth trends using 'density gradients, dispersion index, and concentraiton/deconcentration measure'(Adhvaryu 2010).The RLMsimulates, for a particular future year, distribution of residential location of the workers based on the econometrics of average housing rents using a gravity-type allocation function with destination-constraints, where 'employment location by income-groups' (SEGs[70]) is set as the constraint. Each SEG has a different income elasticity and price elasticity for housing floor space (IEDH and PEDH repsectively), and since this is considered in the model, influence of land/housing markets over an individual's choice of location is fairly brought into simulation. This forms the basis of determining how much residential floor space is consumed in each zone by these SEGs. Based on their residential location, their work trips are simulated. The MSM module generates modal split for these work-trips from the already available (and inputed) data on vehicle ownership and the modeled values of workers' residential location and work-places obtained from the RLM. The model attains equilibrium when the available floor space (supply, and based on allowable FSI) in each zone is completely filled by the the demand, until when, iteration is carried out. This also helps gauge the adequacy of FSI proisions in the city based on how land markets eventually work out under given set of policies. The utility of this model is also further entended by the ASM that helps assess different planning policies for their 'social (SEG mix, distribution of economic benefits, and accessibility), environmental (CO2 emissions) and economic (net benefits) impact on the city' (Adhvaryu 2010).

Most of the data regarding the dynamics of land and housing markets, which is required by SIMPLAN is not usually collected in our context, and can be found only as separate studies, or could be even synthesized by conducting relevant surveys since they are city-specific in nature. Adhvaryu & Echenique(2012) have sourced such data from a separate year 2001 study by the Louis Berger Group Consortium (LBGC). They mainly includes key structural factors such as income elasticity and price elasticity for housing demand (IEDH and PEDH, respectively), attraction factor for each location (zones), and Beta parameters. Data on average rents, generalized cost of travel, land prices, and modal splits are collected from relevant sources which are generally easily available in any city. Another attempt at simulating growth development pattern is by Munshi, et al. (2014) for Ahmedabad. They have

[68]It is a simpler Lowry-based version of the MEPLAN model

[69] Refer (Adhvaryu and Echenique 2012) for a detailed explanation on the working of the model.

[70] Adhvaryu & Echenique(Adhvaryu and Echenique 2012)had four SEG groups for their analysis viz. SEG-1 (professional/managerial), SEG-2 (administrative/clerical), SEG-3 (semi-skilled), SEG-4 (unskilled). These groups were identified based on the census data on main and marginal workers.

used a Cellular Automata (CA) based model where in the model simulations have again shown a resonably sufficient concurrence with the on-ground situation of a known year (the year 2012 in this case)[71].The model uses some strucutral and functional indicators that include residential and employment density, dissimilarity index (to depict variation of land uses and factor in the probability of certain activities developing in vicinity of), job-housing ratio, kernel density (indicating the catchment area of the roads),property values and other accesibility variables. Using these and using a set of transition rules (that represent the most common principles of how various kinds of activities locate spatially under a given set of regulatory policies), land use can be simulated for any projected year. The results of this model has confirmed the heterogenous way Ahmedabad has grown and it can very well be used for simulating scenrios under different kinds of development policies.

5.3. Summary

In the context of the perceived limitations of the conventional approach to the plan preparation process in India, LUTI modeling attempts made in India and discussed before, illustrate how the plan preparation process could be made more transparent and the policies, more rational even with the kind of data-availability here. The results of these models have shown fair concurrence with reality making them compelling tools to add scientific rigor to the plan preparation process. These attempts reiterate what modeling techniques elsewhere has proved- that such scientific modeling simulations can augment urban planning by allowing to foresee how certain policies would work out, and how certain policies may not work out as envisaged, thus they help in making informed decisions. And even while 'planning and the decisions it embodies will remain ultimately political, despite the elaborate legal framework, and procedures and guidances' (Hull et al. 2008), the use of such robustly demonstrative tools as LUTI models facilitate the public discourse on various plans and the policies, thus performing as a guiding spirit for rational analysis. Also significantly, a sense of relization that these various modelling attempts bring is that although exercises in urban simulations using the modelling techniques are typically seen as requiring to be fed with a comprehensive variety of data; and in many (subjective) cases, possibly it is also about having such data covering a significant historical period, ultimately the data-demands of each modelling exercise is actually determined by the desired levels of complexities which are, more often than not, about having additional aspects included to the studying the various urban processes *allied to* the 'land use transport integration', which is the mainstay of the purpose of utilizing such models .

[71]Refer (Munshi, T., Zuidgeest, et al. 2014) for detailed working of their methodology.

6. Operationalizing the LUTI model

Discourses on urban sustainability have compelled planners to think about efficacy of their policies which in turn also leads to being able to make rational (quantifiable) justification for the chosen planning policies from a set of alternatives. With the advantage of being able to bring scientific rigor to the decision making processes in master plan preparation, LUTI models have been used with great advantage towards this purpose. Such techniques have been used rather extensively at various instances in different cities in the developed parts of the world that have the benefit of not only already having a historical practice of collecting comprehensive and reliable data but also a large number of proliferated efforts at developing such scientific methodologies to studying urban processes. In the Indian context, specifically speaking of attempts at LUTI modelling, they have been only handful, but nevertheless they have already illustrated that even with the kind of (limited) data availability here, we can still tailor ourselves modelling techniques that can make reliable simulations, explaining as well as forecasting urban processes, and adding vital information to facilitate the decision making process.

The purpose of the present research is to devise such a LUTI modelling methodology and test it in the Indian context. The findings of this research with LUTI modelling would be then disseminated to a larger audience of planners and concerned stakeholders illustrating how the lacunae in the current plan preparation practices could be remedied using such models.

6.1. Introducing the LUTI model

The proposed 'LUTI model' is inspired by Adhvaryu & Echenique (2012) SIMPLAN modelling suite mentioned earlier. Speaking specifically, it adopts the math for its simulations from the econometric Residential Location Module (RLM) of the SIMPLAN and is a comparatively technologically-improved version.

Allocation of activities is made by the model on the premise that individuals (household) tend to choose their places of residence as near as possible to the place of their jobs. However the decision of location also includes other factors such as the prevalent housing prices (rents) as well as the cost of travel. Certain desirable factors such as accessibility to amenities, public transportation etc. also explain the choice of locating at places that may or may not necessarily be borne out of the tendency to keep nearer to places of work. Additionally, the factor of time involved in travelling to participate in activities, is also considered in terms of cost of time.

6.1.1. Data requirements:

Details of inputs to the model and their sources are given in Table 32. The inputs mainly include projected population and employment values (obtained from the master plan)- both disaggregated at the zonal level, transportation network, property values in each zone, built-up floor space and wages across various income groups. Also a variety of structural indicators are quantified- Beta

parameter, attraction factor, Range and, Price and income elasticity indices for of different socio-economic groups for housing. These are explained subsequently.

Table 32: Inputs to the LUTI model

Input	Type	Source	Input Data Set
1. Input to the Model for Calibration (for Stage 1)			
No. of Zones	Number	User Defined	1
No. of SEGs	Number	User Defined	1
Year	Number	User Defined	1
SEG wise jobs	Number	User Defined	1
SEG wise Vacancy Rate	%age	Primary Survey	1
Zone Wise Input	Number		1
- Population (P)	Number	Census	1
- Resident Workers (R)	Number	Census	1
- Jobs (J)	Number	User Defined	1
- Household (H)	Number	Census	1
- Builtup	Number	GIS Database	1
- Total Area (ha)	Number	Master Plan/ GIS Database	1
Zone Wise SEG Wise HH	%age	Expert Review	1
Zone Wise SEG Wise Jobs	%age	Expert Review	1
Zone Wise Input			3
- Residential Area (ha)	Number	Master Plan/ GIS Database	3
- Permissible FSI	Number	Master Plan/ GIS Database	3
Adjt Factor	Number	User Defined	3
Working days (in a month)	Number	User Defined	3
Working hours (in a day)	Number	User Defined	3
Factor	%age	User Defined	3
SEG wise Beta Parameter	Number	Existing Study	3
Range	Number	Existing Study	1
SEG x PEDH[72]	Number	Existing Study	1
IEDH[73]	Number	Existing Study	1
RoI	%age	Existing Study	1
SEG wise Monthly Income (Rs.)	Number	Existing Study	1
SEG wise Expenditure on Housing (%age)	%age	Existing Study	1
Model Precision Parameters			1
- No. of Iterations	Number	User Defined	1
- DS Ratio	Number	User Defined	1
- Overall	Number	User Defined	1
- ATL Observed (Km)	Number	Existing Study	1
Minimum Dwelling Unit Sizes (mtr2)	Number	Existing Study	1
Valid Year for the Entry	Number	User Defined	2
Vehicle depreciation/Year	%age	User Defined	2
Life (yrs.)	Number	User Defined	2
Driven (km.)	Number	User Defined	2

[72]PEDH- Price Elasticity of Demand for Housing
[73]IEDH- Income Elasticity of Demand for Housing

Input	Type	Source	Input Data Set
1. Input to the Model for Calibration (for Stage 1)			
Capital Cost (Rs.)	Number	User Defined	2
O&M (Rs./Year)	Number	User Defined	2
Mileage	Number	User Defined	2
Fuel cost	Number	User Defined	2
% Modal Share	%age	Existing Study	2
Distance Matrix - Private	Numbers	GIS Database	2
Distance Matrix - Public Transport	Numbers	GIS Database	2
Modal Split SEG Wise Mode Wise	Numbers	Existing Study	2
Average speeds for Private, Cycle and PT	Numbers	Existing Study	2
Public Transport Fare Matrix	Numbers	Primary Survey	2
Property Rates Year	Numbers	Primary Survey	2
Discount rate (%age)	%age	Existing Study	2
Area and Cost of Properties	Numbers	Primary Survey	2
2. Inputs to the Model for Scenarios/Alternatives (for Stage 2)			
Plan Year	Number	User Defined	
No. of decades for Trend	Number	User Defined	
No. of decades for Data availability	Number	User Defined	
- Population (P)	Number	Census	
- Households (HH)	Number	Census	
- Resident Workers (R)	Number	Census	
- Jobs (J) (Optional)	Number	Existing Study	
Zones in Municipal Area	Number	User Defined	
Name of Scenario	Number	User Defined	
Income Growth Rate (Per Annum)	%age	User Defined	
Discount Rate (Per Annum)	%age	User Defined	
Housing Growth Rate (Per Annum)	%age	User Defined	
Zone Wise Public Transport	Rating (Number)	User Defined	
Zone Wise Dwelling Units (Target) (Optional)	Number	User Defined	
Weights for Parameters	Rating (Number)	User Defined	
- Pop. Distribution	Rating (Number)	User Defined	
- Rent Ratio	Rating (Number)	User Defined	
- Public Transport	Rating (Number)	User Defined	
- Jobs	Rating (Number)	User Defined	
- Floors pace Available	Rating (Number)	User Defined	
Percentage breakup for Additional DU (Proposed)	%age	User Defined	
Vehicle O&M Increments	%age	User Defined	
Public Transport Rating Systems - Impact on speeds	Rating (Number)	User Defined	
Model Precision Parameter (DS Ratio)	Number	User Defined	
Dwelling Unit Sizes (mtr2) (Optional)	Number	User Defined	
Housing Prices for 2031 (Optional)	Number	User Defined	

Source: Authors

6.1.2. Modelling methodology

The city area is divided into a number of smaller zones for which data at the relevant level of disaggregation is available. The model ultimately simulates zone-wise

locations of residential and retail activities based on the given[74] locations of the basic-sector employment centres [75] , amongst simulations of other parameters [76] made to achieve the final land-use projection. The econometric residential allocation takes into account the rents across the city, the buildable floor space (consumable FSI) and the size of the dwelling units (DU) at each location, and modelled values of the average trip lengths (hereon referred to as ATL) that in turn help produce an OD cost matrix by time and distance. The econometric allocation takes into account the tendencies of individuals in their locational decisions with their socio-economic conditions as their basis- for which the entire population is disaggregated according to the socio-economic groups (henceforth referred to as SEGs).

These dynamics are incorporated into this model using various structural factors explained here: firstly, resident workers are located in the zones with respect to the economic categories represented by R_{ij}^{m} (SEG wise mode wise trip matrix), secondly, the location of the residents are based on housing rents and the cost of travel represented as $\mathbf{c}_{ij}^{m}$ and finally the model runs by adjusting the housing rents keeping in mind the demand and supply of housing which is represented as r_i^{*unit} . This dynamics represents the calibration part (Stage 1) of the model which is explained further more. The next stage is the scenario testing which uses the calibrated data.

The SEG wise-mode wise trip matrix[77] is defined as:

$$R_{ij}^{m} = E_j^{m} \frac{X_j^{m} \exp(-ß^{m} c_{ij}^{m})}{\sum_i X_j^{m} \exp(-ß^{m} c_{ij}^{m})}$$

Where $\mathbf{R}_{ij}^{m}$ is the number of resident workers of SEG type m locating in zone i with a job in zone j.

$\mathbf{E}_j^{m}$ is employment in zone j by SEG type m

$\mathbf{X}_j^{m}$ is the attraction factor for zone j, calculated as $\mathbf{X}_j^{m} = \mathbf{F}_j \wedge (\boldsymbol{\delta}^{m})$

$\mathbf{F}_j$ is the maximum allowable Floor space area in zone j

$\boldsymbol{\delta}^{m}$ is a factor that explains making a zone more or less attractive over time for a particular SEG type m. It is a parameter that incorporates the factor of entropy in location decisions. It captures the dynamics of how certain locations with desirable

[74] These given locations of employment centres are forecasts made by pertinent stakeholders in the city

[75] This is premised on the well-established 'Economic Base theory' which says that the growth in the basic-sector industries in a city governs growth of non-basic sector and consequently, over-all growth in the city.

[76] explained later in the detailed working of the model

[77] SEG wise Mode wise trip matrix is the number of resident workers of SEG type m locating in zone i with a job in zone j using a particular type of mode.

characteristics influence location choices over other considerations such as distance and cost.

$ß^m$ called 'Beta parameter' is a factor specific to each SEG group m.

c_{ij}^m is the composite measure of generalized cost converted to Rupees (Rs)/day to avoid huge magnitude values; it is calculated as:

$$c_{ij}^m = r_i^m + v_{ij}^m + f_{ij}^m$$

again, where

r_i^m is the average imputed housing rent paid by SEG type *m* in zone *i* obtained as $[r_i^{*unit} d_i^m]$, in Rs/day

v_{ij}^m is the average time cost for a round trip between zone *i* to *j* by SEG type *m*, in Rs/day.

f_{ij} is the average out-of-pocket expense (such as fuel, fare, etc.) for a round trip from zone *i* to zone *j*, in Rs/day.

In order that the modelled values of housing rent reflect the trends of the housing market, they are calculated as:

$$r_i^{*unit} = r_i^{unit} \left(\frac{D_i}{S_i} \right)^{\theta}$$

where,

$r_i^{*\,unit}$ is the (new) unit monthly rent (Rs/sqm) in zone i

r_i^* is the (previous) unit monthly rent (Rs/sqm) in zone i

D_i is the total resident floorspace demanded (sqm) in zone i

S_i is the total residential floorspace supplied in zone i

θ is the control parameter estimated to be 01. (the purpose is to control the oscillations in the demand – supply ratio, enabling the model to converge quickly)

The model is fed with data and after the first run of the model, it is calibrated[78] for a year whose data is already known. Once the model is calibrated, it is ready to be employed for making simulations for testing scenarios for a desired year. Figure 35 shows the flow-chart illustrating the processes of the model, and the steps it mentions can be referred to in annexures.The steps (1 to 30) which are to be followed in the model are detailed out in Annexure 1, which describes the steps with specific instructions/information that the user needs to understand before supplying data to the model. Annexure 2 shows the screen shots (from A to H) from MS Excel which further helps the user as to where to navigate in the excel sheet.

[78] The process of calibrating the model, termed also as 'back-casting' involves making projections for a year, data for which is known, to set the values of structural factors so that the output produced resembles the data of a known time. Once this is done, the model is said to be capable of giving reliable results that are close to reality.

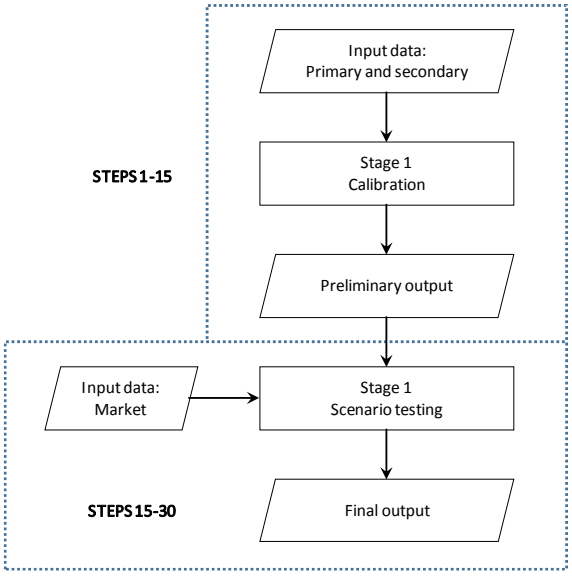


Figure 35: Schematic representation of the processing of the LUTI model
Source: Authors

The model can be said to have two distinct stages: Stage 1- Calibration of the model, and Stage 2- Scenario testing.

Calibration of the model: Calibration of the model starts with providing basic data to the model. Table 32 specifies the nature of the data required for the model. After providing the data as per Table 32, the model begins to calibrate[79], detailed description of which is explained in Figure 36. The data-requirements of the model are segregated into three different sets as indicated in Table 32.After providing the necessary information to the model, it calculates the residential locations for the resident workers based on the generalized cost of each mode. These residential locations are the outcome of the jobs which generate the demand for housing. This generates aggregate demand for housing floor space, which is matched with supply. Model runs for as many iterative steps as required for the demand–supply equilibrium to be reached (Marked as 1, 2 and 3 in Figure 36 as the components of the model for which equilibrium is to be achieved). Once the model reaches equilibrium, the adjusted delta values (attraction factor) for each zone are calibrated. The final adjusted δ_{im} (the SEG wise [m] zone wise [i] Delta values) are the ready to be used in the subsequent model-runs.

Scenario Testing: Once the model is calibrated and values of all the structural factors are obtained, the model is ready for the main run. In this stage different scenarios are projected for different policy alternatives. These scenarios represent the different approaches to urban development policies seen in the case studies selected in the earlier part of this research. For the purpose of this study, there are three scenarios that are taken into consideration and simulations are made for each of them:

[79]This process takes some time-from few hours to few days depending upon the computer's capabilities.

a. Business as usual (BAU)
b. Compact City (CC)
c. Dispersed City (DC)

Most of the parameters here are user defined and numeric, representing alternative policies for urban development that the modeler may want to test-out for the city. Provision of each parameter affects the scenario and hence before deciding its value the model has the help manual attached with the excel sheet (refer annexure) in order to understand the significance of the parameters. The scenarios which are taken for the testing are hypothetical scenarios and hence user can modify/adjust the scenario based on his/her discretion.

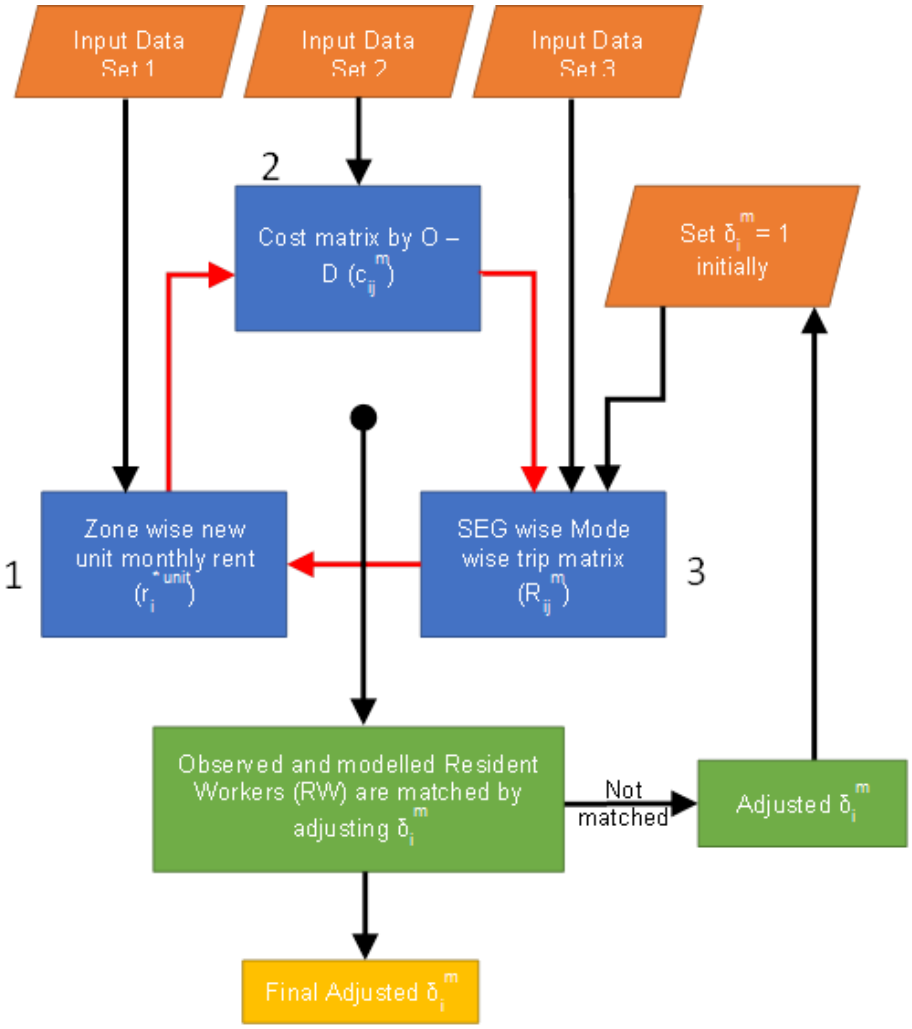


Figure 36: Calibration of the LUTI model
Source: Authors

6.1.3. Outputs of the model

The outputs of the model are produced in terms of the Average trip lengths (ATL), average rents and average dwelling unit (DU) sizes for each socio-economic groups. Also projections of population in each zone and the FSI that would be consumed for all the different scenarios are also made during the simulations towards the final outcomes.

While allocation of activities and the concomitant values of the average trip lengths help to go further in estimation of carbon emissions incurred in each scenarios, the consumption of FSI in each zone helps the planner to get an idea as to the kind of FSI regime and its distribution across the city that would facilitate market forces rather than stifling it. So simply put, the outputs give a better understanding during the decision making process as to which type of development front the city should adopt.

6.2. Application of the LUTI model in the Indian context

6.2.1. Choosing the case city for model application

Rajkot was chosen as the case city for the application of the proposed LUTI model as the investigators of this research are very well versed with the city, having worked extensively on it over various other research projects; and also because of a reasonably comprehensive amount of data was already available for the city.

a) Meeting with Association of Consulting Civil Engineers, Rajkot

b) Meeting with Ar. Shobhit Tayal (DPC), Ahmedabad)

c) Meeting with representatives of Rajkot Builders Association

d) Meeting with Mr. Bakul Rupani, Retired Town Planner (RMC)

Figure 37: Engaging the local stakeholders in Rajkot
Source: Authors

Rajkot is a city of 1.5 million people spread across an area of 684.77 sq km of the urban agglomeration while the municipal corporation area, however, covers an area of 98.24 sq km with a population of 1.28 million people (Census 2011). It has been regarded as one of the fastest growing cities in the country and can be reasonably used as a case for illustrating the LUTI model's utility in the Indian context.

6.2.2. Running the model

The city is divided into 75 zones. The decision of choosing the number of such zonal divisions in any other city could be done on the basis of the spatial level of availability of disaggregated data on employment, population, rents and other data

described earlier. For the purpose of this study, three income groups are chosen: SEG-1 (the high income group-HIG), SEG-2 (middle income group-MIG) and SEG-3 (low income group-LIG). In order to understand the local development trends, stakeholders were engaged in meetings to understand the areas where residential, commercial and industrial development was expected to come in the next twenty years. The local stakeholders included sector experts, consultants and professional associations related to the real estate in the city. The general sense that came from the interactions with the stakeholders was that the residential growth in the city would mostly occur in the western parts of the city, with middle and lower income groups mainly locating around the industrial zones lying on the periphery of the city. Commercial activities in the city do not cluster together at single locations but develop along arterial roads across the city, albeit more on the two major ring roads. These inputs were noted in terms of ranking of each zone for its propensity for development of a particular activity (residential, industrial and commercial) for all the three scenarios that the model would then make tests for. The inputs regarding growth potentials have been represented onto maps in Figure 38.

Stage 1: Calibration of the model

Data as described in Table 32 is fed into the model during the first stage 1, which then results into simulations of the values of the rents, SEG wise Average Trip lengths, and the FSI consumption, in each zone. Since this is the calibration stage, data for the year 2001 is fed into the model, which is then run for as many iterative steps[80] as required for the modelled values for 2011 to match with actual known values from available data for the year 2011. The degree to which the modelled values in this case are allowed to deviate from known observed values is kept at 2% which is reasonable. The average trip length of Rajkot observed in previous studies is 3.8 km (LCMP Report) which is found to be close to the modelled Average trip length of 3.72 km. The SEG-wise average trip lengths according to the LCMP report are 4.2 km for HIG, 3.8 km for MIG and 3.2 km for LIG, which are very close to the modelled average trip lengths. Figure 41 shows the rent variations in the Rajkot Planning Area which is very similar to the observed rents for Rajkot which is Rs. 6,274. Even, the modelled and the observed actually consumed FSI are close to each other as indicated earlier. So, the model is calibrated and stabilized, so ready for testing the scenarios.

[80] In this case, it took 56 iterations for the model to stabilize.

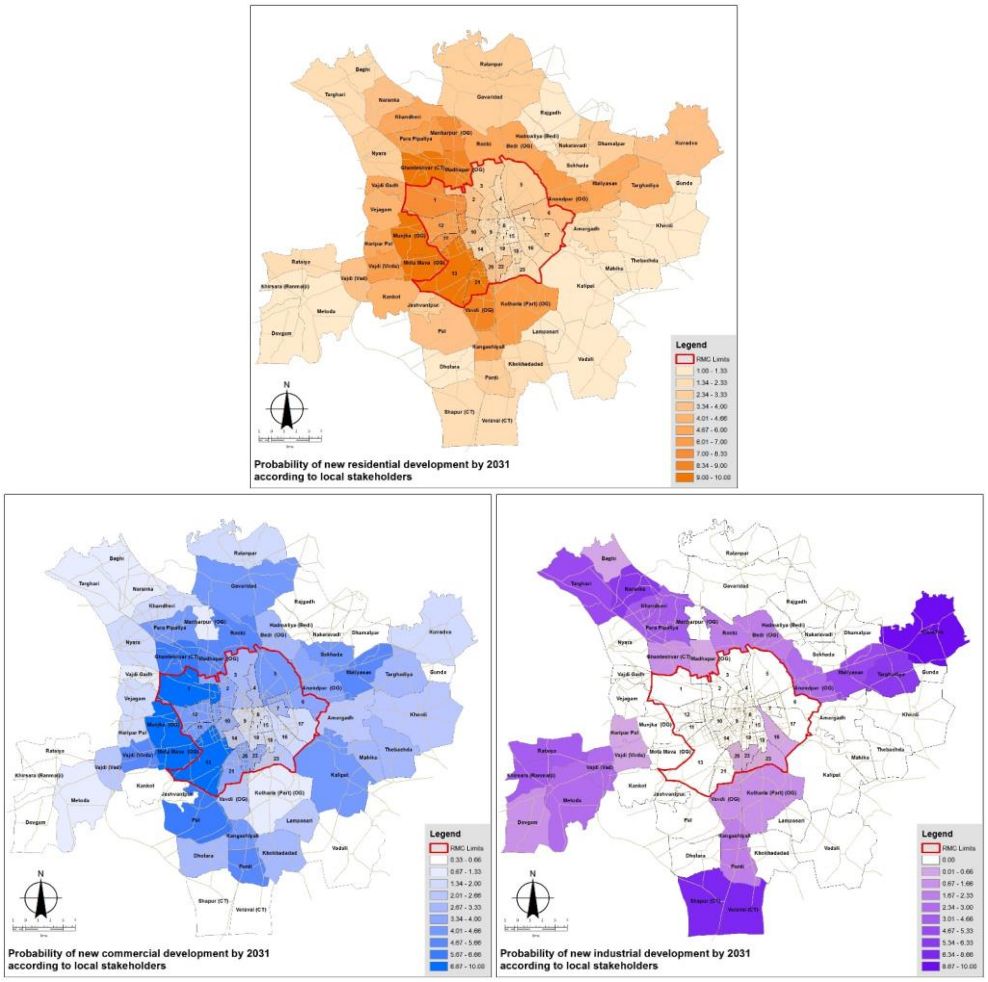


Figure 38: Probability of residential, commercial and industrial development (2031)
Source: Stakeholder meeting, Rajkot

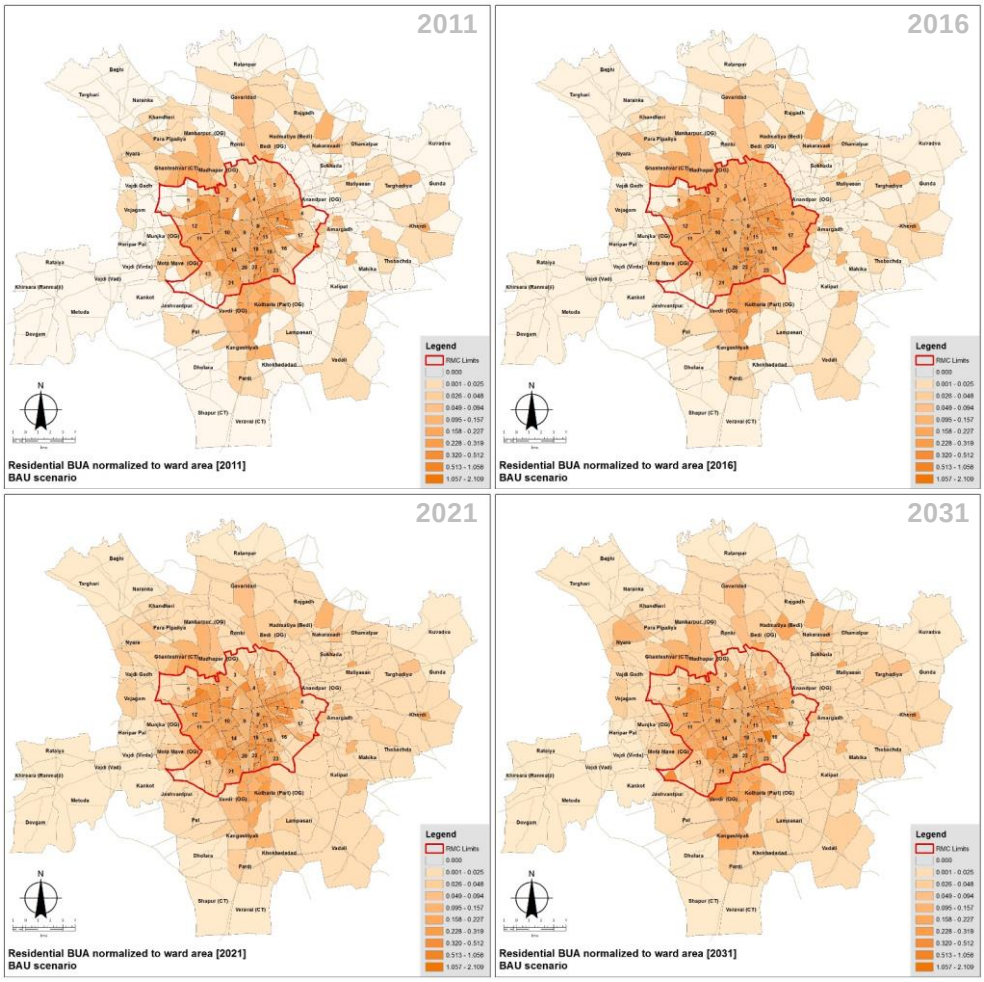


Figure 39: Residential BUA normalized to ward areas
Source: Authors

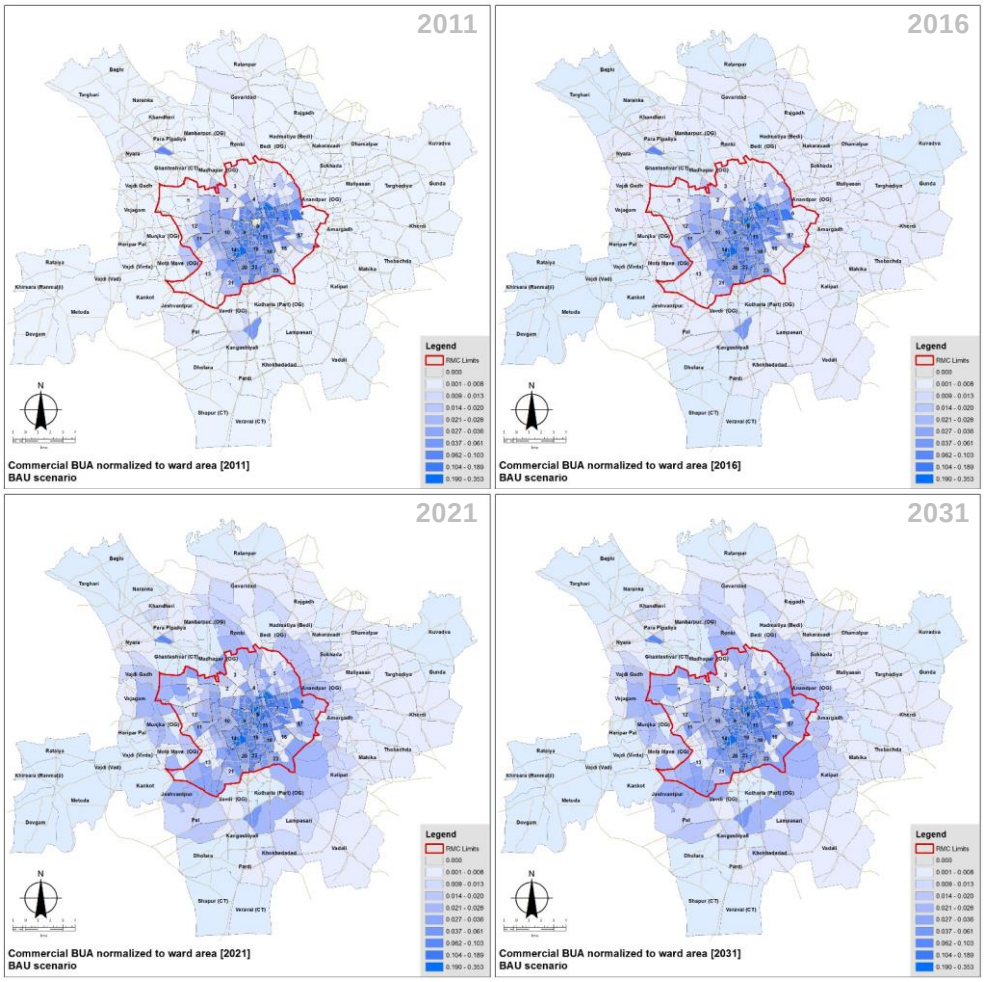


Figure 40: Commercial BUA normalized to ward areas
Source: Authors

Table 33: Modelled values of Average Trip Lengths (ATL)

Mode wise ATL (kms.) for base year				SEG-wise Rents, DU size and ATL		
SEG/Mode	Private	Cycle	PT	Rents (INR)	DU Size	ATL
HIG	4.15	4.03	3.33	10,529	90	3.95
MIG	3.72	4.91	3.88	7,676	64	3.94
LIG	2.32	4.28	3.03	4,391	35	3.16
Overall	3.63	4.69	3.50	6,778	56	3.72

Source: Authors

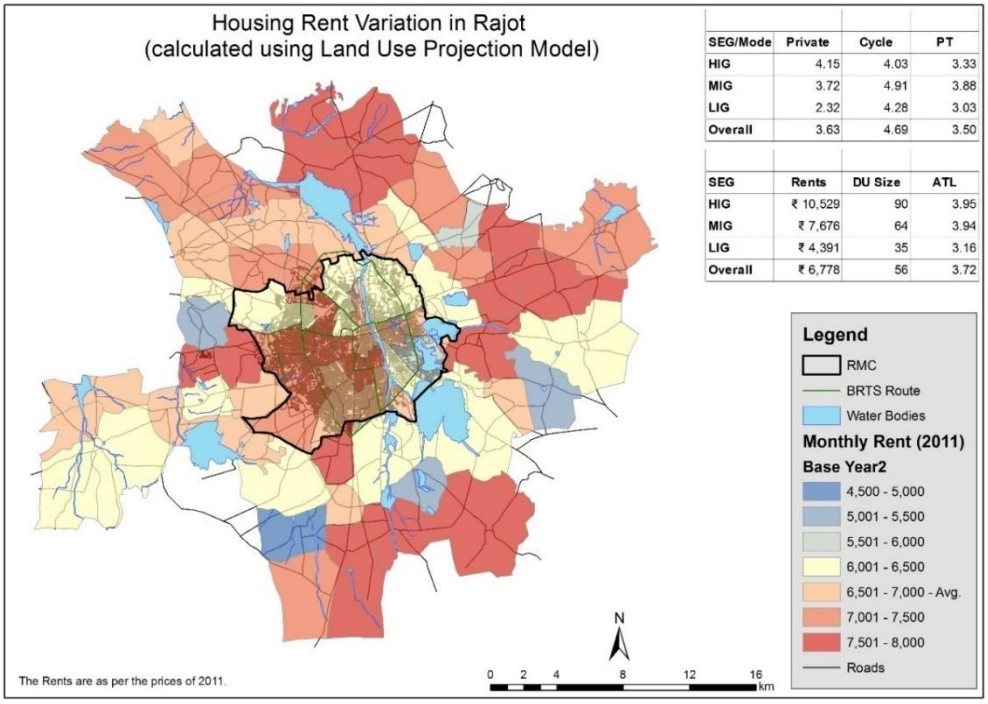


Figure 41: Modelled values of housing rents in 2011

Source: Authors

Table 34: Modelled versus actual consumption of FSI

Zones	FSI Proposed	FSI Consumed	FSI Consumed (Actual)
Zone 1	1.13	0.17	0.16
Zone 2	1.80	0.15	0.15
Zone 3	1.35	0.08	0.08
Zone 4	1.24	0.20	0.20
Zone 5	1.58	0.08	0.08
Zone 6	0.79	0.36	0.36
Zone 7	1.91	0.16	0.17
Zone 8	1.13	0.33	0.33
Zone 9	0.90	0.27	0.27
Zone 10	1.91	0.16	0.16
Zone 11	1.80	0.21	0.21
Zone 12	1.58	0.20	0.20
Zone 13	2.13	0.08	0.08
Zone 14	1.58	0.30	0.30
Zone 15	1.58	0.42	0.42

Zones	FSI Proposed	FSI Consumed	FSI Consumed (Actual)
Zone 16	0.68	0.40	0.39
Zone 17	0.83	0.42	0.40
Zone 18	1.80	0.19	0.19
Zone 19	2.25	0.20	0.20
Zone 20	1.24	0.48	0.48
Zone 21	2.02	0.15	0.15
Zone 22	1.35	0.27	0.27
Zone 23	0.90	0.45	0.45
Zone 24	1.00	0.05	0.06
Zone 25	0.81	0.10	0.10
Zone 26	1.67	0.04	0.04
Zone 27	1.58	0.05	0.05
Zone 28	1.00	0.31	0.31
Zone 29	1.43	0.05	0.05
Zone 30	0.97	0.06	0.06
Zone 31	0.82	0.20	0.19
Zone 32	2.02	0.08	0.08
Zone 33	0.59	0.13	0.12
Zone 34	1.22	0.11	0.10
Zone 35	0.96	0.11	0.09
Zone 36	0.51	0.03	0.03
Zone 37	0.69	0.12	0.11
Zone 38	0.61	0.10	0.10
Zone 39	1.01	0.10	0.11
Zone 40	1.54	0.13	0.10
Zone 41	1.26	0.10	0.10
Zone 42	1.16	0.10	0.10
Zone 43	1.52	0.10	0.10
Zone 44	1.59	0.10	0.10
Zone 45	0.27	0.10	0.10
Zone 46	1.13	0.02	0.01
Zone 47	0.44	0.10	0.11
Zone 48	0.48	0.09	0.10
Zone 49	0.68	0.11	0.11
Zone 50	1.49	0.07	0.06
Zone 51	1.33	0.13	0.13
Zone 52	1.60	0.11	0.11
Zone 53	1.58	0.12	0.08
Zone 54	0.70	0.10	0.10
Zone 55	1.98	0.11	0.11
Zone 56	1.32	0.08	0.07
Zone 57	0.70	0.12	0.12
Zone 58	0.78	0.12	0.12
Zone 59	1.53	0.11	0.11
Zone 60	1.60	0.11	0.11
Zone 61	0.68	0.10	0.10
Zone 62	1.20	0.17	0.11
Zone 63	0.56	0.16	0.16

Zones	FSI Proposed	FSI Consumed	FSI Consumed (Actual)
Zone 64	0.34	0.14	0.14
Zone 65	0.36	0.13	0.13
Zone 66	1.00	0.11	0.11
Zone 67	0.42	0.10	0.10
Zone 68	0.36	0.11	0.12
Zone 69	0.45	0.10	0.10
Zone 70	0.36	0.12	0.12
Zone 71	1.58	0.12	0.12
Zone 72	0.26	0.10	0.10
Zone 73	0.54	0.13	0.13
Zone 74	0.47	0.11	0.11
Zone 75	1.00	0.12	0.12
Total	**1.28**	**0.20**	**0.20**

Stage-2: Scenario testing:

The three scenarios taken up are – Business as Usual, Compact City and Dispersed City. For all the scenarios, the projected employment values for the year 2031 (9.15 lakh jobs) and the total dwelling unit supply are kept same across, whereas the spatial distribution of the jobs would be different and would depend upon the propensity of each zone for growth under the selected growth scenario. Table 35 summarizes the parameters used for these growth scenarios. These parameters represent the policies for each of the three scenarios.

Table 35: Overview of policies

Particulars	Base 2011	BAU 2031	CC 2031	DC 2031
Employment (Lakhs)	5.38	9.15		
Dwelling Units (Lakhs)	3.20	2.64 Additional dwelling units (but different spatial distribution)		
Public Transport	Buses + BRTS	Slight upgrade in Buses + BRTS	Superior in buses + BRTS	Same as base in buses + BRTS
Road Network	As is	Slight upgrade in Road Network	Same as base in road network	Superior in road network
Network Speeds	As observed	Private - Higher than base	Private - Higher than base	Private - Higher than base
		Cycle - Same as base	Cycle - Higher than BAU	Cycle - Higher than BAU
		PT - Higher than BAU	PT - Same as base	PT - Same as base

Note:
Base year: 2011
BAU: Business as Usual
CC: Compact city
DC: Dispersed city

Table 36: Comparison of scenarios across various parameters

Particulars	Base 2011	BAU 2031	BAU vs Base	CC 2031	CC vs BAU	DC 2031	DC vs BAU
Population (Lakhs)							
Municipal Area (MA)	12.9	20.0	55.3%	21.2	6.1%	11.2	-43.9%
Outside MA	2.2	3.6	61.0%	2.5	-30.4%	14.0	289.5%
Overall	15.1	23.6	56.2%	23.7	0.5%	25.3	7.0%
Population densities (Persons per Ha)							
Municipal Area (MA)	131.0	203.4	55.3%	215.9	6.1%	114.2	-43.9%
Outside MA	3.8	10.0	161.0%	4.3	-57.1%	23.9	140.2%
Overall	22.1	34.4	56.2%	34.6	0.5%	33.2	-3.6%
Additional land consumption (Ha)							
Municipal Area (MA)	As is	5,872	N.A	6,562	11.8%	345	-94.1%
Outside MA	As is	3,983	N.A	1,328	-66.7%	25,227	533.3%
Overall	As is	9,855	N.A	7,890	-19.9%	25,573	159.5%
Citizens' cost of living (in terms of Money, Time and Distance)							
[A] Housing Rents	₹ 6,778	₹ 4,428	-34.7%	₹ 4,490	1.4%	₹ 4,100	₹ 4,428
[B] Transport Costs	₹ 405	₹ 770	90.0%	₹ 620	-19.5%	₹ 858	₹ 770
Cost of Living - [A] + [B]	₹ 7,183	₹ 5,198	-27.6%	₹ 5,110	-1.7%	₹ 4,958	₹ 5,198
ATL (km)	3.72	3.91	5.3%	3.75	-4.1%	5.67	3.91
ATL (min)	10.7	11.2	4.0%	10.7	-4.5%	18.9	11.2

Particulars	Base 2011	BAU 2031	BAU vs Base	CC 2031	CC vs BAU	DC 2031	DC vs BAU
Emissions (Thousand Tons per Year)							
HIG	23.87	30.09	26.1%	20.80	-30.9%	31.80	5.7%
MIG	872.72	1,018.98	16.8%	703.07	-31.0%	1,080.27	6.0%
LIG	43.22	66.10	52.9%	45.12	-31.7%	68.49	3.6%
EWS	0.00	0.00	0.0%	0	0.00%	0.00	0.0%
Total	**939.81**	**1,115.17**	**18.7%**	**769.00**	**-31.1%**	**1,180.56**	**5.9%**

Note:
Base year: 2011
BAU: Business as Usual
CC: Compact city
DC: Dispersed city

Table 37: Comparison of scenarios on producer and consumer surpluses

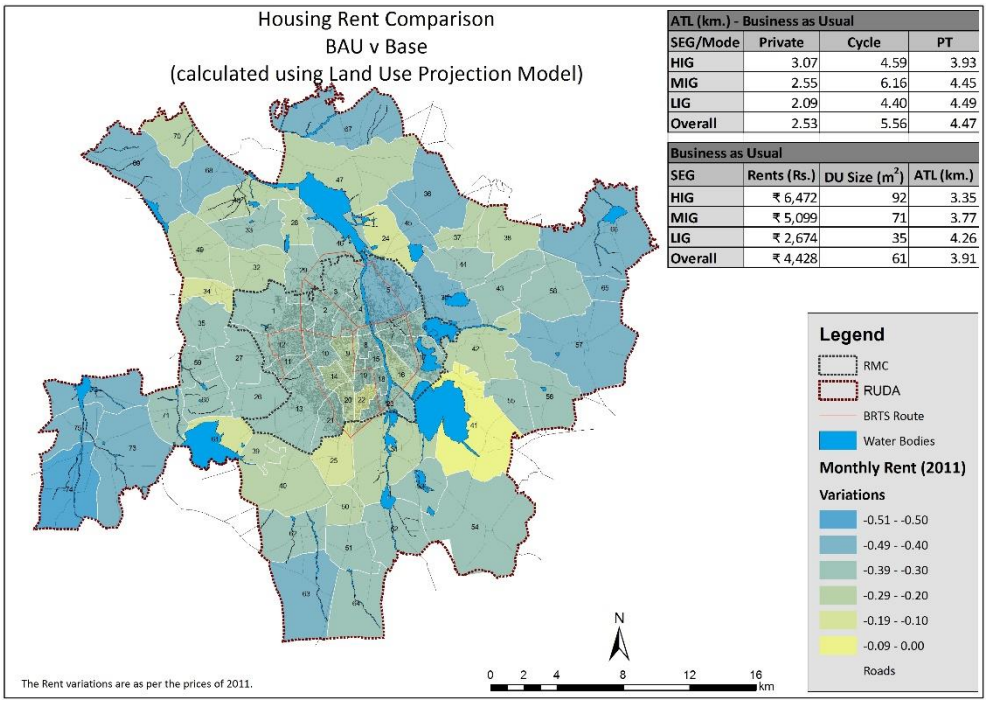
SEG	Housing Rent Consumer Surplus			Housing Rent Producer Surplus			Transport Consumer Surplus		
	BAU vs Base	CC vs BAU	BAU vs Base	CC vs BAU	DC vs BAU	DC vs BAU	BAU vs Base	CC vs BAU	DC vs BAU
HIG	28	-1	-4	0.00	0.00	0.00	-9.18	0.05	0.06
MIG	1216	-63	137	-0.05	1.15	0.91	-325.26	4.66	28.53
LIG	263	-9	18	0.25	-1.02	-2.71	-6.99	9.26	18.79
EWS	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Total	**1507**	**-73**	**152**	**0.21**	**0.13**	**-1.79**	**-341.43**	**13.96**	**47.38**

Note: Base year: 2011, BAU: Business as Usual, CC: Compact city, DC: Dispersed city

Table 38: Assessment of key indicators

Assessment	Category	BAU vs Base	CC vs BAU	DC vs BAU	Remarks
Economic	Housing rent (INR Crores/Year)	1,508	62.0	149.9	Higher value signifies that the people of the city will save money in housing rents.
	Transport (INR Crores/Year)	4,676	-150.0	47.4	Higher value signifies that the people of the city will save more money in travelling.
	Total Economic Benefit	6,184	-88.0	197.3	Total benefits to the city.
Environment	Land consumption (Ha)	N.A.	-1,965	15,718	Smaller value signifies that city will consume less land and thus save the land for future use.
	Emissions ('000 Tons/Year)	175	-346.17	65	Smaller value signifies that the low emissions will lead to lower health hazards and better climate in the city.

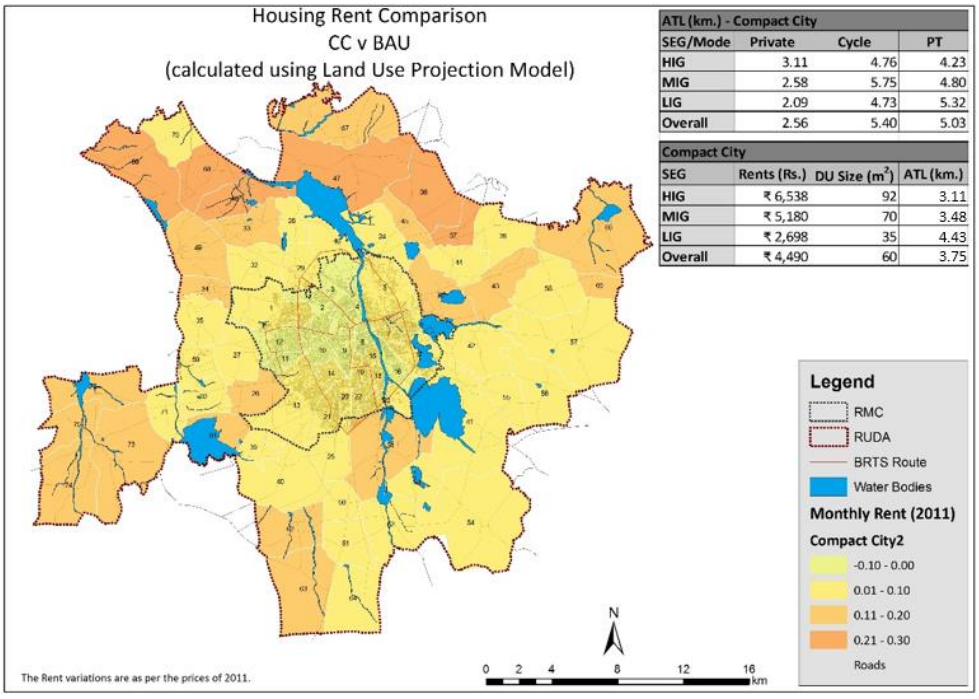
Note:
Base year: 2011
BAU: Business as Usual
CC: Compact city
DC: Dispersed city



ATL (km.) - Business as Usual			
SEG/Mode	Private	Cycle	PT
HIG	3.07	4.59	3.93
MIG	2.55	6.16	4.45
LIG	2.09	4.40	4.49
Overall	2.53	5.56	4.47

Business as Usual			
SEG	Rents (Rs.)	DU Size (m^2)	ATL (km.)
HIG	₹ 6,472	92	3.35
MIG	₹ 5,099	71	3.77
LIG	₹ 2,674	35	4.26
Overall	₹ 4,428	61	3.91

Figure 42: Rent variation of BAU scenario (base year)
Source: Authors



ATL (km.) - Compact City			
SEG/Mode	Private	Cycle	PT
HIG	3.11	4.76	4.23
MIG	2.58	5.75	4.80
LIG	2.09	4.73	5.32
Overall	2.56	5.40	5.03

Compact City			
SEG	Rents (Rs.)	DU Size (m^2)	ATL (km.)
HIG	₹ 6,538	92	3.11
MIG	₹ 5,180	70	3.48
LIG	₹ 2,698	35	4.43
Overall	₹ 4,490	60	3.75

Figure 43: Rent variations of compact city scenario (base year)
Source: Authors

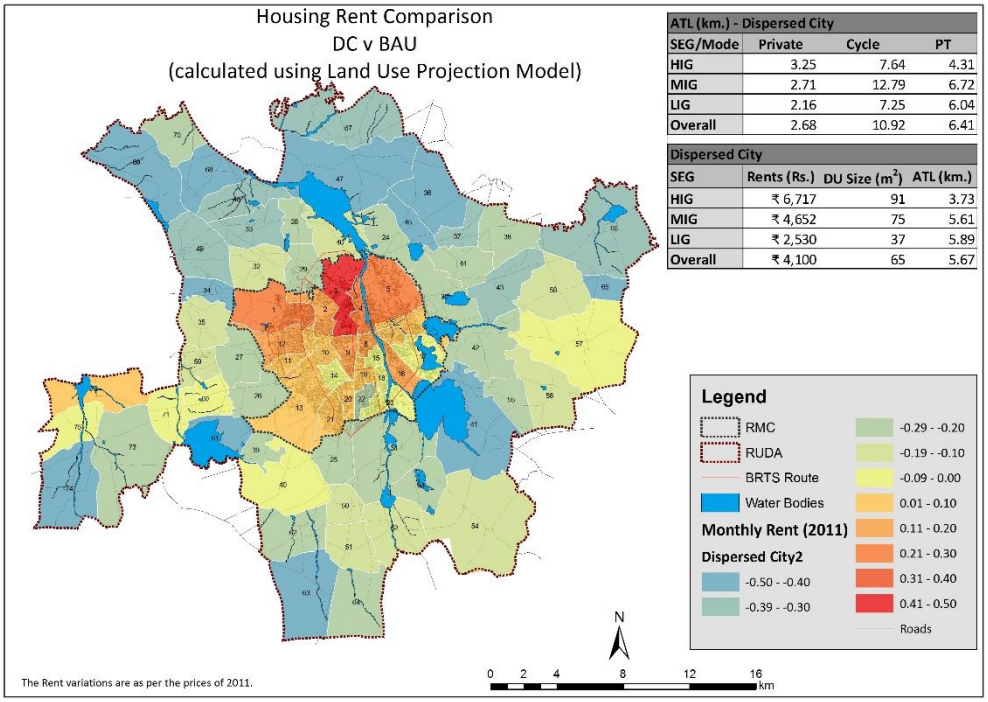


Figure 44: Rent variations of dispersed city scenario (base year)
Source: Authors

This shows that the surplus in housing rent is significantly higher in case of the Dispersed city scenario when compared with the Compact city scenario than in case when compared with the BAU scenario. However, the overall trips as well as the usage of private mode of travel too significantly increase, and the usage of public modes of travel lower down when compared with the compact city scenario than when compared with the business as usual scenario.

6.3. Summary

In the context of the argument that the current practices in master plan preparation process lack rationality in the decisions made regarding the choice of policies for development regulations, and the fact that since such an approach has no way of explaining or knowing how do urban processes actually get influenced with the chosen policies; LUTI model illustrates how they can effectively aid in understanding this relationship and help to ensure that our development policies are not prohibitive and non-conducive to the market based demands and hence help in making sustainable development decisions. This chapter presented the simulation of three growth scenarios for Rajkot namely, business-as-usual, compact city and dispersed city. As expected, the rent values were found to be lowest in a situation where Rajkot sprawled. However, as Dhar et al. (2013) and Munshi, T. et al. (2013) demonstrate using numbers, such development can have negative implications on sustainability in terms of increased trip lengths, higher emissions and rising numbers of accidents.

7. Discussion: Inputs to the planning process

The need to integrate transport and land use planning in the preparation of development plans has been emphasized in Chapter 5. In this context, the lack of a decision making tool that could guide the planners with growth directions, growth intensity was felt and emphasized in our interactions with planners at Pune, Hyderabad, Bengaluru, Ahmedabad and Delhi. As a result, major decisions in this regard were often made at the discretion of those in charge of plan-preparation. In the paragraphs below, the research team wishes to propose its inputs towards reforming the plan preparation process in its current form.

7.1. LUTI as a decision-making tool for sustainable development

This research positions the LUTI model as a useful decision-making tool to help the planners in plan preparation. It must be made clear though that the model itself can't replace planners from the planning process. Listed below are the positive impacts that adoption of the LUTI model.

7.1.1. Rationalizes the plan preparation process

Our experience with five important cities (as covered in Chapter 4) shows that plan preparation happens in an ad hoc manner. The directions in which a city is allowed to grow is often at the discretion of the planner which is often not in sync with the market realities. As a result, cities grow in a manner far different from what was planned and the consecutive plans play catch-up instead of driving the development. Similarly, the prescribed intensities of use (FSI) often are uniform across the city. Even in cases where there are differential FSI slabs, it is found to be patchy, as seen in the case of Ahmedabad. Development control is seen by builders and developers to be overly prohibitive and non-conducive to market demands, thereby driving violations.

The primary objective of this land use transport integration model is to contribute towards rationalizing the planning process. It makes use of data available with municipal corporations and development authorities to first model the current (base scenario) and future (business-as-usual, compact city and dispersed development) scenarios. Inputs given by local stakeholders such as builders, architects, engineers and eminent sector experts are also considered. The model gives average trip lengths and housing rent values as outputs for each scenario. Once the planners have this information, they would be in a position to make informed decisions on matters such as growth directions, intensity of use and zoning regulations.

7.1.2. Integrates land use with transport

Conventional planning processes often give the impression that transport systems like BRTS, metro-rail or mono-rail systems were brought in as an afterthought. Often these projects are sanctioned after the cities have developed and any retrofitting requires huge investments in demolition, rehabilitation and expensive underground boring. In other cases, transport systems look like they were brought in only to

justify higher floor space consumption skewing the property market in the city in often manner which leads to greater exclusion, higher conflicts and higher emissions. Learning from the town planning schemes in Gujarat where developable land is identified and schemes made with provision of services and infrastructure before people have started moving in, the LUTI model uses transport systems as a major input in its operationalizing. In fact, the transport angle guides the model by building up on existing demand rather than skewing the demands based on specific projects. The resulting integration of land use and transport results in positive outcomes for the city especially from the point of social (greater equity, lesser conflicts), economic (lower expenditure on travel, healthcare) and environmental (lesser emissions) sustainability.

7.1.3. Establishes growth directions on the basis of macro-economic trends

Conventional planning processes rely on population projections based on any of the mathematical methods that build on observed trends. Given the rapid advances in technology and its impacts on the economy, these projections often fail resulting in cities that have under-invested in infrastructure. The demand assessment that the LUTI model relies on is based on jobs (employment projections) derived larger macro-economic projections for the region. This method is found to be far more accurate than the conventional methods. The resulting job-driven growth has spatio-temporal implications which are captured by the LUTI model as part of the various scenarios.

7.1.4. Guides the assignment of intensity of land use

The demand for real estate (built-up area) is a function of the employment projections mentioned earlier. Since the LUTI model helps with the growth directions and spatial spread of development, the intensity of land use can be easily determined and assigned on the basis of the outputs of the model. Since the model also considers the wider inputs given by various stakeholders including builders, architects, engineers and sector experts with regards to the probability of residential, commercial and industrial development occurring in a given location, it brings in the market factor as well.

7.1.5. Provides base material for political deliberations

While the technical inputs are welcome, one must concede that planning is a highly political process. Effective negotiations between the various parties are important for democracy to work. Often, as seen in our cities, such negotiations are not based on any scientific inputs but on affiliations (political and social groups) and power equations. The LUTI model cannot deal with all of that. But the information that it can generate on the directions that the city's growth could take can serve as the ideal base material for such political deliberations. Also, citizens can use such information to question the planners on their decisions. In that sense, adoption of scientific methods like the LUTI model can help further the case of deepening effective democracy.

7.2. Reforming development control regulations

The LUTI model is a useful addition to the existing planning process. However, in order for the LUTI model to contribute effectively towards a built form geared for sustainability, it would need to be combined with development control regulations that move away from the prohibitive manner that is followed in most Indian cities, with the exception of Hyderabad and now in parts, Ahmedabad.

7.2.1. Define ideal land use intensity

The regulations should clarify the objectives sought to be achieved through development control. Very often, the development control regulations come across as a stand-alone document – and in some cases as a collection of government orders – prescribing a set of rules to be followed by any party wishing to develop a piece of land in the city. The larger ideas behind the framing of the regulations are not are not accessible to the general public. Questions like 'how many people can an area accommodate while good standards of lighting, ventilation and public health are maintained' must be addressed (Bertaud 2004). In this regard, the zoning must be informed by the outputs of the LUTI model. Given the global academic debates on whether FSI or density is a better means of regulation must also be addressed. This is especially important in India where factors like gentrification owing to higher utilities of living close to transit stations has replaced sustainable built form and communities with higher per-capita floor space consuming segments of the population.

a) Low-rise high density LIG housing

b) Medium-rise low density HIG apartments

Figure 45: Built form more oriented to sustainability
Source: Authors

7.2.2. Simplify norms of FSI and land use intensity

Artificial scarcities of floor space imposed by plans of the past is a common feature across Indian cities. The jury is still out on whether higher FSIs can tackle the problem of scarcity of developable land in Indian cities (Bertaud and Brueckner 2003; Patel 2013a, 2013b). However, from the experiences of Hyderabad, it appears that even with the liberalization of FSI, the market can only respond to the demand. Fears of over estimating demand and building large inventory of unsold floor space are as true of Ahmedabad as Hyderabad. Therefore, while the state needs to intervene in situations where reservations must be made for public housing, social

amenities and allied infrastructure through zoning, a well-regulated market must be allowed to operate in the real estate sector.

7.2.3. Encourage higher intensities of floor space consumption

Sustainable built form necessitates higher intensities of floor space consumption, especially around public transit stations. Zoning regulations must be used to ensure that factors like gentrification can be controlled to ensure that people most likely to use public transit can afford to live closest to transit stations and are not bought out by higher spending capacity segments unwilling to travel by public transit.

a) Low densities result in row ridership: Ahmedabad

b) Higher densities result in higher ridership: Bogota

Figure 46: Densities and ridership are deeply inter-related
Source: Authors

7.2.4. Adopt building envelope approach to built-form

The building regulations often adopt a highly prohibitive approach by stipulating all three among FSI, coverage (and margins) and building heights. This results in over-controlled built-form often at the expense of the creativities of architects and engineers. As a result, there is no incentive to innovate with designs that could contribute to sustainability. Similarly, the front margins on busy streets could be done away with and people could be encouraged to do away with compound walls to have more space in the public realm.

7.2.5. Combine traffic demand management with TOD

There is a need to restrict parking especially in the TOD zone to disincentivize the use of private modes of transport and encourage the use public transport. This will not only help address the economic sustainability of the public transit system but also have positive outcomes on the health and environment fronts through reduced cases of fatalities and lower per-capita emissions.

7.3. Project workshop

In order to disseminate the findings from the research and introduce the LUTI approach to practising consultants and advocacy groups, a project workshop was organized at The Park Hotel, New Delhi on 23rd October 2015. The project workshop saw participation from academia, consultants, policy makers and opinion makers. A full list of participants can be found in the Annexure.

a) Mr. Ravi Gadepalli, SSEF introduces the LUTI SU project

b) Dr. Talat Munshi explains the objectives of the workshop

c) Dr. Rutul Joshi elaborates on the findings from the case cities

d) Dr. Bhargav Adhvaryu on the application of LUTI model

Figure 47: Presenters at the LUTI SU project workshop
Source: Authors

The workshop was inaugurated by Mr. Ravi Gadepalli (Shakti Sustainable Energy Foundation) and subsequently saw presentations being made by the project team led by Dr. Talat Munshi, CEPT University. Mr. Gadepalli explained the context in which this research project was commissioned and stressed upon the need to disseminate the findings of the research to the larger community of academia and practitioners. Dr. Munshi explained the objectives of the workshop and outlined the schedule of the day's proceedings. Dr. Rutul Joshi elaborated on the methodology of the research and presented the findings of the research on the case cities. He also presented a critique on the development planning processes followed in the case cities. This was followed by a detailed discussion on the challenges faced by various cities in the preparation of development plans. The participants were able to bring the local perspective from their own cities thus adding value to the discussion.

a) Mr. Ashok Bhattacharjee, CSE

b) Mr. Ranjit Gadgi, Parisar

Figure 48: Participants offering their comments on the LUTI approach
Source: Authors

The second session saw the presentation on LUTI model by Dr. Bhargav Adhvaryu and later Mr. Arpit Kumar. The presentation explained the LUTI model developed as part of the research and its application on the city of Rajkot. The presentation was followed by a rich discussion where the participants were able to clarify their doubts and develop a deeper understanding of the model. The workshop ended with participants agreeing to take the message of the LUTI model back to their respective cities.

7.4. Conclusion

This research presents arguments for and demonstrates how the integration of land use and transport can contribute towards sustainable urbanism. It presents the various debates surrounding the idea of sustainable urban development through literature and previous studies. The planning process in India is critiqued through the case cities of Pune, Hyderabad, Bengaluru, Ahmedabad and NCT of Delhi. Visits to these cities helped inform the research of the various approaches taken by the planners in these cities towards preparation of development plans. The critique help lead the research to arrive at the need for a data-driven and rational decision-making tool to guide the planners in the preparation of the plan. Review of international literature helped the research understand the various attempts at developing land use transport interaction models. Indian attempts were also reviewed and a model was developed to the specific case city of Rajkot. The model was operationalized and various scenarios were developed including base year, business-as-usual, compact city and dispersed city scenarios. The model was informed of the ideas of the local stakeholders to make it receptive to the market. Based on these developments, the research proposes inputs to the planning process based on the LUTI model and reforming the development control regulations.

Annexures

Annexure 1: LUTI model: Inputs and outputs

SNo.	Inputs	Type
1	Census Demographic Data	Primary Survey or Secondary Sources
2	Jobs Distribution of the residents	
3	Income and Expenditure of the resident	
4	Housing Rents	
5	Working Schedule	
6	Vehicle Costs	
7	Modal Split and Average Speeds	
8	Fare Matrix of PT	
9	Distance Matrix	
10	Decadal Census Demographics	
11	Scenario Settings	User Input
SNo.	**Output**	**Type**
1	Scenario Outputs	Output for Urban Planning Purpose
2	- Average Trip Lengths	
3	- Dwelling Unit Size	
4	- Rents	
5	Zone Wise Output	
6	- FSI consumption	
7	- Housing Rents	
8	- Population	
9	Overview of Policies	Output for Decision Makers
10	Population (lakhs) and Densities (pph)	
11	Additional Land Consumption (ha)	
12	Citizens' Cost of Living (in terms of Money, Time and Distance)	
13	Emissions (Thousand Tons per Year)	
14	Housing Rent Consumer and Producer Surplus	
15	Transport Consumer Surplus	
16	Key Assessment Indicators	

Annexure 2: Help manual for LUTI model

Procedure		Help Manual - Definitions/Instructions
Step 1	**No. of Zones**	The Zones are the areas in the City divided on the basis of either administrative boundaries or Traffic Assessment Zones or any other criteria. Based on these defined zone boundaries, other datasets are need to be created. For e.g. - population, jobs, resident workers etc.
	No. of SEGs	Socio Economic Groups (SEG) as per their income levels. It is generally categorized into 4 groups as High Income Group as SEG 1, Middle Income Group as SEG 2, Low Income Group as SEG 3 and Economically Weaker Section as SEG 4. User May input for all the economic groups or just a few. But user should begin the input from S
	Year	The year for which the data is to be entered.
Step 2	***Click "Step A - Generate User Input"***	Button
Step 3	**SEG wise jobs**	Employment generated for particular area/zone
	SEG wise Vacancy Rate	%age of Dwelling units vacant.
	Zone Wise Input	
	- Population (P)	The population of the zone
	- Resident Workers (R)	aka Main Workers in Census of India 2011
	- Jobs (J)	Employment generated for particular area/zone
	- Household (H)	Household as defined by Census of India 2011
	- Builtup	The built-up area of the zone
	- Total Area (ha)	Total area of the zone.
	Zone Wise SEG Wise HH	HH - Households, zone wise and SEG wise
	Zone Wise SEG Wise Jobs	Jobs - Households, zone wise and SEG wise
	Zone Wise Input	
	- Residential Area (ha)	Residential Area of the zone as per the Master Plan/Development Plan
	- Permissible FSI	Average Permissible of the zone as per the Master Plan/Development Plan
	Adjt Factor	
	Working days (in a month)	Average working days for a person in a month
	Working hours (in a day)	Average working hours for a person in a month
	Factor	The factor implies that how much %age of value of time is to be accounted
	SEG wise Beta Parameter	
	Range	
	SEG x PEDH	Price Elasticity Demand for Housing (PEDH) for the last SEG where xth can be 1, 2, 3 or 4. Price Elasticity Demand for Housing is a measure used in economics to show the responsiveness, or elasticity, of the quantity of housing demanded to a change in its price, ceteris paribus.
	IEDH	Income Elasticity Demand for Housing measures the responsiveness of the demand for housing to a change in the income of the people demanding the good, ceteris paribus. It is calculated as the ratio of the percentage change in housing demand to the percentage change in income.
	RoI	Rate of Interest for the Housing prices to be discounted.
	SEG wise Monthly Income (Rs.)	Monthly income of each SEG
	SEG wise Expenditure on Housing (%age)	%age of income utilized for the expenditure in Housing for each SEG
	Model Precision Parameters	The parameters which decides the total running time of the model

Procedure		Help Manual - Definitions/Instructions
	- No. of Iterations	The model is an iterative process and it might take 10 to more than 500 iterations in order to calibrate itself. The user can either set specific number of runs of the model runs or by default the model runs for 500 iterations. The user can decide based on the Model Run summary which specifies the difference between the supply and demand for floor space after running the model once for 500 iterations. Then based on the iteration number at which the model achieved the minimum difference the user can specify the no. of iterations and then recalibrate the model by running the model again.
	- DS Ratio	It is the precision value up to which the model executes and tries to achieve its balance. Higher the value, the model will take more time and tries to achieve higher precision
	- Overall	It is the precision value up to which the model executes and tries to achieve its balance. Higher the value, the model will take more time and tries to achieve higher precision
	- ATL Observed (Km)	It is observed average trip length of the city. If the average length is achieved by the model, it stops.
	Minimum Dwelling Unit Sizes (mtr2)	It is minimum size of the dwelling unit the user requires to survive.
Step 4	***Click "Step B - Transport Data"***	Button
Step 5	**Valid Year for the Entry**	The year for which the data for costs of vehicle is available
	Vehicle depreciation/Year	%age of the value of the mode is depreciated every year.
	Life (yrs.)	Age of the mode on an average.
	Driven (km.)	No. of kms on an average the mode can be driven.
	Capital Cost (Rs.)	Capital cost of the mode.
	O&M (Rs./Year)	Money invested for the Operation & Maintenance of the vehicle.
	Mileage	Total kms covered or traveled in one liter of fuel
	Fuel cost	Cost of fuel. Generally in Rs. Per liter
	% Modal Share	%age share of private vs cycle.
	Distance Matrix - Private	Matrix of no. of Zones x no. of Zones which tells the distance for each possibility for private mode.
	Distance Matrix - Public Transport	Matrix of no. of Zones x no. of Zones which tells the distance for each possibility for Public Transport
	Modal Split SEG Wise Mode Wise	%age share of each mode for every type of SEG.
	Average speeds for Private, Cycle and PT	Average speed in km/hr for each mode.
	Public Transport Fare Matrix	Fare matrix of the Public Transport generally given as a table of distance vs cost.
Step 6	***Click "Go Home"***	Button
Step 7	***Click "Step C - Housing Data"***	Button
Step 8	**Property Rates Year**	The year for which the property rates data is available.
	Discount rate (%age)	The rate at which the property rates will be discounted to current year.
	Area and Cost of Properties	Property rates in the form of area (in sq.ft.)and cost (in rupees)
Step 9	***Click "Go Home"***	Button
Step 10	***Click "Step D - Set Model for run"***	Button
Step 11 (Optional)	***Click "Improve Data"***	Button
Step 12	***Click "Step D - Run Model"***	Button
Step 13	***Click "Output"***	Button
Step 14 (Optional)	***Click "Print Output Summary"***	Button (If one want to show or present the data to others or for its own reference, pdf files will be generated)

Procedure		Help Manual - Definitions/Instructions
Step 14 (Optional)	***Click "Print Model Run Summary"***	Button (If one want to learn about the model run, the behaviour over the total run time)
Step 14 (Optional)	***Click "Create excel file for GIS"***	Button (If one want an excel file to join and relate with the shape files in GIS)
Step 14 (Optional)	***Click "Regenrate Output"***	Button (If one want to regenerate the tables and charts of the model run visible in Output worksheet)
Step 15	***Click "Future Scenarios"***	Button (To test and learn about the alternatives, one must click on this button)
Step 16	***Click "Step A - Current Scenario"***	Button (It will generate the brief of significant parameters and output from the base year run of the model)
Step 17	***Click "Step B - Generate Input Sheets"***	Button (It will generate the extent format for the user to input the values for the Alternatives)
Step 18	***Click "Step C - Enter Data for Projections"***	Button
Step 19	**Plan Year**	The year for which projections are going to be calculated
	No. of decades for Trend	Insert the no. of decades for which the user wish to enter the decadal data
	No. of decades for Data availability	For each Parameter, user can specify the decade up to which the data is available other than the base year. For e.g. If the base year is 2011 and the user has the data for the decade 1991 only then user must enter 1 as value.
	Population (P)	Enter zone wise population for the decades mentioned by the user.
	Households (HH)	Enter zone wise household for the decades mentioned by the user.
	Resident Workers (R)	Enter zone wise resident worker or also known as total workers in Census of India for the decades mentioned by the user.
	Jobs (J) (Optional)	Enter zone wise jobs for the decades mentioned by the user.
Step 20	***Click "Home"***	Button
Step 21	***Click "Enter Scenario Settings"***	Button
Step 22	**Zones in Municipal Area**	Insert the total number of zones lying the municipal boundary out of the total number of zones.
	Name of Scenario	Name all the types of scenarios and also provide short forms for referencing.
	Income Growth Rate (Per Annum)	Give the growth rate at which the income will increase.
	Discount Rate (Per Annum)	Provide the discount rate at which the incomes and other parameters will be discounted to the present value. If the discount rate and Income growth rate is same then the values used in base year will be same as for the scenarios.
	Housing Growth Rate (Per Annum)	The growth rate for housing, the rate at which its property value will increase.
	Model Precision Parameter (DS Ratio)	It is the precision value up to which the model executes and tries to achieve its balance. Higher the value, the model will take more time and tries to achieve higher precision
	Dwelling Unit Sizes (mtr2) (Optional)	It is minimum size of the dwelling unit the user requires to survive. It is as per the future requirement.
	Housing Prices for 2031 (Optional)	It is the housing prices used for 2031. It is calculated using Housing growth rate and then discounted to current value by discount rate mentioned by the user
	Zone Wise Dwelling Units (Target) (Optional)	If there is any specific no. of units targeted for the zone must be specified here. For e.g. - 6000 units are going to come up in Zone 5, then user must enter the value as 6000. If the user doesn't have any specific values then it must remain blank. If the user specifies it to be 0 the no dwelling units will come in that zone.
	Weights for Parameters	Weights ranging from -1 to +1 where +1 represents highest priority. Need to be specified for all the scenarios. These are taken from the user in order to calculate the total floor space supplied for each and for every scenario.
	- Pop. Distribution	The weight given to the population distribution used in calculating the overall distribution of floor space. The population distribution is current distribution based on Municipal corporation boundary. It follows the principle of MC -UC (Municipal Corporation vs Urban Corridor) as two principle sub-regions in the City and the population distribution is calculated for each zone based on its presence in which sub region it lies.
	- Rent Ratio	The ratio of rent to average rent signifying the strength of rental attraction for the floor space to come in each zone.
	- Public Transport	The weight is to be given to rating provided under Public transport.
	- Jobs	Upcoming jobs in each zone for which user need to specify the weight in comparison with other weights.

Procedure		Help Manual - Definitions/Instructions
	- Floor space Available	Availability of floor space in each zone as per the current land use.
	Percentage breakup for Additional DU (Proposed)	User need to provide the %age breakup for each sub-region for every scenario. User can understand the breakup by looking at the current scenario result.
	Vehicle O&M Increments	The percent increments in the operation and maintenance costs of the vehicle can be provided. If not provided the application uses the default value. The parameters are the same used while calibrating the base year.
	Public Transport Rating Systems - Impact on speeds	The Rating systems used in Public Transport is translated in speeds. Higher the rating higher will be the speed. User can specify the increment in speeds or user can leave it, the application will use the default values.
	DU Densities	The Dwelling Unit Densities are used in the calculation of the land required for the construction of the new DUs. For the value specified by the user, the existing densities for the specific scenario is increased in Inside Municipal Limits for Compact City, Outside Municipal Limits in Dispersed City and remains constant for BAU.
	CO2 Emissions for Private	The CO2 emitted by a private on an average in the unit - Kg./Passenger-km
	Blanket FSI Norms	The FSI values are to be given for the scenarios and specified for within Municipal limits and outside Municipal limits.
	Rating Values for all modes	The rating for all the modes for all the three scenarios. The rating are to be provided from the scale of 1 - 6. The rating 1 meaning very poor and 6 meaning These ratings are applicable only within municipal limits. Ratings for Outside Municipal area indicates the decrement value w.r.t. the ratings given for each scenario For. e.g. if BAU rating for Cycle is 2 and Outside Municipal Value is 1 then the rating for zones outside municipal limits would be 2 - 1 = 1. These ratings are converted into network speeds which the user must have defined earlier.
Step 23	**Select Scenario**	Select One scenario for which the model is to be executed. One must start with first scenario listed.
Step 24	***Click "Set Model for Run"***	Button
Step 25	***Click "Run Scenario"***	Button (After the execution is complete select the other scenario in Step 21 and redo the step 22 and 23).
Step 26	**Select Another Scenario and *click "Run Scenarios"***	Select any other scenario and click run scenarios to test the scenario. Repeat for all the scenarios.
Step 27 (Optional)	***Click "Print Scenario Settings"***	Button (if one want to show or present the base year data and the scenario settings, pdfs will be generated)
Step 28	***Click "Output (For Planners)"***	Button (If all the scenario runs have been executed the user can click on this button to know the final output which is useful for planners)
Step 28	***Click "Output (For Decision Makers)"***	Button (If all the scenario runs have been executed the user can click on this button to know the final output which is useful for Decision Makers)
Step 29 (Optional)	***Click "Print Output Summary"***	Button (If one want to show or present the data to others or for its own reference, pdf files will be generated. The type of the output is - Overall Details which includes income group wise rents DU size and ATL, mode wise ATLs and comparison charts of all the scenarios with the base year, FSI Details which includes zone wise proposed FSI in the base year and the consumed FSI for base year and the scenarios, Rent Details includes zone wise rents for the base year and the scenarios, Rent Difference Details includes the %age difference of scenario rents with the base year, Population shows the population of base year and the scenarios zone wise, Comparison Sheet is the zone wise comparison of DUs, Rents and Rent differences and Charts - Model vs Scenario is the graphical representation of the base year data vis-a-vis the scenarios.)
Step 29 (Optional)	***Click "Create Excel file for GIS"***	Button (If one want an excel file to join and relate with the shape files in GIS)
Step 30 (Optional)	***Click "Go Home"***	Button (If one want to redo the model with different scenario settings ow want to view the output for the planners/decision makers)

Annexure 1: Screen shots from the model

Figure 1: Screen Shot A

User Inputs Panel	
No. of Zones	75
No. of SEGs	3
Year	2011
Step A - Generate User Input	
Step B - Transport Data	
Step C - Housing Data	
Step D - Set Model for Run	
Improve Data	
Step E - Run Model	
Resume Model	
Output	
Reset LUP	Reset Model

Step 1
Step 2
Step 4
Step 5
Step 6
Step 7
Step 10
Step 11 (Optional)
Step 19
Step 12

Job Input	
SEG Type	Jobs (Nos.)
HIG	7,166
MIG	371,427
LIG	159,056
EWS	

Step 3

Vacancy Rate Input	
SEG Type	VR (%age)
HIG	2.0%
MIG	2.0%
LIG	2.0%
EWS	

Calibration Parameters	
Adjt Factor	1.0
Working days (in a month)	24
Working hours (in a day)	8
Factor	50%

Beta Parameter	
SEG Type	Value
HIG	0.053
MIG	0.093
LIG	0.270
EWS	

Elasticity Parameters	
Range	0.2
SEG PEDH	-0.5
IEDH	0.7
RoI	5%
HP in 2011	Rs. 23,711

Monthly Income (Rs.)	
SEG Type	Income (Rs.)
HIG	Rs. 40,000
MIG	Rs. 25,000
LIG	Rs. 7,500
EWS	

Expenditure on Housing	
SEG Type	% income spent on rent
HIG	10.00%
MIG	25.00%
LIG	40.00%
EWS	

Model Precision Parameters	
No . of Iterations	44
DS Ratio	2
Overall	2
ATL Observed (Km)	3.8

Dwelling Unit Sizes (mtr2)	
Minimum Size	35

ID	Zone No.	Population (P)	Resident Workers (R)	Jobs (J)	Households (H)	Residential Builtup (sq. mtr.)	HIG_J	MIG_J	LIG_J	EWS_J	Total_J (%age)	HIG_HH	MIG_HH	LIG_HH	EWS_HH	Total_HH (%age)	Total Area (ha)	Residential Area (ha)	Permissible FSI
1	Zone 1	76,424	26,773	4,988	16,892	1,217,831	2.0%	56.2%	41.9%	0.0%	100.0%	2.0%	56.2%	41.9%	0.0%	100.0%	1,043.6	466.8	1.1
2	Zone 2	54,054	18,927	5,347	12,107	1,141,398	0.4%	85.2%	14.4%	0.0%	100.0%	0.4%	85.2%	14.4%	0.0%	100.0%	405.4	269.2	1.8
3	Zone 3	51,686	18,450	14,616	11,390	1,258,031	0.0%	50.8%	49.2%	0.0%	100.0%	0.0%	50.8%	49.2%	0.0%	100.0%	754.7	484.5	1.4
4	Zone 4	40,398	14,026	10,366	8,546	686,016	0.0%	67.3%	32.7%	0.0%	100.0%	0.0%	67.3%	32.7%	0.0%	100.0%	257.2	186.3	1.2
5	Zone 5	74,434	27,431	18,344	15,991	1,112,747	0.0%	46.2%	53.8%	0.0%	100.0%	0.0%	46.2%	53.8%	0.0%	100.0%	1,095.8	583.5	1.6
6	Zone 6	58,686	20,546	16,548	12,119	1,022,634	0.0%	64.4%	35.6%	0.0%	100.0%	0.0%	64.4%	35.6%	0.0%	100.0%	545.1	226.5	0.8
7	Zone 7	39,088	13,878	14,814	7,793	685,543	0.0%	69.9%	30.1%	0.0%	100.0%	0.0%	69.9%	30.1%	0.0%	100.0%	147.6	135.0	1.9
8	Zone 8	35,097	12,798	31,594	7,500	762,904	0.4%	78.6%	21.0%	0.0%	100.0%	0.4%	78.6%	21.0%	0.0%	100.0%	139.5	116.0	1.1
9	Zone 9	44,118	14,529	54,223	9,192	1,159,626	3.0%	79.6%	17.4%	0.0%	100.0%	3.0%	79.6%	17.4%	0.0%	100.0%	279.1	225.5	0.9
10	Zone 10	44,897	14,307	14,764	9,974	1,751,724	4.2%	82.4%	13.3%	0.0%	100.0%	4.2%	82.4%	13.3%	0.0%	100.0%	266.1	200.8	1.9
11	Zone 11	52,800	17,824	15,928	12,430	1,676,429	8.4%	80.3%	11.3%	0.0%	100.0%	8.4%	80.3%	11.3%	0.0%	100.0%	299.1	208.7	1.8
12	Zone 12	74,369	26,320	10,152	17,144	1,729,426	4.2%	85.3%	10.5%	0.0%	100.0%	4.2%	85.3%	10.5%	0.0%	100.0%	502.9	339.1	1.6
13	Zone 13	95,917	32,426	21,926	21,662	2,158,036	1.9%	84.8%	13.2%	0.0%	100.0%	1.9%	84.8%	13.2%	0.0%	100.0%	1,286.1	812.6	2.1
14	Zone 14	47,450	15,591	22,478	9,958	852,938	0.0%	67.7%	32.3%	0.0%	100.0%	0.0%	67.7%	32.3%	0.0%	100.0%	192.3	114.0	1.6
15	Zone 15	39,496	13,375	11,817	8,146	535,349	0.0%	86.8%	13.2%	0.0%	100.0%	0.0%	86.8%	13.2%	0.0%	100.0%	118.8	75.8	1.6
16	Zone 16	44,421	17,248	37,603	8,914	469,586	0.0%	45.2%	54.8%	0.0%	100.0%	0.0%	45.2%	54.8%	0.0%	100.0%	430.2	153.4	0.7
17	Zone 17	60,994	21,525	17,567	12,488	642,826	0.0%	25.0%	75.0%	0.0%	100.0%	0.0%	25.0%	75.0%	0.0%	100.0%	567.3	146.0	0.8
18	Zone 18	53,863	18,844	13,267	11,383	609,093	2.9%	65.2%	31.9%	0.0%	100.0%	2.9%	65.2%	31.9%	0.0%	100.0%	123.2	186.0	1.8
19	Zone 19	48,910	16,235	13,111	10,445	1,207,144	1.0%	87.1%	11.8%	0.0%	100.0%	1.0%	87.1%	11.8%	0.0%	100.0%	183.3	145.6	2.3
20	Zone 20	46,503	15,752	23,975	10,273	732,881	1.2%	81.3%	17.5%	0.0%	100.0%	1.2%	81.3%	17.5%	0.0%	100.0%	194.7	103.4	1.2
21	Zone 21	80,991	28,712	11,507	18,190	1,112,499	1.2%	69.5%	29.3%	0.0%	100.0%	1.2%	69.5%	29.3%	0.0%	100.0%	406.6	333.5	2.0
22	Zone 22	56,622	19,229	19,510	12,348	761,446	1.1%	73.9%	25.0%	0.0%	100.0%	1.1%	73.9%	25.0%	0.0%	100.0%	165.4	195.6	1.4
23	Zone 23	64,650	24,354	18,549	14,275	1,006,077	0.0%	71.5%	28.5%	0.0%	100.0%	0.0%	71.5%	28.5%	0.0%	100.0%	420.2	195.6	0.9
24	Zone 24	4,455	1,731	128	827	145,938	0.0%	60.0%	40.0%	0.0%	100.0%	0.0%	60.0%	40.0%	0.0%	100.0%	815.7	76.9	1.0
25	Zone 25	5,720	2,192	31,752	1,193	261,431	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	652.7	98.8	0.8
26	Zone 26	5,759	2,091	6,415	1,207	265,618	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	704.7	99.6	1.7
27	Zone 27	3,483	1,174	2,925	752	100,800	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	777.4	60.2	1.6
28	Zone 28	2,232	865	43	443	5,000	0.0%	65.6%	34.4%	0.0%	100.0%	0.0%	65.6%	34.4%	0.0%	100.0%	425.0	7.7	1.0
29	Zone 29	15,036	5,136	1,594	3,266	695,639	0.0%	86.4%	13.6%	0.0%	100.0%	0.0%	86.4%	13.6%	0.0%	100.0%	606.8	259.7	1.4
30	Zone 30	13,483	4,776	352	2,597	20,248	0.0%	50.0%	50.0%	0.0%	100.0%	0.0%	50.0%	50.0%	0.0%	100.0%	1,030.1	200.7	1.0
31	Zone 31	53,794	20,303	35,989	11,973	886,745	0.0%	55.6%	44.4%	0.0%	100.0%	0.0%	55.6%	44.4%	0.0%	100.0%	1,963.7	374.5	0.8
32	Zone 32	5,874	1,894	2,288	1,203	536,523	0.0%	86.4%	13.6%	0.0%	100.0%	0.0%	86.4%	13.6%	0.0%	100.0%	810.8	46.5	2.0
33	Zone 33	2,553	985	1,981	557	102,072	0.0%	62.5%	37.5%	0.0%	100.0%	0.0%	62.5%	37.5%	0.0%	100.0%	848.5	39.6	0.6
34	Zone 34	622	324	43	111	5,000	0.0%	41.7%	58.3%	0.0%	100.0%	0.0%	41.7%	58.3%	0.0%	100.0%	425.2	4.0	1.2
35	Zone 35	1,100	495	265	180	34,425	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	793.2	6.3	1.0
36	Zone 36	576	337	604	112	141,418	0.0%	73.0%	27.0%	0.0%	100.0%	0.0%	73.0%	27.0%	0.0%	100.0%	1,341.7	48.5	0.5
37	Zone 37	1,750	950	43	325	29,848	0.0%	18.2%	81.8%	0.0%	100.0%	0.0%	18.2%	81.8%	0.0%	100.0%	452.0	16.1	0.7
38	Zone 38	1,054	514	43	192	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	880.6	19.9	0.6
39	Zone 39	261	117	33	48	5,000	14.3%	85.7%	0.0%	0.0%	100.0%	14.3%	85.7%	0.0%	0.0%	100.0%	361.6	3.1	1.0
40	Zone 40	2,170	802	3,294	394	61,963	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	1,623.4	7.3	1.5
41	Zone 41	2,892	1,198	4,198	473	91,550	0.0%	42.9%	57.1%	0.0%	100.0%	0.0%	42.9%	57.1%	0.0%	100.0%	2,742.9	16.9	1.3
42	Zone 42	1,351	537	5,469	239	69,724	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,256.0	13.4	1.2
43	Zone 43	3,508	1,187	43	630	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,020.2	26.6	1.5
44	Zone 44	1,697	729	43	307	5,000	0.0%	89.5%	10.5%	0.0%	100.0%	0.0%	89.5%	10.5%	0.0%	100.0%	700.4	11.6	1.6
45	Zone 45	1,000	592	43	178	24,189	0.0%	50.0%	50.0%	0.0%	100.0%	0.0%	50.0%	50.0%	0.0%	100.0%	465.1	31.0	0.3
46	Zone 46	270	155	945	57	69,942	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	893.3	10.8	1.1
47	Zone 47	3,749	1,481	3,532	680	191,860	6.3%	93.8%	0.0%	0.0%	100.0%	6.3%	93.8%	0.0%	0.0%	100.0%	3,001.9	100.5	0.4
48	Zone 48	1,024	396	2,470	171	23,311	0.0%	83.3%	16.7%	0.0%	100.0%	0.0%	83.3%	16.7%	0.0%	100.0%	872.4	22.3	0.5
49	Zone 49	2,226	989	2,894	414	69,475	0.0%	56.3%	43.8%	0.0%	100.0%	0.0%	56.3%	43.8%	0.0%	100.0%	1,185.0	28.7	0.7
50	Zone 50	1,790	682	3,149	381	109,739	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	456.6	12.9	1.5
51	Zone 51	7,818	3,270	43	1,713	79,497	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	746.3	67.7	1.3
52	Zone 52	2,050	867	111	398	88,431	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,161.9	14.7	1.6
53	Zone 53	669	302	327	131	28,470	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	727.4	3.2	1.6
54	Zone 54	2,067	960	239	374	60,507	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	2,927.3	34.0	0.7
55	Zone 55	2,612	1,254	208	515	70,408	0.0%	64.3%	35.7%	0.0%	100.0%	0.0%	64.3%	35.7%	0.0%	100.0%	594.9	12.2	2.0
56	Zone 56	1,922	722	43	382	108,232	0.0%	15.4%	84.6%	0.0%	100.0%	0.0%	15.4%	84.6%	0.0%	100.0%	1,212.1	14.3	1.3
57	Zone 57	3,179	1,532	117	665	136,857	0.0%	44.4%	55.6%	0.0%	100.0%	0.0%	44.4%	55.6%	0.0%	100.0%	2,592.3	36.4	0.7
58	Zone 58	1,748	901	13	357	68,996	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,222.0	25.8	0.8
59	Zone 59	2,178	998	49	427	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	484.9	16.4	1.5
60	Zone 60	1,486	668	43	290	1,529	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	611.8	8.7	1.6
61	Zone 61	1,451	600	2,282	257	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	977.4	19.9	0.7
62	Zone 62	1,983	861	43	380	5,000	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	1,088.7	8.6	1.2
63	Zone 63	9,249	4,302	43	2,802	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,645.2	190.1	0.6
64	Zone 64	19,152	7,524	43	4,620	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	1,255.3	648.5	0.3
65	Zone 65	671	473	43	151	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	338.2	21.5	0.4
66	Zone 66	8,214	3,407	43	1,552	5,000	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	2,427.8	94.6	1.0
67	Zone 67	1,422	479	43	241	5,000	6.3%	93.8%	0.0%	0.0%	100.0%	6.3%	93.8%	0.0%	0.0%	100.0%	1,916.6	39.9	0.4
68	Zone 68	1,191	551	43	248	5,000	6.3%	93.8%	0.0%	0.0%	100.0%	6.3%	93.8%	0.0%	0.0%	100.0%	945.2	39.0	0.4
69	Zone 69	3,472	1,228	43	627	5,000	6.3%	93.8%	0.0%	0.0%	100.0%	6.3%	93.8%	0.0%	0.0%	100.0%	1,771.6	91.0	0.5
70	Zone 70	682	261	43	142	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	763.6	17.7	0.4
71	Zone 71	3,305	1,510	43	709	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	643.5	19.5	1.6
72	Zone 72	895	401	43	160	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	1,098.9	32.1	0.3
73	Zone 73	3,268	1,687	43	728	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	2,151.9	56.4	0.5
74	Zone 74	1,256	779	43	242	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	1,545.5	24.9	0.5
75	Zone 75	2,714	940	43	552	5,000	0.0%	65.2%	34.8%	0.0%	100.0%	0.0%	65.2%	34.8%	0.0%	100.0%	696.4	25.3	1.0
	Total	1,510,561	537,639	537,649	326,523	28,989,369	1.3%	69.7%	29.0%	0.0%	100.0%	1.2%	69.4%	29.4%	0.0%	100.0%	68,477.6	9,109.6	1.1
	Actuals						1.3%	69.1%	29.6%	0.0%	100.0%								

Step 3

Reset Matrix | Default Vehicle Costs

Create Matrix | Go Home

Step 6

Vehicle Cost (Used in trip cost)

Valid Year for the Entry	2014		
Vehicle depreciation/Year	15%		
	2W	Car	Bicycle
Life (yrs.)	7	12	5
Driven (km.)	60,000	100,000	10,000
Capital Cost (Rs.)	40,000	500,000	1,500
Salvage value	15,037	93,454	746
A. Capital Cost/km	0.42	4.07	0.08
O&M (Rs./Year)	1,000	3,000	200
B. Unit Maintenace cost	0.12	0.36	0.10
Mileage	30	10	
Fuel cost	59.6	59.6	
C. Unit Fuel Cost	2.0	6.0	0
Final Unit Cost [A + B + C] (Rs./km)	2.5	10.4	0.2
% Modal Share	80%	20%	
% Cost Share	2.02	2.08	
Average (Rs./km)		4.09	0.18
Average 2011 prices (Rs./km.)	**4.09**		**0.18**

Step 5

Model Split SEG Wise Mode Wise

SEG/Mode	Private	Cycle	PT	Total
HIG	72%	5%	23%	100%
MIG	48%	13%	39%	100%
LIG	9%	16%	75%	100%
EWS				0%

Average Speeds (Km/hr)

Mode	Value
Private	30
Cycle	10
PT	21

Fare Chart

Kms (upto)	Fare (Rs.)
4	5
14	10
22	15
30	20
Barrier Value for time (secs)	1,000,000
Barrier Value for money (Rs)	1,000,000

Step 5

Distance Matrix (Distance in meters) Other than PT

Step 5 – Table Continued in excel..

Zone	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16	Zone 17	Zone 18	Zone 19	Zone 20	Zone 21	Zone 22	Zone 23	Zone 24	Zone 25	Zone 26	Zone 27	Zone 28	Zone 29	Zone 30
Zone 1	2,657	2,581	5,399	8,049	3,227	8,448	13,814	5,344	9,756	6,831	13,783	7,562	8,255	17,178	9,019	18,108	13,165	11,530	19,955	16,267	9,952	14,380	9,743	14,076	17,157	14,619	12,126	12,486	10,137	11,00
Zone 2	2,581	1,842	4,082	6,732	1,527	6,748	12,114	4,027	8,439	5,131	12,467	6,246	6,555	15,477	7,319	16,408	11,464	9,829	18,254	14,951	8,251	12,679	8,042	12,375	15,456	12,918	10,425	10,785	8,437	9,30
Zone 3	5,399	4,082	1,787	3,362	5,609	10,334	15,700	1,900	5,884	8,344	10,197	4,477	10,141	19,064	10,768	19,994	15,051	13,416	21,771	12,681	7,585	15,679	9,112	14,913	18,202	11,612	11,194	13,324	10,639	9,67
Zone 4	8,049	6,732	3,362	2,254	8,259	12,984	18,350	3,573	4,658	10,606	7,150	6,150	12,791	21,714	12,441	22,644	17,701	15,477	23,444	10,913	9,258	17,352	10,785	16,586	19,875	11,428	12,887	14,997	12,312	11,34
Zone 5	3,227	1,527	5,609	8,259	2,028	5,221	10,587	5,554	9,966	4,351	13,993	7,755	5,028	13,951	5,792	14,881	9,938	8,303	16,728	16,477	7,471	11,153	7,262	10,953	13,929	12,138	9,646	9,417	7,586	8,52
Zone 6	8,448	6,748	10,334	12,984	5,221	2,866	7,551	10,279	13,317	5,749	17,344	9,417	4,104	9,097	4,868	11,970	7,596	7,378	14,002	19,647	8,870	9,215	8,025	9,546	11,647	13,536	10,054	8,493	7,229	9,92
Zone 7	13,814	12,114	15,700	18,350	10,587	7,551	1,972	15,645	17,633	11,115	21,612	13,733	6,430	4,832	7,895	4,800	3,443	6,142	6,833	23,080	12,638	6,281	10,629	6,930	8,643	16,758	12,412	7,806	9,391	12,88
Zone 8	5,344	4,027	1,900	3,573	5,554	10,279	15,645	2,065	4,770	7,033	8,798	2,577	10,086	19,009	8,868	19,381	14,437	11,904	19,871	11,282	5,685	13,779	7,212	13,013	16,302	9,712	9,294	11,424	8,738	7,77
Zone 9	9,756	8,439	5,884	4,658	9,966	13,317	17,633	4,770	2,614	8,356	4,512	3,900	11,696	20,996	10,191	20,704	15,760	13,227	21,194	7,942	7,008	15,102	8,535	14,337	17,625	7,914	10,617	12,747	10,062	9,09
Zone 10	6,831	5,131	8,344	10,606	4,351	5,749	11,115	7,033	8,356	2,438	12,384	4,456	4,889	14,479	3,740	14,364	9,421	6,887	15,005	14,686	3,909	8,913	3,319	8,148	11,436	8,550	5,917	6,558	4,209	4,90
Zone 11	13,783	12,467	10,197	7,150	13,993	17,344	21,612	8,798	4,512	12,384	2,537	7,928	15,676	24,976	14,171	24,684	19,740	17,207	25,174	3,945	9,841	19,082	12,038	18,316	21,605	6,639	13,333	16,727	13,766	11,80
Zone 12	7,562	6,246	4,477	6,150	7,755	9,417	13,733	2,577	3,900	4,456	7,928	2,523	7,796	17,096	6,291	16,804	11,860	9,327	17,294	10,412	3,108	11,202	4,635	10,437	13,725	7,135	6,717	8,847	6,162	5,19
Zone 13	8,255	6,555	10,141	12,791	5,028	4,104	6,430	10,086	11,696	4,889	15,676	7,796	2,715	9,793	1,589	9,881	4,938	3,709	11,728	17,361	6,918	6,306	4,914	6,510	8,929	11,039	6,938	5,123	3,951	7,23
Zone 14	17,178	15,477	19,064	21,714	13,951	9,097	4,832	19,009	20,996	14,479	24,976	17,096	9,793	2,261	11,259	4,836	7,722	10,204	8,570	26,444	16,001	10,277	13,992	11,735	11,189	20,122	15,776	12,407	12,755	16,25
Zone 15	9,019	7,319	10,768	12,441	5,792	4,868	7,895	8,868	10,191	3,740	14,171	6,291	1,589	11,259	1,563	10,967	6,023	3,490	12,021	15,774	5,332	6,120	3,327	5,691	8,980	9,452	5,349	4,147	2,362	5,64
Zone 16	18,108	16,408	19,994	22,644	14,881	11,970	4,800	19,381	20,704	14,364	24,684	16,804	9,881	4,836	10,967	1,766	4,943	8,584	3,734	25,935	15,492	6,500	13,483	7,958	7,411	19,613	15,256	9,645	12,040	15,74
Zone 17	13,165	11,464	15,051	17,701	9,938	7,596	3,443	14,437	15,760	9,421	19,740	11,860	4,938	7,722	6,023	4,943	2,529	3,641	6,976	21,205	10,763	3,580	8,754	4,229	5,942	14,883	10,526	5,185	7,310	11,01
Zone 18	11,530	9,829	13,416	15,477	8,303	7,378	6,142	11,904	13,227	6,887	17,207	9,327	3,709	10,204	3,490	8,584	3,641	2,063	10,096	18,674	8,232	4,418	6,223	4,621	7,074	12,353	8,007	4,334	4,985	8,48
Zone 19	19,955	18,254	21,771	23,444	16,728	14,002	6,833	19,871	21,194	15,005	25,174	17,294	11,728	8,570	12,021	3,734	6,976	10,096	2,046	26,082	15,640	6,647	13,631	7,227	5,535	19,760	14,824	9,034	12,090	15,86
Zone 20	16,267	14,951	12,681	10,913	16,477	19,647	23,080	11,282	7,942	14,686	3,945	10,412	17,361	26,444	15,774	25,935	21,205	18,674	26,082	3,873	11,371	19,990	12,814	19,215	22,504	7,330	14,024	17,536	14,543	12,50
Zone 21	9,952	8,251	7,585	9,258	7,471	8,870	12,638	5,685	7,008	3,909	9,841	3,108	6,918	16,001	5,332	15,492	10,763	8,232	15,640	11,371	2,300	9,548	2,372	8,773	12,061	5,050	3,785	7,093	4,101	2,26
Zone 22	14,380	12,679	15,679	17,352	11,153	9,215	6,281	13,779	15,102	8,913	19,082	11,202	6,306	10,277	6,120	6,500	3,580	4,418	6,647	19,990	9,548	2,192	7,539	1,539	3,225	13,668	9,087	3,315	6,095	9,79
Zone 23	9,743	8,042	9,112	10,785	7,262	8,025	10,629	7,212	8,535	3,319	12,038	4,635	4,914	13,992	3,327	13,483	8,754	6,223	13,631	12,814	2,372	7,539	888	6,764	10,052	6,493	2,749	5,084	2,092	2,47
Zone 24	14,076	12,375	14,913	16,586	10,953	9,546	6,930	13,013	14,337	8,148	18,316	10,437	6,510	11,736	5,691	7,958	4,229	4,621	7,227	19,215	8,773	1,539	6,764	1,807	3,558	12,894	7,877	2,077	5,132	8,90
Zone 25	17,157	15,456	18,202	19,875	13,929	11,647	8,643	16,302	17,625	11,436	21,605	13,725	8,929	11,189	8,980	7,411	5,942	7,074	5,535	22,504	12,061	3,225	10,052	3,558	1,949	16,182	11,165	5,365	8,420	12,19
Zone 26	14,619	12,918	11,612	11,428	12,138	13,536	16,758	9,712	7,914	8,550	6,639	7,135	11,039	20,122	9,452	19,613	14,883	12,353	19,760	7,330	5,050	13,668	6,493	12,894	16,182	3,425	7,702	11,214	8,222	6,17
Zone 27	12,126	10,425	11,194	12,867	9,646	10,054	12,412	9,294	10,617	5,917	13,333	6,717	6,938	15,776	5,349	15,256	10,526	8,007	14,834	14,024	3,785	9,087	2,749	7,877	11,165	7,702	1,825	5,849	3,383	2,39
Zone 28	12,486	10,785	13,324	14,997	9,417	8,493	7,806	11,424	12,747	6,558	16,727	8,847	5,123	12,407	4,147	9,645	5,185	4,334	9,034	17,536	7,093	3,315	5,084	2,077	5,365	11,214	5,849	1,404	3,283	7,03
Zone 29	10,137	8,437	10,639	12,312	7,586	7,229	9,391	8,738	10,062	4,209	13,766	6,162	3,951	12,756	2,362	12,040	7,310	4,985	12,090	14,543	4,101	6,095	2,092	5,132	8,420	8,222	3,383	3,283	968	3,96
Zone 30	11,003	9,303	9,673	11,346	8,523	9,921	12,887	7,773	9,096	4,903	11,809	5,196	7,230	16,251	5,641	15,742	11,012	8,481	15,866	12,500	2,264	9,797	2,473	8,908	12,196	6,179	2,399	7,039	3,967	1,82
Zone 31	11,246	9,545	11,827	13,500	8,535	7,860	9,098	9,927	11,250	5,317	15,129	7,350	4,490	12,965	3,177	11,207	6,477	4,984	10,880	15,906	5,463	5,067	3,455	3,922	7,210	9,584	4,284	1,952	1,653	5,26
Zone 32	18,328	17,012	14,742	13,516	18,127	19,525	22,432	13,342	10,003	14,507	7,901	12,472	16,775	25,795	15,185	25,286	20,557	18,026	25,122	4,370	11,422	19,342	12,076	18,164	21,453	6,372	10,633	16,137	13,491	9,86
Zone 33	11,095	9,394	11,246	12,919	8,597	8,369	10,531	9,346	10,669	5,167	13,839	6,769	5,091	13,895	3,502	13,066	8,336	6,125	12,739	14,616	4,173	6,926	2,303	5,782	9,070	6,294	2,303	3,767	1,271	3,72
Zone 34	12,195	10,494	12,638	14,311	9,581	9,090	10,848	10,738	12,061	6,267	15,400	8,161	5,812	14,815	4,222	12,848	8,227	6,787	12,265	16,177	5,734	6,517	3,864	5,307	8,596	9,855	2,857	3,280	2,103	4,66
Zone 35	17,100	15,399	17,707	19,380	14,241	13,207	10,765	15,807	17,130	11,172	20,958	13,230	9,947	14,344	8,979	10,566	8,064	8,236	9,154	21,735	11,292	4,676	9,320	3,887	5,485	15,413	9,156	5,232	7,402	10,88
Zone 36	13,320	11,620	13,928	15,601	10,610	9,881	9,549	12,028	13,351	7,392	17,178	9,451	6,511	14,150	5,231	11,317	6,928	6,077	10,628	17,955	7,513	4,939	5,541	3,584	6,958	11,633	4,987	1,909	3,623	6,78
Zone 37	12,511	10,810	12,473	14,146	10,014	9,869	12,030	10,573	11,896	6,529	14,629	7,996	6,590	15,394	5,001	14,193	9,604	7,625	13,610	15,320	5,292	7,863	3,530	6,653	9,941	8,998	1,701	4,825	2,680	3,69
Zone 38	16,855	15,154	17,692	19,365	13,732	12,697	10,256	15,792	17,116	10,927	21,095	13,216	9,438	13,447	8,470	9,669	7,555	7,727	6,521	21,994	11,552	4,058	9,543	3,378	3,220	15,673	10,019	4,792	7,911	11,48
Zone 39	14,082	12,381	12,895	14,568	11,585	11,533	13,695	10,995	12,318	8,100	14,513	8,418	8,255	17,059	6,666	15,730	11,270	9,289	14,922	15,204	5,486	9,391	5,037	8,008	11,253	8,883	2,416	6,162	4,393	3,57
Zone 40	17,957	16,256	16,534	16,536	15,476	16,874	19,781	14,634	13,023	11,856	10,920	12,057	14,124	23,145	12,535	22,636	17,906	15,375	22,471	7,389	9,125	16,691	9,426	15,513	18,802	7,662	7,982	13,486	10,840	7,21
Zone 41	13,895	12,194	14,476	16,149	11,184	10,694	11,380	12,576	13,899	7,967	17,243	9,999	7,415	15,981	5,826	13,052	8,758	7,727	12,163	17,934	7,846	6,632	5,978	5,249	8,494	11,612	4,412	3,651	4,081	6,30
Zone 42	13,644	11,944	14,057	15,730	11,093	10,662	12,260	12,157	13,480	7,716	16,224	9,580	7,383	16,187	5,794	13,986	9,639	8,359	13,097	16,915	7,050	7,566	5,248	6,183	9,428	10,593	3,393	4,531	3,522	5,29
Zone 43	15,930	14,229	16,512	18,185	13,220	12,729	11,615	14,612	15,935	10,002	19,277	12,035	9,450	16,217	7,861	12,719	8,926	8,460	11,307	19,968	9,933	6,531	8,035	5,071	7,638	13,646	6,600	4,906	6,116	8,34
Zone 44	16,504	14,803	15,173	16,846	14,023	15,421	18,328	13,273	13,881	10,403	12,605	10,697	12,671	21,692	11,082	21,183	16,453	13,922	21,018	10,396	7,764	15,238	7,973	14,061	17,349	6,974	6,529	12,033	9,387	5,76
Zone 45	17,254	15,553	16,523	18,196	14,702	14,435	16,493	14,623	15,946	11,325	18,141	12,046	11,156	19,960	9,567	18,195	13,872	12,191	17,193	18,556	9,114	11,776	8,423	10,393	13,523	12,510	6,044	8,765	7,205	7,20
Zone 46	17,596	15,896	18,118	19,791	14,886	14,395	13,975	16,218	17,541	11,668	19,736	13,641	11,117	18,576	9,527	15,464	11,327	10,820	14,104	20,427	10,709	9,045	9,584	7,657	10,435	14,105	7,639	6,932	7,783	8,80
Zone 47	19,988	18,287	20,570	22,243	17,278	16,275	13,834	18,670	19,993	14,060	23,656	16,093	13,016	17,025	11,919	13,247	11,133	11,305	11,074	24,433	13,991	7,636	12,093	6,956	7,772	18,111	11,121	8,370	10,175	12,91
Zone 48	20,142	18,441	20,723	22,396	17,431	16,940	15,503	18,823	20,146	14,213	23,583	16,246	13,662	18,831	12,073	15,054	12,801	12,561	13,641	24,274	14,144	9,442	12,246	8,763	9,972	17,952	11,274	9,037	10,328	12,64
Zone 49	19,744	18,043	18,414	20,087	17,263	17,069	19,128	16,513	17,837	13,643	20,009	13,937	13,791	22,595	12,202	20,830	16,506	14,825	19,827	18,996	11,004	14,410	10,621	13,027	16,158	14,378	8,000	11,399	9,840	9,09
Zone 50	27,809	26,109	28,647	30,320	24,687	23,330	20,326	26,747	28,070	21,881	32,050	24,170	20,392	22,244	19,425	17,408	17,625	18,682	13,674	32,949	22,506	14,907	20,497	14,333	11,683	26,627	20,973	15,746	18,865	22,43
Zone 51	20,990	19,289	20,984	22,657	18,279	17,788	17,575	19,084	20,407	15,061	22,602	16,507	14,510	21,465	12,921	17,688	14,927	14,419	16,275	23,240	13,575	11,957	12,884	10,995	12,606	16,971	10,505	10,532	11,139	11,66
Zone 52	21,957	20,256	21,226	22,899	19,405	19,138	20,644	19,326	20,650	16,029	22,465	16,750	15,860	24,663	14,270	21,993	17,996	16,894	20,580	18,935	13,817	15,714	13,126	14,326	16,911	17,214	10,748	13,468	11,909	11,91
Zone 53	23,321	21,620	23,315	24,988	20,610	20,119	19,906	21,415	22,738	17,392	24,933	18,838	16,841	24,507	15,252	20,942	17,258	16,750	19,529	21,975	15,906	14,976	15,215	13,588	15,860	19,302	12,836	12,863	13,470	13,99
Zone 54	16,416	15,100	12,063	8,701	16,626	19,977	24,293	11,431	6,661	15,017	5,761	10,561	18,357	27,657	16,851	27,364	22,421	19,888	27,955	9,525	13,669	21,763	15,195	20,997	24,285	12,400	17,278	19,407	16,722	15,75
Zone 55	8,071	8,979	11,797	14,447	9,486	12,121	14,902	11,742	16,154	11,546	20,181	13,961	12,005	15,816	12,769	19,321	15,822	15,280	21,353	22,665	14,666	18,130	14,389	17,931	20,510	19,333	16,721	16,395	14,563	15,71
Zone 56	6,571	7,478	10,296	12,946	7,985	8,834	11,616	10,241	14,653	10,045	18,680	12,460	10,504	12,529	11,268	16,035	12,535	13,135	18,067	21,165	13,165	14,861	12,888	15,228	17,223	17,832	15,220	14,894	13,062	14,21
Zone 57	10,538	8,837	12,424	15,073	7,310	4,274	3,623	12,369	14,670	7,839	18,649	10,770	3,021	6,987	4,610	8,042	3,875	3,934	10,075	20,117	9,675	5,696	7,666	6,027	8,128	13,795	9,449	6,138	6,428	9,92
Zone 58	13,836	12,135	15,722	18,372	10,609	5,388	2,918	15,667	18,705	11,137	22,732	14,805	7,392	3,709	8,981	7,337	6,361	8,290	9,370	24,530	14,087	9,199	12,078	9,848	11,236	18,208	13,862	10,493	10,841	14,33
Zone 59	15,324	14,894	18,480	21,130	13,367	8,146	5,370	18,425	21,463	13,895	25,490	17,563	9,844	4,746	11,433	9,519	9,813	10,742	11,821	26,982	16,539	11,651	14,530	12,300	13,688	20,660	16,314	12,945	13,293	16,78
Zone 60	22,004	20,304	23,890	26,540	18,777	13,923	9,659	23,835	25,823	19,305	29,802	21,923	14,620	8,127	16,085	10,808	13,102	15,030	14,542	31,270	20,828	15,940	18,819	16,589	17,162	24,948	20,602	17,234	17,581	21,07
Zone 61	20,785	19,084	21,622	23,295	17,662	16,305	13,301	19,722	21,045	14,857	25,025	17,145	13,368	15,219	12,400	10,384	10,600	11,657	6,650	25,924	15,482	7,883	13,473	7,308	4,658	19,602	13,949	8,721	11,841	15,41
Zone 62	22,945	21,245	23,783	25,456	19,823	18,466	15,462	21,883	23,206	17,017	27,186	19,306	15,528	17,380	14,561	12,544	12,761	13,818	8,811	28,085	17,642	10,044	15,633	9,469	6,819	21,763	16,109	10,882	14,002	17,57
Zone 63	30,255	28,554	31,092	32,765	27,132	25,775	22,771	29,192	30,515	24,326	34,495	26,615	22,837	24,889	21,970	19,854	20,070	21,127	16,120	35,394	24,952	17,353	22,943	16,778	14,128	29,072	23,419	18,191	21,311	24,88
Zone 64	31,090	29,389	31,928	33,601	27,967	26,611	23,607	30,027	31,351	25,162	35,331	27,451	23,673	25,525	22,705	20,689	20,905	21,962	16,955	36,229	25,787	18,188	23,778	17,613	14,963	29,908	24,254	19,027	22,146	25,71
Zone 65	29,212	27,511	30,050	31,723	26,089	24,733	21,729	28,150	29,473	23,284	33,453	25,573	21,795	23,647	20,828	18,811	19,028	20,085	15,077	34,352	23,909	16,310	21,900	15,736	13,086	28,030	22,376	17,149	20,268	23,84
Zone 66	20,410	21,317	24,136	26,785	20,600	15,416	11,969	24,081	28,133	21,128	32,113	24,233	16,443	10,771	18,032	15,544	15,412	17,341	18,420	33,580	23,138	18,250	21,129	18,899	20,286	27,259	22,913	19,544	19,891	23,38
Zone 67	16,546	17,253	20,272	22,921	15,727	10,506	7,845	20,217	23,822	16,255	27,850	19,922	12,318	6,647	13,908	11,420	11,288	13,216	14,296	29,456	19,014	14,126	17,005	14,775	16,162	23,134	18,788	15,420	15,767	19,26
Zone 68	26,496	24,795	25,923	27,596	23,786	23,295	23,081	24,023	25,346	20,568	27,541	21,446	20,017	27,883	18,427	24,430	20,434	19,926	23,018	24,276	18,514	18,151	17,823	16,764	19,349	21,910	15,444	16,039	16,605	16,60
Zone 69	27,154	25,453	27,148	28,821	24,444	23,953	23,522	25,248	26,572	21,226	28,766	22,672	20,674	27,278	19,085	23,500	20,820	20,563	22,088	26,284	19,739	17,770	19,048	16,807	18,419	23,136	16,670	16,675	17,303	17,83
Zone 70	20,071	18,370	20,908	22,581	16,948	15,592	12,587	19,008	20,332	14,143	24,311	16,432	12,654	14,506	11,686	9,670	9,886	10,943	5,936	25,210	14,768	7,169	12,759	6,594	3,944	18,889	13,235	8,008	11,127	14,69
Zone 71	11,203	9,503	13,089	15,739	7,976	2,755	5,429	13,034	16,072	8,504	20,099	12,172	5,596	6,450	7,185	9,848	6,348	6,947	11,880	22,402	11,625	8,673	10,509	9,040	11,036	16,291	12,519	9,151	9,498	12,67
Zone 72	16,421	15,104	12,067	8,705	16,631	19,982	24,298	11,435	6,665	15,021	3,419	10,565	18,361	27,661	16,856	27,369	22,425	19,892	27,859	4,336	13,261	21,767	15,200	21,002	24,290	10,058	16,752	19,412	16,727	15,22
Zone 73	23,829	22,128	22,499	24,172	21,349	21,458	23,516	20,599	21,128	17,729	19,025	18,022	18,179	26,983	16,590	25,218	20,895	19,213	24,215	15,495	15,090	18,798	15,009	17,415	20,546	14,300	12,388	15,787	14,228	13,08
Zone 74	24,183	22,483	24,188	25,861	21,473	20,982	20,366	22,288	23,611	18,255	25,806	19,711	17,704	24,122	16,115	20,344	17,664	17,407	18,932	26,497	16,778	14,614	16,087	13,651	15,263	20,175	13,709	13,519	14,343	14,87
Zone 75	19,778	18,077	21,594	23,267	16,551	14,269	9,716	19,694	21,017	14,828	24,997	17,117	11,551	11,453	11,844	6,617	8,564	9,919	2,883	25,905	15,463	6,470	13,454	7,050	5,358	19,584	14,658	8,957	11,913	15,68

Figure 3: Screen Shot C

Property Rates for Year

Sr. No	Area (Sq. Ft.)	Area (Sq. Mtr.)	Cost (Rs.)	Rate (Rs./sqm)
1	432	40.1	Rs. 3,000,000	Rs. 74,749
2	500	46.5	Rs. 2,000,000	Rs. 43,056
3	510	47.4	Rs. 1,450,000	Rs. 30,603
4	750	69.7	Rs. 6,000,000	Rs. 86,111
5	900	83.6	Rs. 6,500,000	Rs. 77,739
6	1395	129.6	Rs. 10,100,000	Rs. 77,932
7	1800	167.2	Rs. 12,000,000	Rs. 71,759
8	1116	103.7	Rs. 10,500,000	Rs. 101,273
9	1116	103.7	Rs. 11,000,000	Rs. 106,096
10	1250	116.1	Rs. 4,800,000	Rs. 41,333
11	800	74.3	Rs. 8,500,000	Rs. 114,367
12	1000	92.9	Rs. 5,100,000	Rs. 54,896
13	1375	127.7	Rs. 7,700,000	Rs. 60,278
14	1270	118.0	Rs. 10,500,000	Rs. 88,993
15	2500	232.3	Rs. 8,500,000	Rs. 36,597
16	1485	138.0	Rs. 10,500,000	Rs. 76,108
17	885	82.2	Rs. 5,500,000	Rs. 66,894
18	675	62.7	Rs. 3,500,000	Rs. 55,813
19	1620	150.5	Rs. 6,110,000	Rs. 40,597
20	550	51.1	Rs. 2,500,000	Rs. 48,927
21	1500	139.4	Rs. 5,250,000	Rs. 37,674
22	800	74.3	Rs. 2,300,000	Rs. 30,946
23	617	57.3	Rs. 2,900,000	Rs. 50,592
24	1080	100.3	Rs. 8,500,000	Rs. 84,716
25	1323	122.9	Rs. 11,000,000	Rs. 89,496
26	2500	232.3	Rs. 21,000,000	Rs. 90,417
27	1021	94.9	Rs. 9,000,000	Rs. 94,883
28	1500	139.4	Rs. 7,200,000	Rs. 51,667
29	564	52.4	Rs. 2,250,000	Rs. 42,941
30	66600	6187.3	Rs. 39,000,000	Rs. 6,303
31	450	41.8	Rs. 2,900,000	Rs. 69,367
32	1545	143.5	Rs. 4,000,000	Rs. 27,868
33	765	71.1	Rs. 7,000,000	Rs. 98,493
34	1400	130.1	Rs. 5,000,000	Rs. 38,443
35	792	73.6	Rs. 3,200,000	Rs. 43,491
36	1000	92.9	Rs. 7,500,000	Rs. 80,729
37	6255	581.1	Rs. 7,500,000	Rs. 12,906
38	1270	118.0	Rs. 4,350,000	Rs. 36,869
39	666	61.9	Rs. 4,000,000	Rs. 64,648
40	934	86.8	Rs. 4,800,000	Rs. 55,318
41	625	58.1	Rs. 2,300,000	Rs. 39,611
42	540	50.2	Rs. 6,300,000	Rs. 125,579
43	320	29.7	Rs. 1,951,000	Rs. 65,626
44	650	60.4	Rs. 2,650,000	Rs. 43,884
45	925	85.9	Rs. 6,300,000	Rs. 73,311

Step 8

Step 8

Step 9

Go Home

Property Rates Year	2015	Conversion Year	2011
Discount rate (%age)	5%	Conversion Unit (sqft to sqm)	0.09

Step 8

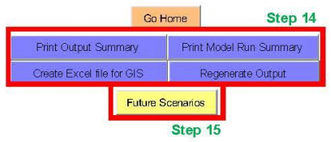
Area (Sq. Ft.)	Area (Sq. Mtr.)	Cost (Rs.)	Rate (Rs./sqm)
118,061	10,968	Rs. 316,111,000	Rs. 28,821

Figure 4: Screen Shot D

ATL (km.)				
SEG/Mode	Private	Cycle	PT	Overall
HIG	4.15	4.03	3.33	3.95
MIG	3.72	4.91	3.88	3.94
LIG	2.32	4.28	3.03	3.16
EWS				
Overall	3.63	4.69	3.50	3.72

Rents (Rs./DU), DU Sizes (mtr2) and ATL (km.)			
SEG/Mode	Rents	DU Size	ATL
HIG	₹ 10,529	90	3.95
MIG	₹ 7,676	64	3.94
LIG	₹ 4,391	35	3.16
EWS	₹ 0	0	0.00
Overall	₹ 6,778	56	3.72

Model Split SEG Wise Mode Wise (used as Input)				
SEG/Mode	Private	Cycle	PT	Total
HIG	72%	5%	23%	100%
MIG	48%	13%	39%	100%
LIG	9%	16%	75%	100%
EWS	0%	0%	0%	0%



FSI Consumption Status and Rents Zone wise							
Zones	FSI Proposed	FSI Consumed (Modelled)	FSI Consumed (Actual)	Total Monthly Rent (Rs./DU)	Population (Modelled)	Population (Actual)	Population (Diff)
Zone 1	1.13	0.17	0.16	Rs. 6,385.8	76,429	76,424	5
Zone 2	1.80	0.15	0.15	Rs. 7,105.6	54,768	54,854	-86
Zone 3	1.35	0.08	0.08	Rs. 6,345.5	51,523	51,696	-173
Zone 4	1.24	0.20	0.20	Rs. 6,629.9	40,129	40,398	-269
Zone 5	1.58	0.08	0.08	Rs. 6,230.9	74,076	74,434	-358
Zone 6	0.79	0.36	0.36	Rs. 6,539.7	58,420	58,686	-266
Zone 7	1.91	0.16	0.17	Rs. 6,780.8	38,933	39,088	-155
Zone 8	1.13	0.33	0.33	Rs. 6,949.1	34,971	35,097	-126
Zone 9	0.90	0.27	0.27	Rs. 7,075.5	43,955	44,118	-163
Zone 10	1.91	0.16	0.16	Rs. 7,213.9	44,685	44,897	-212
Zone 11	1.80	0.21	0.21	Rs. 7,324.6	52,520	52,800	-280
Zone 12	1.58	0.20	0.20	Rs. 7,251.1	74,005	74,369	-364
Zone 13	2.13	0.08	0.08	Rs. 7,176.9	95,899	95,917	-18
Zone 14	1.58	0.30	0.30	Rs. 6,623.3	47,536	47,450	86
Zone 15	1.58	0.42	0.42	Rs. 7,084.8	39,627	39,496	131
Zone 16	0.68	0.40	0.39	Rs. 6,156.3	44,102	44,421	-319
Zone 17	0.83	0.42	0.40	Rs. 5,587.0	59,783	60,994	-1,211
Zone 18	1.80	0.19	0.19	Rs. 6,702.9	53,503	53,863	-360
Zone 19	2.25	0.20	0.20	Rs. 7,213.5	48,891	48,910	-19
Zone 20	1.24	0.48	0.48	Rs. 6,923.9	46,521	46,503	18
Zone 21	2.02	0.15	0.15	Rs. 6,881.8	80,995	80,991	4
Zone 22	1.35	0.27	0.27	Rs. 6,885.9	56,489	56,622	-133
Zone 23	0.90	0.45	0.45	Rs. 6,687.8	64,460	64,650	-190
Zone 24	1.00	0.05	0.06	Rs. 6,729.3	4,460	4,455	5
Zone 25	0.81	0.10	0.10	Rs. 7,593.0	6,075	5,720	355
Zone 26	1.67	0.04	0.04	Rs. 6,653.8	5,802	5,759	43
Zone 27	1.58	0.05	0.05	Rs. 7,587.2	3,622	3,483	139
Zone 28	1.00	0.31	0.31	Rs. 6,596.6	2,232	2,232	0
Zone 29	1.43	0.05	0.05	Rs. 7,231.8	15,096	15,036	60
Zone 30	0.97	0.06	0.06	Rs. 6,259.3	13,452	13,483	-31
Zone 31	0.82	0.20	0.19	Rs. 6,372.4	53,996	53,794	202
Zone 32	2.02	0.08	0.08	Rs. 7,217.9	5,898	5,874	24
Zone 33	0.59	0.13	0.12	Rs. 6,577.9	2,562	2,553	9
Zone 34	1.22	0.11	0.10	Rs. 6,243.3	633	622	11
Zone 35	0.96	0.11	0.09	Rs. 5,344.2	1,149	1,100	49
Zone 36	0.51	0.03	0.03	Rs. 7,087.5	591	576	15
Zone 37	0.69	0.12	0.11	Rs. 5,511.3	1,750	1,750	0
Zone 38	0.61	0.10	0.10	Rs. 7,598.8	1,076	1,054	22
Zone 39	1.01	0.10	0.11	Rs. 6,655.5	305	261	44
Zone 40	1.54	0.13	0.10	Rs. 6,140.2	2,231	2,170	61
Zone 41	1.26	0.10	0.10	Rs. 6,217.9	2,709	2,692	17
Zone 42	1.16	0.10	0.10	Rs. 7,822.4	1,379	1,351	28
Zone 43	1.52	0.10	0.10	Rs. 7,544.3	3,569	3,508	61
Zone 44	1.59	0.10	0.10	Rs. 7,181.7	1,719	1,697	22
Zone 45	0.27	0.10	0.10	Rs. 6,332.9	1,006	1,000	6
Zone 46	1.13	0.02	0.01	Rs. 6,591.0	279	270	9
Zone 47	0.44	0.10	0.11	Rs. 7,720.7	3,836	3,749	87
Zone 48	0.48	0.09	0.10	Rs. 7,241.4	1,036	1,024	12
Zone 49	0.68	0.11	0.11	Rs. 6,503.7	2,199	2,226	-27
Zone 50	1.49	0.07	0.06	Rs. 6,841.2	1,823	1,790	33
Zone 51	1.33	0.13	0.13	Rs. 7,528.7	8,215	7,818	397
Zone 52	1.60	0.11	0.11	Rs. 7,548.3	2,158	2,050	108
Zone 53	1.58	0.12	0.08	Rs. 5,195.2	797	669	128
Zone 54	0.70	0.10	0.10	Rs. 7,579.7	2,128	2,067	61
Zone 55	1.98	0.11	0.11	Rs. 6,543.7	2,642	2,612	30
Zone 56	1.32	0.08	0.07	Rs. 5,436.9	1,957	1,922	35
Zone 57	0.70	0.12	0.12	Rs. 6,019.9	3,150	3,179	-29
Zone 58	0.78	0.12	0.12	Rs. 7,583.7	1,777	1,748	29
Zone 59	1.53	0.11	0.11	Rs. 7,597.3	2,249	2,178	71
Zone 60	1.60	0.11	0.11	Rs. 6,470.6	1,501	1,486	15
Zone 61	0.68	0.10	0.10	Rs. 6,629.0	1,491	1,451	40
Zone 62	1.20	0.17	0.11	Rs. 4,967.2	2,458	1,983	475
Zone 63	0.56	0.16	0.16	Rs. 7,444.0	9,519	9,249	270
Zone 64	0.34	0.14	0.14	Rs. 7,520.7	20,251	19,152	1,099
Zone 65	0.36	0.13	0.13	Rs. 7,565.3	693	671	22
Zone 66	1.00	0.11	0.11	Rs. 7,396.9	8,278	8,214	64
Zone 67	0.42	0.10	0.10	Rs. 7,583.2	1,440	1,422	18
Zone 68	0.36	0.11	0.12	Rs. 7,302.0	1,138	1,191	-53
Zone 69	0.45	0.10	0.10	Rs. 7,478.8	3,494	3,472	22
Zone 70	0.36	0.12	0.12	Rs. 6,678.3	720	682	38
Zone 71	1.58	0.12	0.12	Rs. 6,522.8	3,314	3,305	9
Zone 72	0.26	0.10	0.10	Rs. 6,576.0	901	895	6
Zone 73	0.54	0.13	0.13	Rs. 6,495.1	3,272	3,268	4
Zone 74	0.47	0.11	0.11	Rs. 6,388.4	1,272	1,256	16
Zone 75	1.00	0.12	0.12	Rs. 6,583.2	2,724	2,714	10
Total	1.28	0.20	0.20	₹ 6,778	1,510,244	1,510,561	-317

Figure 5: Screen Shot E

Step 16 | Step 17 | Step 18

Step A - Current Scenario | Step B - Generate Input Sheets | Step C - Enter Data for Projections

Base Year Settings (Used in Future Scenario)											
Name	Current Situation										
SEG Type	Jobs (Nos.)	Beta Paramter		Income	% income spent on rent			Callibration Paramaters			
LIG	7,166	0.05		Rs. 40,000	10.00%			Adjt Factor			1
MIG	371,427	0.09		Rs. 25,000	25.00%			Working days (In a month)			24
LIG	159,056	0.27		Rs. 7,500	40.00%			Working hours (In a day)			8
EWS	0	0.00		Rs. 0	0.00%			Factor			50%
Zone No.	AF HIG	AF MIG	AF LIG	AF EWS	HIG_J	MIG_J	LIG_J	EWS_J	Total_J (%age)	Residential Area (%age)	Permissible FSI
Zone 1	4.1	1.0	2.0	1.0	2.0%	56.2%	41.9%	0.0%	100.0%	44.7%	1.13
Zone 2	3.6	0.9	1.4	1.0	0.4%	85.2%	14.4%	0.0%	100.0%	66.4%	1.80
Zone 3	1.0	0.9	2.1	1.0	0.0%	50.8%	49.2%	0.0%	100.0%	64.2%	1.35
Zone 4	1.0	0.9	1.8	1.0	0.0%	67.3%	32.7%	0.0%	100.0%	72.4%	1.24
Zone 5	1.0	1.0	2.2	1.0	0.0%	46.2%	53.8%	0.0%	100.0%	53.3%	1.58
Zone 6	1.0	1.1	2.0	1.0	0.0%	64.4%	35.6%	0.0%	100.0%	41.6%	0.79
Zone 7	1.0	0.9	1.8	1.0	0.0%	69.9%	30.1%	0.0%	100.0%	91.5%	1.91
Zone 8	4.4	0.8	1.6	1.0	0.4%	78.6%	21.0%	0.0%	100.0%	83.2%	1.13
Zone 9	4.3	0.7	1.4	1.0	3.0%	79.6%	17.4%	0.0%	100.0%	80.8%	0.90
Zone 10	4.0	0.8	1.3	1.0	4.2%	82.4%	13.3%	0.0%	100.0%	75.5%	1.91
Zone 11	4.0	0.7	1.3	1.0	8.4%	80.3%	11.3%	0.0%	100.0%	69.8%	1.80
Zone 12	3.8	0.8	1.3	1.0	4.2%	85.3%	10.5%	0.0%	100.0%	67.4%	1.58
Zone 13	3.3	0.7	1.0	1.0	1.9%	84.8%	13.2%	0.0%	100.0%	63.2%	2.13
Zone 14	1.0	0.9	1.7	1.0	0.0%	67.7%	32.3%	0.0%	100.0%	59.3%	1.58
Zone 15	1.0	0.9	1.4	1.0	0.0%	86.8%	13.2%	0.0%	100.0%	63.8%	1.58
Zone 16	1.0	1.0	2.6	1.0	0.0%	45.2%	54.8%	0.0%	100.0%	35.7%	0.68
Zone 17	1.0	1.1	3.0	1.0	0.0%	25.0%	75.0%	0.0%	100.0%	25.7%	0.83
Zone 18	4.3	0.9	1.6	1.0	2.9%	65.2%	31.9%	0.0%	100.0%	151.0%	1.80
Zone 19	4.1	0.7	1.2	1.0	1.0%	87.1%	11.8%	0.0%	100.0%	79.4%	2.25
Zone 20	4.6	0.8	1.3	1.0	1.2%	81.3%	17.5%	0.0%	100.0%	53.1%	1.24
Zone 21	3.7	0.8	1.4	1.0	1.2%	69.5%	29.3%	0.0%	100.0%	82.0%	2.02
Zone 22	4.3	0.8	1.7	1.0	1.1%	73.9%	25.0%	0.0%	100.0%	118.3%	1.35
Zone 23	1.0	1.0	1.8	1.0	0.0%	71.5%	28.5%	0.0%	100.0%	46.6%	0.90
Zone 24	1.0	0.7	2.8	1.0	0.0%	60.0%	40.0%	0.0%	100.0%	9.4%	1.00
Zone 25	1.0	0.5	1.0	1.0	0.0%	100.0%	0.0%	0.0%	100.0%	15.1%	0.81
Zone 26	1.0	0.8	1.6	1.0	0.0%	65.2%	34.8%	0.0%	100.0%	14.1%	1.67
Zone 27	1.0	0.7	1.0	1.0	0.0%	100.0%	0.0%	0.0%	100.0%	7.7%	1.58
Zone 28	1.0	1.0	3.5	1.0	0.0%	65.6%	34.4%	0.0%	100.0%	1.8%	1.00
Zone 29	1.0	0.6	1.3	1.0	0.0%	86.4%	13.6%	0.0%	100.0%	42.8%	1.43
Zone 30	1.0	0.9	2.6	1.0	0.0%	50.0%	50.0%	0.0%	100.0%	19.5%	0.97
Zone 31	1.0	0.9	1.7	1.0	0.0%	55.6%	44.4%	0.0%	100.0%	19.1%	0.82
Zone 32	1.0	0.7	1.4	1.0	0.0%	86.4%	13.6%	0.0%	100.0%	5.7%	2.02
Zone 33	1.0	0.8	2.6	1.0	0.0%	62.5%	37.5%	0.0%	100.0%	4.7%	0.59
Zone 34	1.0	1.2	7.1	1.0	0.0%	41.7%	58.3%	0.0%	100.0%	0.9%	1.22
Zone 35	1.0	1.0	8.9	1.0	0.0%	0.0%	100.0%	0.0%	100.0%	0.8%	0.96
Zone 36	1.0	0.6	2.8	1.0	0.0%	73.0%	27.0%	0.0%	100.0%	3.6%	0.51
Zone 37	1.0	1.2	6.2	1.0	0.0%	18.2%	81.8%	0.0%	100.0%	3.6%	0.69
Zone 38	1.0	0.4	1.0	1.0	0.0%	100.0%	0.0%	0.0%	100.0%	2.3%	0.61
Zone 39	1.0	-0.2	1.0	1.0	14.3%	85.7%	0.0%	0.0%	100.0%	0.9%	1.01
Zone 40	1.0	1.0	9.6	1.0	0.0%	0.0%	100.0%	0.0%	100.0%	0.5%	1.54
Zone 41	1.0	1.0	3.8	1.0	0.0%	42.9%	57.1%	0.0%	100.0%	0.6%	1.26
Zone 42	1.0	0.5	1.0	1.0	0.0%	100.0%	0.0%	0.0%	100.0%	1.1%	1.16
Zone 43	1.0	0.9	1.0	1.0	0.0%	100.0%	0.0%	0.0%	100.0%	2.6%	1.52
Zone 44	1.0	1.3	2.2	1.0	0.0%	89.5%	10.5%	0.0%	100.0%	1.7%	1.59
Zone 45	1.0	1.6	5.7	1.0	0.0%	50.0%	50.0%	0.0%	100.0%	6.7%	0.27
Zone 46	1.0	1.0	9.9	1.0	0.0%	0.0%	100.0%	0.0%	100.0%	1.2%	1.13
Zone 47	5.7	0.6	1.0	1.0	6.3%	93.8%	0.0%	0.0%	100.0%	3.3%	0.44
Zone 48	1.0	0.8	2.5	1.0	0.0%	83.3%	16.7%	0.0%	100.0%	2.6%	0.48
Zone 49	1.0	1.3	3.4	1.0	0.0%	56.3%	43.8%	0.0%	100.0%	2.4%	0.68
Zone 50	1.0	1.0	9.7	1.0	0.0%	0.0%	100.0%	0.0%	100.0%	2.8%	1.49

Figure 6: Screen Shot F

Step 20

Home

Zone No.	Zone Name	Population (P)					Households (HH)					Resident Workers (R)				
		No. of decades for Data availibility				1	No. of decades for Data availibility				1	No. of decades for Data availibility				1
		1981	1991	2001	2011	2031	1981	1991	2001	2011	2031	1981	1991	2001	2011	2031
Zone 1	Rajkot (M Corp.) - Ward No.1	Step 19	9,328	24,120	76,424	181,032	Step 19	1,535	4,461	16,892	41,754	Step 19	2,844	8,078	26,773	64,163
Zone 2	Rajkot (M Corp.) - Ward No.2		13,299	25,423	54,854	113,716		2,141	4,837	12,107	26,647		4,080	8,032	18,927	40,717
Zone 3	Rajkot (M Corp.) - Ward No.3		20,438	29,008	51,696	97,072		3,190	5,229	11,380	23,682		6,002	9,880	18,450	35,590
Zone 4	Rajkot (M Corp.) - Ward No.4		13,480	29,861	40,398	61,472		2,165	5,683	8,546	14,272		4,024	9,910	14,026	22,258
Zone 5	Rajkot (M Corp.) - Ward No.5		11,934	61,040	74,434	101,222		2,023	12,064	15,991	23,845		3,405	20,341	27,431	41,611
Zone 6	Rajkot (M Corp.) - Ward No.6		24,958	51,660	58,686	72,738		4,550	10,375	12,119	15,607		7,122	17,361	20,546	26,916
Zone 7	Rajkot (M Corp.) - Ward No.7		47,079	52,310	39,088	12,644		8,389	10,311	7,793	2,757		13,611	16,677	13,878	8,280
Zone 8	Rajkot (M Corp.) - Ward No.8		32,213	26,602	35,097	52,087		5,870	5,066	7,500	12,368		9,366	8,265	12,798	21,864
Zone 9	Rajkot (M Corp.) - Ward No.9		14,804	22,436	44,118	87,482		2,691	4,148	9,192	19,280		4,459	7,138	14,529	29,311
Zone 10	Rajkot (M Corp.) - Ward No.10		56,155	41,789	44,897	51,113		10,373	8,265	9,974	13,392		16,663	13,178	14,307	16,565
Zone 11	Rajkot (M Corp.) - Ward No.11		45,482	28,058	52,800	102,284		8,284	5,585	12,430	26,120		13,325	8,773	17,824	35,926
Zone 12	Rajkot (M Corp.) - Ward No.12		95,253	33,669	74,369	155,769		19,956	6,757	17,144	37,918		27,878	10,541	26,320	57,878
Zone 13	Rajkot (M Corp.) - Ward No.13		28,975	41,005	95,917	205,741		5,078	8,252	21,662	48,482		8,674	13,369	32,426	70,540
Zone 14	Rajkot (M Corp.) - Ward No.14		14,093	36,816	47,450	68,718		2,505	7,437	9,958	15,000		4,207	11,383	15,591	24,007
Zone 15	Rajkot (M Corp.) - Ward No.15		38,432	26,126	39,496	66,236		7,042	5,159	8,146	14,120		10,900	8,530	13,375	23,065
Zone 16	Rajkot (M Corp.) - Ward No.16		44,170	25,667	44,421	81,929		8,622	4,877	8,914	16,988		12,684	8,093	17,248	35,558
Zone 17	Rajkot (M Corp.) - Ward No.17		13,462	59,220	60,994	64,542		2,624	11,064	12,488	15,336		3,801	19,544	21,525	25,487
Zone 18	Rajkot (M Corp.) - Ward No.18		35,852	46,382	53,863	68,825		6,783	8,430	11,383	17,289		10,581	14,933	18,844	26,666
Zone 19	Rajkot (M Corp.) - Ward No.19			58,361	48,910	30,008			10,904	10,445	9,527			18,407	16,235	11,891
Zone 20	Rajkot (M Corp.) - Ward No.20			35,458	46,503	68,593			6,251	10,273	18,317			12,863	15,752	21,530
Zone 21	Rajkot (M Corp.) - Ward No.21			76,467	80,991	90,039			15,330	18,190	23,910			24,361	28,712	37,414
Zone 22	Rajkot (M Corp.) - Ward No.22			39,154	56,622	91,558			8,444	12,348	20,156			11,863	19,229	33,961
Zone 23	Rajkot (M Corp.) - Ward No.23			47,768	64,650	98,414			10,298	14,275	22,229			15,005	24,354	43,052
Zone 24	Bedi (OG) - Ward No.24		1,031	3,313	4,455	6,739		181	509	827	1,463		429	1,245	1,731	2,703
Zone 25	Vavdi (OG) - Ward No.25		1,382	2,158	5,720	12,844		248	405	1,193	2,769		553	723	2,192	5,130
Zone 26	Mota Mava (OG) - Ward No.26		1,954	3,053	5,759	11,171		323	568	1,207	2,485		766	1,004	2,091	4,265
Zone 27	Munjka (OG) - Ward No.27		1,498	2,191	3,483	6,067		272	440	752	1,376		582	717	1,174	2,088
Zone 28	Manharpur (OG) - Ward No.28		1,136	2,796	2,232	1,104		175	492	443	345		330	992	865	611
Zone 29	Madhapar (OG) - Ward No.29		3,134	3,746	15,036	37,616		532	698	3,266	8,402		1,119	1,392	5,136	12,624
Zone 30	Anandpar (OG) - Ward No.30		4,924	7,273	13,483	25,903		889	1,324	2,597	5,143		1,529	2,241	4,776	9,846
Zone 31	Kotharia (Part) (OG) - Ward No.31		6,322	9,848	53,794	141,686		1,174	2,019	11,973	31,881		2,336	3,448	20,303	54,013
Zone 32	Ghanteshvar (CT)		858	4,087	5,874	9,448		155	920	1,203	1,769		244	1,104	1,894	3,474
Zone 33	Para Pipaliya		895	1,624	2,553	4,411		142	303	557	1,065		266	565	985	1,825
Zone 34	Vajdi Gadh		527	681	622	504		94	126	111	81		268	415	324	142
Zone 35	Vejagam		1,025	1,194	1,100	912		163	206	180	128		439	471	485	513
Zone 36	Rajgadh		393	437	576	854		64	85	112	166		111	148	337	715
Zone 37	Nakaravadi		907	1,364	1,750	2,522		153	232	325	511		235	599	950	1,652
Zone 38	Dhamalpar		780	858	1,054	1,446		127	162	192	252		393	432	514	678
Zone 39	Jashvantpur		308	326	261	131		51	58	48	28		117	162	117	27
Zone 40	Pal		1,702	1,953	2,170	2,604		280	366	394	450		633	970	802	466
Zone 41	Kalipat		1,421	2,240	2,692	3,596		207	342	473	735		397	875	1,198	1,844
Zone 42	Amargadh		1,117	1,140	1,351	1,773		165	197	239	323		552	415	537	781
Zone 43	Maliyasan		2,130	2,735	3,508	5,054		307	436	630	1,018		596	1,212	1,187	1,137
Zone 44	Sokhada		887	1,257	1,697	2,577		152	226	307	469		285	481	729	1,225
Zone 45	Hadmatiya (Bedi)		910	938	1,000	1,124		159	165	178	204		254	442	592	892
Zone 46	Ronki		139	166	270	478		22	30	57	111		36	66	155	333
Zone 47	Gavaridad		2,905	3,372	3,749	4,503		503	597	690	876		1,188	1,598	1,481	1,247
Zone 48	Khandheri		869	845	1,024	1,382		140	137	171	239		304	243	336	522
Zone 49	Nyara		1,539	1,891	2,226	2,896		235	327	414	588		670	921	989	1,125
Zone 50	Kangashiyali		1,256	1,382	1,790	2,606		304	265	381	613		480	1,000	682	46

Screen Shot G

Step 21 else user can click "Default Values"

Step 23 | Step 24 | Step 25 | Step 26 | Step 28 | Step 28 | Step 27

Step D - Enter Scenario Settings | Default Values (Scenario Settings) | Select Scenario: DC | Step E - Set Model for Run | Step F - Run Scenario | Output (For Planners) | Output (For Decision Makers) | Reset Scenarios | Print Scenario Settings

Future Scenario Parameters

Provide Inputs to the Scenarios for 2031 (Step 22)

Jobs decadal growth rate from 2001 - 2011	54%	Name of Scenario	Business as Usual	BAU	Base Year	2011	Income Growth Rate (Per Annum)	7%	Model Precision Parameter (DS Ratio)	2	Weights for Parameters			
Jobs increase in 2031 (%age)	70%		Compact City	CC	Plan Year	2031	Discount Rate (Per Annum)	7%	Minimum Habitable DU Size (mtr2)	35	All	BAU	CC	DC
Zones in Municipal Area (Step 22)	23		Dispersed City	DC	No. of decades	3	Housing Growth Rate (Per Annum)	8%	Housing Prices for 2031	₹ 28,559	Pop. Distribution (Step 22)	1.0	1.0	1.0
Scenarios Names		BAU Parameters					CC Parameters (Step 22)				DC Parameters						Rent Ratio	1.0	1.0	1.0
		Private	Cycle	Public Transport	Dwelling Units		Private	Cycle	Public Transport	Dwelling Units		Private	Cycle	Public Transport	Dwelling Units		Private Transport	1.0	1.0	1.0
Zone No.	Zone Name (Step 22)	Medium	Low	Slight Upgrade	Increase	Target	Low	Medium	Superior	Increase	Target	Medium	Low	Same as Base	Increase	Target	Cycle	1.0	1.0	1.0
Zone 1	Rajkot (M Corp.) - Ward No.1	3	2	3	17,642		2	4	5	19,717		4	1	2	1,038		Public Transport	1.0	1.0	1.0
Zone 2	Rajkot (M Corp.) - Ward No.2	3	2	3	10,731		2	4	5	11,993		4	1	2	631		Jobs	1.0	1.0	1.0
Zone 3	Rajkot (M Corp.) - Ward No.3	3	2	3	19,033		2	4	5	21,272		4	1	2	1,120		Floorspace	1.0	1.0	1.0
Zone 4	Rajkot (M Corp.) - Ward No.4	3	2	3	7,040		2	4	5	7,868		4	1	2	414		Percentage breakup for Additional DU (Proposed)			
Zone 5	Rajkot (M Corp.) - Ward No.5	3	2	3	22,307		2	4	5	24,931		4	1	2	1,312			Inner City	Outer City	Total
Zone 6	Rajkot (M Corp.) - Ward No.6	3	2	3	8,244		2	4	5	9,214		4	1	2	485		Current Scenario 2011 (Step 22)	85.5%	14.5%	100.0%
Zone 7	Rajkot (M Corp.) - Ward No.7	3	2	3	4,993		2	4	5	5,580		4	1	2	294		Business as Usual	85.0%	15.0%	100.0%
Zone 8	Rajkot (M Corp.) - Ward No.8	3	2	3	4,215		2	4	5	4,711		4	1	2	248		Compact City	95.0%	5.0%	100.0%
Zone 9	Rajkot (M Corp.) - Ward No.9	3	2	3	9,105		2	4	5	10,176		4	1	2	536		Dispersed City	5.0%	95.0%	100.0%
Zone 10	Rajkot (M Corp.) - Ward No.10	3	2	3	7,939		2	4	5	8,873		4	1	2	467		Additional DU (Proposed) - According to above %ages			
Zone 11	Rajkot (M Corp.) - Ward No.11	3	2	3	7,970		2	4	5	8,908		4	1	2	469			Inner City	Outer City	Total
Zone 12	Rajkot (M Corp.) - Ward No.12	3	2	3	13,379		2	4	5	14,953		4	1	2	787		Current Scenario 2011	273,567	46,426	**319,993**
Zone 13	Rajkot (M Corp.) - Ward No.13	3	2	3	35,043		2	4	5	39,166		4	1	2	2,061		Business as Usual	224,362	39,592	**263,954**
Zone 14	Rajkot (M Corp.) - Ward No.14	3	2	3	3,674		2	4	5	4,106		4	1	2	216		Compact City	250,756	13,197	**263,953**
Zone 15	Rajkot (M Corp.) - Ward No.15	3	2	3	2,250		2	4	5	2,515		4	1	2	132		Dispersed City	13,198	250,753	**263,951**
Zone 16	Rajkot (M Corp.) - Ward No.16	3	2	3	5,301		2	4	5	5,925		4	1	2	312		Vechicle O&M Increments			
Zone 17	Rajkot (M Corp.) - Ward No.17	3	2	3	4,347		2	4	5	4,858		4	1	2	256		(Step 22)	Change	Period	Unit
Zone 18	Rajkot (M Corp.) - Ward No.18	3	2	3	6,700		2	4	5	7,488		4	1	2	394		Life (yrs.)	10%	20	year
Zone 19	Rajkot (M Corp.) - Ward No.19	3	2	3	5,241		2	4	5	5,858		4	1	2	308		Driven (km.)	10%	20	year
Zone 20	Rajkot (M Corp.) - Ward No.20	3	2	3	3,157		2	4	5	3,528		4	1	2	186		Capital Cost (Rs.)	6%	1	year
Zone 21	Rajkot (M Corp.) - Ward No.21	3	2	3	12,234		2	4	5	13,673		4	1	2	720		Salvage value	6%	1	year
Zone 22	Rajkot (M Corp.) - Ward No.22	3	2	3	7,128		2	4	5	7,967		4	1	2	419		O&M (Rs./Year)	6%	1	year
Zone 23	Rajkot (M Corp.) - Ward No.23	3	2	3	6,689		2	4	5	7,476		4	1	2	393		Mileage	15%	20	year
Zone 24	Bedi (OG) - Ward No.24	2	1	2	921		1	3	4	307		3	1	1	5,832		Fuel cost	6%	1	year
Zone 25	Vavdi (OG) - Ward No.25	2	1	2	1,315		1	3	4	438		3	1	1	8,330		Rating Systems - Increase in speeds			
Zone 26	Mota Mava (OG) - Ward No.26	2	1	2	1,170		1	3	4	390		3	1	1	7,411		Rating	Private	Cycle	Public
Zone 27	Munjka (OG) - Ward No.27	2	1	2	799		1	3	4	266		3	1	1	5,061		1	0%	0%	0%
Zone 28	Manharpur (OG) - Ward No.28	2	1	2	77		1	3	4	26		3	1	1	489		2 (Step 22)	5%	5%	5%
Zone 29	Madhapar (OG) - Ward No.29	2	1	2	3,300		1	3	4	1,100		3	1	1	20,899		3	15%	15%	15%
Zone 30	Anandpar (OG) - Ward No.30	2	1	2	2,224		1	3	4	741		3	1	1	14,085		4	20%	20%	20%
Zone 31	Kotharia (Part) (OG) - Ward No.31	2	1	2	3,986		1	3	4	1,329		3	1	1	25,244		5	30%	30%	30%
Zone 32	Ghanteshvar (CT)	2	1	2	562		1	3	4	187		3	1	1	3,559		6	50%	50%	50%
Zone 33	Para Pipaliya	2	1	2	458		1	3	4	153		3	1	1	2,900		Jobs (Current vs Plan Year)			
Zone 34	Vajdi Gadh	2	1	2	42		1	3	4	14		3	1	1	268		SEG Type	Base	Plan (Step 22)	Difference
Zone 35	Vejagam	2	1	2	58		1	3	4	19		3	1	1	366		HIG	1.8%	2.0%	0.7%
Zone 36	Rajgadh	2	1	2	626		1	3	4	209		3	1	1	3,966		MIG	69.1%	69.0%	-0.1%
Zone 37	Nakaravadi	2	1	2	156		1	3	4	52		3	1	1	986		LIG	29.6%	29.0%	-0.6%
Zone 38	Dhamalpar	2	1	2	267		1	3	4	89		3	1	1	1,693		EWS	0.0%	0.0%	0.0%
Zone 39	Jashvantpur	2	1	2	36		1	3	4	12		3	1	1	228		DU Densities	BAU	CC	DC
Zone 40	Pal	2	1	2	74		1	3	4	25		3	1	1	467		In Percetage (Step 22)	0.0%	10.0%	10.0%
Zone 41	Kalipat	2	1	2	179		1	3	4	60		3	1	1	1,133		CO_2 Emissions for Pvt (Step 22)	0.1366	in kg/Passenger-Km	
Zone 42	Amargadh	2	1	2	175		1	3	4	58		3	1	1	1,110		Blanket FSI Norm	BAU	CC	DC
Zone 43	Maliyasan	2	1	2	336		1	3	4	112		3	1	1	2,127		Inside Municipal Limits (Step 22)	1.8	2.5	1.8
Zone 44	Sokhada	2	1	2	138		1	3	4	46		3	1	1	877		Outside Municipal Limits	1.2	1.2	1.8
Zone 45	Hadmatiya (Bedi)	2	1	2	354		1	3	4	118		3	1	1	2,242		Ratings	Private	Cycle	Public
Zone 46	Ronki	2	1	2	130		1	3	4	43		3	1	1	821		Base	2	1	2
Zone 47	Gavaridad	2	1	2	1,386		1	3	4	462		3	1	1	8,780		BAU (Step 22)	3	2	3
Zone 48	Khandheri	2	1	2	289		1	3	4	96		3	1	1	1,830		CC	2	4	5
Zone 49	Nyara	2	1	2	328		1	3	4	109		3	1	1	2,078		DC	4	1	2
Zone 50	Kangashiyali	2	1	2	152		1	3	4	51		3	1	1	964		Outside Municipal Limits	1	1	1

Figure 8: Screen Shot H

ATL (km.) - Base Year				
SEG/Mode	Private	Cycle	PT	Overall
HIG	4.15	4.03	3.33	3.95
MIG	3.72	4.91	3.88	3.94
LIG	2.32	4.28	3.03	3.16
EWS				
Overall	3.63	4.69	3.50	3.72

ATL (km.) - Business as Usual				
SEG/Mode	Private	Cycle	PT	Overall
HIG	3.31	4.55	4.73	3.70
MIG	2.61	5.29	4.69	3.78
LIG	2.13	4.83	4.45	4.30
EWS				
Overall	2.59	5.13	4.59	3.93

ATL (km.) - Compact City				
SEG/Mode	Private	Cycle	PT	Overall
HIG	3.17	4.76	4.96	3.66
MIG	2.62	5.75	5.18	4.03
LIG	2.07	4.13	3.82	3.71
EWS				
Overall	2.59	5.20	4.58	3.93

ATL (km.) - Dispersed City				
SEG/Mode	Private	Cycle	PT	Overall
HIG	3.19	4.55	4.64	3.59
MIG	2.58	5.52	4.87	3.86
LIG	2.07	4.01	3.63	3.55
EWS				
Overall	2.56	5.01	4.32	3.77

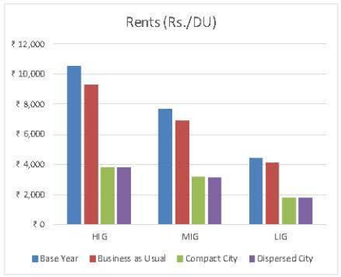
Base Year			
SEG	Rents	DU Size	ATL
HIG	₹ 10,529	90	3.95
MIG	₹ 7,676	64	3.94
LIG	₹ 4,391	35	3.16
Overall	₹ 6,778	56	3.72

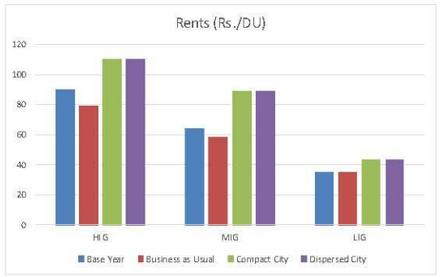
Business as Usual			
SEG	Rents (Rs.)	DU Size (mtr2)	ATL (km.)
HIG	₹ 9,298	79	3.70
MIG	₹ 6,907	58	3.78
LIG	₹ 4,125	35	4.30
Overall	₹ 6,130	52	3.93

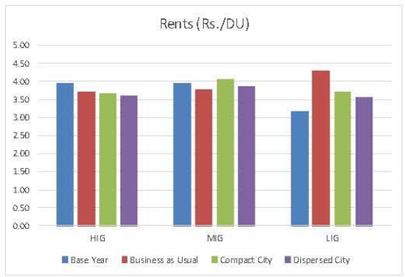
Compact City			
SEG	Rents (Rs.)	DU Size (mtr2)	ATL (km.)
HIG	₹ 3,772	110	3.66
MIG	₹ 3,117	89	4.03
LIG	₹ 1,756	43	3.71
Overall	₹ 2,743	76	3.93

Dispersed City			
SEG	Rents (Rs.)	DU Size (mtr2)	ATL (km.)
HIG	₹ 3,771	110	3.59
MIG	₹ 3,106	89	3.86
LIG	₹ 1,755	43	3.55
Overall	₹ 2,735	77	3.77

Overall Comparisions						
Scenarios	Rents	Rent (Diff)	DU Size	ATL	FSI	Population
Base Year	6,778		56	3.72	0.20	1,510,561
Business as Usual	6,130	-9.6%	52	3.93	0.25	2,403,720
Compact City	2,743	-59.5%	76	3.93	0.37	2,378,774
Dispersed City	2,735	-59.6%	77	3.77	0.37	2,378,429







Step 30

Go Home

Print Output Summary | Create Excel file for GIS

		FSI Proposed	FSI Consumed			
Zone No.	Zone Name	Base Year	Base Year	Business as Usual	Compact City	Dispersed City
Zone 1	Rajkot (M Corp.) - Ward No.1	1.13	0.17	0.21	0.34	0.34
Zone 2	Rajkot (M Corp.) - Ward No.2	1.80	0.15	0.18	0.29	0.29
Zone 3	Rajkot (M Corp.) - Ward No.3	1.35	0.08	0.16	0.23	0.23
Zone 4	Rajkot (M Corp.) - Ward No.4	1.24	0.20	0.23	0.38	0.38
Zone 5	Rajkot (M Corp.) - Ward No.5	1.58	0.08	0.18	0.25	0.25
Zone 6	Rajkot (M Corp.) - Ward No.6	0.79	0.36	0.40	0.69	0.68
Zone 7	Rajkot (M Corp.) - Ward No.7	1.91	0.16	0.17	0.30	0.30
Zone 8	Rajkot (M Corp.) - Ward No.8	1.13	0.33	0.40	0.64	0.64
Zone 9	Rajkot (M Corp.) - Ward No.9	0.90	0.27	0.49	0.69	0.69
Zone 10	Rajkot (M Corp.) - Ward No.10	1.91	0.16	0.20	0.31	0.31
Zone 11	Rajkot (M Corp.) - Ward No.11	1.80	0.21	0.30	0.44	0.43
Zone 13	Rajkot (M Corp.) - Ward No.13	2.13	0.08	0.35	0.42	0.41
Zone 14	Rajkot (M Corp.) - Ward No.14	1.58	0.30	0.36	0.60	0.59
Zone 15	Rajkot (M Corp.) - Ward No.15	1.58	0.42	0.44	0.73	0.72
Zone 16	Rajkot (M Corp.) - Ward No.16	0.68	0.40	0.49	0.85	0.85
Zone 17	Rajkot (M Corp.) - Ward No.17	0.83	0.42	0.43	0.86	0.86
Zone 18	Rajkot (M Corp.) - Ward No.18	1.80	0.19	0.23	0.37	0.37
Zone 19	Rajkot (M Corp.) - Ward No.19	2.25	0.20	0.22	0.35	0.35
Zone 20	Rajkot (M Corp.) - Ward No.20	1.24	0.48	0.53	0.86	0.86
Zone 21	Rajkot (M Corp.) - Ward No.21	2.02	0.15	0.20	0.32	0.32
Zone 22	Rajkot (M Corp.) - Ward No.22	1.35	0.27	0.36	0.55	0.54
Zone 23	Rajkot (M Corp.) - Ward No.23	0.90	0.45	0.51	0.85	0.85
Zone 24	Bedi (OG) - Ward No.24	1.00	0.05	0.06	0.10	0.10
Zone 25	Vavdi (OG) - Ward No.25	0.81	0.10	0.16	0.20	0.52
Zone 26	Mota Mava (OG) - Ward No.26	1.67	0.04	0.05	0.07	0.13
Zone 27	Munjka (OG) - Ward No.27	1.58	0.05	0.05	0.09	0.10
Zone 28	Manharpur (OG) - Ward No.28	1.00	0.31	0.31	0.54	0.54
Zone 29	Madhapar (OG) - Ward No.29	1.43	0.05	0.06	0.10	0.14
Zone 30	Anandpar (OG) - Ward No.30	0.97	0.06	0.06	0.12	0.13
Zone 31	Kotharia (Part) (OG) - Ward No.31	0.82	0.20	0.70	0.69	0.63
Zone 32	Ghanteshvar (CT)	2.02	0.08	0.08	0.13	0.14
Zone 33	Para Pipaliya	0.59	0.13	0.12	0.22	0.23
Zone 34	Vajdi Gadh	1.22	0.11	0.10	0.20	0.19
Zone 35	Vejagam	0.96	0.11	0.09	0.21	0.21
Zone 36	Rajgadh	0.51	0.03	0.03	0.04	0.04
Zone 37	Nakaravadi	0.69	0.12	0.11	0.23	0.23
Zone 38	Dhamalpar	0.61	0.10	0.11	0.17	0.17
Zone 39	Jashvantpur	1.01	0.10	0.10	0.17	0.17
Zone 40	Pal	1.54	0.13	0.10	0.25	0.25
Zone 41	Kalipat	1.26	0.10	0.10	0.19	0.20
Zone 42	Amargadh	1.16	0.10	0.10	0.16	0.17
Zone 43	Maliyasan	1.52	0.10	0.10	0.17	0.17
Zone 44	Sokhada	1.59	0.10	0.10	0.17	0.17
Zone 45	Hadmatiya (Bedi)	0.27	0.10	0.10	0.19	0.19
Zone 46	Ronki	1.13	0.02	0.01	0.03	0.03
Zone 47	Gavaridad	0.44	0.10	0.11	0.17	0.18
Zone 48	Khandheri	0.48	0.09	0.10	0.16	0.16
Zone 49	Niyara	0.68	0.11	0.11	0.19	0.20
Zone 50	Kangashiyali	1.49	0.07	0.06	0.14	0.14

Screenshot I

Overview of Policies				
	Base 2011	BAU 2031	CC 2031	DC 2031
Employment (Lakhs)	5.38	9.15		
Dwelling Units	3.20	5.84 (But Different Spatial Distribution)		
Public Transport	Buses	Buses & No BRTS	Buses & Superior BRTS	Buses & BRTS
Road Network	As is	Same as Base Year	Same as Base Year	Same as Base Year
Network Speeds	As Observed	Private - Higher than Base	Private - Same as BAU	Private - Higher than BAU
		Cycle - Same as Base	Cycle - Higher than BAU	Cycle - Higher than BAU
		PT - Higher than Base	PT - Higher than BAU	PT - Higher than BAU

Comparison of Scenarios							
	Base 2011	BAU 2031	BAU vs Base	CC 2031	CC vs BAU	DC 2031	DC vs BAU
Population (Lakhs)							
Municipal Area (MA)	12.9	20.0	55.5%	20.5	2.3%	15.2	-24.0%
Outside MA	2.2	3.7	66.4%	3.2	-15.0%	11.4	206.8%
Overall	15.1	23.7	57.1%	23.6	-0.4%	26.6	12.2%
Population Densities (Persons per Hectare)							
Municipal Area (MA)	131.0	203.7	55.5%	208.3	2.3%	154.8	-24.0%
Outside MA	3.8	10.2	166.4%	5.4	-46.9%	19.5	91.6%
Overall	22.1	34.7	57.1%	34.5	-0.4%	34.3	-1.1%
Additional Land Consumption (ha)							
Municipal Area (MA)	As is	6,095	N.A	6,812	11.8%	359	-94.1%
Outside MA	As is	3,055	N.A	1,018	-66.7%	19,586	541.1%
Overall	As is	9,150	N.A	7,830	-14.4%	19,945	118.0%
Citizens' Cost of Living (in terms of Money, Time and Distance)							
[A] Housing Rents	₹ 6,778	₹ 6,034	-11.0%	₹ 2,717	-55.0%	₹ 2,565	-57.5%
[B] Transport Costs	₹ 405	₹ 777	91.8%	₹ 779	0.2%	₹ 782	0.6%
Cost of Living - [A] + [B]	₹ 7,183	₹ 6,812	-5.2%	₹ 3,497	-48.7%	₹ 3,347	-50.9%
ATL (km)	3.72	3.81	2.5%	4.03	6.0%	4.13	8.4%
ATL (min)	10.7	10.9	1.4%	9.9	-9.1%	11.8	8.7%
Emissions (Thousand Tons per Year)							
HIG	23.87	31.28	31.0%	30.71	-1.8%	30.52	-2.4%
MIG	872.72	1,024.65	17.4%	1,037.18	1.2%	1,020.07	-0.4%
LIG	43.22	66.41	53.6%	65.45	-1.4%	66.10	-0.5%
EWS	0.00	0.00	0.0%	0.00	0.0%	0.00	0.0%
Total	939.81	1,122.33	19.4%	1,133.34	1.0%	1,116.69	-0.5%

Surplus (Rs. Crores/Year)									
	Housing Rent Consumer Surplus			Housing Rent Producer Surplus			Transport Consumer Surplus		
SEG	BAU vs Base	CC vs BAU	DC vs BAU	BAU vs Base	CC vs BAU	DC vs BAU	BAU vs Base	CC vs BAU	DC vs BAU
HIG	2	63	62	0.000	0.004	0.005	109	-7	-14
MIG	117	2796	2892	-0.100	1.540	1.505	3213	414	582
LIG	33	609	622	0.008	-1.655	-2.725	971	176	24
EWS	0	0	0	0.000	0.000	0.000	0	0	0
Total	152	3467	3576	-0.092	-0.111	-1.215	4292	583	592

Key Assessment Indicators					
Assessment Type	Category	BAU vs Base	CC vs BAU	DC vs BAU	Remarks
Economic	Housing rent (Rs. Crores/Year)	152	3,467	3,575	Higher value signifies that the people of the city will save money in housing rents.
	Transport (Rs. Crores/Year)	4,292	583	592	Higher value signifies that the people of the city will save more money in travelling.
	Total Economic Benefit	4,445	4,050	4,167	Total benefits to the city.
Environment	Land Consumption (Hectares)	N.A.	-1,320	10,795	Smaller value signifies that city will consume less land and thus save the land for future use.
	Emissions ('000 Tons/Year)	183	11	-6	Smaller value signifies that the low emissions will lead to lower health hazards and better climate in the city.

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Print Analysis Summary

Annexure 3: Participants at the project workshop held on 23rd October 2015 at The Park Hotel, New Delhi

Sl. No.	Name of participant	Organization
1	S Gopiprasad	IDES Consulting Pvt Ltd
2	Ranjit Gadgil	Parisar, Pune
3	Sanskriti Menon	CEE, Pune
4	Avinash Madhale	CEE, Pune
5	Ravi Gadepalli	SSEF, New Delhi
6	Shilpa Kharwal	SSEF, New Delhi
7	Anvita Arora	iTrans, New Delhi
8	Anusha Matam	iTrans, New Delhi
9	Ashok Bhattacharjee	CSE, New Delhi
10	Rajendra Ravi	IDS, New Delhi
11	Anusha Vaid	IIT Delhi
12	Sangeetha Ann	TERI, New Delhi
13	Akshan Bhide	CGM, New Delhi
14	Anmol Anand	iTrans, New Delhi
15	Ashish Rao Ghorpade	ICLEI, New Delhi
16	Juhi Malpani Bhatt	Consultant/Academician
17	Manas Murthy	Aapki Sadak
18	Talat Munshi	CEPT University
19	Rutul Joshi	CEPT University
20	Bhargav Adhvaryu	CEPT University
21	Yogi Joseph	CEPT University
22	Arpit Kumar	CEPT University

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