PLANNING FOR TRANSIT ORIENTED DEVELOPMENT : CASE STUDY OF GHAZIABAD

A Project Submitted

in Partial Fulfilment of the Requirements

for the Degree of

MASTER

In

Urban and Regional Planning

By

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(University roll No. 1210106013)

Under the Guidance of

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BABU BANARASI DAS UNIVERSITY

LUCKNOW

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ROOPAL GOEL

1210106013

ABSTRACT

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

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

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

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

[Keywords: High-density, mixed-use, public transit, accessibility, new paradigm]

CERTIFICATE

Certified that **ROOPAL GOEL** (1210106013) has carried out the research work presented in this Project entitled **"Planning for Transit Oriented Development : Case study of Ghaziabad"** for the award of **master's in urban and regional planning** from Babu Banarasi Das University, Lucknow under my supervision. The Project embodies results of original work, and studies are carried out by the student herself and the contents of the Project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Signature -

Ar. Shalini Diwakar (Guide)

Assistant Professor,

School of Architecture and planning

B.B.D. University, Lucknow

Date: ___/___/2023

Place: Lucknow

DECLARATION

I hereby declare that the work, which is represented by me in this dissertation, entitled "Planning for Transit Oriented Development : Case study of Ghaziabad", in partial fulfilment of the requirements for the award of the degree of **Master In Urban And Regional Planning** submitted to the School of Architecture and planning, Babu Banarasi Das University Lucknow, is an authentic record of my own work carried out during the period from **February 2023 to June 2023** under the supervision of **Ar. Shalini Diwakar**, School of Architecture and planning,

B.B.D. University Lucknow Uttar Pradesh ,India.

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

Date - ___/___/2023

Place – Lucknow

Signature

Roopal Goel
(Enrolment no.1210106013)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date - ___/___/2023

Place – Lucknow

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EXECUTIVE SUMMARY

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

The study "Planning for Transit Oriented Development: Case study of Ghaziabad" is an attempt to understand the theory of Transit-Oriented Development (TOD) and how this theory can be applied for planning Indian metropolises. The promotion of private auto-oriented development coupled with increase in real estate investment has led to large scale housing projects coming up haphazardly along the city fringe areas. These projects lack basic infrastructure facilities including a connection to the city public transport system. The availability of land as a resource is limited and therefore its cautious use is extremely important. The city development plans and comprehensive mobility plans of many cities make a mention of Transit-Oriented Development as a 'tool for integrating transport and land use'. However, in the name of TOD, intensive development is planned along the transit corridors to partly recover the huge investments done in the transit development. This study focuses on physical planning or urban fabric around the proposed Delhi-Ghaziabad-Meerut RRTS Corridor in Ghaziabad city of Uttar Pradesh state as per TOD guidelines. The study area is limited to the Ghaziabad Municipal Corporation (GMC) administrative boundary.

In conclusion, the study highlights the achievements of TOD through a comparative analysis between the existing condition and the suggested TOD proposal for the planning area. The outcome of the research clearly indicates that it is possible to conserve land to the extent of more than 50% by planning a compact, high-density, highly accessible and transit-oriented development and utilize the land for mixed income housing, etc.

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

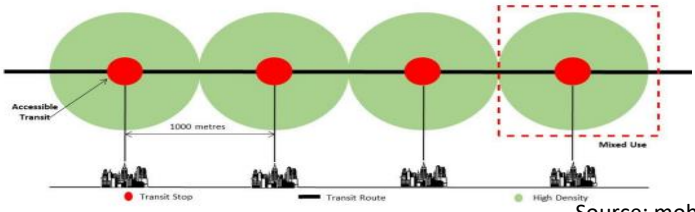
1. INTRODUCTION

1.1 Background

•**Transit Oriented Development** is the exciting fast growing trend in creating vibrant, livable, sustainable communities.

•Also known as TOD, it's the creation of compact, walkable, pedestrian-oriented, mixed-use communities centered around high quality train systems. This makes it possible to live a lower-stress life without complete dependence on a car for mobility and survival.

•Transit oriented development is also a major solution to the serious and growing problems of climate change and global energy security by creating dense, walkable communities that greatly reduce the need for driving and energy consumption. This type of living arrangement can reduce driving by up to 85%.



Source: mohua

Figure 1.1: TOD along Transit Stations

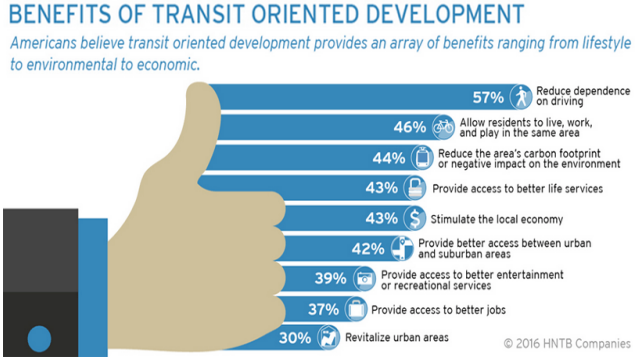
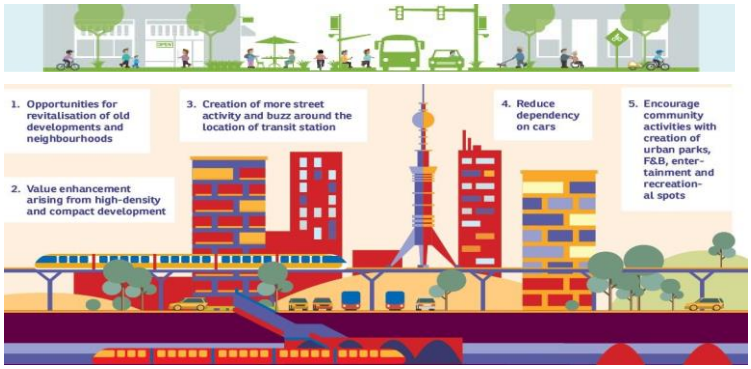


Figure 1.2 Benefits of TOD



Source: tod.org.in

Figure 1.3

Figure 1.3: A schematic diagram of the section showcasing the aftermath of implementation of TOD Design Principles in a particular chose street–Green depicts the additions

Figure 1.4 : Principles of TOD

Source: mohua

Figure 1.5 : TOD support principle tools

1.1.1 Vision of the TOD Policy:

The vision of the policy is three fold:

- **ENABLE TRANSFORMATION:** to assist in transformation of cities from private vehicle dependent city to public transport oriented development.

- **ACCESSIBLE PUBLIC TRANSPORT:** to promote the usage of public transport by making it accessible, encourage green mobility by encouraging people to walk and cycle and at the same time curb pollution and other negative impacts of motorization.

- **COMPACT WALKABLE COMMUNITIES:** to create livable and affordable communities, which are compact and walkable.

1.2 Research Questions:

1. What are the main features and recent advancements discussed in international literature about Transit-Oriented Development (TOD)?

2. What roles does TOD play in planning a metropolis like Ghaziabad?

3. Can TOD be integrated with the current ongoing transport projects in Ghaziabad?

4. How can the analysis and recommendations be used to develop future TOD projects in other cities of India?

1.3 AIM:

TO UNDERSTAND THE CURRENT SCENARIO OF GHAZIABAD AND HELP THEM TO PREPARE TOD PLAN.

1.4 Objectives:

1. To understand the TOD concepts & policies and draw relevant inference and planning guidelines from relevant case studies.

2. To Evaluate the current Urban form & development around the upcoming metro station on TOD parameters.

3. To investigate the potential of TOD for achieving sustainable urban development.

4. To achieve reduction in the private vehicle ownership, traffic and associated parking demand.

5. To develop strategies for Urban development in the line with the principles of TOD along a proposed RRTS Corridor.

1.5 Need of the study:

To solve problems like congestion, Green house gases emission, much more the city has invested in **RRTS(REGIONAL RAPID TRANSIT SYSTEM).**Transit investment can help to increase the access to opportunities, and in conjunction with good land use planning and policies can achieve sustainable urban development. Thus, TOD can be good practice to tackle with all these problems.

1.6 Scope:

1. The thesis focuses on physical planning of urban fabric around the proposed RRTS Corridor in Ghaziabad City as per the guidelines of TOD.
2. The study area is limited to the Ghaziabad Municipal Corporation(GMC) administrative boundary.
3. Designing of the transit-system itself and a detailed economic analysis of the proposal is not within the scope of this thesis.

1.7 Limitations:

1. To work within the framework of current master plan of Ghaziabad.
2. To take acknowledgment of the proposed RRTS routes, broad recommendations enlisted in the detailed project report of RRTS.
3. Due to time constrains, detailed land use planning cannot be carried out for all proposed RRTS route.

1.8 Methodology:

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

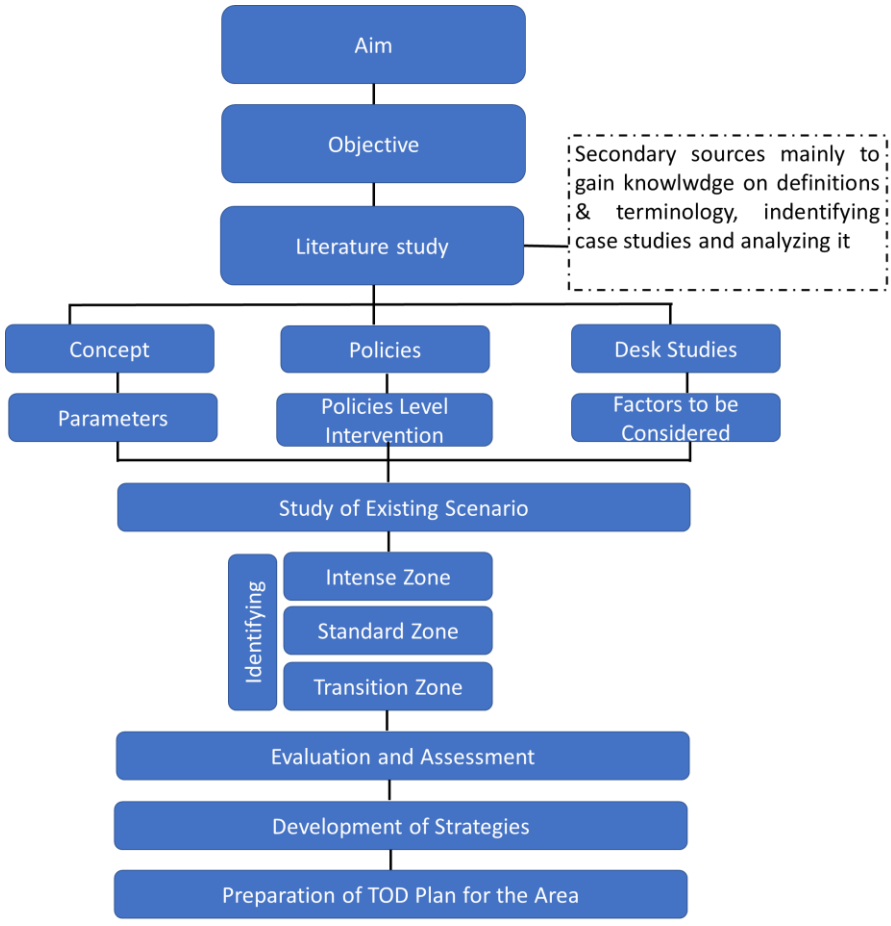


Figure 1.6 : Flow chart showing methodology of work

2. LITERATURE REVIEW

2.1 Background : Concept of TOD

Walkable , Compact, Mixed use, Higher density development within walking distance of a transit facility

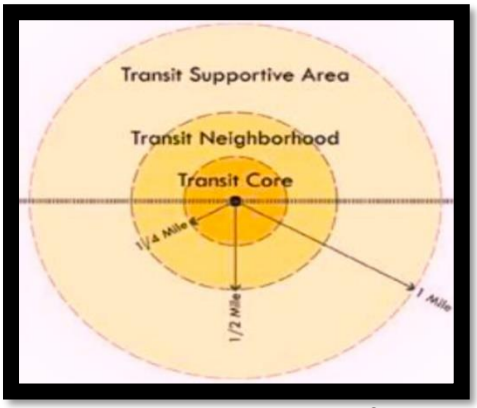
TOD occurs within ¼ to ½ mile or within a 5 to 10 minute walk, of a transit station.

All these definition includes The 3'D's

- (High) **Density**
- **Diversity** (Mixed Use, Mixed Income)
- **Design** (Safe, Comfortable, active 24x7)

TOD GOALS

- Reduce private vehicle and promote public transport
- Public transport access to maximum people



Source: UTTIPEC

Figure 2.1 : Transit Zones

2.2 Principles of Transit-Oriented Development

2.2.1 DENSITY, DIVERSITY & DESIGN

Minimized Walking & Biking Distance/Environment from MRTS & Amenities.

1. Within 5 min walk of Station (500 M)

High Density Housing, Retail and Employment uses

Figure 2.2

Figure 2.3

Source: UTTIPEC

High Density Housing and commercial development near transit

2. Within 10 min walk of Station (1000 M)

High Density Housing, informal retail, commercial, public spaces.

FAR bonuses provided for affordable housing, public spaces and parks, & infrastructure.

Figure 2.4

Figure 2.5

Source: UTTIPEC

3. Within 5 min Cycle/Rickshaw-ride from Station

Incorporating bicycles and pedestrians in street and building design

Bike lanes in most streets

Figure 2.6

Figure 2.7

Bike parking at destinations, transit stops

2.2.2 FEEDER NETWORKS

Within 500 M - Pedestrians
Cycles, NMVs

Beyond 500 M - Rerouted buses
Battery Operated Feeders (MPD)

- 500 M

Beyond 500 M

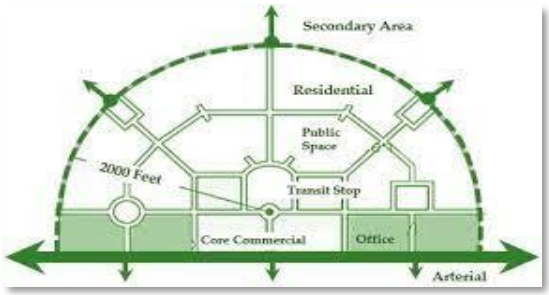
Source: UTTIPEC

Figure 2.8

2.2.3 DIRECT CONNECTIVITY

Finer Street Network for shortest routes to pedestrians & cyclists.
Faster to walk or cycle; than to drive.

- Mix of uses to provide people of varied social groups with options to live, work and play within easy access to public transport and daily necessities.
- Interconnected Street Network
- Small walkable blocks; Pedestrian cut-through every 100 M.

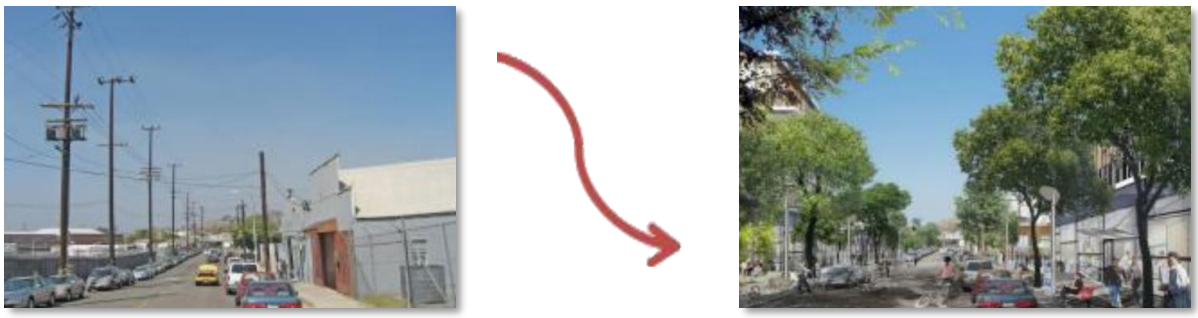


Source: UTTIPEC

Figure 2.9

2.2.4 PUBLIC REALM DESIGN

Pedestrian/disabled friendly, safe, pollution free



Source: UTTIPEC

TRANSFORMATION of a similar street in Los Angeles

Figure 2.10

2.2.5 PLACEMAKING

- Create Places, not gated developments.
- Build communities: Create interaction places, public plazas, markets and parks- near public transport nodes & along daily paths of people.
- Mix of uses to provide people of varied social groups with options to live, work, shop and play within easy access to public transport and daily necessities.

Nanjing Lu, Shanghai

Mizner Park, Florida

Figure 2.11

2.3 TOD Standards

TOD Standard, built on the experience of many organizations, addresses development that maximizes the benefit of public transit while firmly placing the emphasis back on the users i.e. people.

TOD **STANDARD 2017 RANKING**

GOLD STANDARD
86 – 100 POINTS

SILVER STANDARD
71 – 85 POINTS

BRONZE STANDARD
56 – 70 POINTS

Figure 2.12

2.4 TOD PRINCIPLES

CONNECT
(15 POINTS)

- Walking and cycling routes are short, direct and varied.
- Walking and cycling routes are shorter than motor vehicle routes.

CYCLE
(5 POINTS)

- The cycling network is safe and complete.
- Cycle parking and storage is ample and secure.

WALK
(15 POINTS)

- The pedestrian realm is safe and complete.
- The pedestrian realm is active and vibrant.
- The pedestrian realm is temperate and comfortable.

MIX
(25 POINTS)

- Trip lengths are reduced by providing diverse and complementary uses.
- Lower income groups have short commutes.

TRANSIT
(REQUIREMENT)

- High quality transit is accessible by foot.
- Required 4.1 Walk Distance to Transit.

Walk distance (meters) to the nearest transit station.

SHIFT
(15 POINTS)

The land occupied by motor vehicles is minimized.

COMPACT
(10 POINTS)

- The development is in an existing urban area.
- Travelling through the city is convenient.

DENSIFY
(15 POINTS)

- Residential and job densities support high quality transit and local services.

PRINCIPLES	PARAMETERS
WALK	WALKWAYS
	CROSSWALKS
	VISUALLY ACTIVE FRONTAGE
	PHYSICALLY PERMEABLE FRONTAGE
	SHADE & SHELTER
CYCLE	CYCLE NETWORK
	CYCLE PARKING AT TRANSIT STATIONS
	CYCLE PARKING AT BUILDINGS
	CYCLE ACCESS IN BUILDINGS
CONNECT	SMALL BLOCKS
	PRIORITIZED CONNECTIVITY
TRANSIT	
MIX	COMPLEMENTARY USES
	ACCESSIBILITY TO FOOD
	AFFORDABLE HOUSING
DENSIFY	LAND USE DENSITY
COMPACT	URBAN SITE
	TRANSIT OPTIONS
SHIFT	OFF-STREET PARKING
	DRIVEWAY DENSITY
	ROADWAY AREA

Table 2.1 Source: ITDP

2.5 Comparison and TOD in Indian context

- Indian metropolitan cities have complex organic growth patterns, Diverse neighborhoods, densities and landuses.
- Old city centers and associated infrastructure built before the invention of automobiles and modern transportation systems.
- These city centers support major economic activies to this day.
- Rs. 2000billion on metro rail projects in eight cities.

2.5.1 Tod Analysis

CITY	STATION NAME	DESIGN		DENSITY		DIVERSITY	
		Walkability & Access to transit	Active, 24 x7	Land Use Density	Transit Ridership	Mixed Use	Mixed Income
NEW YORK	Times Square						
	Woodhaven Boulevard						
LONDON	Picadily Circus						
	Hainault						
HONG KONG	Causeway Bay						
	Tai po						
SINGAPORE	Raffles Place						
	Kallang Station						
DELHI	Chawri Bazar						
	Race Course						
MUMBAI	Dadar						
	Churchgate						

Table 2.2

2.5.2 Comparision Of Station Area, Street Design, Density & Land Use

CITY	STATION NAME	STREET PATTERN	ROAD WIDTHS	DENSITY	NO. OF FLOORS	LAND USE
NEW YORK	Times Square	Grid	8m-13m	High	15+	Commercial Office
	Woodhaven Boulevard	Grid	10m-25m	Low to Medium	2 TO 4	Residential
LONDON	Picadily Circus	Grid	6m-10m	Medium	5 TO 7	Commercial Office
	Hainault	Grid	8m-20m	Low to Medium	2 TO 4	Residential
HONG KONG	Causeway Bay	Grid with irregular parcels	7m-30m	High	15+	Mixed Use
	Tai po	Grid with irregular parcels	7m-30m	High	15+	Mixed Use
SINGAPORE	Raffles Place	Grid with varied parcels	8m-45m	High	15+	Mixed Use
	Kallang Station	Grid with varied parcels	8m-25m	High	15+	Mixed Use
DELHI	Chawri Bazar	Irregular	≤10m	High	2 TO 5	Mixed Use
	Race Course	plots eith cul-de-sac	25m-30m with 9m inner roads	Low to Medium	2 TO5	Mixed Use
MUMBAI	Dadar	Grid with irregular parcels	6m-20m	Medium to High	5 TO 15+	Mixed Use
	Churchgate	Grid	6m-10m	Medium to High	5 TO 15+	Mixed Use

Table 2.3

2.5.3 Summary Of Tod Analysis For Tod Components:

Transit Stations & Stops in USA, UK, Asia	Transit Stations in India
Walkability and access to transit is safe, convenient and comfortable due to a walkable street network multimodal connectivity.	Existing street networks, walkability and access to transit is not safe, convenient and comfortable and multimodal connectivity is lacking.
24X7 environment created by placemaking components like parks, seating areas and a pleasurable walking experience.	24X7 environment created by existing diverse uses but placemaking components like parts, seating areas, pleasurable walking experience in lacking.
Land use density varies but is adequate to generate transit ridership	Land use density varies and may be adequate to generate transit ridership
Transit ridership is adequate and continues to be enhanced with greater connectivity.	Lack of accessibility to transit and multimodal connectivity may be detrimental to the potential of generating ridership.
Some of the stations have predominantly residential uses, the transit network provides connectivity to commercial/employment areas & ensures ridership.	Most of the stations have mixed uses and the transit network provides connectivity to commercial and employment areas.
Although all the transit stations areas do not have mixed income uses, they are accessible to mixed income groups.	Most of the stations have mixed income groups and are assessable to mixed income groups.

Table 2.4

2.5.4 TOD in Indian context:

CHALLENGES FOR TOD IN INDIA

Share of road fatalities by type of vehicle (year 2019)

In cities, it is the pedestrian, NMT and small vehicle users that are the most vulnerable

Improvements that focus on making fast travel safe do not necessarily improve net safety within cities.

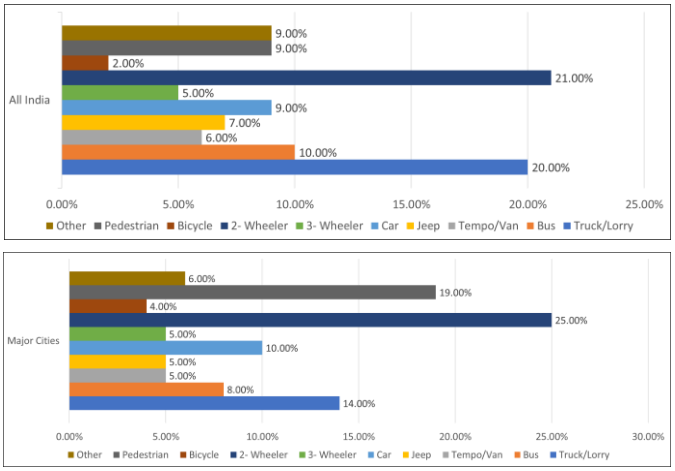


Figure 2.13 Source: morth.nic.in

TRANSIT ORIENTED DEVELOPMENT || POLICY . NORMS . GUIDELINES ||

PRIMARY GOALS OF TOD

- Reduce private vehicle and promote public transport
- Public transport access to maximum people

DEMARCATION OF THE TOD INFLUENCE ZONE

Zone 1: Intense TOD Zone	Zone 2: Standard TOD Zone	Zone 3: TOD Transition Zone
300 M influence zone of all MRTS stations	800 M (10-min walking) influence zone of all MRTS stations	2000 M (10-min cycling distance) influence zone of all MRTS stations
*Walking speed is considered approx. 5km/hour **Cycling speed is considered approx. 12km/hour		

Table 2.5

2.5.5 Development Types Within Influence Zones Based On Ground Situation:

Infill Sites are opened up for development.

Redevelopment sites could be any of the following:

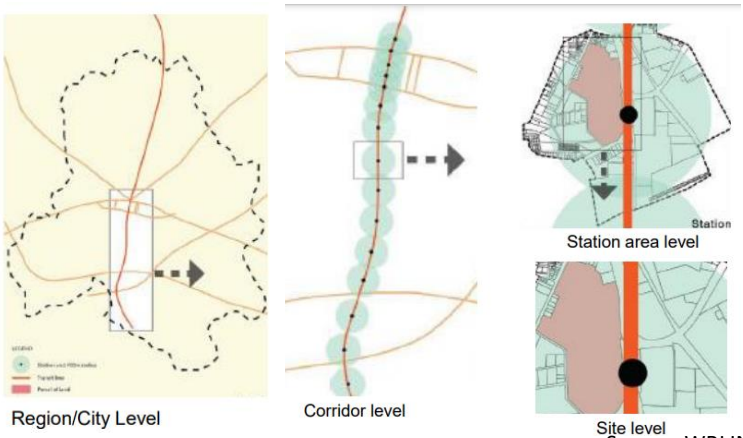
- Low density areas with gross density less than 250 du/ha
- Shopping/ Commercial centres
- Industrial areas/ clusters
- Resettlement colonies
- Unauthorized colonies
- Urban Villages

B. Greenfield – Sites within the Intense/ Standard Tod Zones

C. Retrofit – having existing gross density higher than 250 du/ha may need retrofitting to meet TOD Zone requirements.

The following criteria may be used as benchmarks for selecting such dense sites for need for retrofitting.

- Lack of street network and connectivity
- Lack of fire access to buildings
- Lack of adequate physical and social infrastructure facilities



Source: WRI INDIA

Figure 2.14 Scale of TOD

2.6 Tod Policy And Development Control Norms

Each TOD must have the following components:

- **Pedestrian & Cycle/ Cycle-Rickshaw Friendly Environment**
- **Connectivity:** Create dense networks of streets and paths for all modes
- **Multi-Modal Interchange:** Mass transportation modes servicing the area should be well integrated to afford rapid and comfortable modal transfer
- **Modal Shift Measures:** Shift to Sustainable Modes by using Design, Technology, Road use regulation, Mixed use, Parking Policy and fiscal Measures
- **Placemaking and safety:** Urban places should be designed for enjoyment, relaxation and equity
- **High density, Mixed income Development:** Compact neighborhood for shorter commutes and equity for all sections of society

2.7 Literature study 1: CURITIBA, BRAZIL

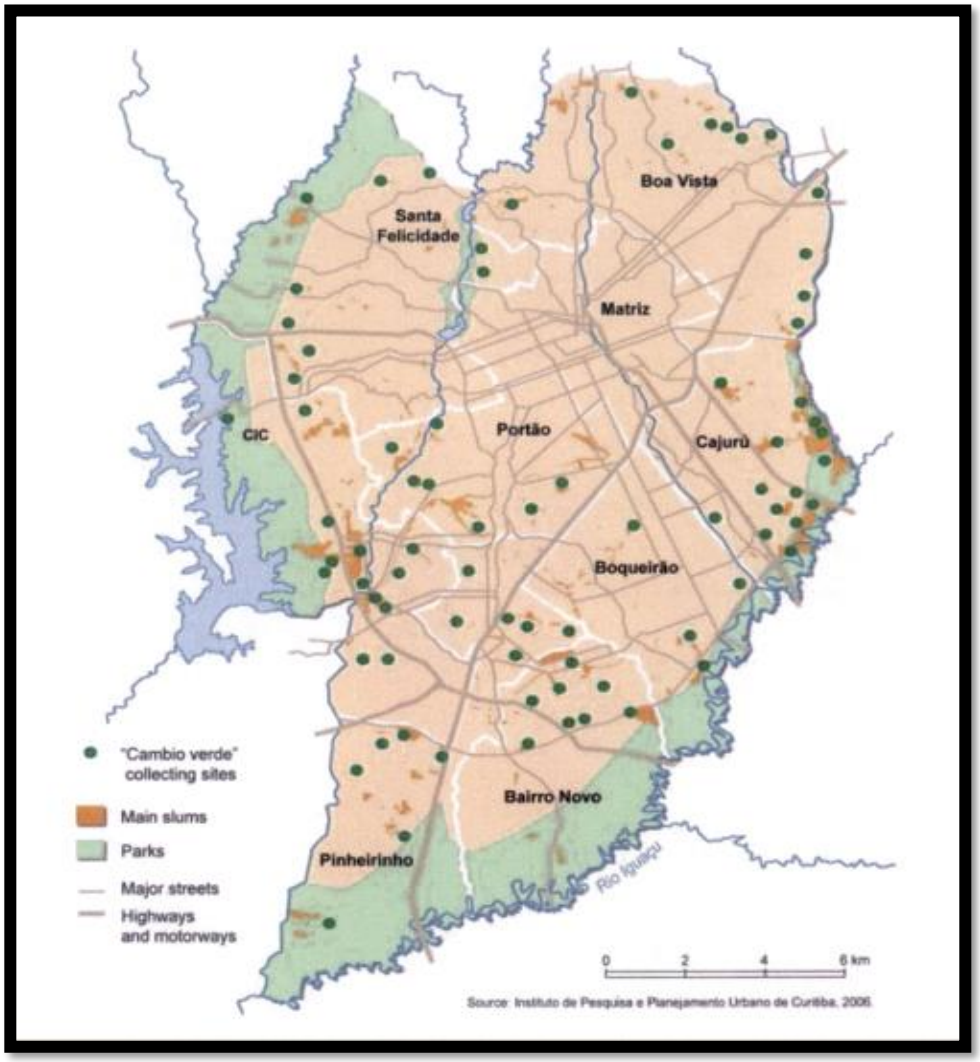
2.7.1 Background:

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

Figure 2.15: LOCATION OF CURITIBA

2.7.2 Brief overview of the city:

- Curitiba is the capital city of the State of Parana in Southern Brazil.
- The land in the central part of the city is relatively flat and major development has occurred in this part.
- The city is located about 250 kilometers south-west of Sao Paulo.
- Currently, it has a population of more than 1.8 million (2015) distributed over an area of about 430 sq.km and a total metropolitan area population of over 3.2 million.



LOCATION OF CURITIBA
Source: maps.grida.no

2.7.3 Steps taken in the direction of TOD:

- Transport system was planned as a means to promote city's growth along particular corridors.
- The entire MTS is currently operated by Urbanizes de Curitiba (URBS), a publicly-administered, privately funded company; together with Institute for Research & Urban Planning in Curitiba (IPPUC).
- Both agencies are responsible for land use development, maintenance & extension of MTS. A surface system was planned for two major reasons.
- When a system is buried, the citizen loses reference with the city. He no longer knows in which part of the city he is.
- Elevated system spoils the city skyline, is difficult for the aged and cannot have universal accessibility.
- Also, the adjacent structures lose their privacy. The buses run on a trinary road pattern, i.e. the central lane is exclusively for rapid buses in opposite directions while the remaining two side lanes are meant for private vehicles running parallel in opposite directions.
- About 1100 buses make 12,500 trips a day, serving about 1,300,000 passengers in the main city.
- Additional 800 buses transport 1,900,000 passengers in the adjacent towns.
- There are 25 transfer terminals, 221 tube stations and 340 routes.
- There is a tube station at an interval of every 500 meters. The maximum time for which a citizen has to wait for boarding a bus is 2 minutes (Taniguchi)

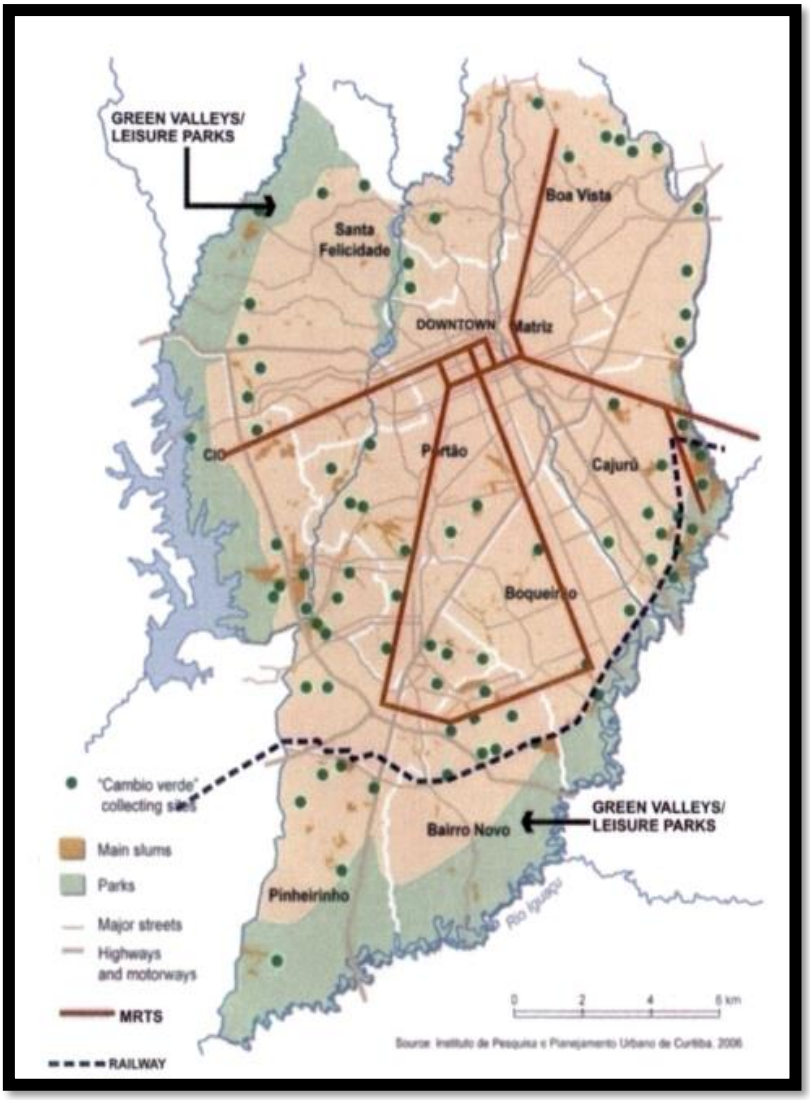


Figure 2.16: BUS CORRIDOR OF CURITIBA
Source:(mappery.com)

2.7.4 Success of TOD:

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

Tangible benefits:

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

Intangible benefits:

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

2.7.5 Inference:

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

2.8 Literature study 2: DELHI, INDIA

2.8.1 Background:

Delhi, is the second most populous urban area in the country after the Mumbai Metropolitan Region.

As per Census 2011, its population stood at over 16.7 million persons. From 1951 to 2001, NCT Delhi has seen an average decadal growth rate of 50% (although it slowed down to 21% in the last decade), higher than any other urban area. Much of this growth has occurred along the city's outer areas such as East Delhi, Noida, Ghaziabad and Gurgaon.

The NCT Delhi is spread over an area of 1484 sq.km and has an average population density of 11,289 persons/sq.km.

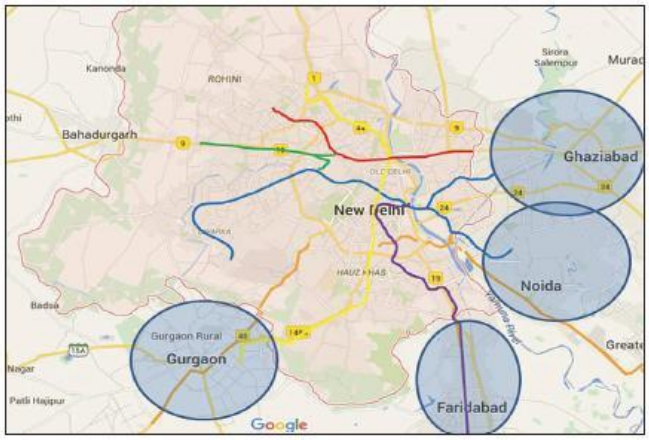


Figure 2.17: Delhi Metro Network, as on June 2016
(source: Google Map,2016)

2.8.2 Provisions Of Delhi Tod Policy Draft 2012

The master plan of delhi 2021 clearly outlines its goals for densification along MRTS corridors.

Its TOD policy was developed over a period of six years beginning in 2009. In 2012, the TOD policy was taken up for extensive public consultation by the management action group (MAG) for transportation.

An updated version of the policy was approved by the ministry of urban development in 2015. The policy was further changed and released for public suggestions and objections in 2016.

:The policy is still to be finalized. Delhi's Transit Oriented Development Policy Draft of 2012 covers following key components

- Pedestrian and NMT friendly environment and connectivity.
- Multi-Modal Interchange
- Density
- Land-Use
- Minimum Housing Mix Criteria
- Parking Reform
- Open Spaces and Social Infrastructure

Figure 2.17

2.8.3 Transforming City With Metro:

- The metro changed the face of public transit in Delhi. Delhi metro rail corporation (DMRC) opened its first corridor between Shahdara in east Delhi and tis hazari in north Delhi on 25th December, 2002.
- Since then the DMRC network (today 190 km) has crossed the boundaries of Delhi to reach Noida and Ghaziabad in Uttar Pradesh and Gurgaon in Haryana.
- The system has kept more than 3.9 lakh vehicles off the roads in 2014, resulting in a saving of Rs. 10,364 crore in fuel consumption, reduction in pollution, work hours lost and fuel due to decongestion along with other benefits (PTI, 2015).
- The metro network came up in response to alleviate high travel demand patterns existing along the arterial roads of Delhi but did not change the travel patterns; it provided relief from the road based congestion by accommodating the growing number of commuters along the existing corridors.

2.9 Comparative Analysis Of The Components:

CITY	CURITIBA	DELHI
SCALE	CITY	REGIONAL
AREA	430.9sq.km	1484sq.km
MODE OF TRANSIT	Bus Rapid Transit	Metro
TYPOLOGY	Transit Corridor	Transit Corridor
DIVERSITY	Land within two blocks of the bus-way zoned for mixed commercial residential uses.	At least 30% residential and 20% commercial and institutional use mandatory in all new/redevelopment projects.
DESIGN	Trinary road-system. Open spaces and green ways adjacent to transit system.	Social amenities shall be allocated the required built-up area within planned redevelopment schemes as per master plan requirements.
HOUSING	Housing outside BRT Zones made accessible using feeder buses	Minimum percentages fixed for rental and scale of smaller unit size. Mixed of housing typologies proposed.
MOBILITY	Limited on-street parking central city area restricted to private vehicles. Expensive off-street parking within structural corridors, development must meet maximum off-street parking limit bi-articulated buses and features of sub-way.	Parking for IPT and NMT prioritized at TOD zones.

Table 2.6

3. CASE STUDIES

3.1 Case study 1: Naya Raipur, Sec 31

3.1.1 Introduction:

- The new state of Chhattisgarh was formed on 1st of Nov. 2000.
- Raipur, the largest city of the state was named its capital. Recognizing the growing demands for high-quality infrastructure in the State, the Government has decided to establish a modern, hi-tech, eco-friendly city.
- The New Capital was developed to serve as the administrative capital of the State and also cater to the infrastructural needs of industry and trade in the region.

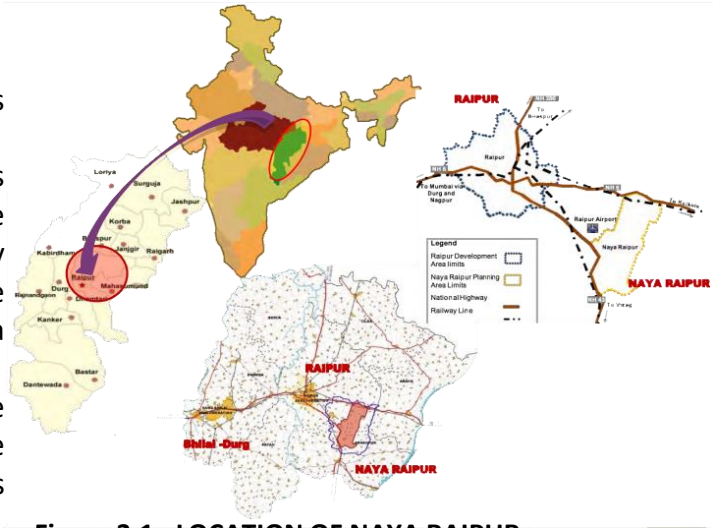


Figure 3.1 : LOCATION OF NAYA RAIPUR
Source: nayaraipur.gov.in

3.1.2 Objectives Of Naya Raipur:

- An agent of economic change and social transformation in the state. An efficient engine of growth and prosperity.
- A servicing hub not only in manufacturing of goods but also in Information Technology and Bio-Technology sectors.
- A financial centre of the region.
- Hub of trade and hospitality sectors in Naya Raipur Hub of cultural services which would supplement local economy.
- Hub of affordable and high quality medical services. Hub of quality educational facilities and strive to develop as a knowledge base

3.1.3 Vision Of Naya Raipur:

Naya Raipur would be a planned and designed new city of the 21st century to be a focus of socioeconomic and cultural life of the state of Chhattisgarh having its role and recognition at national and international levels. The new city would be eco-friendly integrated in its inspiring existing landscape; efficient, healthy; modern, but caring for its traditional values.

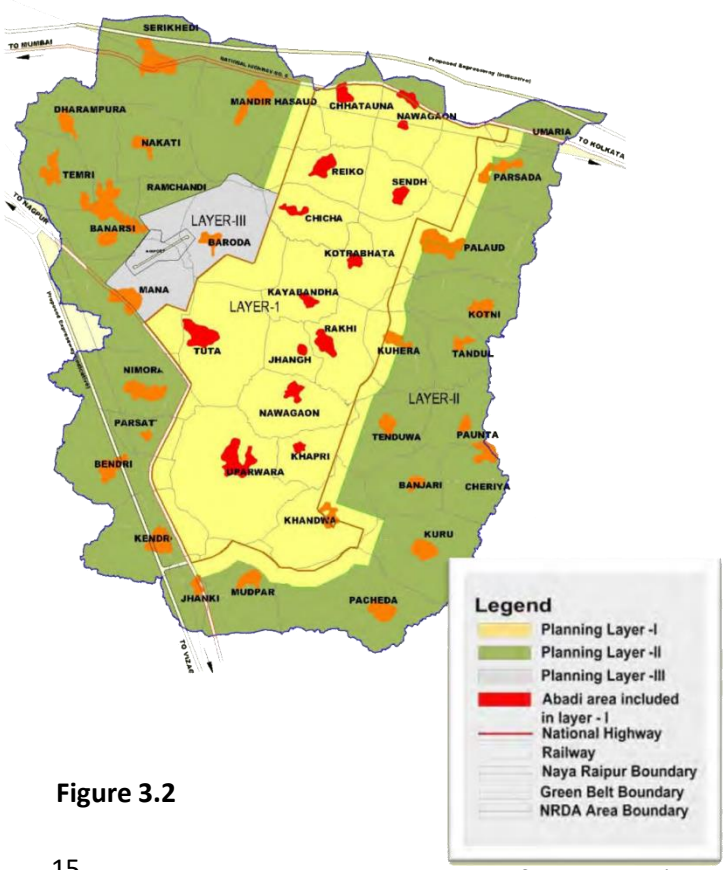


Figure 3.2

Source: nayaraipur.gov.in

3.1.4 Background:

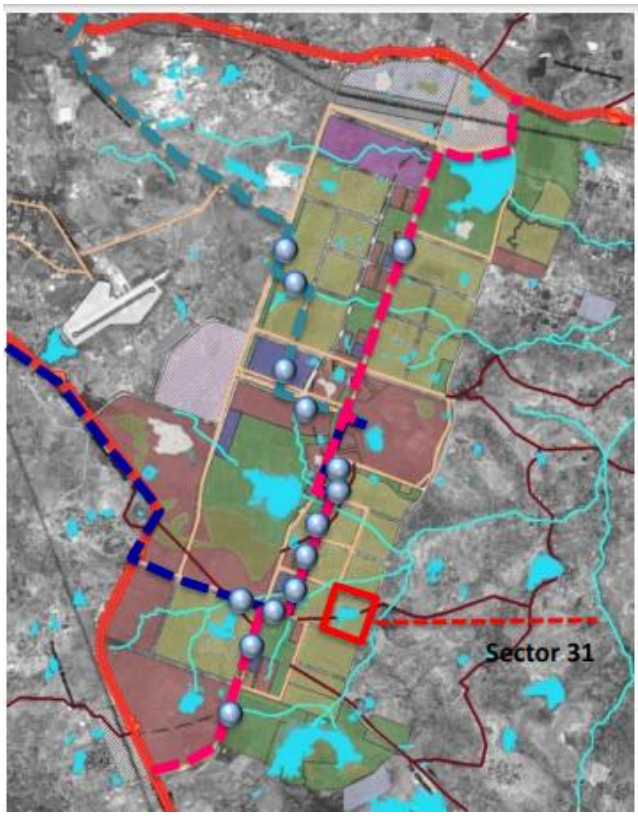
- Project type: Green field
- Demonstration site : Sector 31- Residential site measuring 60.3hec.
- 16,000population as per proposed master plan.
- Project worth is INR 300 crore.
- Sector 31 is not along the BRTS but it is adjacent to the sector which is along BRTS.
- Sector 31 was designed based on the TOD concept.

3.1.5 Need For The Project:

- To integrate Tod principles in Designing the city
- To preserve natural terrain and water networks.

3.1.6 Limitations

- Certain parameters were fixed like Sector roads were already laid and there density norms could not be changed.



Source: nayaraipur.gov.in

Figure 3.3: LOCATION OF SEC 31

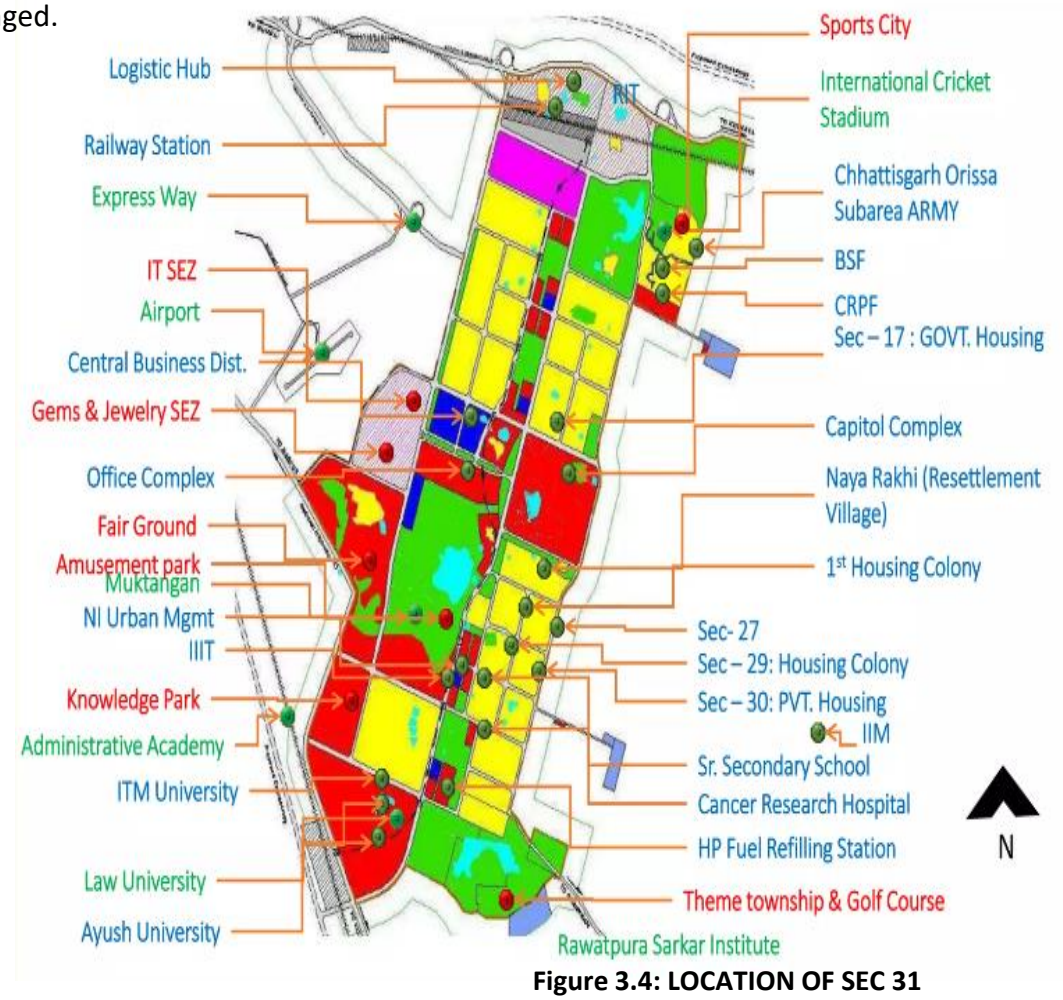
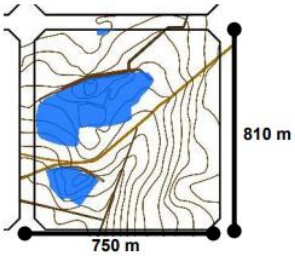
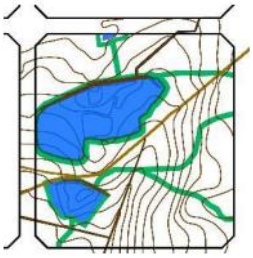


Figure 3.4: LOCATION OF SEC 31

3.1.7 Layered Approach To Sector Design:



1. – Existing Terrain



2.- Riparian Corridor

3.- Road Network

4.- NMT Network

5.- Amenities & Commercial Areas aligned to the NMT and open spaces

6.- Final Layout

Source: WRI INDIA

- This design ensures that the high densities were placed along the sector roads for easy access to road connectivity the most that will connect them to the BRTS stops.
- The proposal took into consideration all 7 principles since it was a Greenfield scenario.

3.1.8 IMPACT:

Source: WRI INDIA

TOD PRINCIPLES	PROPOSALS
Complete streets (Walking and cycling)	Walking Grid of 150mx150m, Connected Greens, Safe Junctions, Bicycle Pats
Transit Supportive Uses (Active Edges)	Shared uses along the transit corridors, Mixed/Commercial Uses on the ground floor, Permeable edges.
Integrated Transport (Public Transit)	The design integrates the feeder bus stops, thus making the transit stations accessible to both housing and public open spaces.
Public Spaces (Open Spaces)	Varied hierarchy, Inclusive greens, Inter - connected
Cultural Landscapes (Historic & Environmental)	The design respects the natural terrain. The valley are retained. The traditional routes connecting the existing villages are also retained tus helping to preserve the memory of the place.
Compact Development (Mixed Use and Density)	Tiered Density along the transit routes. Mixed-uses proposed at the junctions.

Table 3.1

3.2 Case study 2: INDIRANAGAR, BANGALORE

3.2.1 Introduction:

- The City of Bangalore, also known locally as Bengaluru is the capital and largest city of the State of Karnataka.
- It has a population of more than 8 million and a metropolitan population of around 11 million
- It is the fifth largest metropolitan city in the country in terms of population of 11,556,907 approximately (Year2016).

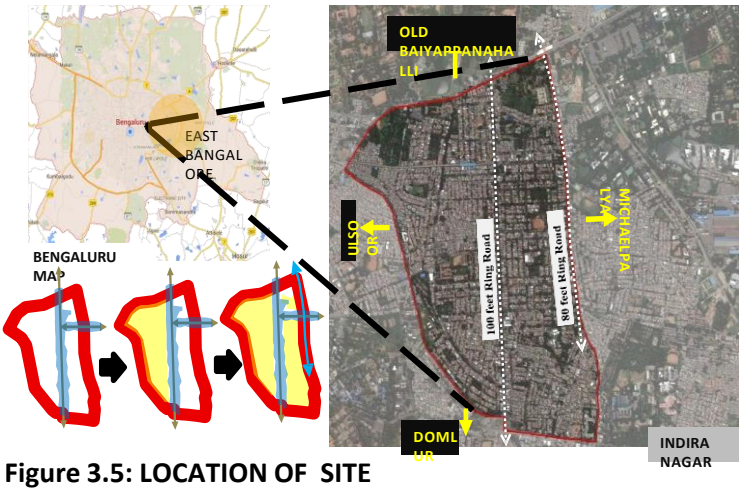


Figure 3.5: LOCATION OF SITE

Identification Of Station Area

Figure 3.6

Source: WRI INDIA

3.2.2 Background:

- Project type: Retrofitting
- Scale of TOD: Station area level

3.2.3 Objective:

- To facilitate a development trend that allows higher numbers of people to use the Metro system and discourage automobile dependent activities around the station area.
- To make the area investment friendly as well as inclusive
- To guide the design of built form to improve the street interface thereby creating a more pedestrian friendly and safe environment.
- To develop a station area analysis and development plan methodology that can be applied to stations across the city while ensuring that each DCR proposal caters to the needs of the context (ecological, historical, development) in which the station is set.

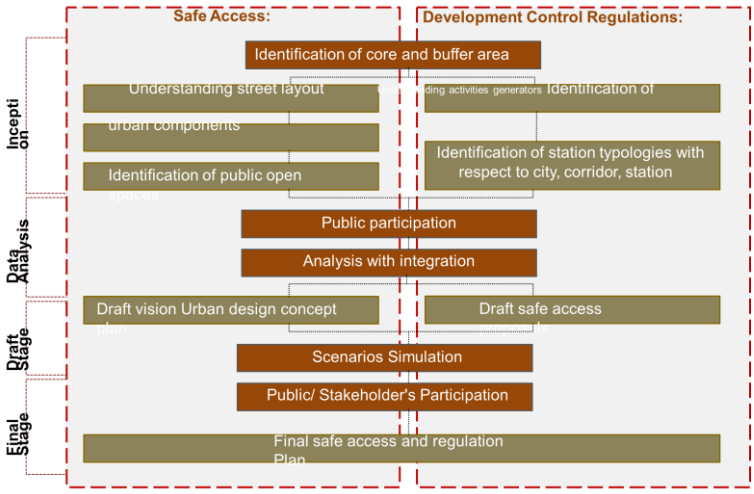


Figure 3.7

Source: WRI INDIA

3.2.4 Transformational Analysis:

Safe Access Proposals

- Existing Landuse (compared to RMP 2015)
- Landuse mix (Floor wise)
- FAR (Achieved & Proposed)
- Building Heights (Achieved & Proposed)
- Road Hierarchy
- Natural Features
- Activities & Generators
- Street Rating

The aim of these analyses is to predict the transformation in these areas.

Development Control Regulations

- Station Typology - Influence @ City, Corridor & Local levels
- Ecological Network
- Historical / Cultural Significance
- Plot Size
- Street Network
- Building Typology (Single Family, Apartment, Informal)
- Density
- Existing Landuse (compared to RMP 2015)
- Building Heights (Achieved & Proposed)
- Construction Activity
- FAR (Achieved and Proposed)
- Activity Generators and Informal Activities
- Pedestrian Movement Patterns & LOS
- Infrastructure Capacities

3.2.5 Proposals:

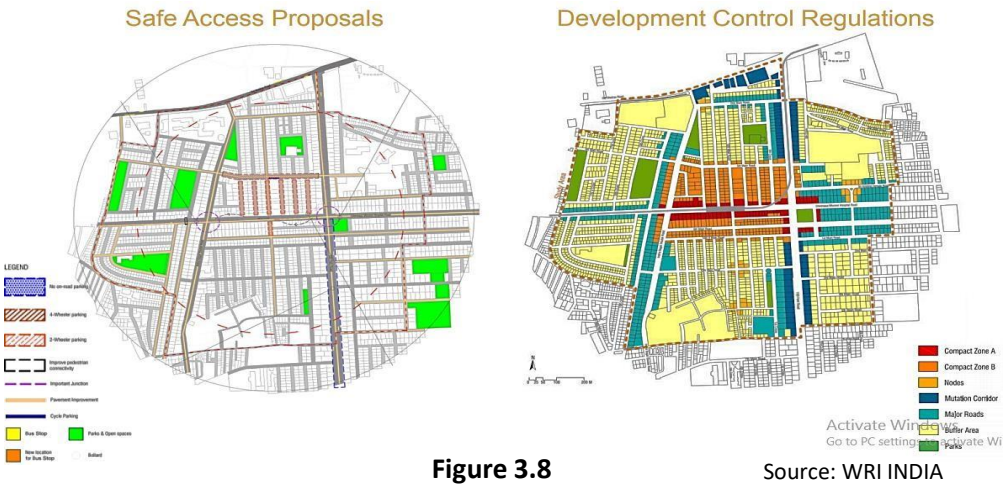


Figure 3.8 Source: WRI INDIA

3.2.6 Key Proposals:

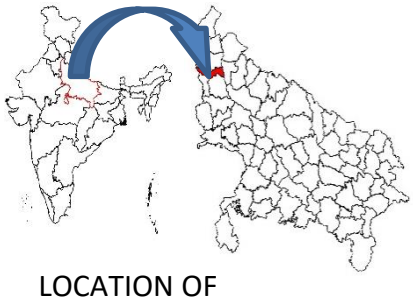
Key Strategies- SAP	
Traffic Management	Provide traffic calming measures such as treatment, table top crossing
IPT & PT	Integrate bus stops & rickshaw stands with metro station
Continuity	Create complete and continuous pedestrian and NMT networks
Parking	Parking demand management, multi-level parking beyond core area.
Street Design Guidelines	Safer intersections, reduced vehicular speeds, wider pavements, street furniture
Key Strategies- DCRs	
Landuse	Enforcing mixed-use, minimum % for residential and ancillary uses
Ground Coverage	Increasing ground coverage to ensure maximum utilization of FAR
FAR	Redistributing the FAR over a 500m
Parking	Controlled parking regulations, encourage metro ridership
Street Design Guidelines	DCRs dovetail with Safe Access proposals to ensure a safe and walkable neighbourhood

Table 3.2 Source: WRI INDIA

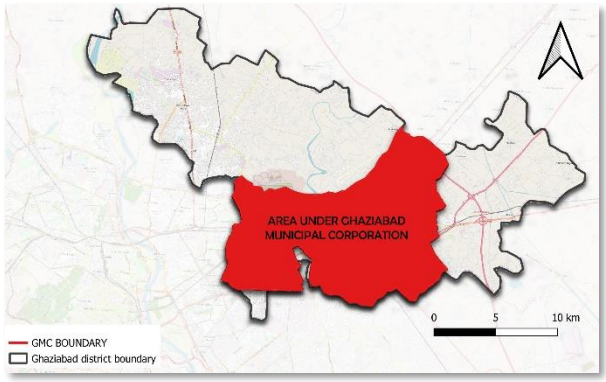
4. ANALYSIS OF PLANNING AREA

4.1 Introduction:

- **Ghaziabad** is a city in the Indian state of Uttar Pradesh and a part of Delhi NCR.
- Ghaziabad city is governed by Municipal Corporation which comes under Ghaziabad Metropolitan Region. The Ghaziabad city is located in Uttar Pradesh state of India.
- It is the administrative headquarters of Ghaziabad district and is the largest city in western Uttar Pradesh, with a population of 1,729,000.
- Ghaziabad Municipal Corporation is divided into 5 zones - City Zone, Kavi Nagar Zone, Vijay Nagar Zone, Mohan Nagar Zone and Vasundhara Zone.
- The Municipal Corporation comprises 80 wards.
- Well connected by roads and railways.



LOCATION OF GHAZIABAD

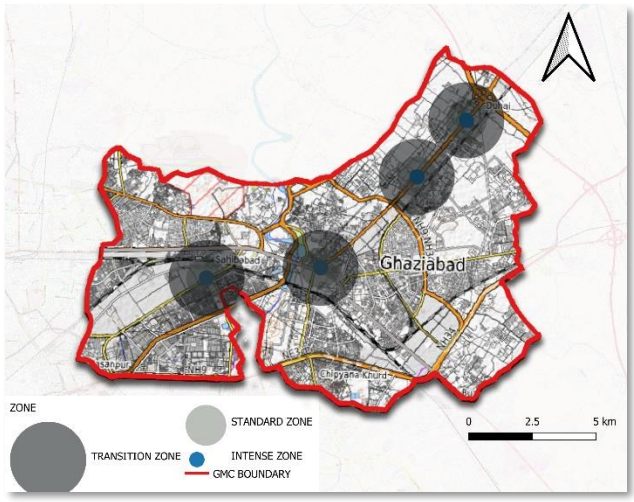


Source: Ghaziabad municipal corporation, Author

Figure 4.1

4.1.1 Physical and Administrative structure at a glance:

- A growing satellite town of National Capital Region.
- Ghaziabad is established on Upper Gangatic Plane.
- Hindon River divides this city into two Halves which Cis-Hindon Area & Trans-Hindon Area
- Area under Municipal Limit : 210 sq. km.
- Area covered under reform work : 210 sq. km.
- Population (2011) : 17.29 Lakhs
- Total number of zones : 5
- Total number of wards : 80
- Total number of house holds : 2.86 Lakhs (as per record)



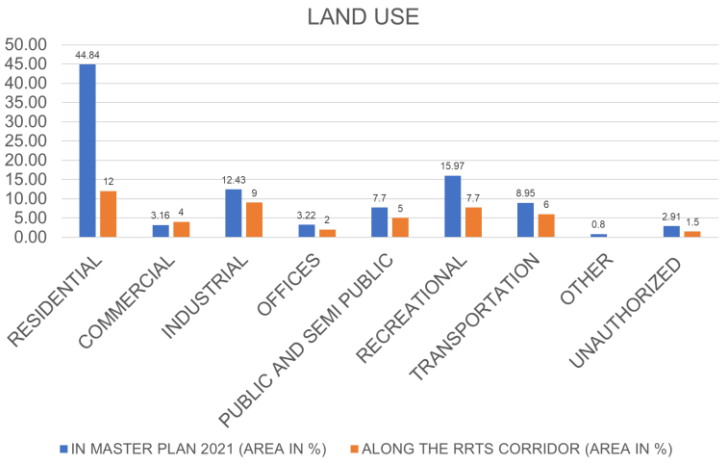
Source: Ghaziabad municipal corporation, Author

Figure 4.2

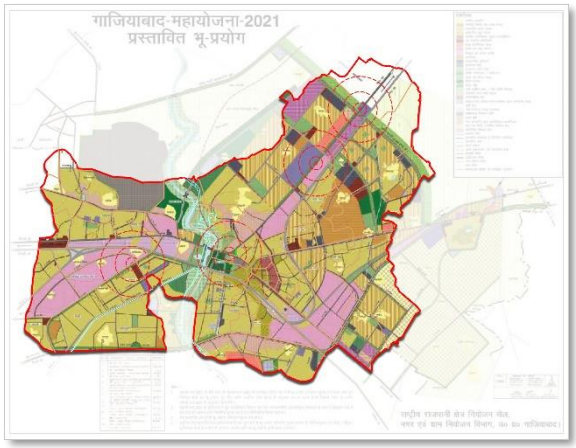
PARAMETERS	UNIT	DISTRICT	GMC
AREA	Sq.km	1,179	210
ZONES	No.	5	-
MUNICIPAL WARDS	No.	80	-
POPULATION(2011)	No.	46.82 lakhs	30.86 lakhs
LITERACY RATE(2011 CENSUS)	%	78.07	80.2
SEX RATIO(2011 CENSUS)		881	880

Table 4.1

4.2 Proposed land use map of Ghaziabad(2021):



Graph 4.1

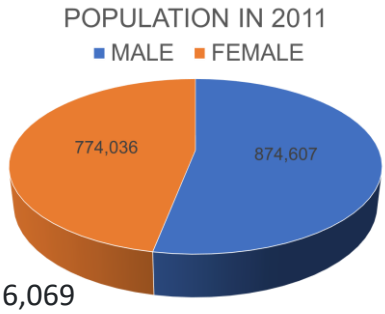


Source: Ghaziabad development authority, Author

Figure 4.3

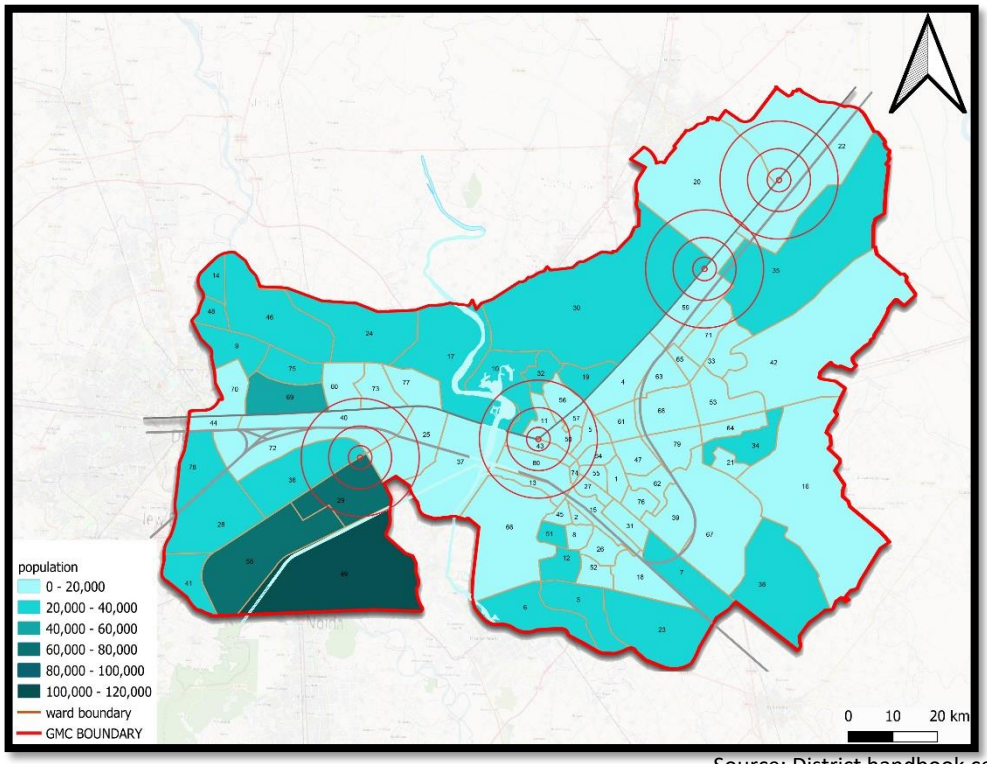
4.3 Demographic profile:

- The population of Ghaziabad city (Nagar Nigam) as per 2011 census is 1,648,643 out of which male and female are 8,74,607 and 7,74,036.
- As per census 2011 there are total 80 wards in municipal corporation area.
- The total no. of household in GMC area is 3,36,069.



Graph 4.2

- Ghaziabad Municipal Corporation has total administration over 336,069 houses to which it supplies basic amenities like water and sewerage.
- It is also authorize to build roads within Municipal Corporation limits and impose taxes on properties coming under its jurisdiction.

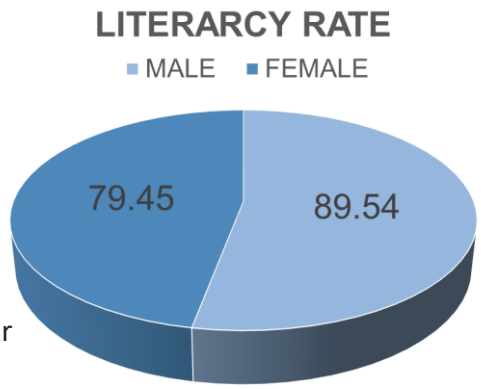


Source: District handbook census (2011), Author

Figure 4.4 Ward wise share of population in total population of Ghaziabad

4.3.1 Sex Ratio And Literacy Rate:

- In education section, total literates in Ghaziabad city are 1,220,667 of which 681,195 are males while 539,472 are females.
- Average literacy rate of Ghaziabad city is 84.78 percent of which male and female literacy was 89.54 and 79.45 percent.
- The sex ratio of Ghaziabad city is 885 per 1000 males. Child sex ratio of girls is 835 per 1000 boys.



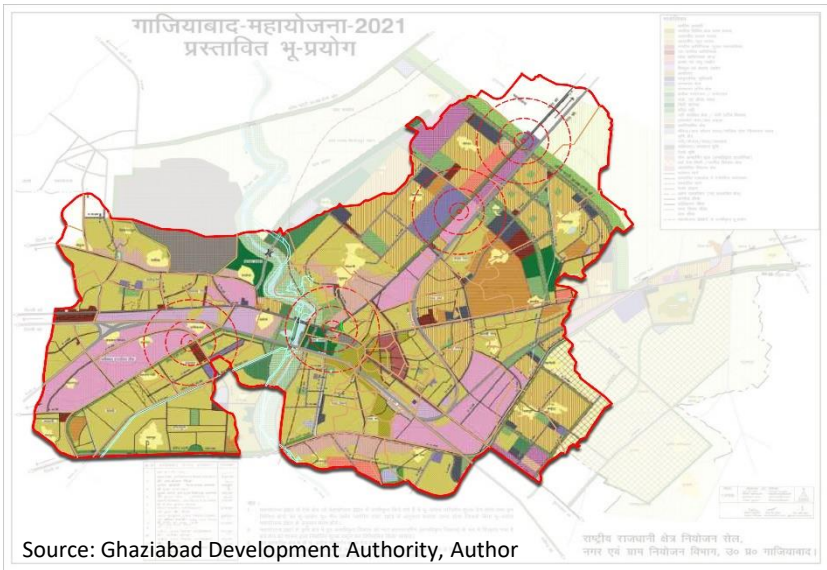
Graph 4.3

- Out of total population, 577,369 were engaged in work or business activity.
- Of this 456,537 were males while 120,832 were females.
- In census survey, worker is defined as person who does business, job, service, and cultivator and labour activity.
- Of total 577369 working population, 84.07 % were engaged in Main Work while 15.93 % of total workers were engaged in Marginal Work.

4.3.2 Observation:

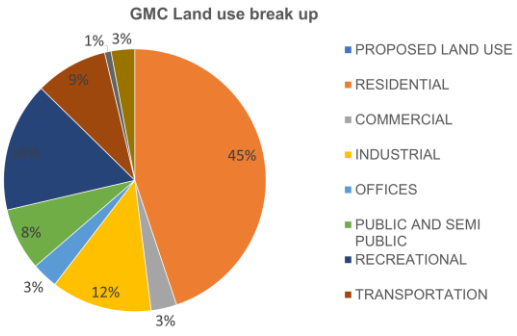
- Major population is concentrated in the industrial area of Ghaziabad City, in close vicinity to National Highway 24 (20,000 – 120,000).
- Comparatively, the area surrounding the Meerut Road at Hindon Circle towards Meerut have less population (less than 40,000).
- This corridor is important at it meets the Eastern Peripheral Expressway towards Meerut.
- As a result, it is extremely important to recognize the future urban growth along the highway and plan the land use accordingly.

4.4 Proposed Land Use:



Source: Ghaziabad Development Authority, Author

Figure 4.5



Graph 4.4

4.4.1 Proposed FAR:

The proposed FAR for the core areas and the new areas.

USE	FAR	Maximum allowable FAR
CORE AREAS		
Residential	1.75	2.00
Mixed	1.50	2.00
Commercial	1.50	2.00
Institutional	1.00	
NEW AREAS		
Residential	1.25	
Commercial	1.75	3.00
Mixed	1.50	
Institutional	1.50	

- Mixed, Commercial use area have been allocated a uniform FAR of 1.50.
- There is no provision made to identify special areas especially around major transport corridor which could have a higher FAR.

Table 4.2 Source: Ghaziabad Development Authority, Author

4.4.2 Observations:

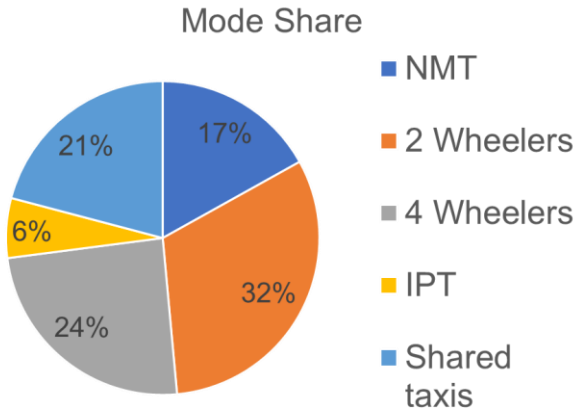
- The proposed land use plan for GMC is a combined plan taking into consideration the current area within the municipal corporation limits as well as the surroundings of Ghaziabad master plan.
- As a result, major industries are located in the current city limit.
- Mainly the city is planned as residential areas (44.84% residential land use). It is important that these residential areas are well connected to the workplaces.
- A well planned public transport network is necessary to achieve a good connection between areas of residence and areas of work.
- The land use plan has 8.95% of total area reserved for circulation and transportation.
- Thus, it becomes vital to plan in detail the land uses along these transportation links so that places of stay and places of work are well connected with each other

4.5 GMC Transport:

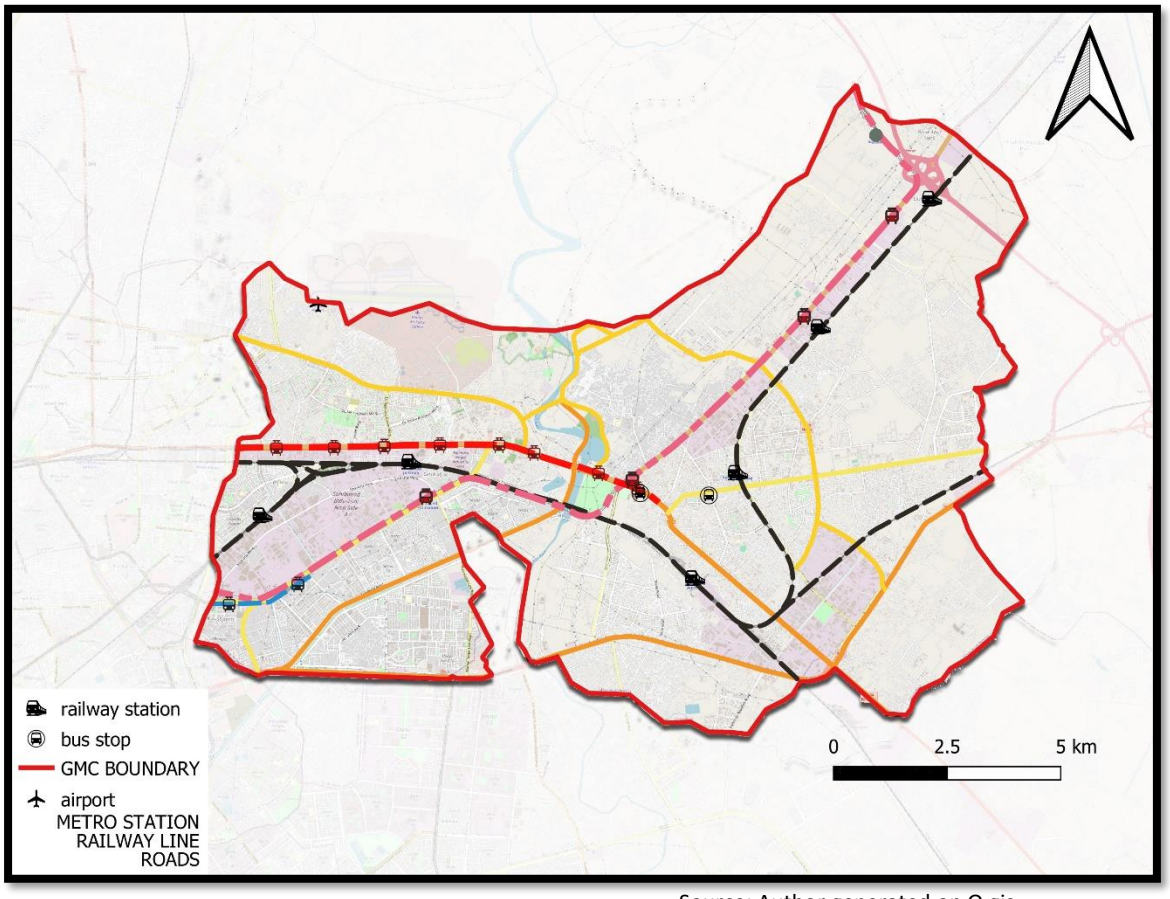
- Road and Transport constitute the main entities of efficiency working of any urban area.
- Ghaziabad City is one of the most important administrative center and is a part of the National Capital Region of Delhi.
- It is a planned Industrial city, well connected by roadways and railways and an educational hub for western UP.
- Ghaziabad city at present is at the state of corridor node development in which the corridor concept in integrated.

4.5.1 Traffic Modal Split:

- The modal share of public transport is 27%, which includes public buses, private buses and Vikram.
- The modal share of 2-wheelers and 4-wheelers is 34% and 26% respectively, which suggests that the people are using private modes of transport more than public transport system.
- The modal share of NMT including walk, bicycle and cycle rickshaw is 17%.



Graph 4.5



Source: Author generated on Q gis

Figure 4.6: Connectivity in planning area

4.5.2 Transport characteristics:

S. NO.	Category Name	Road No.	Name of Road	Length (in km.)
1	National Highway	NH0024	Delhi Bareilly Lucknow	80
2	National Highway	NH0058	Delhi Meerut Road	26.6
3	National Highway	NH058E	Delhi Ghaziabad Mohan Nagar	9.650
4	State Highway	SH0057	Delhi Saharanpur Yamunotri Marg	15
5	Major District Road	MD148W	Modi Nagar Hapur Marg	12.5

Source: uppwd.gov.in

Table 4.3 Road characteristics

As per landuse cover with land under transportation accounts 8.95% of total GNN area as per master plan 2011.

RAILWAYS

- Ghaziabad provides railway connectivity through 1 main station
  - Ghaziabad Junction
- Ghaziabad city has further 4 more railway stations, viz. Sahibabad, Naya Ghaziabad, Guldhar, Duhai.

BUS

- Ghaziabad city's bus service is operated by Uttar Pradesh State Road Transport Corporation (UPSRTC).
- There are total 8 bus depots in Ghaziabad region.
- Two bus stands are there in Ghaziabad City
  - New Bus Stand
  - Old Bus Stand

AIRWAYS

- Hindon Airport is an airport serving Ghaziabad and has been operational since 2019.
- It is the second commercial airport in the Delhi–NCR after Indira Gandhi International Airport.
- The Indira Gandhi International Airport is the closest international airport.
- Hindon Airport currently operates flights to Pithoragarh, Uttarakhand, and Hubli, Karnataka.

METRO

- The Blue and Red Lines of the Delhi Metro serve Ghaziabad and connect it with the national capital, Delhi.
- The Red Line serves Ghaziabad, with eight stations, and Blue Line with two stations.
- The Red Line's eastern terminus, Shaheed Sthal, is located in this city.
- The Blue Line stations exist at Vaishali which serves that area as well as Vasundhara and Indira puram, and Kaushambi Station serving the Kaushambi area

5. ANALYSIS OF SELECTED RRTS CORRIODR

5.1 About the RRTS Corridor:

- RRTS IS REGIONAL RAPID TRANSIT SYSTEM.
- RRTS is different from metro as it caters to passengers looking to travel relatively longer distance with fewer stops and at higher speed
- RRTS is different from conventional Railway as it will provide reliable, high frequency, point to point regional travel at high speed along dedicated path way.
- RRTS is a new, dedicated, high speed, high capacity, comfortable commuter service connecting regional nodes in NCR.

CORRIDOR BEING DEVELOPED UNDER RRTS PHASE 1-

1. DELHI-GHAZIABAD-MEERUT
2. DELHI-GURUGRAM-SNB-ALWAR
3. DELHI-PANIPAT

OTHER CORRIODR

1. DELHI-FARIDABAD-BALLABGARH-PALWAL
2. GHAZIABAD-KHURJA
3. DELHI-BAHADURGARH-ROTAK
4. GHAZIABAD-HAPUR
5. DELHI-SHAHADRA-BARAUT

The network would be planned and spatially oriented to ensure seamless integration with the Indian railways, Indian Bus Terminals(ISBTs), Airports and the Delhi Metro.

Figure 5.1: 3 times faster than metro –RRTS NETWORK

DELHI –GHAZIABAD-MEERUT

The Delhi-Meerut corridor originates from Sarai kale khan in Delhi and Terminated at Modipuram in Meerut.

The project covers NCT-Delhi, Ghaziabad and Meerut.

The total length of the corridor is 82.15 km with a total of 25 stations (including Sarai kale khan), out of which NCT Delhi will have 4 stations, Uttar Pradesh will have 21 stations.

There are 3 Depot i.e., Jangpura, Duhai, Modipuram.

Delhi-Meerut RRTS Corridor will cover the distance from Sarai Kale khan in Delhi to Modipuram in Meerut in about 60 minutes.

RRTS Infrastructure will also be used to operate local transit services (Meerut Metro Services) to meet the local mobility needs besides providing high-speed regional mobility for towns like Ghaziabad, Murad Nagar, Modi Nagar< Duhai etc.

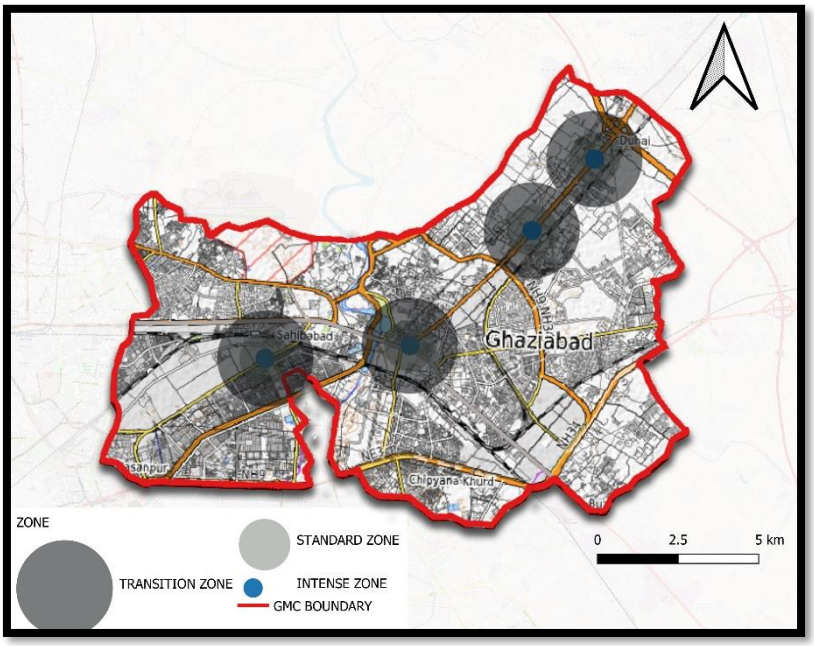
Length = 82 kms

– Number of RRTS Stations =16

– Number of additional Stations for Meerut MRTS = 9

5.2 Ghaziabad Planning Area:

There are 4 RRTS Stops and one Depot that comes under Ghaziabad Municipal Corporation i.e.,Duhai Depot, Duhai, Guldhar, Ghaziabad, Sahibabad.



Project type is **REDEVEPLOMENT**
Scale of TOD is **CORRIDOR LEVEL**

Source: Ghaziabad municipal corporation, Author

Figure 5.2: Selected Area

5.3 Delhi-Ghaziabad-Meerut Study:

- The Delhi-Ghaziabad-Meerut project corridor is 82 kms long, connecting the area of Delhi to Meerut in about 60 mins.
- It also serves as a connecting link to the NH58. There are total 25 stations along the stretch of the corridor.
- The selected stretch of the corridor in Ghaziabad city contains 4 RRTS and 1 depot.
- There are substantial parcels of vacant land around this corridor.
- This is the appropriate stage to plan a TOD model for the corridor, before the areas around the corridor get developed.

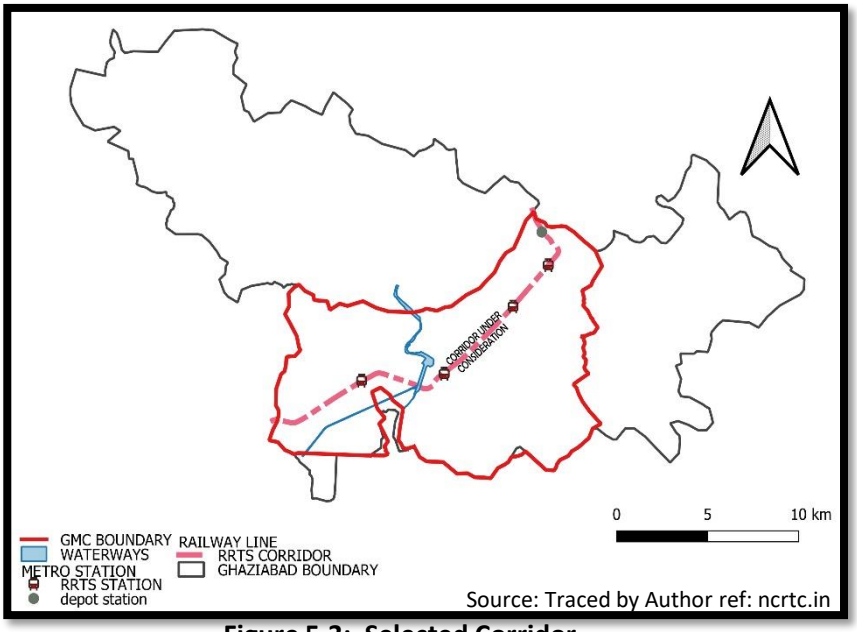


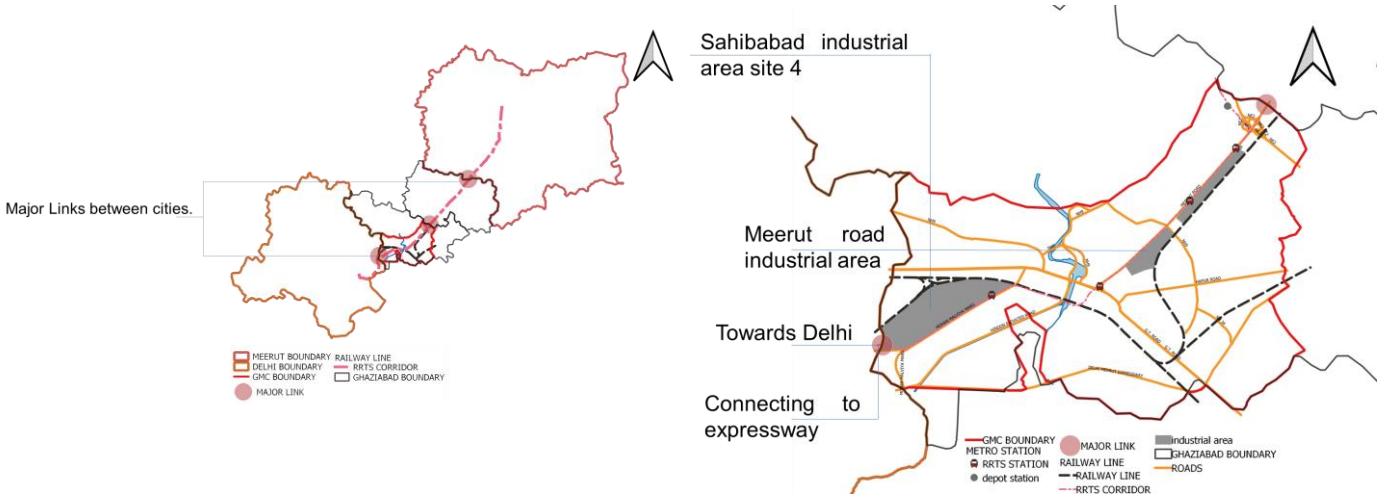
Figure 5.3: Selected Corridor

5.4 Reasons for Selecting the Corridor:

The Delhi-Ghaziabad-Meerut Corridor has been selected for TOD demonstration for the following reasons:

1. The corridor is a major link connecting Delhi and Meerut through NH58

2. This route is the shortest distance for residents of Ghaziabad to the industrial areas and to reach there work places.



3. The corridor area has a natural edge in the form of Hindon River. It is also important to protect the patches of city forest and parks along the corridor.

4. The corridor has potential for commercial and residential development which would also serve adjoining Industrial Area.

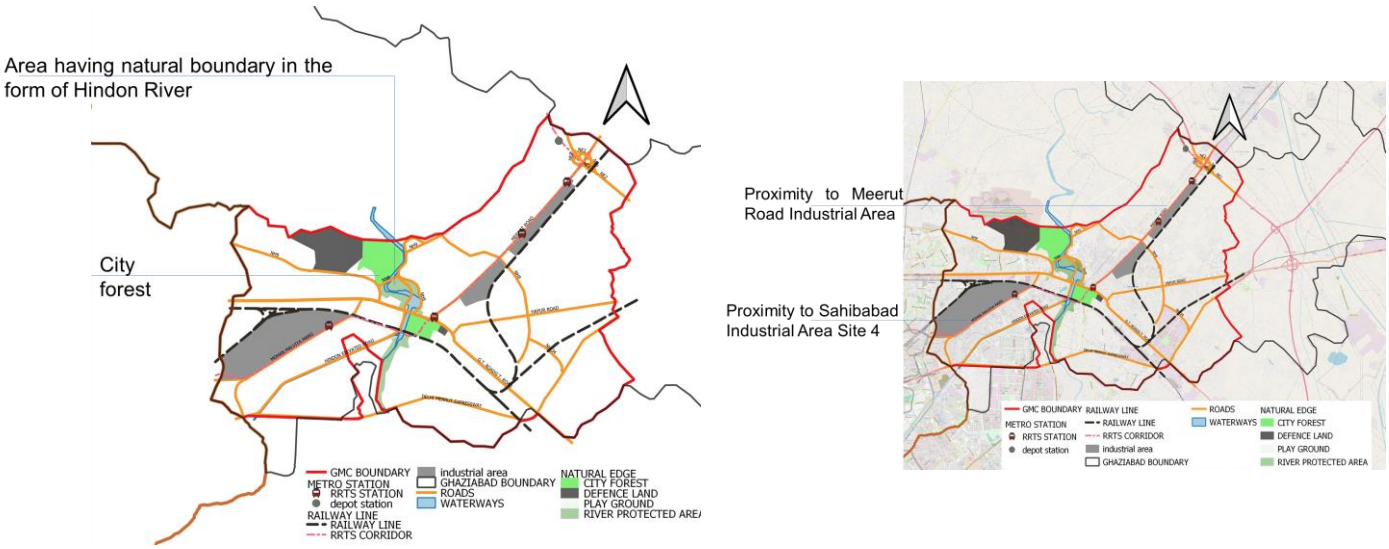
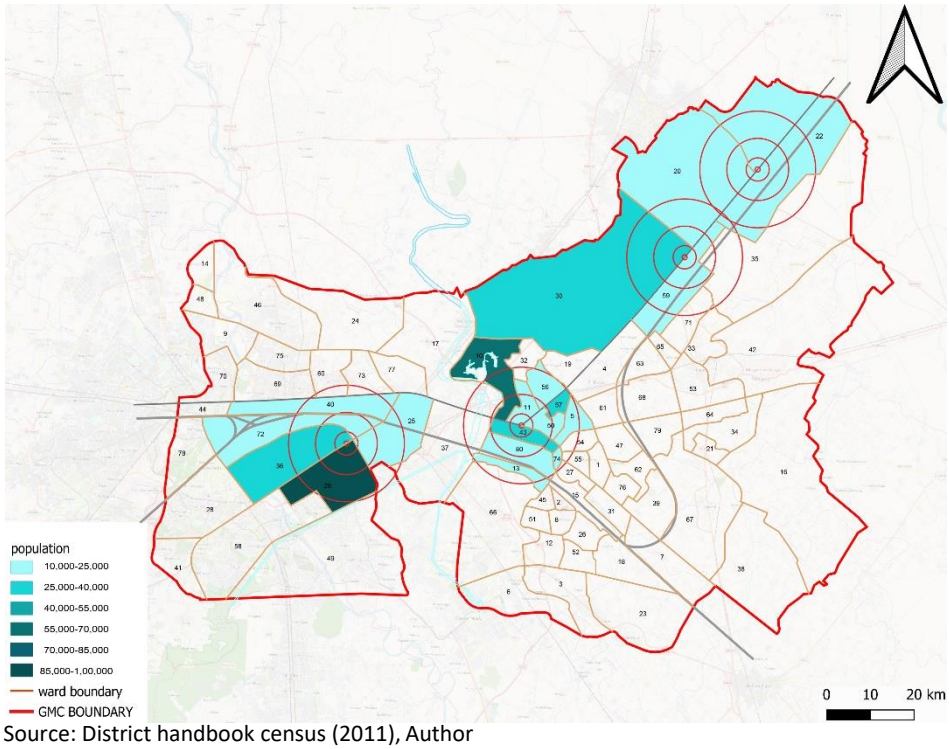


Figure 5.4 Criteria for selection of the corridor

Source: Traced by Author ref: gmc

5.5 Demographic Profile along the corridor:

- The area around the RRTS Corridor is composed of 19 electoral wards which had a population of 3,75,218 in 2011.
- Considering the population growth rate of 41% for the past decade, the current population around the corridor would be 5,50,219.



Source: District handbook census (2011), Author

Figure 5.5: Electoral Wards around RRTS Corridor

5.5.1 Observations:

- Approx. 23% of the overall population of GMC stays within the RRTS Corridor area under consideration. The population density of 8,958 person/sqkm for the selected corridor area is higher as compared to the overall GMC area of population density 11,528person/sqkm. Out of the total 19 wards, 13 wards have a population density exceeding the average overall density of the corridor. As a result, these wards will reach a level of saturation beyond which it would be difficult for them to hold additional population.
- On the other hand, the remaining wards have a potential for densification.
- The area of ward no.20 (Morta) has the lowest population density of 1845person/sqkm .
- As a result, a part of this area has been considered for TOD demonstration.

Ward No.	Name	Area of Ward (hectares)	Population		Density(person/hectare)	Projected Population		Density(person/hectare)
			2001	2011	2011	2021	2023	2023
29	Vasundhara	259	9392	67945	262	95802	99634	385
36	Sahibabad Industrial Area(Site-4)	370	7689	21376	58	30140	31346	85
72	Brij Vihar	312	9623	16309	52	22996	23916	77
40	Rajendra Nagar Industrial Area	216	8944	15158	70	21373	22228	103
25	Arthala	160	10188	17268	108	24348	25322	158
13	Kailash Nagar	63	8764	14854	236	20944	21782	346
80	Kaila Batta	115	9371	15883	138	22395	23291	203
74	Prem Nagar	13	7468	12658	974	17848	18562	1428
5	Maliwara	68	6259	10609	156	14959	15557	229
50	Patel Nagar	61	10284	17430	286	24576	25559	419
43	Islaam Nagar	80	11415	19348	242	27281	28372	355
11	Mukand Nagar	63	7626	12926	205	18226	18955	301
10	Nandgram	251	23124	39192	156	55261	57471	229
57	Jawahar Park	35	10816	18332	524	25848	26882	768
56	Sewa Nagar	84	6077	10300	123	14523	15104	180
59	Sanjay Nagar	310	6977	11826	38	16675	17342	56
30	Raj Nagar Extn.	1782	13553	22971	13	32389	33685	19
20	Morta	1060	7869	13337	13	18805	19557	18
22	Guldhar 2 Freehold	840	10323	17496	21	24669	25656	31
	TOTAL	**6142**	**185762**	**375218**	**61**	**529057**	**550219**	**90**

Table 5.1: Population of wards around RRTS Corridor

5.5.2 Limit for holding additional Population:

- The URDPFI Guidelines specify an average urban population density in the range of 125poh-175pph for a metropolitan area.
- The remaining wards have population density far less than the prescribed range in URDPFI Guidelines.
- This is partly because of the reason that these wards are not fully developed to their optimum potential.
- Therefore, considering an average population density of 150pph for the wards, they would be able to hold additional population.

Ward No.	Name	Area of Ward (hectares)	Projected Population		Density(person /hectare)	Assumed density	Additional population
			2021	2023	2023		
36	Sahibabad Industrial Area(Site-4)	370	30140	31346	85	150	24,050
72	Brij Vihar	312	22996	23916	77	150	22,776
59	Sanjay Nagar	310	16675	17342	56	150	29,140
30	Raj Nagar Extn.	1782	32389	33685	19	150	233,442
20	Morta	1060	18805	19557	18	150	139,920
22	Guldhar 2 Freehold	840	24669	25656	31	150	99,960
	TOTAL						**549,288**
Total population that can be accomodated including current population							**700789**

Source: District handbook census (2011), Author

Table 5.2: Capacity of wards to hold the additional population

- Thus, the wards have the capacity to hold the projected population of 2023 i.e 2,420,999 , beyond which the wards will be incapable to accommodate any additional population.

5.6 Development along the corridor:

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

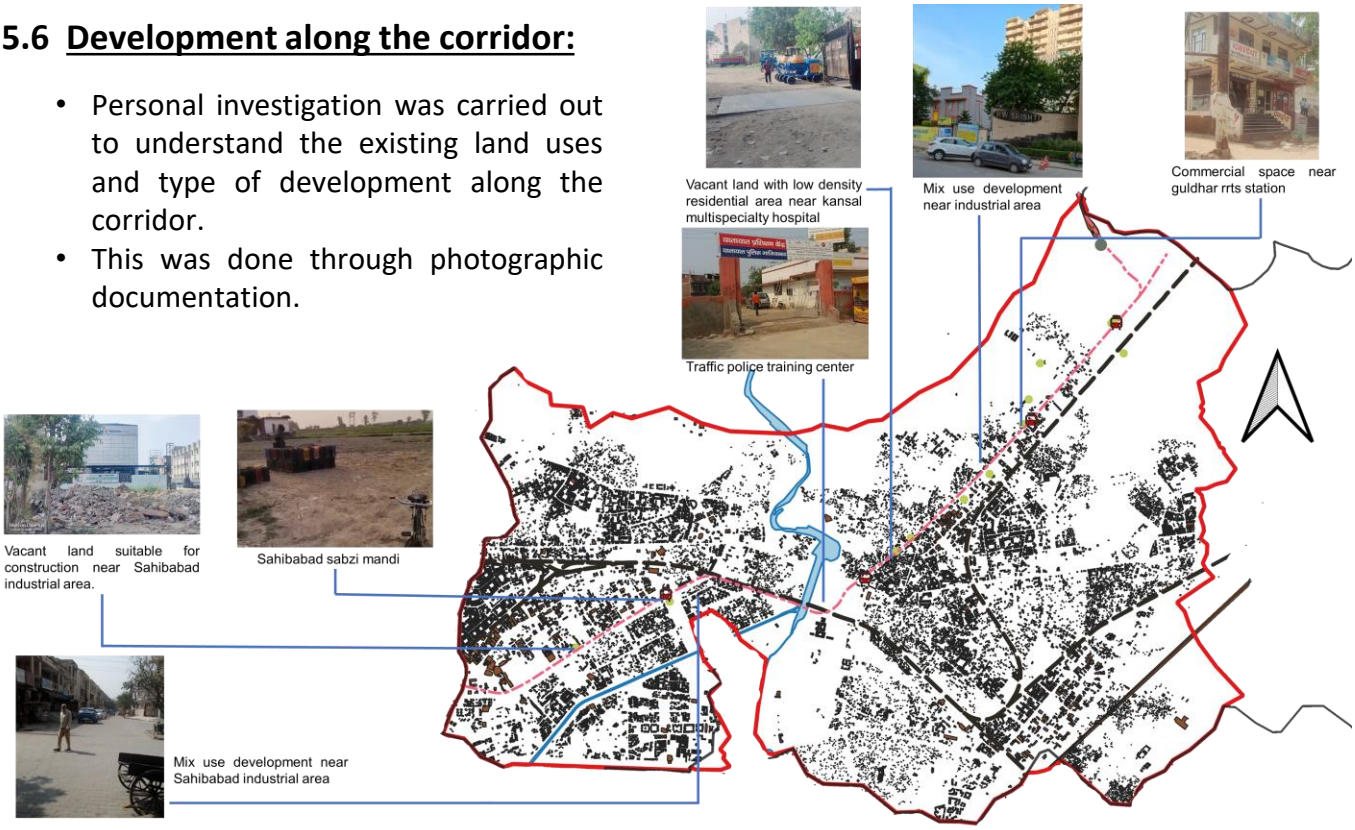


Figure 5.6: Type of development around the corridor

5.6.1 Observations:

- The land ownership varies along the length of the corridor.
- The land is owned by Central Govt., State Govt. or private parties.
- The development around the corridor has taken place in a very haphazard manner.
- There are many small and big settlements around the corridor which have already come up.
- In spite of this there are significant patches of vacant land around the corridor.
- It is therefore important to take all these aspects into consideration before planning any development along the corridor.

5.7 Infrastructure facilities along the corridor:

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

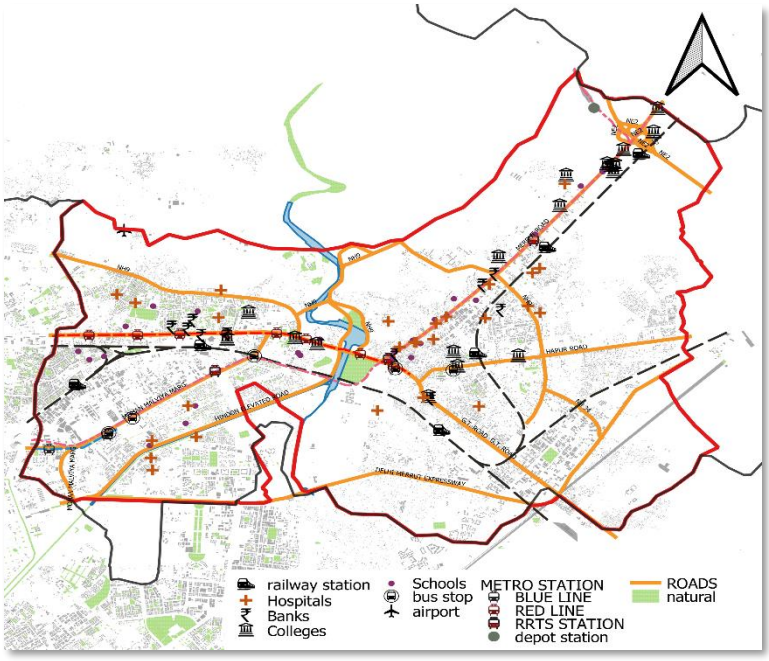


Figure 5.7: Infrastructure facilities along the corridor

5.7.1 Observations:

- **RRTS Stations**

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

- **Schools and Colleges**

The schools in the corridor area are mostly run by private organizations.
Besides, there are around 6-8 colleges offering higher education.
As seen in the plan most of the colleges are concentrated near the Guldhar and Duhai RRTS Stations.
All the schools and colleges need to be easily accessible by walking, cycling and use of public transport.

- **Parks**

There are so many patches of public parks and there is city forest also.
But these parks are not easily visible to the people from the main roads as they are located in the interior of the neighborhood.

- **Banks and ATM's**

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

- **Medical Facilities**

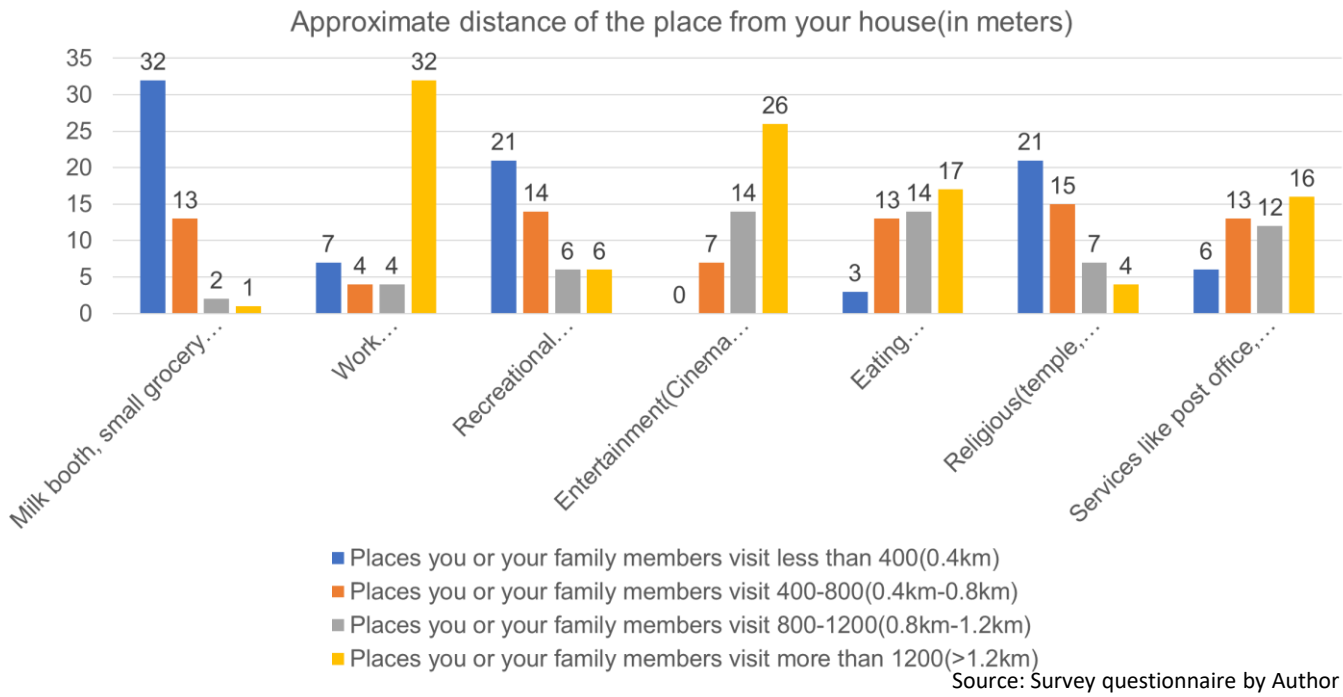
Mmg district hospital is a govt hospital while the others are private hospitals.
Area opposite to Meerut Road Industrial Area does not have a medical facility that is easily accessible.
It is important that every ward has a basic medical facility like polyclinic for emergency purposes.

- **Inference**

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

5.8 Accessibility to the various infrastructure facilities:

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



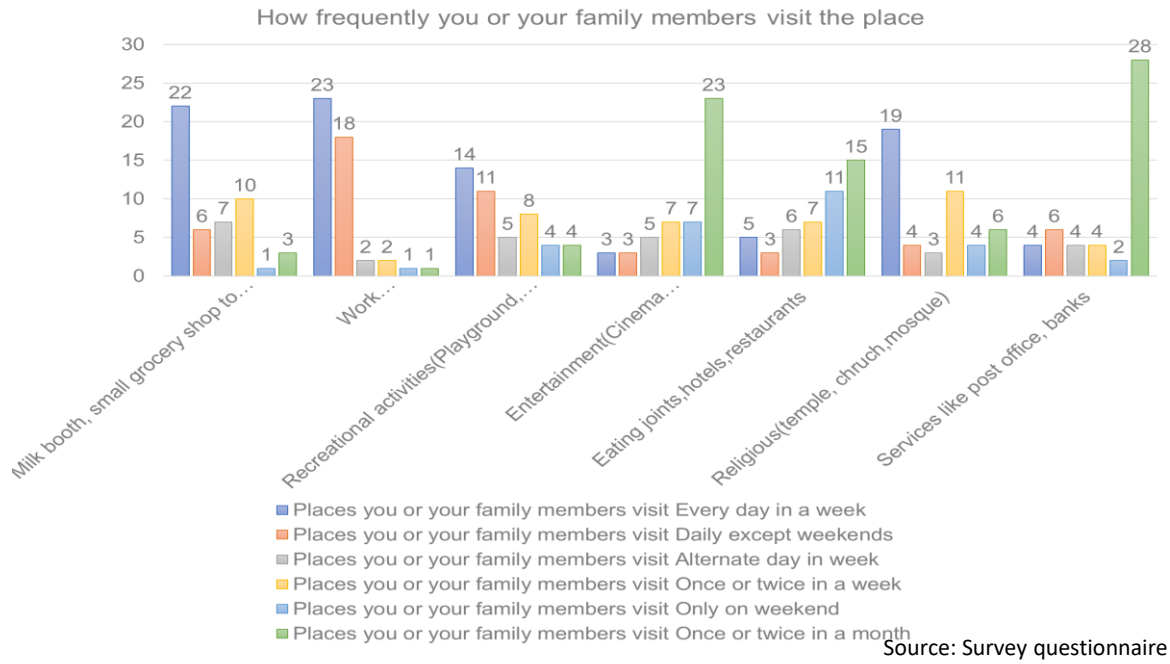
Source: Survey questionnaire by Author

Graph 5.1

5.8.1 Observations:

- The graph above shows that the nearest infrastructure facility from residential area is the corner shop or the milk Booth.
- In almost 75% of the cases the milk booth or the grocery shop is located within a 5 minute walking distance of less than 400m.
- The remaining infrastructure facilities are located at a distance of more than 1200 M that is more than 1.2 km.
- One of the significant aspects revealed through the questionnaire is that 85% of the work places and educational facilities where people commute daily are located at more than 1.25 km from the residential area.

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



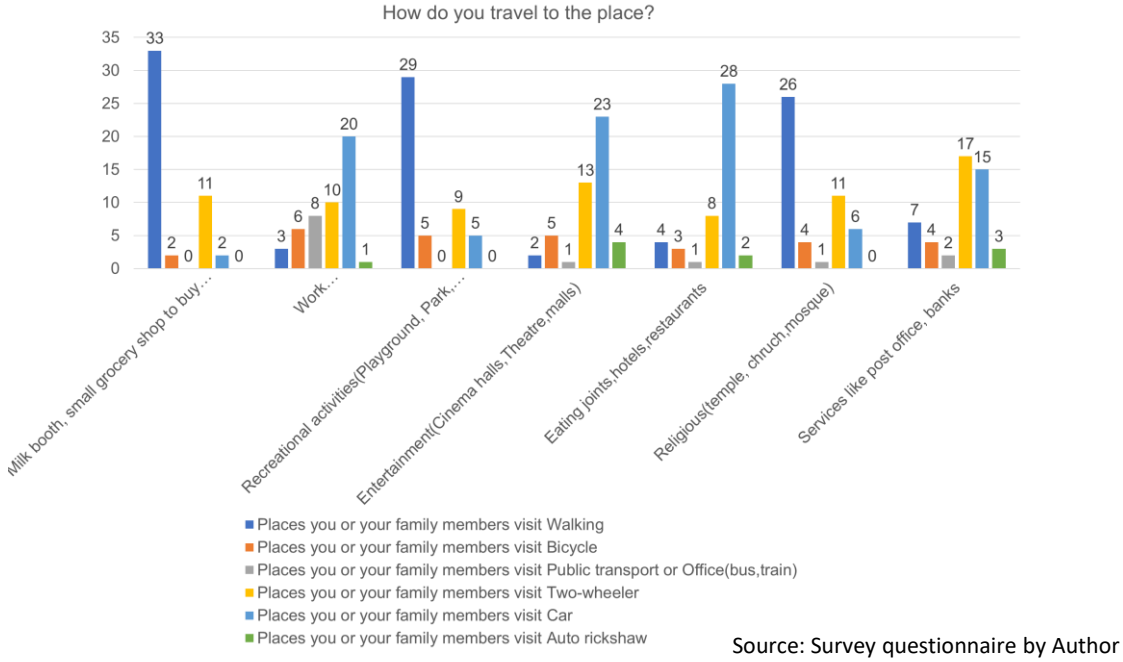
Source: Survey questionnaire by Author

Graph 5.2

5.8.2 Observations:

- Chart above shows that people access the facility like a corner grocery shop or milk booth, work place and educational facilities like school and colleges almost daily.
- People visit recreational places like a park and religious places on certain days throughout the week.
- Most people visit a cinema hall, restaurant, commercial centers like banks less frequently; only occasionally in a week or in a month.
- It is evident from this travel pattern that the facilities which are accessed by people on a daily basis should be located as close as possible from the residential area.
- In many cases where these facilities are located far away from the residential area, they should be well connected by a good public transport system.

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



Source: Survey questionnaire by Author

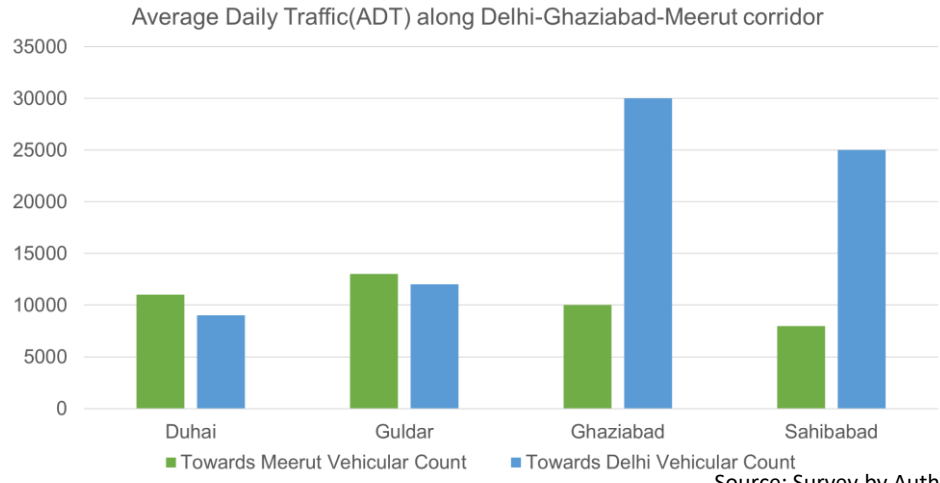
Graph 5.3

5.8.3 Observations:

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

5.9 Traffic Volume:

- The average daily traffic and modal composition of vehicles on a typical week day in both the directions along the corridor is given below :

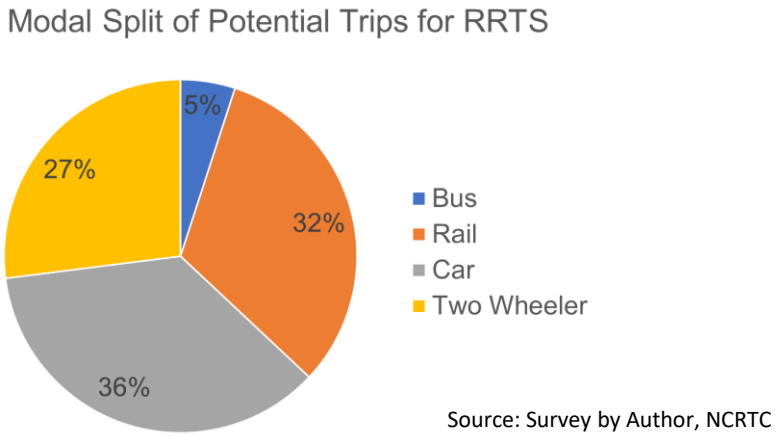


Graph 5.4

Source: Survey by Author, NCRTC

5.10 Travel characteristics by Rail, Bus and Private Vehicles:

- The total passenger movement along the study corridor is 6,89.415 passengers per day.
- The modal share shows that maximum (36%) share of passengers is carried by car followed by 32% by Rail.
- Bus and Rail together carry about 37 of total trips.



Source: Survey by Author, NCRTC

Graph 5.5

5.11 Conditions to be met for selected corridor:

Integrated transport system:

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

Housing Requirement:

The vacant areas need to be utilized cautiously to accommodate the 2021 projected population of 666,995. At the same time, infrastructure facilities need to be improved in the other wards that already accommodate population beyond their holding capacity.

Creation of jobs within 500m corridor distance of RRTS:

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

Planning land uses around RRTS Stations:

The locations of infrastructure facilities need to be coordinated with the location of RRTS stations as per the inference of travel pattern survey so that the facilities become easily accessible to the people by using the RRTS.

Restricting the spread of development up to the river edge:

The administrative wards around the corridor have a natural edge in the form of Hindon river. The present area has the capacity to hold additional population up to year 2025. During this period of population growth, it is important to prevent any urban sprawl towards the edge of the River.

Protect the city forest and river protected area:

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

5.12 Swot analysis of the selected corridor:

STRENGTHS :

- The plan has a proposal to reserve the bank of Hindon River as an ecological sensitive area.
- 16% of total area is under recreational zone.
- A good hierarchical road network has been established.

WEAKNESSES :

- Most of the land under planning area is proposed as residential development.
- No considerations has been made about the National Highway 58 cutting through the site.

OPPORTUNITIES :

- The planning area provides an opportunity to follow a sustainable pattern of development.
- The National Highway 58 and RRTS route cutting through the site provide a chance to plan a high density mixed use development along their length.
- Utilize the grid of roads for TOD with emphasis on walking and cycling.
- Plan a self-contained and self-sustainable development.
- The area can serve as residential area for employees of Industrial Area.

THREATS :

- The pressure of real estate and housing demand can exploit the capacity of the planning area beyond its sustainable limit.
- Since the site does not have a definite boundary earmarked by any physical features; the development may sprawl into adjoining areas.
- Proximity to the National Highway 58 will result in heavy traffic. This traffic needs to be properly channelized.

6. PROPOSAL FOR SELECTED RRTS CORRIDOR

All the previous study has provided the necessary background and direction to frame a TOD Proposal. The proposal is based on inferences drawn through literature review, case studies, detailed analysis of planning area and the RRTS Corridor. This study attempts to explain the requirements for a TOD.

6.1 Conceptual Plan For Transport Integration:

- From the literature review and case studies, it is evident that the main point of argument is not whether to have a RRTS, of bus transit but to have a well-connected and well integrated transport system enabling the commuters to easily choose different modes of transit suiting their requirement.
- For the city of Ghaziabad and the Delhi-Ghaziabad-Meerut RRTS Corridor, it is important that the RRTS system is well connected to other modes of travel like the commuter train or bus transit or para-transit system.

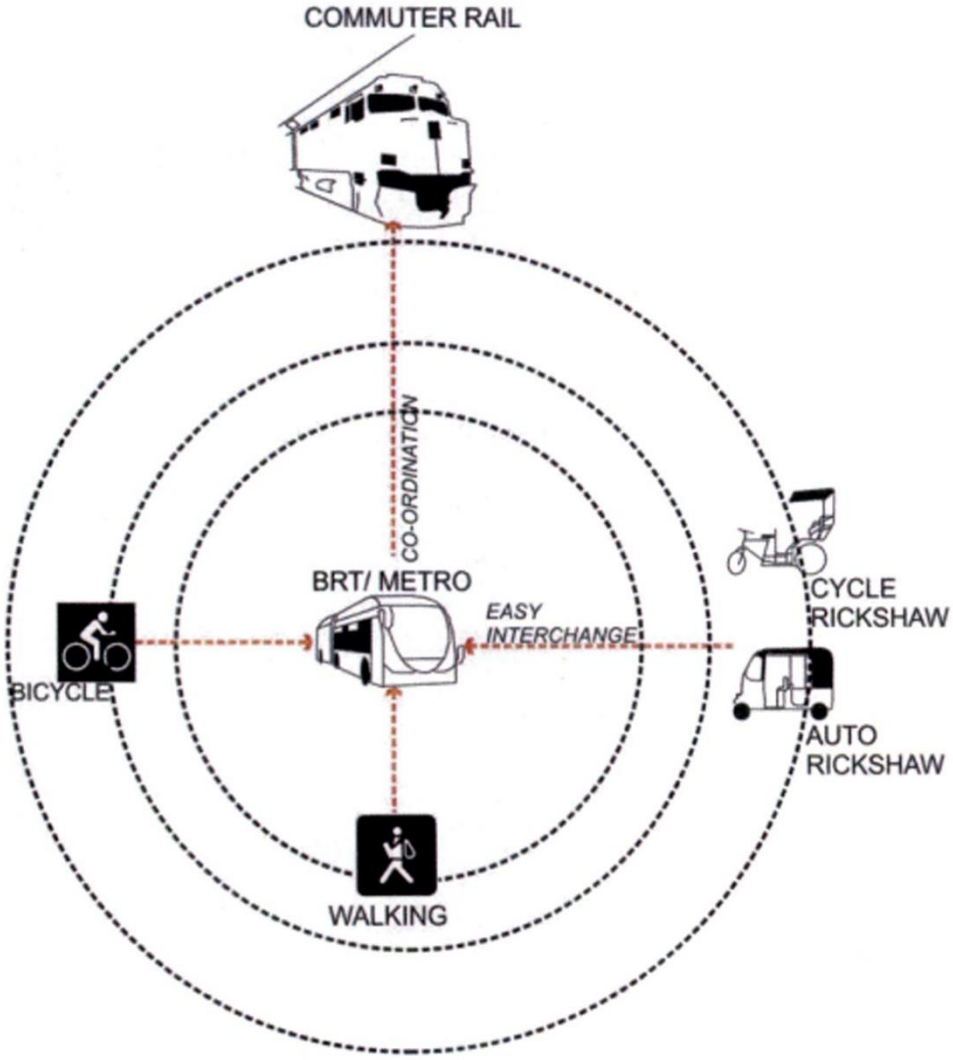


Figure 6.1: Proposed Travel Mode

6.2 Proposed TOD for Selected Corridor:

- Based on TOD, a conceptual plan is prepared for the selected RRTS Corridor area.
- The plan illustrates the various planning concepts for the corridor to enable a TOD.

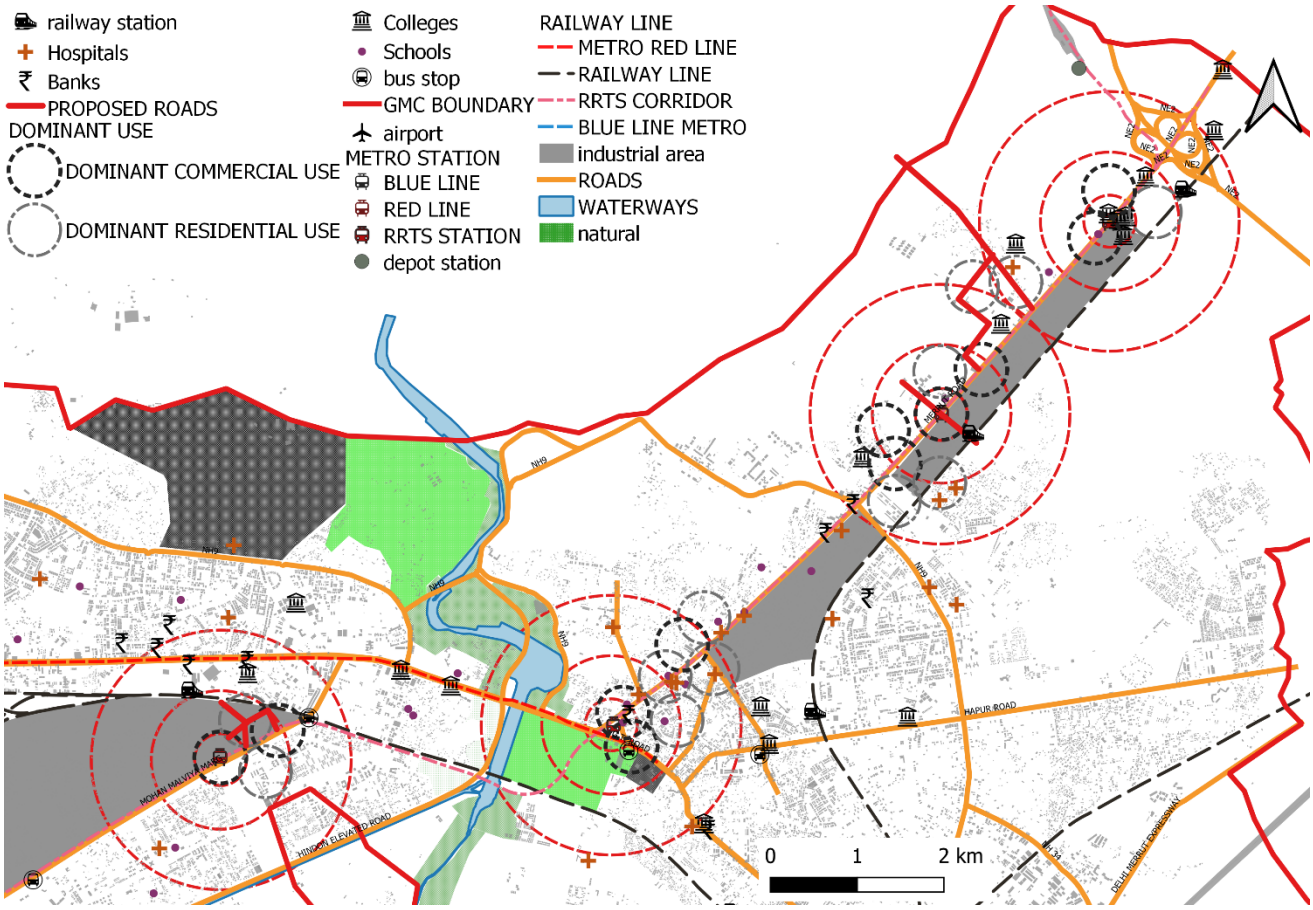


Figure 6.2: TOD Conceptual Proposal for the selected corridor

Work places along the RRTS Corridor:

- The development along the corridor will be in the form of commercial establishments and some residents connecting them to the nearest industrial area. Thus, it would create a mixed use development within the 500m of RRTS station also and will also help in promoting walking and cycling to workplaces.

MULTI MODAL INTERCHANGE:

- Minimize the number and time required for mode transfers for maximum commuters by providing the better para-transit network.
- By proving bus feeder stops and para-transit stops at regular distance creating walkable environment.
- Minimize travel time and cost for majority of commuters. Provide multiple mode options for all sections of society with safety and affordability.
- Prioritize pedestrians, public transport, IPT and NMT modes over private modes in the design, management and spatial planning of public spaces.

6.3 Recommendations in the Conceptual Framework:

6.3.1 Parking:

Background study and statistics:

- At present, near the Ghaziabad RRTs station the bus stand has developed into a commercial hub and it also has a number of govt. establishments.
- As per the primary survey, it was found that there is a lot of on-street and off-street parking.
- Also, the modal split indicates that a lot of people (50%) are using private vehicles for commuting. this results in encroachment of the carriage way and the effective width is reduced from almost 30m to 20m at many places because a part of road is occupied by vehicles parked on street.

Suggested Recommendations:

- Some of the open and abandoned spaces can be used to make multi level parking.
- Designated parking zones can be established.
- Area shall be pooled to build off-street parking structures in the neighborhood. Parking pricing shall be revised so as to price the large cars more as compared to small ones.
- Park-and-Ride facilities for private modes may be provided by RRTS stations.
- If off-street long term public parking facilities are provided, they shall be preferably located beyond 300m (3-min walk) from the center point of the Metro Station.
- Only highly priced short term parking facilities and drop off locations for private vehicles may be provided within 300m Intense zone.

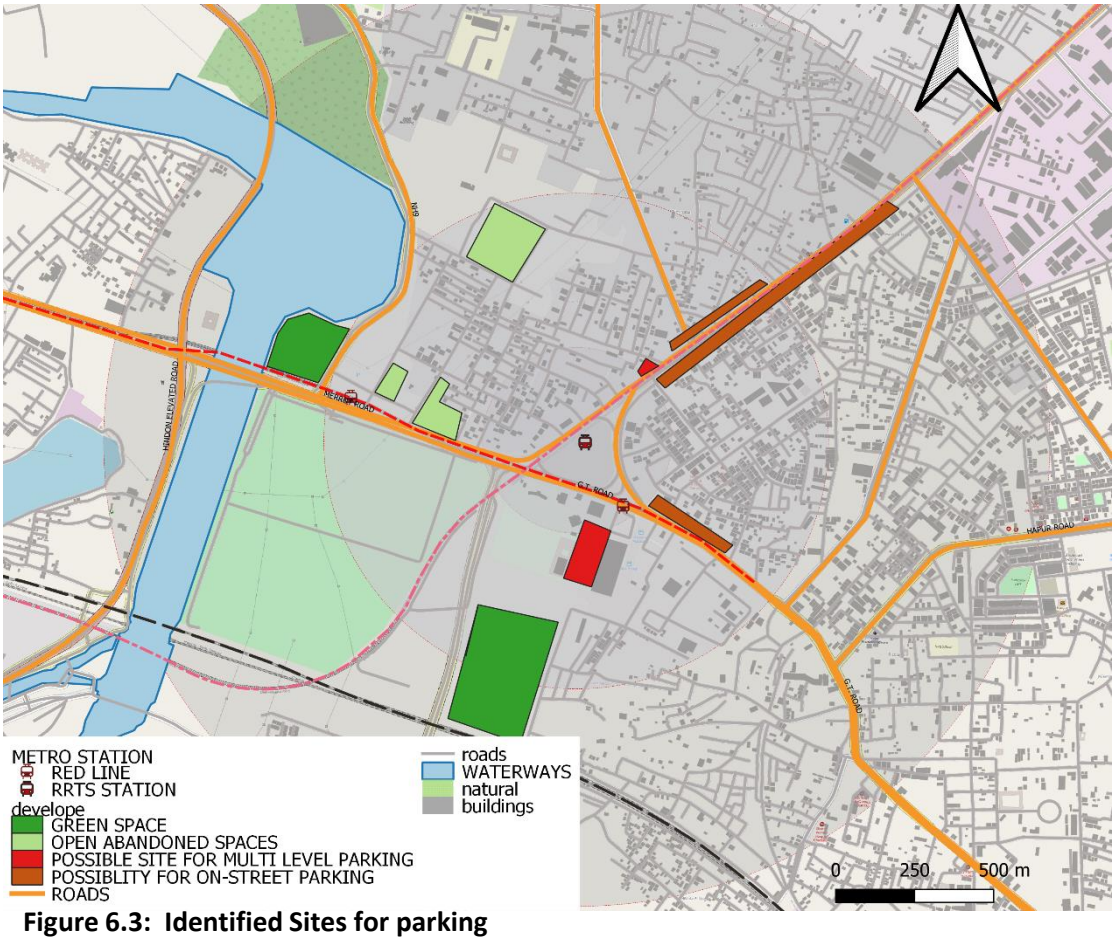


Figure 6.3: Identified Sites for parking

Zone 1: Intense TOD Zone	Zone 2: Standard TOD Zone	Zone 3: TOD Transition Zone
The 400m walking zone is to be provided as a pedestrian/NMT priority zone and be designed for multi modal interchange.	Shared parking zones	Shared parking is desirable.
Parking for IPT and NMT modes is mandatory.	On-street parking for NMT and IPT to be provided within 300m of all homes.	On-street parking for NMT and IPT to be provided
No long term public parking is to be provided in this zone.	Off-street shared public parking facilities may be provided. Single agency shall manage both on-street and off-street parking facilities.	

Table 6.1

OBSERVATIONS:

- Illegal parking is observed in this site; hence this site can be used for multi level parking and underground parking which will ease the congestion.
- Ghaziabad new bus stand is located near the RRTs Station in intense TOD zone .
- Which will help commuters to travel easily and will increase the ridership in bus transit also.

BENEFITS:

- The construction of the multi-level parking can ease the congestion in the area and adjoining area can be made totally pedestrian since there is low density residential use and the area will be easily walkable.

6.3.2 Open spaces, Public spaces and Green areas:

- Miscellaneous patches of green lands: These lands are presently in a bad state and are numerous in the area.
- Landscape plans can be initiated for these areas which could boost up the number of well maintained green spaces in the area.

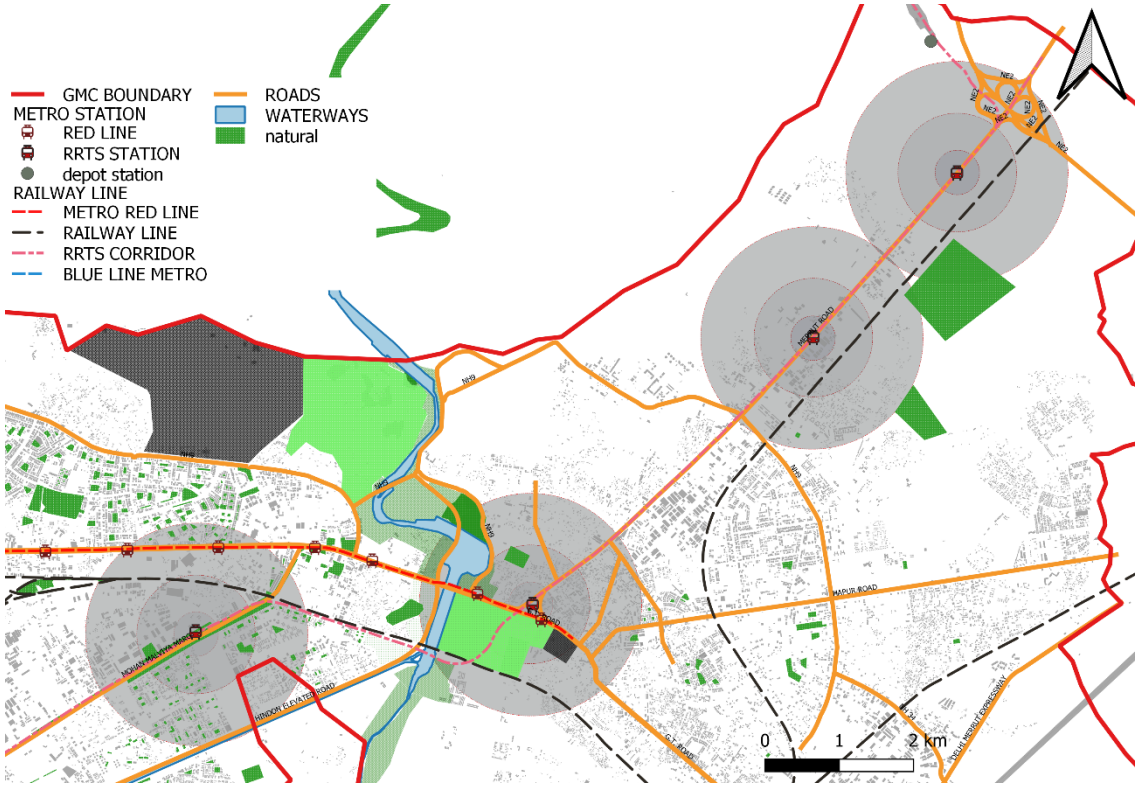


Figure 6.4: Existing Green spaces along the corridor

GREEN DENSIFICATION CONCEPT:

- Green densification can be done in the area by identifying potential spaces and creating green corridors.
- Space can be acquired by demolishing abandoned buildings which are in bad conditions.

Green Densification

The objective is to achieve a green network and to make a positive use of abandoned spaces and to improve the existing green spaces.

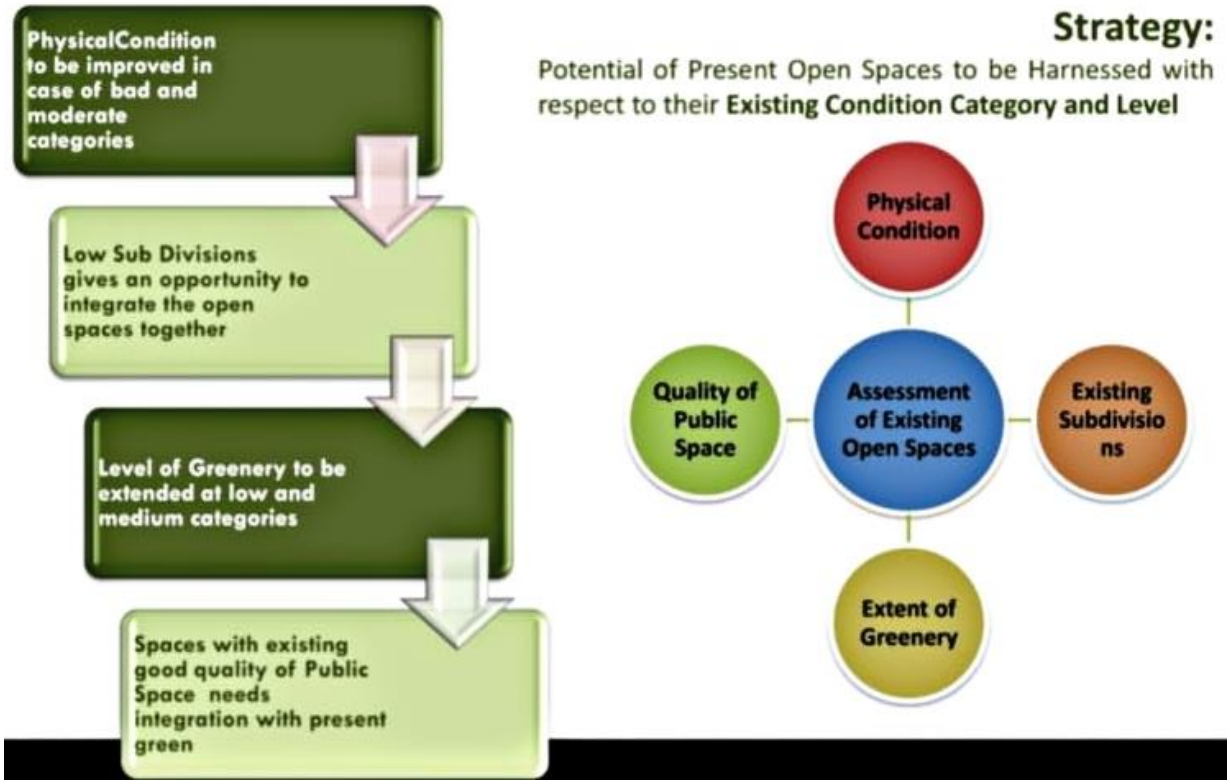


Figure 6.5

OBSERVATIONS:

Most of the open spaces along the corridor are in moderate or poor condition and need to be properly landscaped and alternatives must be provided to boost their potential as gathering spaces, parks recreational hubs and public spaces.

Suggested Recommendations:

Ramlila Maidan:

- The Ramlila ground in Vasundhara is situated in the center which is not well maintained and sees a low footfall. and can be utilized to make an underground parking with landscape area above or can be partially used to make commercial hub.

Unidentified green patches near Guldhar station area:

- They are been used as unauthorized parking or encroachments has been done by the shopkeepers and scrape materials are kept there.
- These patches can be used as a urban hub with recreational centers like cafeterias can be provided in these patches integrating them along with well maintained landscape spaces.

6.3.3 Facilities for Pedestrians:

- As per the findings from the Primary Survey, the visitors have complained about the absence of sidewalks/pedestrian pathways.
- Hence, the key objective during suggesting traffic circulation lies in integrating pedestrian pathways in the existing road infrastructure.

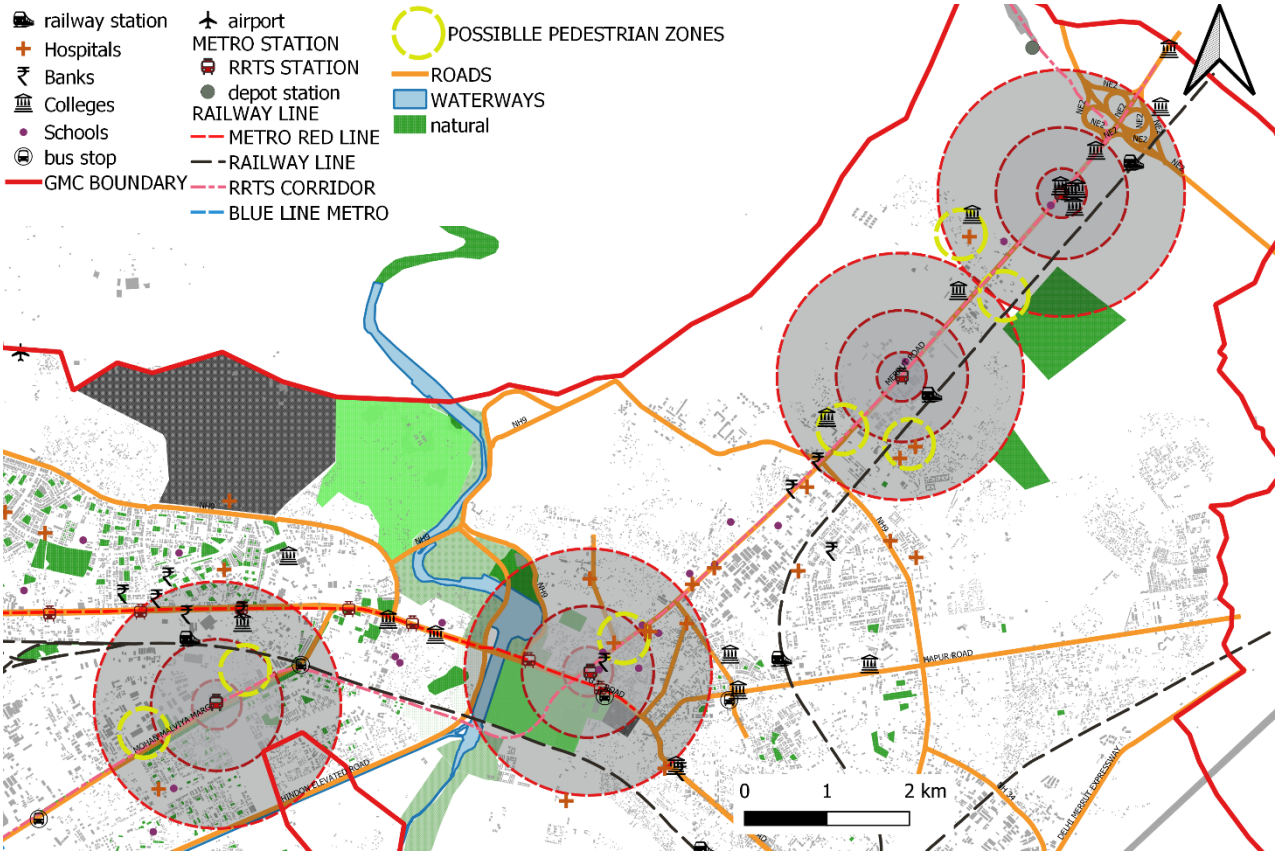


Figure 6.6: Possible Pedestrian Zones

Suggested Recommendations:

- Wide and comfortable environment friendly pathways near every RRTS Station so that commuters can walk easily.
- Since it is easily walkable, it will enhance the walkability index of the area.
- Uniform width Footpaths should be provided all over the roads with separation of pedestrian and vehicular movement.
- Due to lack of proper infrastructure facilities within the TOD transition zone, people don't prefer to walk to the central markets. This is clear from the primary survey which indicates that only few people prefer walking as a commuting modes.
- If proper infrastructure is provided, this percentage is likely to increase in near future.

Possible Pedestrian Zones:

- A peripheral loop for the public transport can be provided, making the inner most lanes totally pedestrian based. This can create a vehicle free zone which eventually helps in decongesting of the area.
- Circle with the radius of around 300m indicating the possible walkable zones if a peripheral public transport loop is created.

- Design for pedestrian safety, comfort and convenience on all streets.
- Create street level activity and well watched streets.
- Create “eyes on the street”- by removing setbacks and boundary walls and building to the edge of the street ROW. This would allow people from inside to look out on to the pavement, thus discouraging misbehavior, shady corners, etc.
- Create commercial/hawking zones at regular intervals (10 min walk from every home) to encourage walkability, increase street activity and provide safety.
- Provide adequate Street Lighting for pedestrians and bicycles.
- Trees are an essential component for all streets- to provide shade to pedestrians and reduce solar gain. High albedo (diffuse reflectivity) materials for paving reduces urban heat island effect.

6.3.4 High-Density and Mixed-use development:

- Densification through redevelopment and infill within existing Urban areas.
- Underutilization of FAR is not permissible for any new or redevelopment projects. Development of empty sites within 800m influence zone must begin within 5 years of operationalization of RRTS Station.
- Permitting FAR-Density bonuses for ‘Redevelopment” projects within the intense or standard TOD Influences zones.
- Ensure a minimum supply of affordable housing options for low and medium income populations within walking/cycling distance of stations, and in close proximity to sources of employment and recreation.

BENEFITS OF MIX-INCOME HOUSING:

- Helps workers find housing near jobs.
- Helps employers find a closely available pool of labor
- Reduces commuting time
- Promotes neighborhood diversity and stability, so people can remain in a community through changes in their lifestyles.

7. Conclusion

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

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

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

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

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Appendix

Travel Pattern Survey:

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

1. Kindly answer to the questions as 'Yes' or 'No'
2. Do you prefer to use your own vehicle than public transport
3. If the roads were made pedestrian and bicycle friendly, would you walk or use a bicycle to access nearby places?
4. Do you think the increase in petrol and diesel prices has reduced your usage of private vehicles?
5. Would you advice school, college students to walk or use bicycles to reach their school, college, classes, if they are located nearby from their house?
6. Do you think Ghaziabad urgently needs an efficient public transport system like metro or bus rapid transit system?
7. Do you use your own vehicle only because it saves time than public transport?
8. How much percentage of your monthly income do you approximately spend on transport?
9. How much do you travel daily using your own private vehicle?
10. Approximately how much do you walk daily?