Comprehensive Mobility Plan
Visakhapatnam

Final Report

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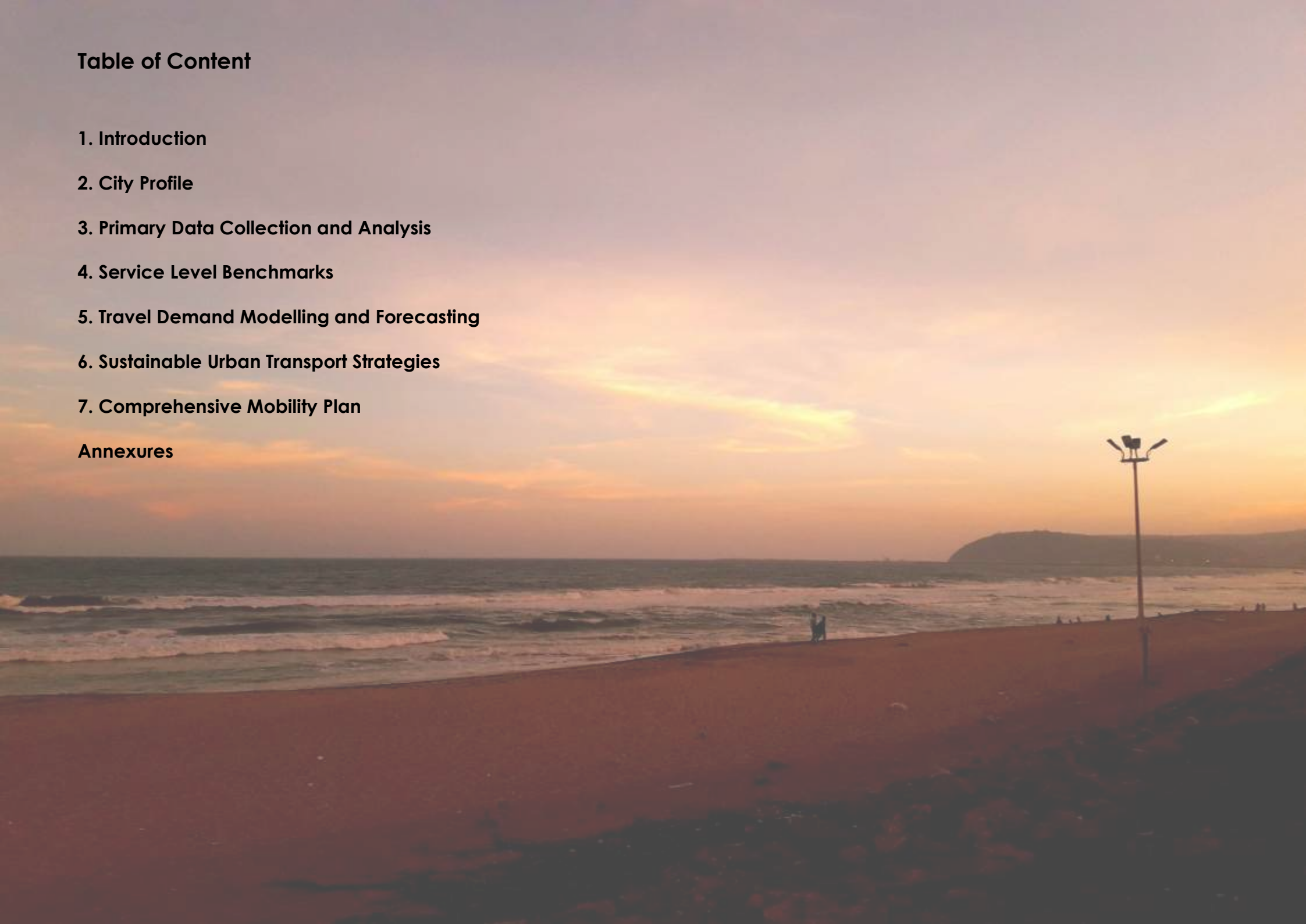

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Chapter 1

Introduction

1. Introduction

1.1 The Study Background

Amravati Metro Rail Corporation Limited (AMRCL), is a designated nodal agency engaged in the execution of Metro Rail projects in Vijayawada and Vishakhapatnam and project appraisals, obtaining sanctions, monitoring of project implementation etc., in Vijayawada.

AMRCL, on the orders of the State Government engaged UMTC as Consultant for preparing Comprehensive Mobility Plan (CMP) for Vishakhapatnam Metropolitan Area. The CMP would, inter alia, cover assessment of the traffic and transportation needs of the city based on the present and projected transport and travel demands in the study area

AMARAVATI METRO RAIL CORPORATION LIMITED

engaged

Urban Mass Transit Company Limited

Preparation of

"Comprehensive Mobility Plan "

of

Greater Visakhapatnam Municipal Corporation- GVMC

1.2 Comprehensive Mobility Plan

The objective of this study is to prepare a Comprehensive Mobility Plan for Vishakhapatnam City supporting its economic growth, and providing safe, affordable and clean mobility to the city residents and tourists, which in turn improves the quality of life.

Comprehensive Mobility Plan (CMP) is a vision statement of the direction in which Urban Transport in the city should grow. It is a long-term vision for desirable accessibility and mobility pattern for people and goods in the city to provide, safe, secure, efficient, reliable and seamless connectivity. It should cover all elements of Urban Transport under an integrated planning process. CMP being a long-term vision document is not envisaged to include Detail Designs of proposed Transport Infrastructure, Detailed Project Reports (DPR), Detailed Traffic Engineering Plans, and Detailed Cost Estimates. The main objectives of CMP includes;

- Improvement in mobility for all socio-economic groups and genders
- Improvement in air quality of Sustainable Urban Transport Scenario with reference to the BAU scenario
- Improvement in safety and security for pedestrians, NMT and live-ability in the city
- Increase in sustainable transport mode share and a decrease in private motor vehicle use
- Achievement of desirable indicators and benchmarks
- Integral part of Master Plan

Accordingly, the overall objective of the CMP is to provide a long term strategy, which ensures desirable mobility, safety and accessibility to people across gender and socioeconomic profiles.

1.3 Report Structure

This Interim Report is organized into 7 chapters as:

Chapter 1: Study Introduction

The chapter includes the study background and brief about the 'Comprehensive Mobility Plan'

Chapter 2: City Profile

The chapter includes the city profile, civic administration details, location and regional connectivity, demographic characteristics, economy, land use, existing traffic and transportation system etc.

Chapter 3: Primary data collection and Analysis

The chapter describe the Methodology adopted for primary data collection in the study area. The survey locations and Sample size along with Objective, Scope and Conduct of the Surveys has been explained.

Chapter 4: Travel Demand Modelling and Forecasting

The chapter outlines the brief of Four stage modelling, Travel demand forecast and traffic scenarios, Transport strategy etc. The brief of Travel demand forecast for future years.

Chapter 5: Service Level Benchmarking

The chapter outlines the assessment of level of service provided by the existing Transport system.

Chapter 6: Sustainable Urban Transport Strategy

The chapter outlines the proposed transport strategies for the urban transport.

Chapter 7: Comprehensive Mobility Plan

The chapter includes projects and proposals for the Visakhapatnam

Chapter 2

City Profile

2. City Profile

2.1 Introduction

Visakhapatnam is a port city on the southeast coast of India and often called "The Jewel of the East Coast". With a population of 17.28 lakhs as per 2011 Census and occupying an area of 643 sq.km, it is the second largest city in the state of Andhra Pradesh and the third largest city on the east coast of India after Chennai and Kolkata.

2.2 Civic Administration

Greater Visakhapatnam Municipal Corporation (GVMC) is the governing body of Visakhapatnam City. It was formed in November, 2005 by merging the erstwhile municipality with Gajuwaka municipality and 32 surrounding gram panchayats. GVMC comprises of total 72 wards. With the inclusion of the Gajuwaka Municipality, GVMC now includes a large industrial base.

2.2 Location

Visakhapatnam is located on the coast of Bay of Bengal in the north eastern region of Andhra Pradesh. It is the administrative headquarters of Visakhapatnam district and also the Financial Capital of Andhra Pradesh. The city coordinates lies between 17.6883° N latitude, and 83.2186° E longitude. Its periphery consists of plains along the coast line while the interiors boast of the beautiful hills of the Eastern Ghats which surround it on the North and the West.

Figure 2.1 Location and map of Vishakhapatnam City

2.4 Regional Connectivity

Situated almost midway between Chennai in the south (762km) and Kolkata in the north (879km), this region occupies an important place in the development of modern Andhra Pradesh. To the region's east is the Bay of Bengal, while in the north is Srikakulam district, in the southeast is Godavari district of Andhra surrounds. On the western side lies the rest of Visakhapatnam district, which is surrounded by the state of Orissa in its extreme western limits. There are five major urban centres: Visakhapatnam, Gajuwaka, Anakapalli, and Bheemunipatnam in Visakhapatnam district, and Vizianagaram in Vizianagaram district. The principal city in this region is Visakhapatnam. The state capital of Hyderabad is 637km from Vizag, well connected with road, railway and air.

2.5 Demographic characteristics

2.5.1 Population

The population of Visakhapatnam Urban Agglomeration as per 2011 Census is 17.28 lakhs which has grown from 13.29 lakhs in 2001 at a decadal growth rate of 30% over the period 2001-11. The growth trends of population in Visakhapatnam Urban Agglomeration since last 1961 is provided in the Table 2.1 and shown in Figure 2.2.

Table 2.1 Population Trend of GVMC

SN	Years	Population (Lakhs)	Decadal Growth Rate
1	1961	2.11	
2	1971	3.63	72.0%
3	1981	6.03	66.1%
4	1991	10.57	75.3%
5	2001	13.29	25.7%
6	2011	17.28	30.0%

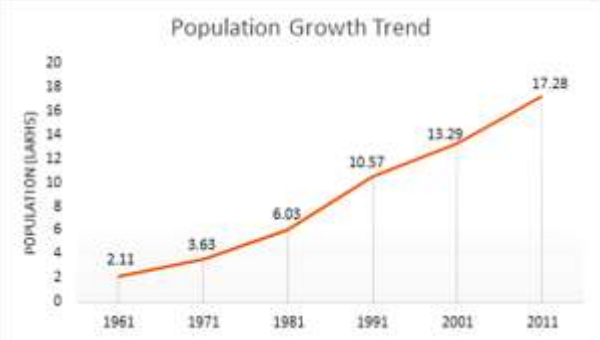


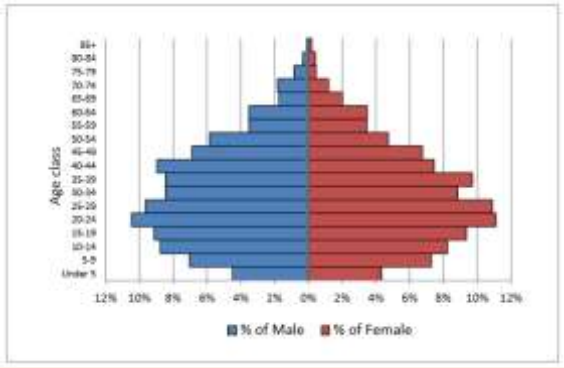
Figure 2.2 Population growth trend

20.44 Lakhs

(2016 Population)

2.5.2 Age-Sex Distribution of Population

The demographic profile of the city shows the presence of a largely young population, with 68% of population less than 40 years of age. The age-sex pyramid of the city shown in Figure 2.3 gives the proportion of men and women in the city in various age categories. The 17.28 lakhs population of the city comprises of 8.75 lakhs males and 8.55 lakhs females i.e. 977 females per 1000 males in the city (Census 2011).



875,000 males & **855,000** females i.e.
977 females per 1000 males

Figure 2.3 Age-Sex Pyramid of Vishakhapatnam

2.5.3 Population Density

With a population of 17.28 lakhs and a total area of 643 sq. km., the average population density of the city is around 2,700 persons per sq. km. However, since the effective built up area is only around 166 sq. km, the effective population density in the city is around 10,400 persons per sq. km. Within this 50 sq. km of the core city area holds up to 50% of the city population and has a very high population density of 27,000 persons per sq. km. Some wards in the core city even have a density of 60,000 persons per sq. km. In summary, the population density is concentrated mostly in the core city area while the outward growth pockets are sparsely populated.

2.6 Economy

Visakhapatnam is the 8th largest city by GDP in India with $48 billion. Fishing industry, road–rail connectivity, many heavy industries like Vizag Steel, GAIL, Hindustan Shipyard, Visakhapatnam Steel Plant etc., are the factors that transforms the city into an industrial hub, from a small hamlet. Tourism also plays an important role in generating revenue, with numerous tourist destinations in and around the city. Blessed with a natural harbour and one of the largest ports of India, sea trade was made possible with other countries which also boosts city's economy. Sector-wise contribution to the GDP of Visakhapatnam is shown in Figure 4. The service sector contributes for 55% of the total GDP of Visakhapatnam, while 35% comes from the industrial sector and 10% from agricultural and allied sectors.

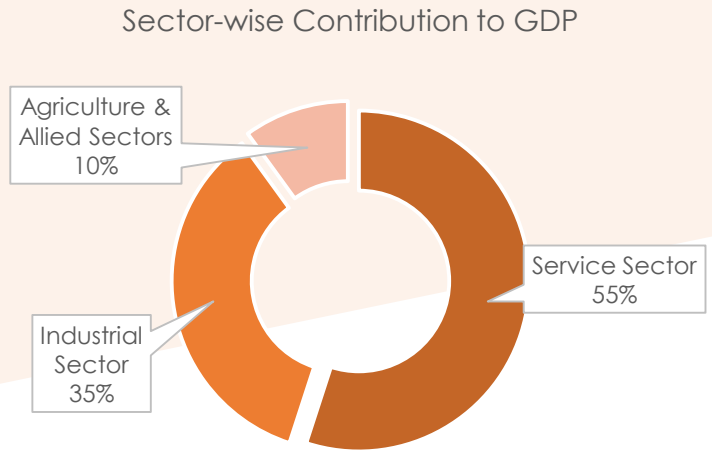


Figure 2.4 Sector-wise Contribution in the GDP of Visakhapatnam

2.7 Land-use

The existing land use of the GVMC area of 543 Sq. km as per the master plan 2021 is provided in Table 2.2. The land under recreation, barren and vacant lands, agriculture, reserve forest and hills, water logged areas, plantations etc. is 60.4% of the total GVMC area. Water bodies with canal, rivers, reservoir, and tanks constitutes 2.67% of the total GVMC area. About 18.4% of the total GVMC area comprises of residential, commercial and mixed-residential land use. The industrial land use is 13.55% which includes areas of Port, Hindustan Shipyard, Naval Dockyard, Vizag steel plant, Coromandal Fertilizers limited, being the large-scale industries. The public and semi-public, cultural and religious use, stadium and playground occupied about 0.31%, 0.02%, and 0.25% of the total study area. The roads constitute 3.13% of the total study area. The existing land use pattern is presented below in Table 2.2.

Table 2.2 Existing Land Use Pattern

Sl. No.	Existing Land Use	Area (ha)	% Share
1	Built-Up Area (BUA) which includes residential, commercial & mixed-residential	9,813.0	18.4
2	Industrial	7,224.3	13.6
3	Public & Semi Public	165.5	0.3
4	Cultural and Religious places	8.6	0.016
5	Stadium & Play Ground	134.5	0.3
6	Roads	1,670.5	3.1
7	Airport	460.4	0.9
8	Bus Terminals	3.5	0.08
9	Water Bodies	1,422.0	2.7
10	Recreation, Barren and Vacant lands, Agriculture, Reserved Forest, Hilly Areas, Plantations, etc.	32,168.1	60.4
11	Others	231.6	0.4
	Grand Total	53,302.0	100.0

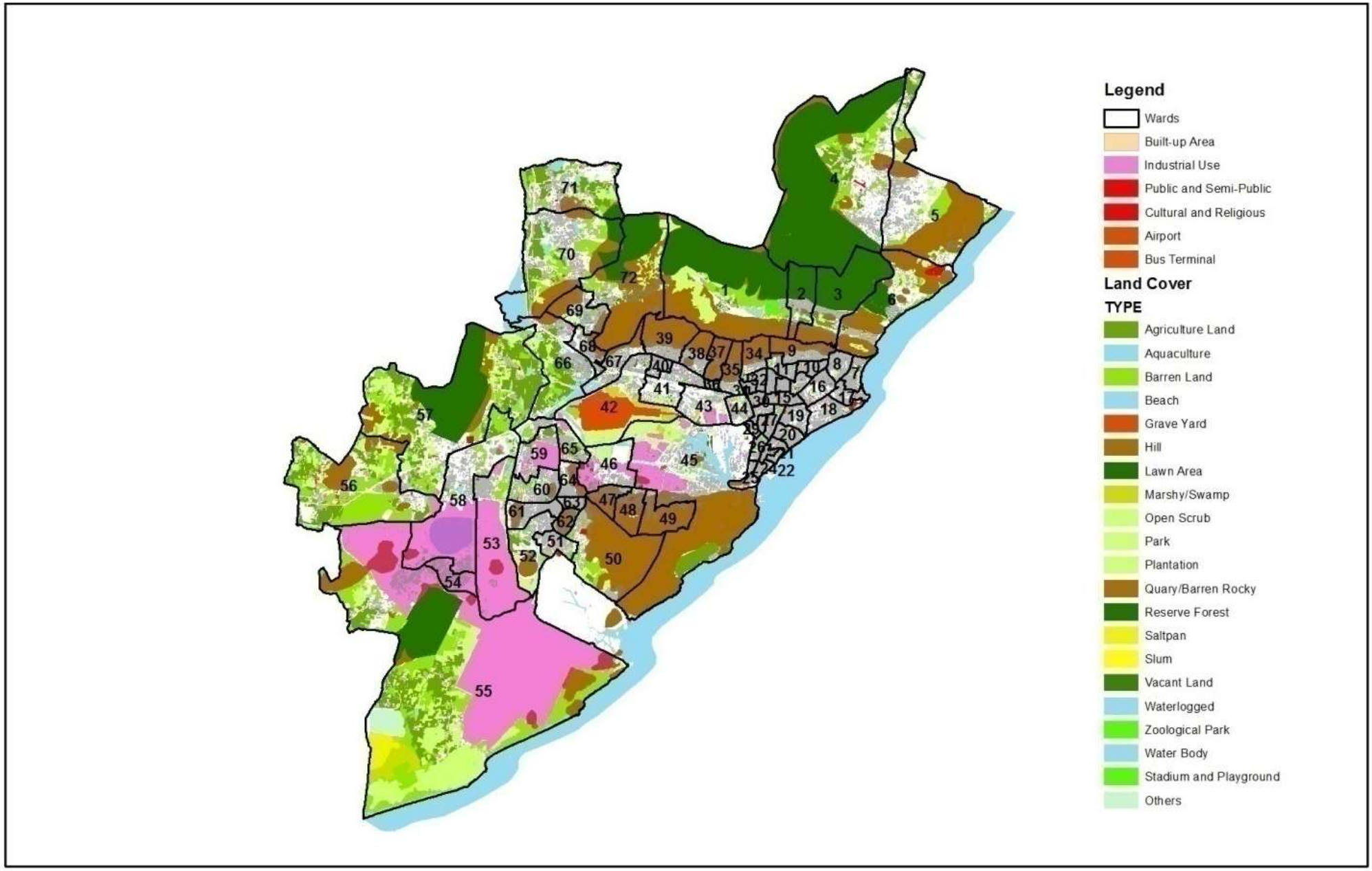


Figure 2.5 Land use of GVMC area

2.8 Existing Traffic and Transportation System

2.8.1 Network and Connectivity

Greater Visakhapatnam is well connected with most parts of the state and the country through roadways, railways, airways and waterways. It holds the distinction of having one of the major Port Trust and industrial establishments like Steel Plant, HPCL etc. in the state and is connected by the two National Highways - NH 5 connecting Chennai and Kolkata and NH-43 connecting Raipur and the State Highway also connect the city area to the vast hinterland. It can be said that no other city in Andhra Pradesh has such connectivity through the network of roads, rails and waterways. Around 7.88% of the total area is covered by Roads, 2.13% by Railways and 0.85% by the Port Authorities.

Visakhapatnam is connected to other parts of the state and country through Orissa Highway (NH-5), Tamil Nadu Highway (NH-5), Paderu Road (SH-38), and Araku Road (SH-39). Regional roads also connect to Visakhapatnam from places of Vizianagaram, Srikakulam, Bheemili, and Anakapalli towns by the NH-5 passing through the study area. Visakhapatnam is one of the major cities on the east coast of India connected by NH5, a major highway and a part of the Golden Quadrilateral system of Indian highways connecting Chennai and Kolkata.

Railways - The Vishakhapatnam Railway station is located on the Chennai Central-Howrah Station route, although the main line bypasses the Central Station. Duvvada railway station, a suburban station on the main line (near the Visakhapatnam Steel Plant) is being developed into a satellite hub to improve train service into the city.

Airport - Vishakhapatnam Airport is the busiest airport in Andhra Pradesh. It is connected by daily flights with Dubai, Singapore, Kuala Lumpur, Chennai, Coimbatore, Delhi, Mumbai, Bangalore, Hyderabad, Kolkata, Kochi, Mangalore, Bhubaneswar, Raipur, Tirupati, Port Blair and Vijayawada. Visakhapatnam Airport has been operating night flights, and the airport is 24hr operational.

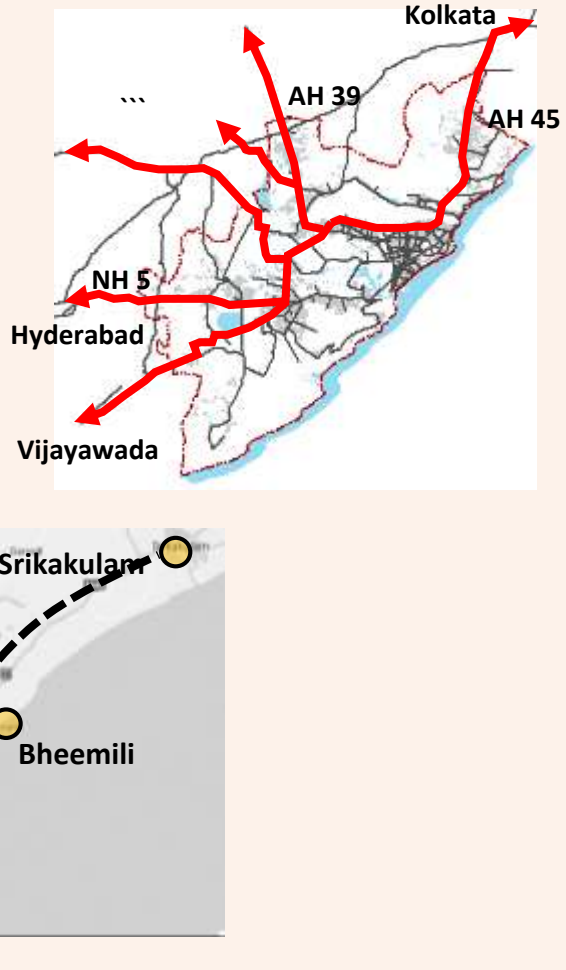


Figure 2.6 Connectivity of the Vishakhapatnam

2.8.2 Accidents

An insight into the trends and type of accidents observed in the City indicates a total of about 1000 road accidents have taken place in year 2005. About 10% of accidents are fatal with 220 fatal casualties. About 1150 persons received injury. There has been overall reduction in total accidents from last five years because of awareness campaign undertaken by Traffic Police Department. The main causes are the road junctions with meagre facilities for pedestrian crossings.

2.8.3 Registered Vehicles

Time series vehicle registration data for Visakhapatnam was collected and is presented in Table 3. Vehicle ownership levels in Visakhapatnam grew at a steep rate in 2011 as shown in Table 3, which might be due to low levels of supply of public transport and rising income levels. The proportion of 2-wheeler and Cars is observed to be 76% and 11% respectively.

Table 3 Vehicle Registration details in Visakhapatnam

	2012	2013	2014	2015	2016
Two Wheelers	485871	518555	554905	593608	610580
Four Wheeler	61605	68167	74826	82214	88299
Auto Rickshaw	23081	25845	28469	31470	33600
Goods Vehicles	16517	18123	19505	21290	23239
Educational Insti. Bus	780	882	979	1068	1154
mini Bus	1709	1832	1920	2048	2145
Ambulance	189	222	304	334	370
Construction Vehicles	2603	2709	2852	2998	3139
Fire Fighting Vehicles	44	48	52	54	56
Others	7017	7836	8597	9464	10964
Total	599416	644219	692409	744548	773546

Chapter 3

Primary Data Collection and Analysis

3 Primary Data Collection

The primary surveys exercise involves preparatory work for the same (i.e. preparation of survey formats, data collection techniques, team building etc.), pilot survey (i.e. pilot survey at site for rectification of forms/ data collection technique etc.) and detailed primary surveys (data collection as per rectified data forms and its digitization etc.). The purpose of Primary surveys is to ascertain traffic and travel behavior related information.

A set of primary traffic & transportation surveys and other surveys such as house hold interview survey, origin – destination surveys, traffic volume counts, speed and delay surveys, Vehicle Occupancy Survey etc. were conducted in the study area (GVMC boundary) during Feb and march 2017 to assess the demographics, employment, traffic and transport characteristics. Table 3.1 represents the primary surveys conducted as part of Primary data collection. The survey location, duration, desired day of the week and purpose has been indicated.

Table 3.1 Survey locations and Quantities

S .No	Surveys	Unit	Quantity
1	Classified Volume count and Occupancy surveys at outer cordon locations(16 hours; 1 -day)	Location	5
2	Classified Volume counts and Occupancy surveys at Mid-block locations (16 hours)	Location	2
3	Classified Turning moment Volume Counts at Junctions (16hours)	Location	14
4	Road Side Interview at Outer Cordon locations (16 hours)	Location	5
5	Bus Stop Waiting, boarding and alighting survey (16 hours)	Location	10
6	Bus Stop OD surveys including the Stated Preference surveys of bus users (16 hours)	Location	10
7	PT & IPT Stated Preference Surveys for private users along major activity centers	Sample	1000
8	Bus / Rail Terminal Passenger Count survey (boarding & alighting) 16 hours	Location	3
9	Bus/Rail/Terminal passenger OD Surveys (16 hours)	Location	3
10	Pedestrian Volume Counts at critical junctions (16 hours)	Location	13
11	Speed and Delay Study at peak and off peak hours	Km	250
12	Vehicle Operator Survey (Taxi/auto/goods)	Sample	50
13	Parking Number Plate Survey (Off Street; 16 hrs.)	Location	10
14	Parking Number Plate Survey (On Street; 16 hrs.)	Km	15
15	Parking - Willingness to Pay Survey (8 hours)	Sample	50
16	House Hold Interview (1%)	Sample	5000
17	Road Network Inventory	Km	250

3.2 Summary of Primary Data Analysis

Classified Volume Count Surveys at Outer cordon and Mid-Blocks

• The peak hour traffic is approximately 8-10% of the daily traffic observed.

• Share of two wheelers is predominant at all screen line locations and averages at 35.9 %.

• Truck and MAV Movement is very high (40% share) at Chennai Sirkakulam road (Vizag to Sabbavaram) followed by Vishakhapatnam Chhenai road (Vizag to Aganampudi) with 31%.

• From the OC volume count survey the morning peak period is found between 10.00 AM to 11:00 AM and the evening peak period is from 5.00 PM to 6:00 PM.

Occupancy Surveys – Outer Cordon

• The average occupancy of two wheelers and Car is 1.7 and 2.7 respectively.

• The average occupancy of three wheeler and shared auto is 3.5 and 4.9 respectively.

• The average occupancy of city bus, intercity bus, private bus and mini bus id 39.3, 51.8, 36.7 and 17.1 respectively.

Occupancy Surveys –Mid-block locations

• The average occupancy of two wheelers and Car is 1.6 and 2.2 respectively.

• The average occupancy of three wheeler and shared auto is 1.9 and 6.3 respectively.

• The average occupancy of city bus, intercity bus, private bus and mini bus id 50.6, 54, 46.1 and 20.6 respectively.

Classified Turning Movement Count Surveys at Junctions

• Highest flow witnessed at NAD junction with 3,57,876 PCUs per day. Peak hour share at intersections is varying from 7.9% to 8.8%.

• The observed peak hour is 9.00- 10.00 am.

Road Side Interview at Outer Cordon

• Trip Frequency: Analysis of the trip frequency of passenger vehicles shows that majority of the trips are daily trips (up and down), which constitutes 41% of the total trips whereas Daily one way trips are 29% of the total trips

• Trip Purpose: Analysis on trip purpose of passenger vehicles revealed that majority of passengers were making work trips which contribute 44% of the total trips and education purpose trips as 22%.

• The average trip length for two wheelers is 22 km, whereas the four wheelers have 62 km. The average trip length of other passenger vehicles (Auto, shared Auto and Cycle) is less i.e. 16-19 Kms.

• Work trips are mostly observed at Vishakhapatnam Araku Road which constitutes 61% followed by Vishakhapatnam Achutapuram road where work trip are 50%.

• Education trips are mostly observed at Vishakhapatnam to Kolkata road and Vishakhapatnam Chennai road.

• The average trip length for multi-axle truck is 809 km. The average trip length of LCV is very low i.e. 70 km.

Bus Stop Waiting, boarding and alighting survey

The maximum daily loading can be observed at Gajuwaka junction with 7977 (Boarding+Alighting) followed by Madhurawada with 5169

Bus Stop OD surveys including the Stated Preference surveys of bus users

Analysis of O-D survey at bus stops reveal that about 88% of trips are made within study area whereas only 0.5% of trips are through traffic

PT & IPT Stated Preference Surveys for private users along major activity centers

• About 89% of PT users are having age between 20 years and 50 years of age and are males

• About 37% of PT users belong to monthly family income group of Rs 10,000 to Rs 15,000 followed by 23% belongs to monthly family income group of Rs. 15,000 to Rs. 20,000.

• Average household size of PT user is 3.7 with 1.2 students per household

• Average distance of a PT user from residence to place of work is 19 km.

• Average travel distance of a PT user is 18 km

• Commuters are more sensitive towards the 'comfort factor'. if the proposed public transport is more convenient, the modal shift of 30% can be achieved.

• If waiting time is increased, then 'comfort factor' as well as travel time/cost reduction are important criterion for mode choice.

Pedestrian Volume Count

The maximum pedestrian volume can be observed at Hanumanthawaka Junction i.e. 2215 pedestrians between 0930 – 1030 hrs, followed by Assilmetta Junction with 1387 pedestrians between 1715 – 1815 Hrs.

Vehicle Operator Survey (IPT and Goods)

• Majority of the operators are of age group 30-34, followed by age group of 35 – 39 (22.8 % operators).

• Most of the IPT modes currently in operations are of 2012-13 model (i.e. manufactured in 2012 or 2013) and most of them are self-owned.

• The maximum growth of self-owned vehicles can be seen in 2012-2013.

• Majorly, the Intermediate para transit mode i.e. Shared Autos and Tata magic are operated for 7-9 hours

Parking Survey (On-Street)

• The peak incoming volume can be observed at Jagdamba Junction (91 vehicles) followed by Vizag Railway Station road (82 vehicles).

• The peak hour in most of the locations is 1930 – 2030 Hrs

• The parking duration is half hour for 98% of the vehicles.

Parking Survey (Off-Street)

• The peak incoming volume can be observed at Dwarka Bus Stand (Outgate side parking) and Maddilapalem compound (66 vehicles) followed by Purna Market road (64 vehicles).

• The peak hour in most of the locations is 2000 – 2100 Hrs

Parking Willingness to pay Survey

• Majorly, the commuters are willing to pay for parking if 'good parking management' system is been provided. in case of Off-Street parking 49% of the respondents were willing to pay Rs. 10/Trip, followed by 37% respondents which said rs. 5/Trip is optimum.

• For managed on street parking more than 53% respondents were willing to pay rs. 10/Trip followed by 33% respondents who chosen for rs. 15/Trip.

• Commuters are willing to pay for improved transport facilities i.e. improved public transport system if that significantly save time and commute stress.

• Apart from their nominal fare they are willing to pay Rs. 5 – 10/Trip Additional for same. More than 50% commuters were willing to pay Rs.10/Trip additionally.

• Majority of the commuters anticipate a travel time saving of 10 – 15 mins. Long distance commuters (3% only) desired a travel time saving of 30 mins.

Willingness to pay Survey-Rental Bicycles

Commuters have neutral response towards usage of rental bicycle. Though they are willing to pay Rs 5/Trip or Rs. 10/Trip, if suitable public transport is provided which can significantly save time and money.

Household Surveys-

Demographics

• The average household size is 4.

• 23% residents are in the age group of 21-30, 19% in the range of 33-40, which forms the major working class in the city.

• The students population i.e. <10 and 10-20 comprises of 13.1% and 20.4 % respectively

• Only 23 % population is illiterates, whereas the rest of the population is literate.

• Most of the residents are earning upto 20,000

Housing Characteristics

• The rented and Self owned properties are equally distributed (48% each), whereas the Govt. quarters comprises of 4% only.

• The rental values of rented properties varies between 2001-4000.

• 43% of the households have parking facility.

Vehicle Ownership and Travel Characteristics

• Most of the households have only one vehicle i.e. Two Wheeler.

• 34% household doesn't own any vehicle.

• Car ownership is very less i.e. 7.7% only.

• Most of the registered vehicles are 3-5 years old.

• 90% of the vehicles are petrol driven.

Travel Time and Cost Characteristics

• Most of the city is covered with city bus service network therefor the access and egress time is 5 -10 minutes by walk.

• 2.5 – 3.3% commuters walk for 11-15 mins to access/egress the main mode.

• For 60% of the trips, the waiting time to use the main transit mode is 5-10 mins.

• The average travel time of is 10 – 20 mins.

Public Transport Characteristics

• 70 –75 % of the commuters responded that nearest bus stop is at 5-10 minute walkable distance i.e. 0 – 600 m.

• The perceived waiting time at the bus stop is 5-10 minutes.

• The average travel cost is Rs. 10 – 20.

• 40% of the bus users used 4 to 6 times a week, they had neutral opinion towards reliability. Since the service is available at 5-10 minutes of headway 99% of the respondents termed that as good or ok.

IPT Characteristics

• 70 –75 % of the commuters responded that nearest bus stop is at 5-10 minute walkable distance i.e. 0 – 600 m.

• The perceived waiting time for 62.5 % of the commuter at the bus stop is 5-10 minutes.

• 89% of the respondent felt 'good' or 'ok' regarding the safety whereas 12% (majorly by females) considered it to be an issue.

Road Inventory Survey

• Of the total roads covered in the inventory, nearly half of the roads (55%) have four lane carriageway, while 41 % is with two lane carriageway. Six lane roads account to only 1% of the total road network.

• Majority of roads in GVMC area have median and it is available only for 68% of roads.

• Most of the roads (73%) are not having footpath. 4% roads are having unpaved footpath. Only 23% roads are having footpath in desirable condition.

• Most of the major roads are 15 – 30 m wide, roads with width ranging between 30m- 45m are 20% and these can be developed as major mass transit corridors.

• Road markings are not available for about 6% of total network length in the study area.

• Bus network is present in all the major roads i.e 83% in the GMVC area, fewer collector roads are not having transit coverage

Chapter 4

Service Level Benchmarks

4 Service Level Benchmarks

4.1 Introduction

Benchmarking is a tool used by public agencies to make more informed decisions regarding the performance, make comparisons internally and with other organizations and continuously improve performance using the lessons learned through this comparison process. Benchmarking allows public agencies to direct limited resources to the program. Benchmarking helps to establish baseline measures of performance, and helps monitor the agency's individual performance over time, and also how it compares with the other organizations, and also improving performance by sharing of lessons learnt from different entities

4.2 Need for Benchmarking for Visakhapatnam

The National Urban Transport policy (NUTP) 2006 highlights the crucial link between transport demand and land use planning and the need to develop an integrated mobility plan for each city. Accordingly, each city should develop comprehensive mobility plan during the 12th five year plan with focus on accessibility, mobility and traffic flow (in that order). Rather than the present approach of "predict and provide" it has to be "Planning for the desirables". However, there need to be some yardstick to measure and compare the effectiveness of policies and urban projects across cities. Urban agencies in India currently do not have any system for measuring performance of urban transport activities, assessing impacts of projects and taking further action on them. Visakhapatnam City is no exception to this. The service level benchmarks (SLB) issued by MOUD specify parameters to measure the effectiveness of land use-transport planning in Visakhapatnam.

The SLBs describe the levels of transport performance like safety and access, pollution, accidents, congestion etc. in Visakhapatnam currently. They indirectly reflect the state of governance in the city. Above all, these benchmark indicators allow stakeholders to quantify the past, present and changes in transport and its sustainability.

4.3 Performance Benchmarks for Urban Transport

In Service Level Benchmark, four levels of Service (LoS) have typically been specified. They are LOS1, LOS2, LOS3 and LOS4. The LOS1 represents the highest performance level whereas LOS4 represents the Lowest. Hence, the goal is to attain LOS1. This section describes the computation process for all the indicators for Visakhapatnam City. Service level benchmarks have been identified for the following parameters by the Ministry of Urban Development (MoUD):

4.3.1 Public Transport Facilities

4.3.2 Pedestrian Infrastructure facilities

4.3.3 Non-Motorized Transport (NMT) facilities

4.3.4 Level of usage of Intelligent Transport System (ITS) facilities

4.3.5 Travel speed (Motorized and Mass Transit) along major corridors

4.3.6 Availability of parking spaces

4.3.7 Road Safety

4.3.8 Integrated land use transport system

4.3.9 Sustainability of Public Transport

4.3.1 Public Transport Facilities

Presence of organized public transport system in urban area (%)

Vizag's public transportation system was operated and maintained by APSRTC. At present, In addition to its own 451 buses, city has hired 146 buses thus making a total of 597.

A = Total Number of Buses in the City operating – 597 buses

B = Total Number of operating Buses under the ownership of STU/SPV - 597 buses

Presence of Organized Public Transport System in Urban Area (%) = (B/A)*100

= 100 %, therefore corresponds to LoS 1

Extent of supply availability of public transport (Availability of Public Transport / 1000 Population)

The Population of Vizag Urban Limits for the year 2016 is 20,44,257.

A = Total Number of Buses in the City – 597 buses

B = Total Population of the Vizag Urban limits – 20,44,257.

Availability of Public Transport / 1000 Population

= A/ (B/1000)

= 0.29, Therefore corresponds to LoS = 2

Average waiting time for public transport users (mins)

The average headway for each bus route is about 10 minutes. Therefore the average waiting time is half the headway 1.e. 5-10 minutes, Therefore corresponds to LoS 3.

Service coverage of public transport in the city

The Vizag city area is 643 sq.km. The total length of corridor on which public transport system is plying is 250 km.

A=Total length of road Kms of the corridors on which the PT systems ply in study area= 250 kms (in Road Kilometers) for metropolitan area

B = Area of the Urban Limits (study area) = 643 (in Square Kilometers)

Service Coverage of public transport in the city is 643/250 =0.39, therefore corresponds to LoS 3

Level of comfort in public transport

Load factor was calculated for different routes (Peak and Off peak hours). From the calculated load factor distribution table was prepared. The average value obtained from the distribution is about 0.80. Therefore corresponds to LoS 1

% of fleet as per urban bus specification

A = Total Number of Buses in the City operating – 597 buses

B = Total number of buses as per the Urban Bus specifications in the city operating – 0 buses

% of fleet = (B/A)*100 = (0/200)*100 = 0%, Therefore corresponds to LoS 4.

The overall LoS of Public Transport Facilities is obtained by summing up the LoS of individual parameters, Overall Level of Service of Public Transport facilities in Vizag, Thus overall LoS corresponds to 2.

4.3.2 Pedestrian Infrastructure facilities

Signalized intersection delay (%)

A = Total Number of signalized intersections in the city = 43 (out of total surveyed)

B = No of intersections having average waiting time of pedestrian more than 45 seconds = 0

(Desired average waiting time for a pedestrian is not more than 45 seconds)

Signalized intersections delay (%) = (B/A) =0%

Therefore corresponds to LoS 1

Street Lighting (Lux)

It is estimated that the LoS for the city is 3

% of city covered

Almost 23% of surveyed network has a paved footpath. Some of the network has footpath on the both side but the width was less than 1.8m.

A = Total length of road network in the city and multiplied by 2 = 500 kilometers (Surveyed)

B = Total length of the footpath having minimum width of 1.8 m and available on both sides = 115 in Kilometers. (Surveyed)

Percentage of the city covered = (B/A)*100

= (115/500)*100 = 23%, Therefore corresponds to LoS=4

Overall Level of Service of pedestrian Infrastructure facilities city wide = LoS1+ LoS2 + LoS3 = 1+3+4= 8

Therefore corresponds to LoS 2.

4.3.3 Non-Motorized Transport (NMT) facilities

NUTP recommends that cities should have NMT tracks on all major roads within a year. In view of above said this indicator reflects the availability of dedicated cycle track along all the arterial, sub arterial roads and public transport corridors, its encroachment and parking facilities.

In Vizag, the NMT parking facility is present at places such as railway station, and at bus stands. As an overall percentage this value is negligible and is taken as zero. Hence, for this performance indicator the level of service for all the above said three sub divisions are below the least level of service category (Normally zero for all).

4.3.4 Level of usage of Intelligent Transport System (ITS) facilities

Availability of traffic surveillance (%)

A = Total no of bus stations on BRTS, major bus stops, terminals, metro stations and signalized intersection having CCTVs < 20

B = Total no of bus stations on BRTS, major bus stops, terminals, metro stations and signalized intersections = 226 (in No) (including 2 important Bus stands, 1 major Railway stations, 43 signalized intersections)

Availability of traffic surveillance (%) = (A/B)*100 = 20/226 = 8.84. Therefore corresponds to LoS 4

Passenger Information System (PIS) (%)

A = Total no of bus stops, terminals, metro stations having Passenger Information System facility = 4

B = Total no of bus stops, terminals, metro stations = 226

Passenger Information System= (A/B)*100 = (4/226)*100 = 2. Therefore corresponds to Los 4

Global Positioning System (GPS)/ General Pocket Radio Service (GPRS) (%)

A = No of public transport vehicles and IPT with functional on board GPS/GPRS and connected to common control center = 0

B = Total no of public transport vehicles = 597 (in No)

Global Positioning System = (A/B)*100

= (0/597)*100

= 0 %, Therefore LoS 3 = 4

Signal Synchronization (%)

In Vizag, so far no signals have been synchronized.

A = No of signals synchronized = 0 (in No.)

B = Total number of signalized intersections = 43 (in No.)

Signal Synchronization (%) = (A/B)*100

= (0/43)*100

=0 %, Therefore LoS 4 = 4.

Integrated ticketing System (%)

Integrated Ticketing System is absent in Vizag. So the level of service for this benchmark is 4.

Overall Level of Service of ITS facilities city wide = LoS1+ LoS2 + LoS3 + LoS4 + LoS5 = 4+4+4+4= 16. This corresponds to LoS 4.

4.3.5 Travel speed (Motorized and Mass Transit) along major corridors

Average travel speed of personal vehicles (Kmph)

From the speed and delay survey for private vehicles, the average journey speed for major corridors for the private vehicles = 28 Kmph. Therefore correspomds to LoS 2.

Average travel speed of public transport (Kmph)

From the speed and delay survey for public transport, the average journey speed for major corridors for the public transport =18 Kmph. Therefore corresponds to LoS 2.

4.3.6 Availability of parking spaces

This indicator represents the availability of paid on-street parking spaces for all vehicles in the Vizag. Paid on-street parking facility is not yet introduced in Vizag city except in some off-street locations like Bus stands and railway stations. In some places like Market complexes, parking is maintained by private people. As the percentage is negligible it is considered as <25 %. Therefore LoS 1= 4.

The ratio of maximum and minimum parking fee is 1 for Vizag city. Therefore LoS 2 = 4.

4.3.9 Integrated land use transport system

Population Density – Gross (Persons/Developed area in hectare)

A = Developed area (in Hectare) computed from Master Plan = 64300 hectares

B = Population of the year for which data is available = 20.44 lakhs

Population density (No.) = B/A

= 64300/20.44 = Therefore corresponds to LoS 1.

Mixed Land-use on Major Transit Corridors / Network (% area under Non-residential use)

A= Non Residential Development along Transit corridors=353 kms

B=Total road length (Transit corridor)= 250 +250 km= 500 kms

A/B*100= (353/500)*100= 68%, Therefore corresponds to LoS 1.

Intensity of Development – City wide (FSI)

As per the Development plan Floor Space Index (FSI) as applicable to the developed area lies in the range of 1.00 - 1.75. Normally, FSI varies due to plot size, ground coverage and road width.

Floor Space Index is between 1.5 to 2.0, Therefore corresponds to LoS 2.

Intensity of development along transit corridor (FSI transit corridor/FSI)

A = Floor Space Index (Applicable to most part of the city as per master plan is 1.0 to 1.75.

B = FSI for the proposed transit corridor is also 1.33 TO 1.75

Intensity of development along transit corridor = B/A= 1,

Therefore corresponds to LoS 3.

4.3.10 Sustainability of Public Transport

Extent of Non fare Revenue (%)

Performance of APSRTC had been collected as a secondary data collection.

A = Revenue collections per annum from non-fare related sources (i.e. excluding tariff box collections) less than 5 %

B = Total revenue per annum from all the sources i.e. majorly fare 100%

Extent of non-fare revenue (%).

= A/B * 100

= <5 %, Therefore LoS 1 = 4

Staff /bus ratio

A = Total staff of bus operation and maintenance – 1104+1412 = 2516

B = Total number of buses – 597 (in Number)

Staff / Bus Ratio (ratio) = A/B = 4.2,

Therefore LoS 2 = 1

4.4 Summary Table

Summary table of LoS calculated for study area (Overall LoS) is presented in Table 4.1

Table 4.1 Summary of the LoS calculated for GVMC area

	Existing LoS	Remarks
Public Transport Facilities	2	The city has a public transport system which may need considerable improvements in terms of supply of buses/coaches. The network coverage is good but frequency of services available may need improvements.
Pedestrian Infrastructure facilities	3	The city has very poor pedestrian facilities which need significant improvements at intersections, footpaths and street lighting as some parts of the city are not served by it.
Non-Motorized Transport (NMT) facilities	4	The city lacks adequate NMT facilities.
Level of usage of Intelligent Transport System (ITS) facilities	4	The city lacks adequate ITS facilities.
Travel speed (Motorized and Mass Transit) along major corridors	2	Small increase in flow may cause substantial increases in approach delay and hence decrease in arterial speed
Availability of parking spaces	4	The city authorities need to initiate immediate actions with respect of providing paid parking spaces and demand management for parking
Integrated land use transport system	3	Faint coherence between study area structure and public transport system.
Sustainability of Public Transport	2	The public transport is financial sustainable but need significant improvements

Chapter 5

Travel Demand Modelling and Forecasting

5 Travel Demand Modelling and Forecasting

An urban transport model to replicate the GVMC area transportation system (roads, congestion delays, transit system, etc.) is developed with a state-of-the-art software and modelling technology. This model can be used for forecasting, using altered model inputs to reflect future year conditions. By simulating roadway conditions and travel demand on those roadways, deficiencies in the system can be assessed. Potential major future network enhancements such as introduction of Public Transport, land use modifications and Other Transport Strategies can be analyzed by this tool and its efficacy can be established at a planning level.

Several software programs are available for developing travel demand models. The Vizag transport model is developed using PTV VISUM (Version 14) software (a state-of-the-art Travel Demand Modeling software).

5.1 Pre modelling analysis

5.1.1 Study area and its delineation

The study area comprises of Greater Visakhapatnam Municipal Corporation Area (GVMC) having an area of 643 sq.km. It has been subdivided into smaller physical units, termed as Traffic Analysis Zones (TAZs) to facilitate understanding of travel pattern within the study area. Consultant have chosen current municipal wards as TAZs for which demographic, socio-economic and other planning data is readily available from secondary sources.

5.1.2 Internal zones

The Greater Visakhapatnam Municipal Corporation (GVMC) area is divided into 75 TAZs (74 Wards and 1 Gangavarm port area) as per prevailing demarcation of municipal wards. These wards are taken as internal zones

5.1.3 External zones

Regions beyond the GVMC area have been delineated into external zones based on the catchment of the existing transport links feeding into the study area. A total of 7 external zones are considered representing the world outside the study area. In summary, study area is divided into total 82 TAZs.

5.1.4 Horizon period

Year 2016 is considered as Base Year. The travel demand forecasts is to be prepared up to 2041. Therefore for the purpose of sequential planning and design of the systems, these travel demand forecasts are presented for the years 2021, 2031 and 2041.

5.1.5 Preparation of Data Base

Data required for the analysis of travel demand can be categorized into three types.

1. Planning variables
2. Transport network
3. Travel Demand and Characteristics

The base year data is summarized in the following sections.

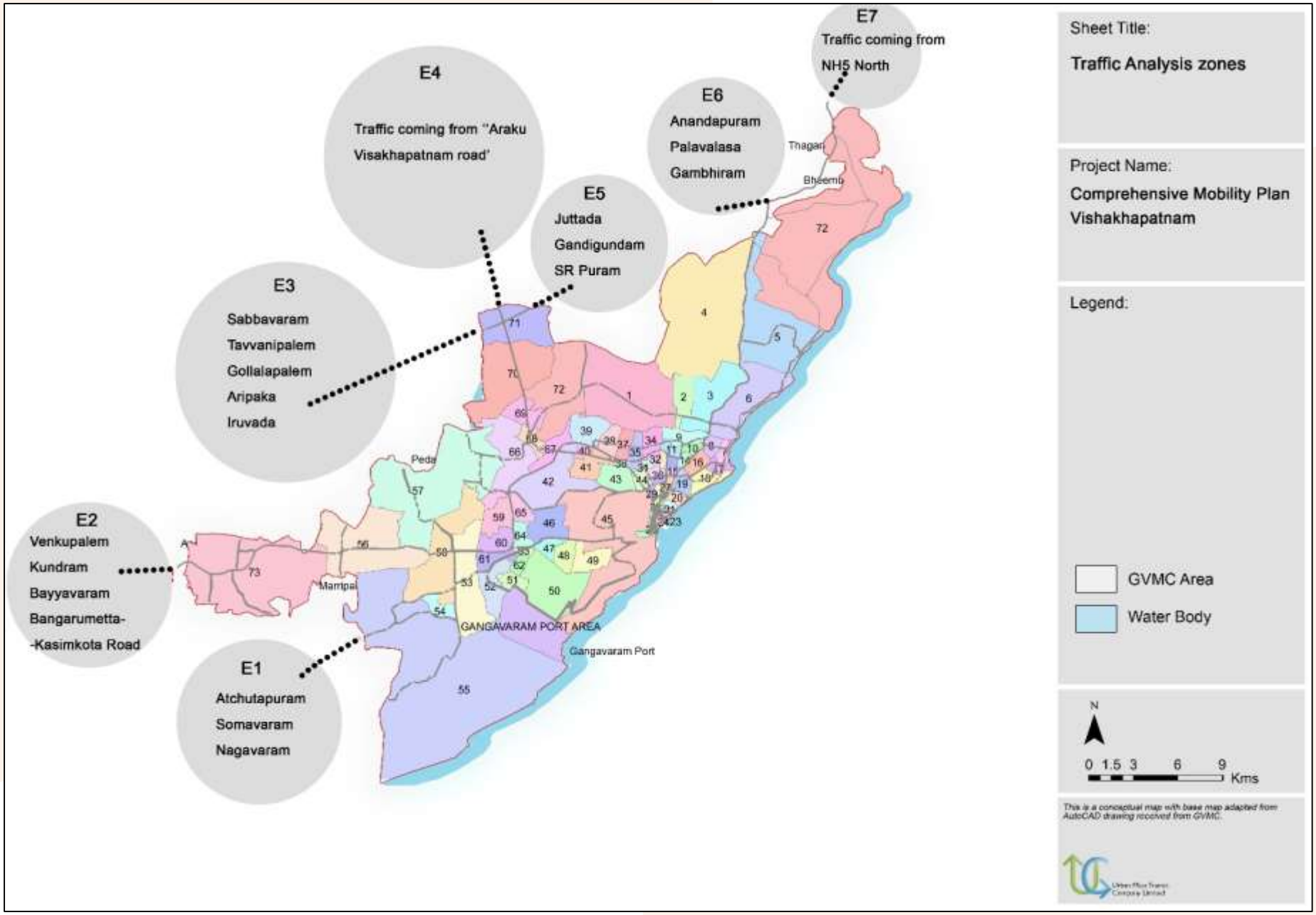


Figure 5.1 Traffic Analysis zones in study area

Planning Variables

Planning variables i.e. population and employment are some of the important data required for estimating the travel demand generated at zonal level. Base year demographic data is obtained from the Census and GVMC database. Zone wise employment is collated from various published reports.

Transport Network

The transport network in the study area includes road network and public transport network. All the characteristics of the road links are collected by network inventory and, speed and delay surveys. Link characteristics collected include length, carriageway type (divided/ undivided), type of circulation (one-way/ two-way), number of lanes, average speed, capacity etc. Public Transport Network includes all roads on which public transport buses operate. Details of bus routes, frequencies, seating capacities, maximum load factor, and fares have been collected and coded. In addition, in this study, Auto rickshaw is considered as an intermediate public transport and is made available on the road links. The road network is properly connected to all zone centroids by means of dummy links.

5.2 Strategic Model development

The model is based on a conventional 4-stage transport modelling approach which includes:

Trip Generation - calculation of the number of origins and destinations for each zone.

Trip Distribution - attaching the origins and destinations for complete trips.

Mode Choice - determination of the mode for each trip (TW, car, Intermediate Public Transport (IPT), Public transport).

Assignment - assigning passengers to their respective highway and transit networks.

5.2.1 Trip Generation

The analysis and the model building phase starts with the step commonly known as Trip Generation. This is the term used in the transportation planning process to estimate the number of trip ends in a given area (i.e., how much travel; for example either from homes or workplaces). The objective of the trip generation stage is to understand the reasons behind the trip making behavior and to produce mathematical relationships to synthesize the trip making behavior and to analyze the trip making pattern on the basis of observed trips, land use data and the household characteristics.

For this study:-

- All the existing trips on the project stretch have been considered for the base year. This is arrived through the Household Survey (travel diary), Volume count survey and Road side interview conducted in the study area.

• All the proposed developments and their scale of developments have been captured to estimate future trip generations within the study area.

Trips are usually divided into two types i.e. home-based and non-home based trips

Home-based trips are those having one end of the trip either origin or destination at home, of the persons making the trip, The home based trips are further classified as home based work trips, home based education trips and Home based other trips

Non home based trips are those having neither end at home of the person making the trip.

(The volume of non-home based trips was less than 1%, therefore these trips are not considered in regression exercise). The base year planning variables and Trip generated are shown in Table 5.1.

Table 5.1 Base Year (2016) Planning Variable

Base Year (2016) Planning Variables	
Population 2016	2044257
Employment_2016	602155
Resident Students_2016	567300
Student Enrolment	424300
Trips Produced in base year	
Home Based Work	1398000
Home Based Education	905400
Home based Others	47400

Based on the correlation between the Planning Variables and the trips produced, the trip production and attraction equations are developed. They are shown in Table 5.2.

Table 5.2 Correlation equations

Trip Type	Productions/Attraction Model	R^2 value
Home based Work Trips		
Production	0.6669*(Population) + 427.6	0.76
Attraction	0.4179+4358	0.23
Home based Education Trips		
Production	0.4179*(Resident students)+2482	0.44
Attraction	0.4329*(Student enrolment)+3407	0.17
Home based Other Trips		
Production	0.0174*(Population) + 144.47	0.05
Attraction	0.0344*(Employment) + 282.41	0.11

The regression exercise showed a good correlation between planning variables and trip generated. The regression plot have been represented in Figure 5.2 to Figure 5.7.

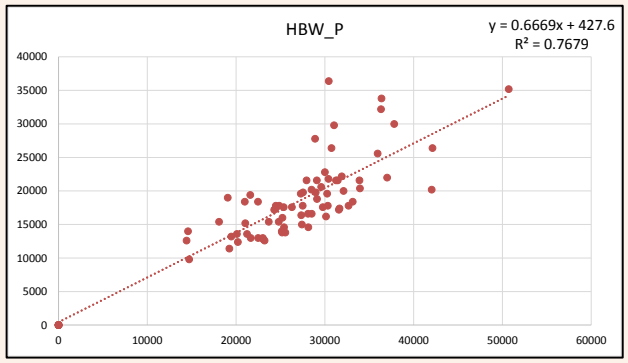


Figure 5.2 Home Based Work Production

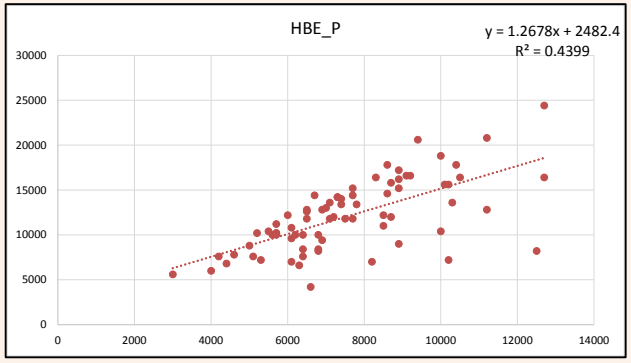


Figure 5.3 Home Based Education Production

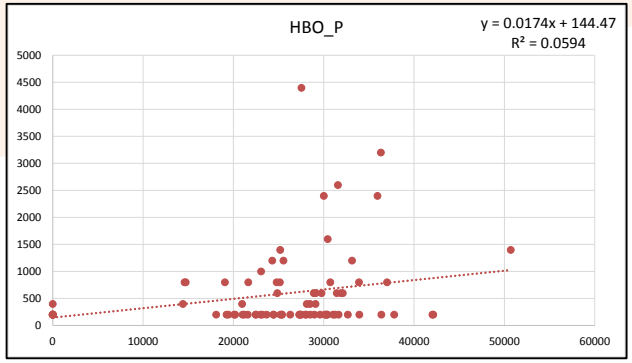


Figure 5.4 Home Based Others Production

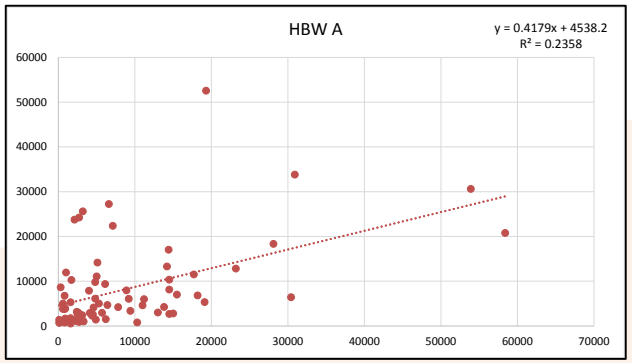


Figure 5.5 Home Based Work Attraction

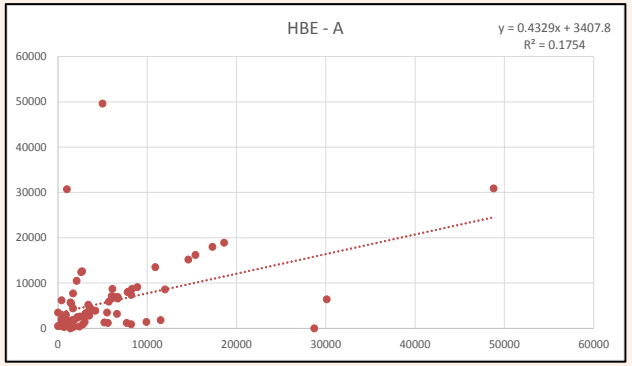


Figure 5.6 Home Based Education Attraction

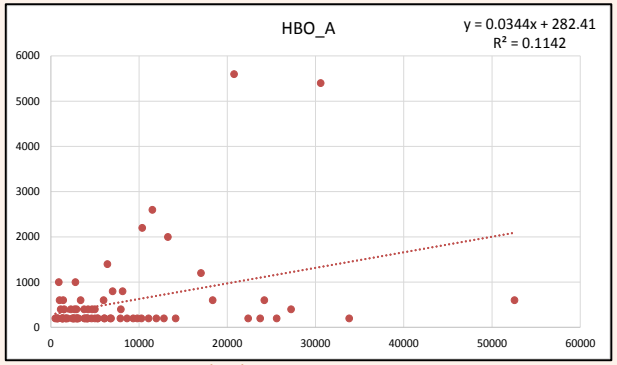


Figure 5.7 Home Based Others Attraction

5.2.2 Trip Distribution

Second stage is Trip distribution or interchange. In this stage the spatial interchange of trips is modeled (from where to where). Trip distribution modeling is done based on the observed travel pattern which was analyzed from the OD survey and passenger survey. OD matrix for the entire horizon year was developed at this stage. In this study doubly constrained gravity model has been used.

This model originally generated from an analogy with Newton's gravitational law. Newton's gravitational law says, F= GM1M2/d2, Analogous to this Tij=C OD/Cij, introducing some balancing factors

Tij=Ai Oi Bi Di f(Cij),

where Ai and Bi are the balancing factors,

F(Cij) is the generalized function of the travel cost.

This function is called deterrence function because it represents the disincentive to travel as distance (time) or cost increases. For calculation of deterrence function the 'combined function' i.e. combination of exponential and power function is used in this study. The form of the model is such that power (α=0) or exponential (β=0) functions may be used for the deterrence function. The inclusion of both a and β represents a gamma function, sometimes called a Tanner function.

The base year (2016) Productions and Attractions obtained from the corrected O-D matrices, skim matrices from network and the calibrated function parameters were used to generate synthetic matrices in Visum.

The Trip length distributions from Observed/Corrected and Synthetic O-D matrices were calculated and comparison graphs are shown in. The average trip length obtained from the model is presented in the Table 5.3.

Table 5.3 Average Trip Length (Estimated and plotted)

Trip Distribution	Avg. Trip Length (km)	Error (%)
Estimated Mean Trip Length (Excluding Intra-Zonal)	8.5	-1
Plotted Mean Trip Length (Excluding Intra-Zonal)	8.5	

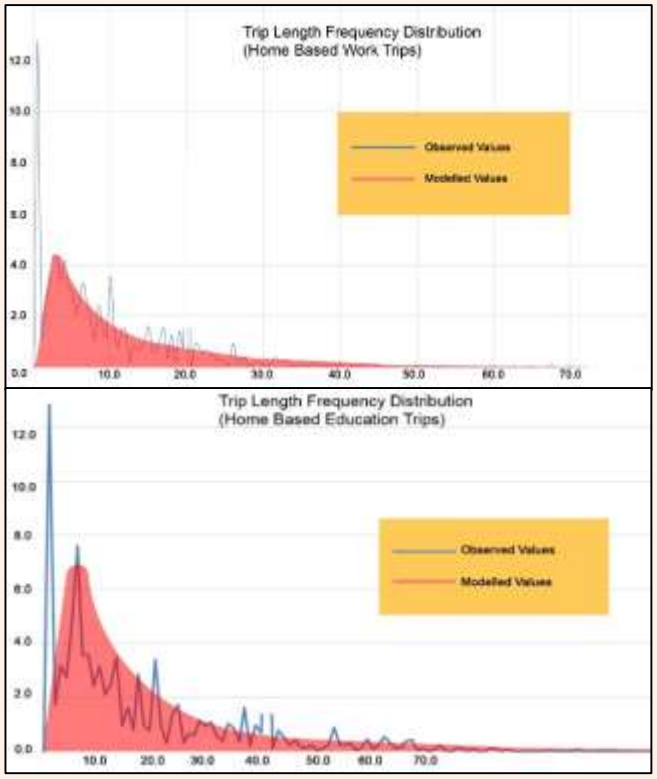


Figure 5.7 Trip Length Frequency Distribution

5.2.3 Modal Split

Third stage is related to modal split (which modes are used). This depends upon the observed relationship between modes used in relation to personal characteristics, trip characteristics and mode characteristics.

- For base year model, the existing Modal share (as derived in Household Survey) has been used.
- For horizon year models, the modal share as derived from 'willingness to pay and shift' , PT & IPT Stated Preference Surveys etc. was used.

Table 5.8 Modal Share (Base Year 2016)

Modal Share(Base Year 2016)			
Mode	*Home based Work Trips*	*Home based Education Trips*	*Home based Other Trips*
City Bus (Govt.)	24.05%	38.43%	24.05%
2-Wheeler	43.08%	3.03%	43.08%
Walk	11.79%	25.20%	11.79%
Auto-Rickshaw	10.82%	21.28%	10.82%
Shared Auto / Tata Magic	5.14%	7.77%	5.14%
Car / Jeep / Van	3.55%	0.53%	3.55%
Private Bus	0.96%	3.08%	0.96%
Mini Bus	0.23%	0.55%	0.23%
Rail	0.27%	0.13%	0.27%
Intercity bus/ Inter-state (Govt.)	0.13%	0.11%	0.13%

5.2.4 Traffic Assignment

The test corridor was coded in the VISUM (Version 14) model with the network attributes as captured through road inventory surveys and traffic and transit details from primary and secondary sources. The traffic volume originating from every zone in the network in terms of PCUs are given as per the site survey. The other properties such as free flow speed, vehicular speeds, permitted network speeds, lane capacities etc were provided.

The calibrated model is validated by comparison of field results and model output results. The 'Multi criterion' approach was followed for model validation. The zone to zone travel time at aggregate level were analyzed in all the trials till the error of below 5% is achieved. The second criteria was traffic concentration at roads, quantitatively measured by flow at the mid blocks. This was validated by comparison of model outputs and field survey outputs (traffic volume survey at mid blocks).

Table 5.9 Observed and Modelled Traffic Volume

	Observed	Modelled	Residual Error
OC1	1930	1950	1.04%
MB2	2700	2529	-6.33%
MB1	2620	2588	-1.22%
OC2	1244	1458	17.20%
OC3	1808	2045	13.11%
OC4	2539	2339	-7.88%
OC5	930	829	-10.86%

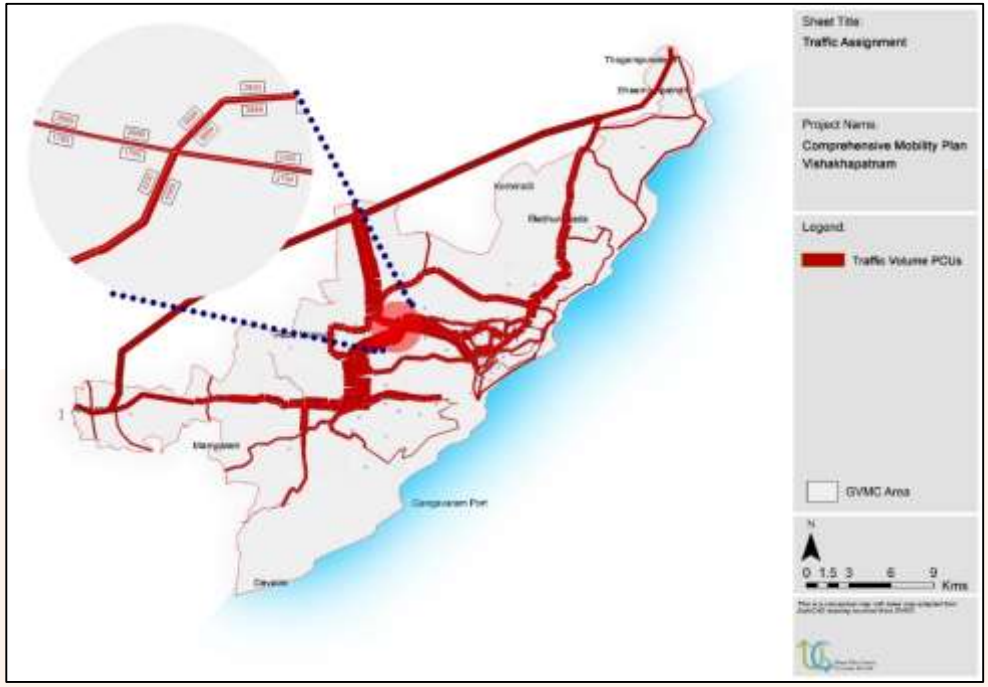


Figure 5.8 Traffic Assignement

The existing network was modeled, calibrated and validated based on real data from the field, including network geometry, traffic and transit operations. Table 5.9 shows the validation results. The final output from this process was a validated and calibrated simulation model of the existing conditions for peak hour (9 AM to 10 AM).

5.2.5 Base Year Travel Demand Model

The base year scenario represents the present road network and current travel demand of the city. The interaction between traffic analysis zones based on the mode people choose will give fair idea about the travel behavior. This information allows transport agency / stakeholders to comprehend travel patterns and characteristics; measure trends; provide input to travel demand model development, forecasting, and planning for city wide transportation infrastructure needs and monitor progress and changes due to implementation of transportation systems. The trunk network length modelled is 250 kms.

The trips shown in Table 5.10 and Table 5.11 were assigned to the base model to assess the network efficacy

Table 5.10 Number of Trips Modelled

Mode	Number of Trips
Home based Work	1398000
Home based Education	905400
Home based Others	47400

Table 5.11 Number of Trips Modelled

Mode	Number of Trips
APSRTC Bus	336158
Two Wheeler	602209
Auto Rickshaw	151242
Shared Auto	71879
Four Wheelers	49626
Private Bus	13391
Mini Bus	3151
Rail	3742
Interstate Bus	1772

Inferences:

Base year model stands validated and V/C ratios along some of the major roads have been compiled and presented in Table 5.12. Link flow diagram is presented in Figure 5.9.

Table 5.12 V/C Ratio of major roads

Sno	Name of road	V/C Ratio
1	Kailasapuram road	0.70
2	VEPZ Road	0.71
3	Lankalapalem Road and Adjoining NH5	0.71
4	HB Colony road	0.72
5	Vizag Srikakulam Highway	0.78
6	Anakapalli Main road	0.80
7	Railway Market Road (Towards DRM Office)	0.80
8	Maddilapalem Complex road (NH5)	0.83
9	Autonagar Main road	0.83
10	Town Main road	0.85
11	Gajuwaka Bye pass road	0.84
12	Waltain Station approach road	0.87
13	RTC Complex raod	0.87
14	Bowdra Ring Road	0.89
15	NH5 (NAD Approach road)	0.94
16	NH5 (Gopalapatnam Rural to Viswesyaraya Nagar)	0.94
17	Waltair Main Road	0.95
18	Daba Garden road	0.95
19	Seethamadhara road	0.95
20	Diamond Park Road, Seethammapetha road, Akkayapalem road	0.95
21	Simhachalem Road	1.19
22	Allipuram Main Road	1.29
23	Convemt Junction Road	1.41

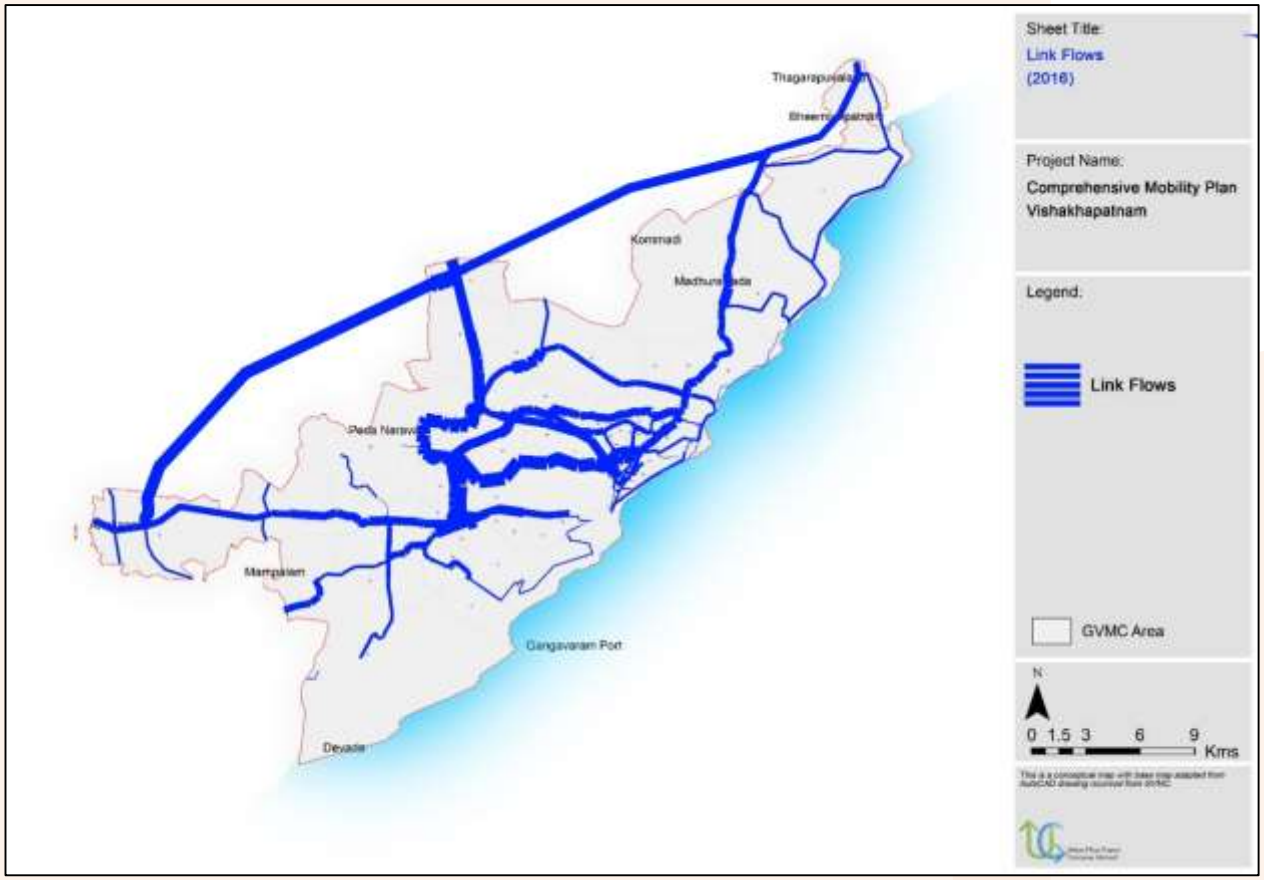


Figure 5.9: Link Flow Diagram for Base Year (2016)

The congested network (network length having volume to capacity ratio (v/c) more than 0.85) is 11 %.

Table 5.13 % Network Lnegth and V/C Ratio

V/C Ratio	% Network Length
0	2%
0.00 - 0.50	28%
0.51 - 0.85	35%
0.86 - 0.95	6%
0.95 - 1.00	5%

5.3 Horizon year Travel Demand Modelling

5.3.1 Scenarios Specifications and Travel Demand

The section provides the description and analysis for the scenarios for understanding of the transport network and indicators while describing the travel pattern. As per ''trip generation model zoning'' the framework for understanding of interaction (trips) between the zones is created i.e. scenarios are developed as discussed below:

Business as Usual/Do nothing scenario: Scenario describe the future year (2021, 2031 and 2041) and future demand with minimum investments done on public transportation sector, this will help in analyzing the efficacy of the existing network, and how it perform under given traffic demand. The problems (congestion and congested network, increased travel time etc.) can be identified and possible solutions/ interventions can be proposed to mitigate the same. The population and employment for horizon years have been projected based on the parameters such as potential density and highway connectivity. The projected population and employment figures for the horizon years are shown in the Table 5.14.

Table 5.14 Planning Variables in BAU Scenario

Year	Population	Employment	Resident Students	Student Enrolment
2016	2044256	602155	567300	508277
2021	2323938	680111	577735	524842
2031	2994511	772691	819578	739206
2041	3667837	881106	1003864	911958

With the help of the base year transport model developed for the study area, travel demand has been estimated for the horizon years 2021, 2031 and 2041 for business as usual scenarios listed in Table 5.15

Table 5.15 Trip in the study area (BAU Scenario)

Year	I-I	I-E	E-I	E-E	Total
2021	2315678	188485	161559	26926	2692649
2031	3150580	138487	138487	17311	3462175
2041	3799823	211101	189991	21110	4222026

Year	I-I	I-E	E-I	E-E	Total
2021	86.0%	7.0%	6.0%	1.0%	100%
2031	91.0%	4.0%	4.0%	0.5%	100%
2041	90.0%	5.0%	4.5%	0.5%	100%

Year	Internal Trips (BAU)	
	Public	Private
2021	44%	56%
2031	43%	57%
2041	41%	59%

Sustainable Urban Transport Scenario

A Sustainable Urban Transport Scenario (Transit Oriented Development Scenario) is a compact high density mixed use development that is planned along public transit stations (or corridors) which provide housing, employment, entertainment and civic functions within the walking distance. In this scenario, it is assumed that a population density of 400 persons per hectare will be achieved in the zones along transit corridors by the year 2051. Accordingly, projected population and Employment for SUT scenario is presented in Table 5.16.

Table 5.16 Planning Variables in SUT scenario

Year	Population	Employment	Resident student	Student Enrolment
2016	2044256	602155	567300	508277
2021	2609047	708988	648614	589232
2031	3816598	863303	1044578	942141
2041	4831079	1037266	1322236	1201182

With the help of the base year transport model developed for the study area, travel demand has been estimated for the horizon years 2021, 2031 and 2041 for Sustainable Urban Transport scenarios listed in Table 5.17

Table 5.17 Planning Variables in SUT scenario

Mode	I-I	I-E	E-I	E-E	Total
2021	2573794	209495	179567	29928	2992784
2031	3976152	172876	151267	21610	4321904
2041	4998097	217309	190145	27164	5432714

Table 5.18 Trip in the study area (SUT Scenario)

Year	I-I	I-E	E-I	E-E	Total
2021	86.0%	7.0%	6.0%	1.0%	100%
2031	91.0%	4.0%	4.0%	0.5%	100%
2041	90.0%	5.0%	4.5%	0.5%	100%

Year	Internal Trips		External Trips	
	Public	**Private**	**Public**	**Private**
2021	49%	51%	70%	30%
2031	55%	45%	70%	30%
2041	55%	45%	70%	30%

Sustainable Urban Transport Scenario comprises of transport network incorporating committed projects along with major proposed projects as follows:

- Major Roads Proposed in "Smart Cities" Proposal
- Proposed Links to complete the ring radial Network
- Missing Links (Refer Table 75)

(the sections 'Comprehensive Mobility Plan' describes each in detail.

5.3.2 Traffic Characteristics – Horizon (2041)

Business as usual scenario:

It has been observed that the share of Public Transport (Bus) and IPT in Business As Usual Scenario is 41%. Table 5.19 shows the modal share for various trip purposes.

Table 5.19 Modal Share in BAU scenario

	Public Transport	Intermediate Para Transit		Private	
	Bus (All)	Auto-Rickshaw	Shared Auto	Two-Wheeler	Private Four Wheelers
HBW	23.1%	9.8%	4.7%	58.8%	4.8%
HBE	31.0%	15.7%	5.7%	5.9%	0.7%
HBO	23.1%	9.8%	4.7%	58.8%	4.8%
Share	41 % (PT+ IPT)			59% (Private)	

Table 5.20 gives the estimated future trips by various modes for study area and external zones for Business as Usual scenario.

Table 5.20 Total trips in SUT scenario

	Public Transport	Intermediate Para Transit	Private
Trips Share	2037999 (PT+IPT)		2184026 (Private)
Total Trips	42,22,026		

Sustainable Urban Transport Scenario

It has been observed that the share of Public Transport (Metro, Bus and IPT Trips) in Scenario b (Sustainable Urban Transport Scenario) has increased by 14 % in comparison to Scenario 1 (Business As Usual Scenario). The modal split is given in Table 5.21.

Table 5.21 Modal Share in SUT scenario

	Public Transport	Intermediate Para Transit			Private	
	Metro	Bus	Auto-Rickshaw	Shared Auto	Two-Wheeler	Private Four Wheelers
HBW	13.1%	17.3%	8.4%	4.0%	52.9%	4.4%
HBE	37.7%	23.3%	13.3%	4.9%	20.3%	0.6%
HBO	13.1%	17.3%	8.4%	4.0%	52.9%	4.4%
Share	54.5 % (PT+ IPT)				45.6 % (Private)	

Table 5.22 gives the estimated future trips by various modes for study area and external zones for this scenario.

Table 5.22 Total trips in SUT scenario

	Public Transport (Metro and Bus)	Intermediate Para Transit	Private
Trips Share	2956547 (PT+IPT)		21476167 (Private)
Total Trips	54,32,714		

5.3.2 Comparison of Network Characteristics in various Scenarios

Network characteristics for Base year (2016) and Horizon year (2041) for various scenarios during peak hour are presented in Table 5.23.

Table 5.23 Comparison of Network Attributes (Aggregate level) on links for Various Scenarios

Network Characteristics	Base Year (2016)	Horizon Year (2041)	
		Scenario-I: Business As Usual Scenario	Scenario-II: Sustainable Urban Transport Scenario
Avg. Network Speed (kmph)	24	22.5	27.0
Avg. V/C Ratio	0.75	0.92	0.84

Table 5.24 Comparison of Network Attributes (Link wise) on links for Various Scenarios

Major Road	V/C Ratio comparison	
	Scenario-I: Business As Usual Scenario	Scenario-II: Sustainable Urban Transport Scenario
Vizag Srikakulam highway	1.19	1.00
Convent Junction Road (Port Gymkhana road)	0.90	0.72
Chennai Srikakulam Highway	0.7	0.55
Pedanarava road	0.91	0.85
Sheela nagar road	0.95	0.90
Gajuwaka Bye pass road	1.5	0.8
Gangavaram Yarada Road	0.9	0.85

It is observed that, in comparison to BAU 2041, average V/C ratio has reduced by 0.8 and average network speed has increased by 20 % in Sustainable urban transport scenario. Scenario-II is selected for proposing various transport improvement proposals.

Table 5.25 Comparison of Network Attributes (Link wise) on links for Various Scenarios

Major Road	capacity	
	Scenario-I: Business As Usual Scenario	Scenario-II: Sustainable Urban Transport Scenario
Vizag Srikakulam highway	1400	2100
Convent Junction Road (Port Gymkhana road)	1400	2800
Chennai Srikakulam Highway	1400	2800
Pedanarava road	1400	2100
Sheela nagar road	1400	2800
Gajuwaka Bye pass road	1400	2100
Gangavaram Yarada Road	1400	2100

Chapter 6

Sustainable Urban Transport Strategies

6.1 Vision Statement

"To ensure that Visakhapatnam will have a systematically planned Urban Transport system for people and goods Mobility that is smart, economical and safe, which aims to support economic development while improving livability".

6.2 Goals

Goal 1: Develop public transit system in conformity with the land use that is accessible, efficient and effective.

Goal 2: Ensure safety and mobility of pedestrians and cyclists by designing streets and areas that make a more desirable, livable city for residents and visitors and support the public transport system.

Goal 3: Develop traffic and transport solutions that are economically and financially viable and environmentally sustainable for efficient and effective movement of people and goods

Goal 4: Develop a Parking System that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles.

Each goal can be achieved by meeting the following objectives:

1. Goal 1: Develop public transit system in conformity with the land use that is accessible, efficient and effective

Objectives

(a) Provide good quality of public transport system that is accessible, efficient and effective

(b) Develop strategy to integrate public transport system with existing IPT System

(c) Develop strategies to encourage people to use public transport system and discourage use of private vehicles

(d) Develop policies that encourage concentrated mixed land use development along the public transport corridors

Figure 6.1: Public Transport System in Bogota
(Source: Wikimedia Commons, the free media repository)

Figure 6.2: London Cycle Superhighway no.7
(Source: Geograph.com)

Goal 2: Ensure safety and mobility of Pedestrian and cyclist by designing streets and areas that make a more desirable, livable city for residents and visitors and support the public transport system.

Objectives

(a) To improve pedestrian facilities in areas of pedestrian concentration

(b) To provide facilities to pedestrians and cyclists and ensure safety to segregate their movement from vehicles along major corridors

(c) To encourage pedestrian movement in heavy pedestrian movement areas and restrict use of private vehicles

(d) To provide safe pedestrian facilities along major public transport nodes and transfer points

(e) To develop a Pedestrian policy for safe and efficient movement of people within the city

Goal 3: Develop traffic and transport solutions that are economically and financially viable and environmentally sustainable for efficient and effective movement of people and goods.

Objectives

(a) Develop immediate / short term strategies such as traffic management and engineering solutions to ease flow of traffic at major congestion points within the city

(b) Develop medium / long term measures such as ring roads, new links, road network development, flyovers, underpasses, ROBs and RUBs to ease traffic flow along major roads within the city

Figure 6.3: VDL Evolans Electric Buses
(Source: https://www.flickr.com/photos/22902505@N05/30448764052)

Figure 6.4: Multi-level stack parking NYC
(Source: Wikimedia Commons)

Goal 4: Develop a Parking Policy that reduces the demand for parking and need for private mode of transport and also facilitate organized parking for various types of vehicles.

Objectives

(a) Restrict On Street Parking at critical locations in the city

(b) Create off Street Parking (wherever possible Multilevel Parking) near major activity centers, transit stations/terminals to meet the growing parking demand.

(c) To suggest various measures through a combination of demand management and fiscal measures to restrain the demand for parking of private vehicles at critical locations.

The goals and objectives set for the mobility needs of Visakhapatnam can be achieved by formulating a series of strategies as per NUTP guidelines. Each of the strategies will be evaluated to see their suitability and applicability for Visakhapatnam.

This CMP study also attempts to integrate NUTP principles in its approach.

Make walkable Cities and Towns

A great walking environment must protect pedestrians from motor vehicles. Vehicle speeds need to be radically slowed or else, streets need footpaths. Footpaths need to be unobstructed, continuous and well lit. Crossings should be made safer with pedestrian crossing signals, pedestrian islands and pedestrian table-tops that minimize crossing distances and offer safety for pedestrians. Accessibility to wheelchairs must be ensured. The pedestrian network should foster the most direct access to all local destinations like schools, work, bus stops etc.

The following indicators have been recommended for pedestrian facilities:

• All arterial streets should have >= 75% of their lengths having non obstructed footpaths to achieve a LOS 1 for the pedestrian facility

• All other sub arterial and local streets should have 50 – 75% of their lengths having footpaths for a LOS 2

• At-grade pedestrian crossings at maximum intervals of 70-250 m

Visakhapatnam does not meet these standards. We include a separate strategy to non-motorized transport improvements where the focus is to develop better walking and cycling facilities in Visakhapatnam.

Figure 6.5: London Cycling
(Source: Flickr.com)

Create environment for bicycles

The more bicycles (and any people-powered transport) on the streets the safer and less polluted the streets become. Segregated bicycle lanes are needed on higher speed roads, while on local streets traffic calming and shared street designs are better, allowing traffic to mix at slower speeds. Building bike lanes and slowing down traffic are keys to making urban transport sustainable.

The following indicators have been recommended for pedestrian facilities:

- NMT network should have at least 25% of the road network coverage to achieve a LOS 1 for NMT facilities
- NMT parking facilities should be available at more than 50% of the interchanges (bus stops, terminals, railway stations) to achieve a LOS 2.
- Visakhapatnam has a significant cycling population and every care must be taken to preserve and better it. The observed 3% cycle share of total trips can be improved. Our cycling strategy hence will focus on developing a strong bi-cycle network.

Connect the blocks

Cities that are pleasant to walk and bicycle typically have large numbers of short streets and many intersections per unit of area. This makes the traffic slow down while walking becomes more direct, varied, interesting and attractive. The tighter the street grid, the fewer detours to a destination. Detours can affect the decision to undertake a trip and by what means. Streets that are short offer good opportunities to connect with the surroundings. Buildings, shops and streetscape elements are closer to the pedestrians and cyclists as they travel.

It is recommended that the indicator for the number of intersections of pedestrian and cycle network per square kilometer be 50.

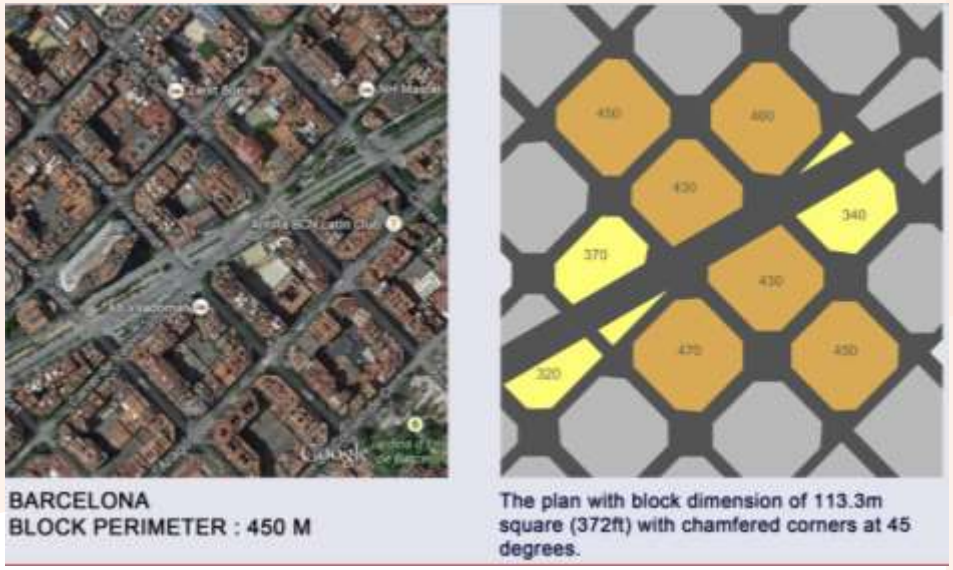


Figure 6.6: Barcelona Urban Block Perimeter
(Source: Mid term Mapping exercise 2014, APL and Google Earth)

Figure 6.7: London underground – Metro System
(Source: Wikimedia Commons)

Get on the Public Transport

Mass transit can move a large number of people quickly and comfortably using a fraction of the fuel and street space required by automobiles. The Metro along with bus transit systems are proving able to keep pace with the rapid motorization and metropolitan growth. Busses are more accessible, have a wider coverage and are cheaper. The following indicators need to be used to assess the effective usage of public transport:

- Percentage of residents within 800 m of public transport stops
- Percent mode share of public transport and IPT desired
- Percent of stops with frequency of service greater than 15 buses per hour.

The system requires detail route rationalization with well-defined integration of main haul and feeder services.

Build dense - people and transit oriented cities; mix people and activities

The first step to accommodating future urban growth is to densify existing urban land while providing excellent and diversified services and amenities. Dense communities are a foundation for the mixed-use urban areas where walking, cycling and transit can be integral parts of the way of life.

The following indicators are recommended for densification:

- Densify transport nodes according to pedestrian and cycling – 10 minute catchment areas
- 800 m for pedestrians and 3 km for cyclists

Integrating residential, work, retail and entertainment activities into one area makes for better cities. Trip lengths and travel times can be reduced. The average trip length for cycle is 2.5-3.0 km which is ideal.

Figure 6.8: Arlington County(Densified area along transit corridor) in Virginia (Source: Wikimedia Commons)

Shift to Public Transport

Shift from unsustainable mobility to sustainable mode like the public transport can be achieved using technology, regulating road use, parking and fiscal measures. High quality public transport vehicles with efficient service, easy accessibility, wide coverage and reasonable affordability are required to induce shift from private to public vehicles. This has to be coupled with measures like congestion charges in core areas; high parking fee; limited parking spaces; tax on private vehicles; implementation of demand management measures etc.

No parking fees are charged in the city. As a strategy we must adopt the levy of parking charges. Also there is requirement of providing off-street parking facility which can help in increasing the effective road capacity.

Urban Transport Funding

Proper institutional set up and an efficient funding mechanism are need of the hour to ensure financial sustainability of investments in public transport and non-motorized transport. Urban transport financial resources should be pooled within an urban transport fund administered by the strategic transport authority at the municipal or metropolitan level. Private sector financing for transport infrastructure should be raised through competitive tendering of concessions that may be supported by public contributions as long as they are subjected to cost-benefit analysis.

6.3 Mobility Plan Approach (All major Strategies)

The mobility goals for Visakhapatnam need to be addressed through a multipronged approach. Solutions for complex transport improvements cannot be achieved by a single strategy. The following strategies need to be adopted in tandem to meet the various goals set for Visakhapatnam.

- Land Use and Transport Strategy
- Development of Mobility Corridors
- Public Transit Improvement Strategy
- Non-Motorized Transport Strategy
- Freight Management Strategy
- Traffic Engineering Measures
- Travel Demand Management Strategy

It is important to note that each of the above strategies is equally important and the order of listing does not imply priority. Each of the broad strategies includes sub strategies of immense importance. The strategies when implemented through specific projects shall fulfill the goals and objectives of the CMP. The sections below discuss these strategies

6.3.1 Land Use Transport Plan

The structure and shape of the transport network is dependent on land use. Land use and the network strategy must go hand in hand. As land use cannot happen as planned, if there is no connectivity. This strategy should focus on accessibility, connectivity, mixed land use developments to minimize vehicle trips, encourage transit oriented development, and the long term transport strategy be framed around the structural form of urban growth envisaged.

Integrated land use and transport development promotes balanced regional growth in line with regional development strategies, with the objective of:

- Promoting balanced spatial growth
- Minimizing land requirements for transport
- Promoting transit oriented growth
- Reducing the need to travel
- Encouraging walkable/cycle-able neighborhoods

In order to provide mobility solutions for Visakhapatnam it is vital that there is an effective integration between land use and transport in the entire region, without which, it will be difficult to coordinate growth in sustained manner. The urban sprawl in Visakhapatnam has taken place in almost all the directions. However, a greater potential for urbanization has been observed in the Southern and western direction. Newer settlements have primarily emerged along the major radial transport corridors.

One of the strategies integrating land use and transport that can be adopted for Vizag is the Transit Oriented Development (TOD) strategy. This concept can be applied along the major identified mobility corridors that have the potential to carry higher order mass transit systems.

Transit Oriented Development (TOD)

By designating certain roads as corridors to maximize passenger throughput, these corridors get priority planning for public transit systems. Mixed use development that is cognizant of the low income users of the transit system, is important. Land use planning can be used to create urban and suburban environments where walking and transit are viable transportation options (Transit Oriented Design/Transit Supportive Design, TOD) by making it easier to go from one transportation mode to another, the connection between community and development is enhanced ensuring that a community is accessible to all. Resilient neighborhoods will provide the needs of daily living, within walking distance (1/2 to 1 km radius). Vizag has the potential to adopt these principles. The TOD planning process includes:

The Proposed density for transit oriented zones is 400 persons per hectare.

Travel Connections: This would focus on convenient and direct pedestrian connections, pedestrian scale blocks, interconnected street network including bicycle circulation and parking. Increased density in neighborhood centers would make transit service more effective.

Building Scale and Orientation: Transit-supportive design assumes people are willing to walk a maximum of ½ mile for premium transit and rail service and ¼ mile for other bus services. Building placement is a powerful tool in reinforcing streets as public amenities. Sensitivity to the physical design and location of buildings is important in order for travel connections to be attractive. The quality of "out of vehicle" experiences is influenced by the placement of buildings in relation to the street and other buildings, as well as their height and scale.

Public Spaces: This would include pedestrian-friendly streets including adoption of traffic calming measures, parks and Plazas as community gathering spaces to enable social interaction, quality facilities for transit users (features such as benches, shelters, landscaping and adequate lighting make people feel comfortable while waiting for transit service). Additionally, services such as child care facilities, dry cleaners, postal facilities and health care offices can be included as part of bus transfer centers or rail stations.

Parking: The proper location and size of parking facilities are essential if pathways, buildings and public spaces are to succeed in creating transit-supportive settings. Parking structures/shared parking lots are two ways to reduce the amount of space occupied by parking facilities.

Successful Transit Oriented Development can significantly reduce per capita motor vehicle travel, and reduced travel time. Reduced travel time in turn leads to lower pollution including lower GHG and particle emissions.

Keeping in view the existing situation, the future vision of the metro corridor area and the intended functions of the identified station areas; the following strategies and guidelines based on the principles of planning are suggested for effective implementation of TOD on ground. The strategies have been defined under following heads:

1. Compact development with densification and diversification
2. Direct Connectivity (street network and access)
3. Non-motorised transport including walking and bicycling
4. Multi-modal Integration

❑ METRO CORRIDORS (1 KM BUFFER)

- ***NAD Junction to Kommadi Junction***
- ***NAD junction to Gajuwaka junction***
- ***Gurudwara to Old Post Office***
- ***Tadichetlapalem to Chinvalteru***

❑ BRTS CORRIDORS

- ***STC BRTS Corridor***
- ***PTC BRTS Corridor***
- ***Kommadi Junction to Thagarapuvalasa***
- ***Gajuwaka Jn to Anakapalle***

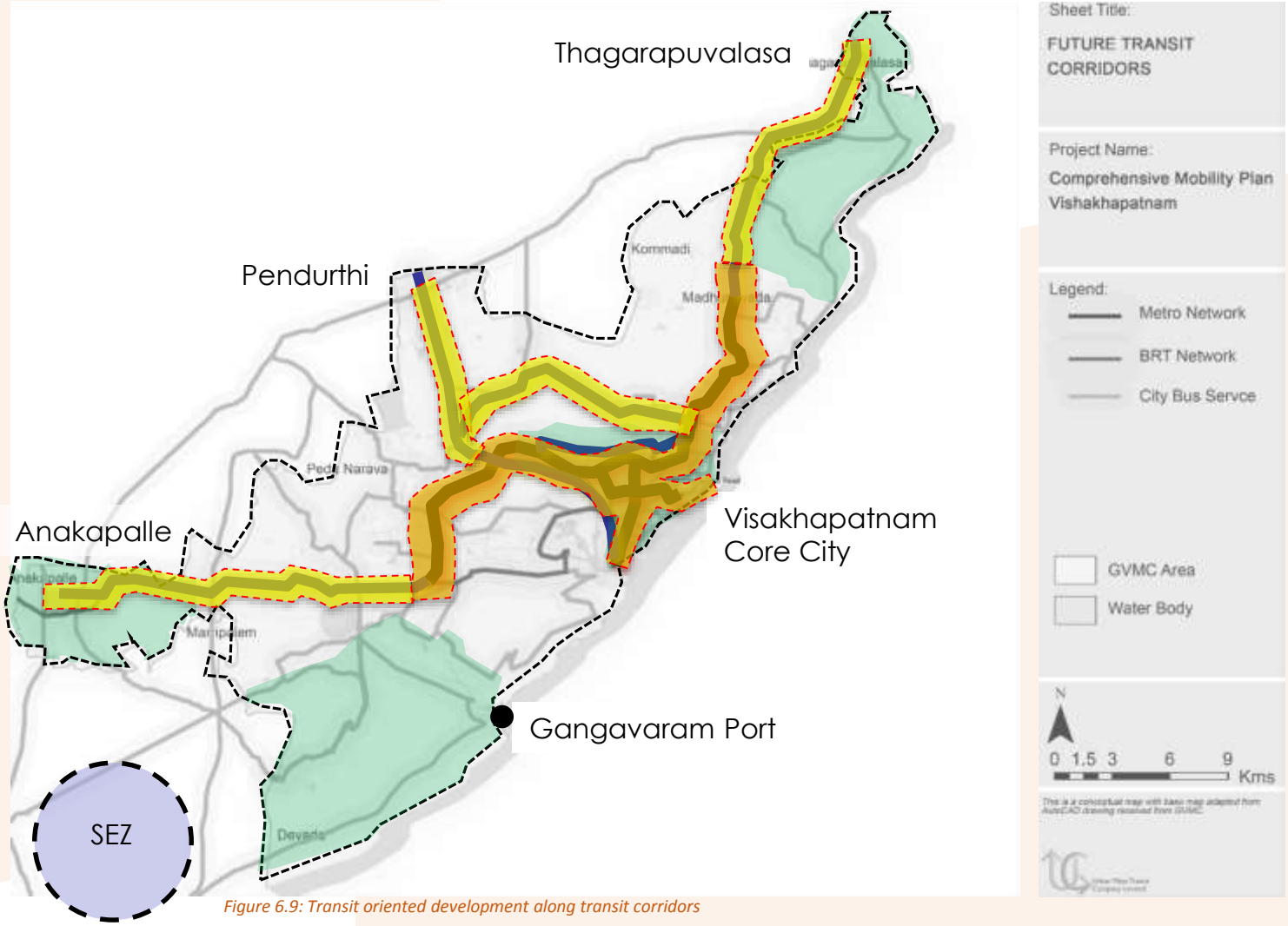
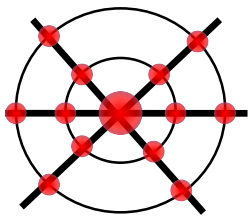
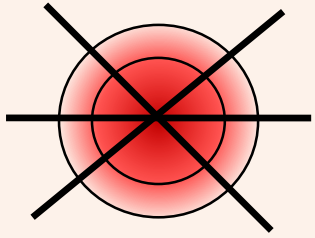


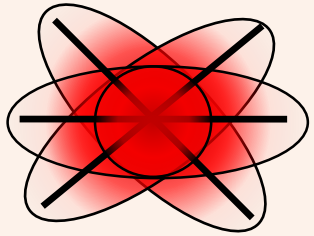
Figure 6.9: Transit oriented development along transit corridors



Multi nodal transit network



Compact city concept



Hybrid Development

Keeping in view the existing situation, the future vision of the metro corridor area and the intended functions of the identified station areas; the following strategies and guidelines based on the principles of planning are suggested for effective implementation of TOD on ground.

The strategies have been defined under following heads:

1. Compact development with densification and diversification

2. Direct Connectivity (street network and access)

3. Non-motorised transport including walking and bicycling

4. Multi-modal Integration

Compact Development with densification Compact Development as a principle of TOD encourages high density and mixed land use as discussed herein.

Diversification: Mixed Land Use

One of the key principles of TOD is to have a mix of land uses around the transit station. Mixed land use with high population density ensures good ridership throughout the day as well as optimum utilisation of land space. They also encourage activity density through the day by combining primary activities of living and working with support facilities such as leisure and community activities within the common space. They also promote walking and use of non-motorised transit modes.

Strategies to achieve densification and mixed use

In-fill Development

In-fill development may be achieved by focusing on empty sites within the influence zones, clusters with gross density less than 200 du/ha, and old and dilapidated structures. In Vijayawada the dwelling unit densities are very low at about 32 du/ha. This necessitates the need for redistribution of population closer to the transit corridor.

Re-development

Re-development is also required to be taken up in most of the station areas to accommodate higher dwelling unit densities along with the population densities. This holds true especially in areas with a significant percentage of old and dilapidated structures. However, consent of the residents and the stakeholders is crucial. A major tool for this is plot amalgamation.

Development of Greenfield sites

Development of Greenfield sites such as vacant lands to be undertaken as per TOD guidelines.

Plot Amalgamation

it is imperative to encourage plot amalgamation for higher FAR, preferably more than 2000 sq.m which can actually utilise high FAR along with the desirable residential densities as well.

Strategies to achieve Direct Connectivity (Street Network and Access) and NMT

Street Networks are the backbone for accessibility and mobility. Good street network designs reduce land consumption, provide greater accessibility through more direct routes, and increase overall network efficiency and reliability. They also affect several other factors such as travel patterns and road safety. Compact and connected street networks tend to promote higher levels of people walking and using non-motorised transport modes. A block size of 250 x 250 is recommended.

The important infrastructure factors that influence the walkability are given below

- Access to public transport services
- Presence of quality footpaths
- Street furniture
- Traffic volume and speed
- Buffers to moving traffic (curb side parking)
- Pedestrian cross-walk
- Aesthetics to nearby local destinations
- Shade or sun shine in appropriate seasons

Strategies for Multi Modal Integration

Refer section – Strategies for Public Transport Planning

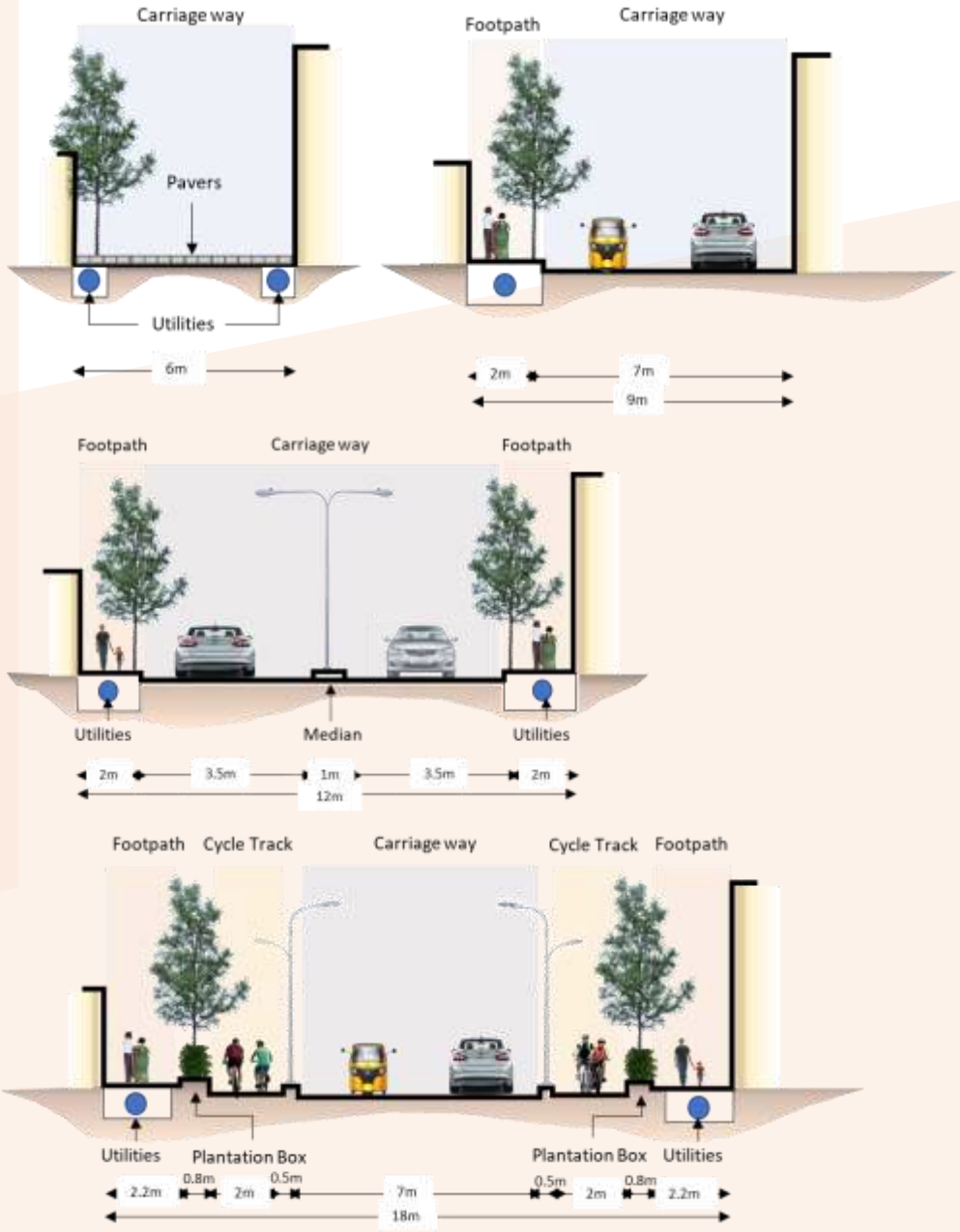


Figure 6.10: Street with pedestrian infrastructure

6.3.2 Mobility Corridor Strategy

The city clearly indicates the ring radial road network development. Majority of these corridors are either state or national highways and are important mobility corridors of Visakhapatnam. In essence, mobility corridor maximizes throughput of people, focusing on mass transport and non-motorized traffic, rather than vehicle traffic. These mobility corridors offer a strong network providing connectivity to major attraction centers in the city along with regional connectivity. Mobility is achieved by introducing higher order mass transit systems on these designated corridors.

As a part of this strategy, it has been proposed that some corridors will act as mobility corridors in the city. The same have been presented in Figure 6.11. These corridors should be considered with desired and dedicated public transport systems. The typical cross sections for dedicated public transport systems on the mobility corridors are presented. Initially, the mobility corridors should be implemented up to the National Highway 5 and later can be extended. The study will need revision in the ridership estimation for the extension part in future.

Typical Mobility corridors characteristics

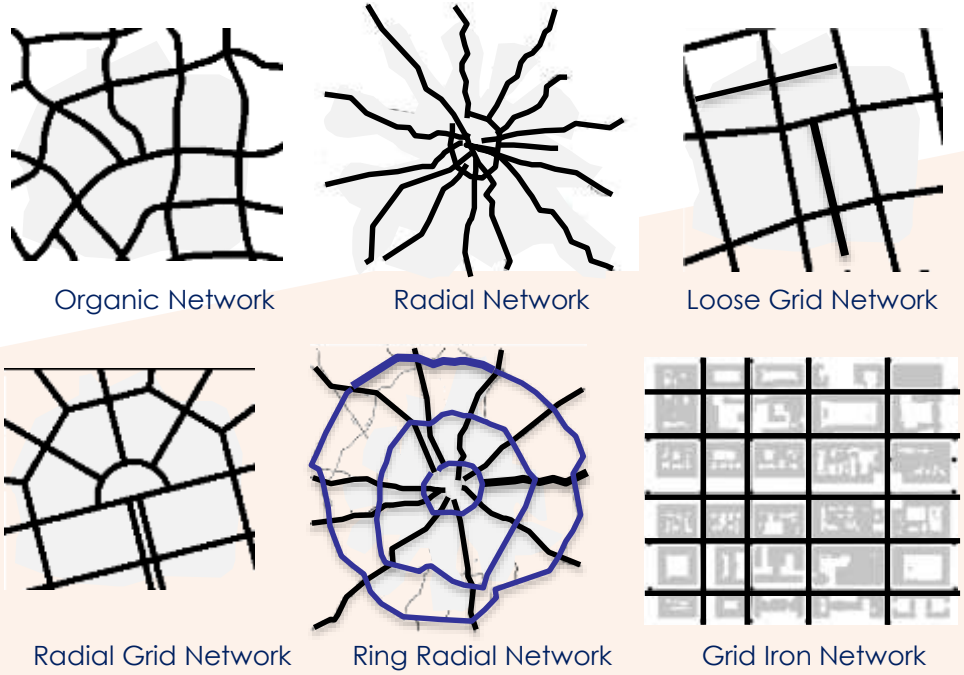


Figure 6.11: Concepts and Proposal for Visakhapatnam road network

6.3.3 Public Transport Strategy

One of the goals identified as part of the vision is to increase the public transport share to 50-55% from the existing 40%. For this purpose, we could consider augmentation of City Bus System, including Route Rationalization, before embarking on capital intensive system(s). Bus systems only may not be able to meet the desired goal and on key corridors (mobility corridors) a case exists for installing a higher order mass transit system such as BRT / Monorail / LRT/ Metro.

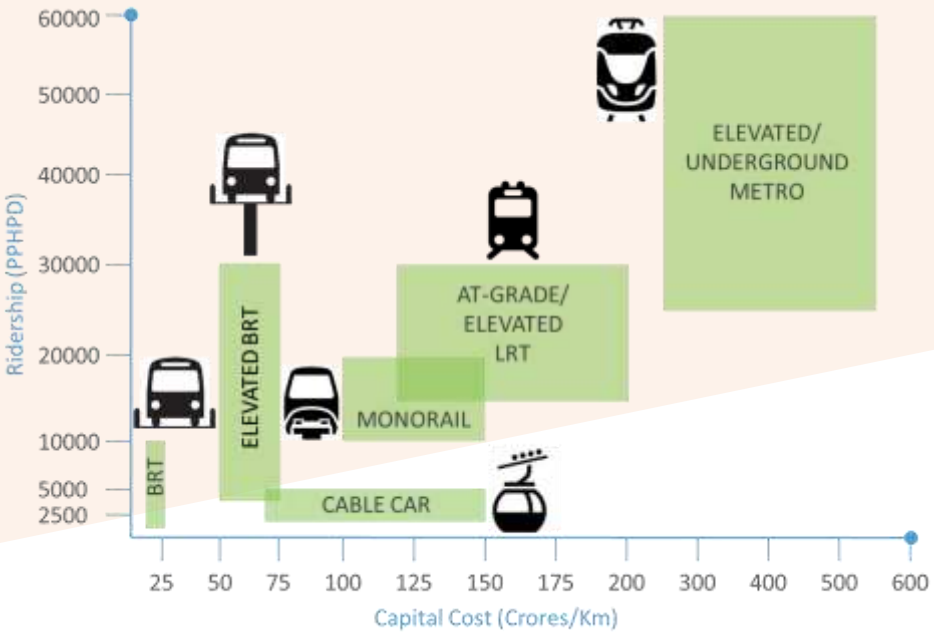


Figure 6.12: Capital cost and Ridership of various transit systems

Higher Order Public Transport refers to the mass rapid transit systems such as Bus Rapid Transit System, Monorail, LRT, Commuter Rail, Metro etc. These systems have higher carrying capacity and network speed.

The role of higher order system is to cater more trips along the mobility corridors by public transport mode in an efficient manner.

The higher order system selection is based on the Passengers per Hour per Direction (PPHPD), cost and feasibility of implementation, along with other parameters. Figure 138 shows the proposed transit corridors in three levels i.e. Metro, Bus rapid Transit System (BRTS) and City Bus Service

Figure 6.13: Transit systems with high carrying capacity

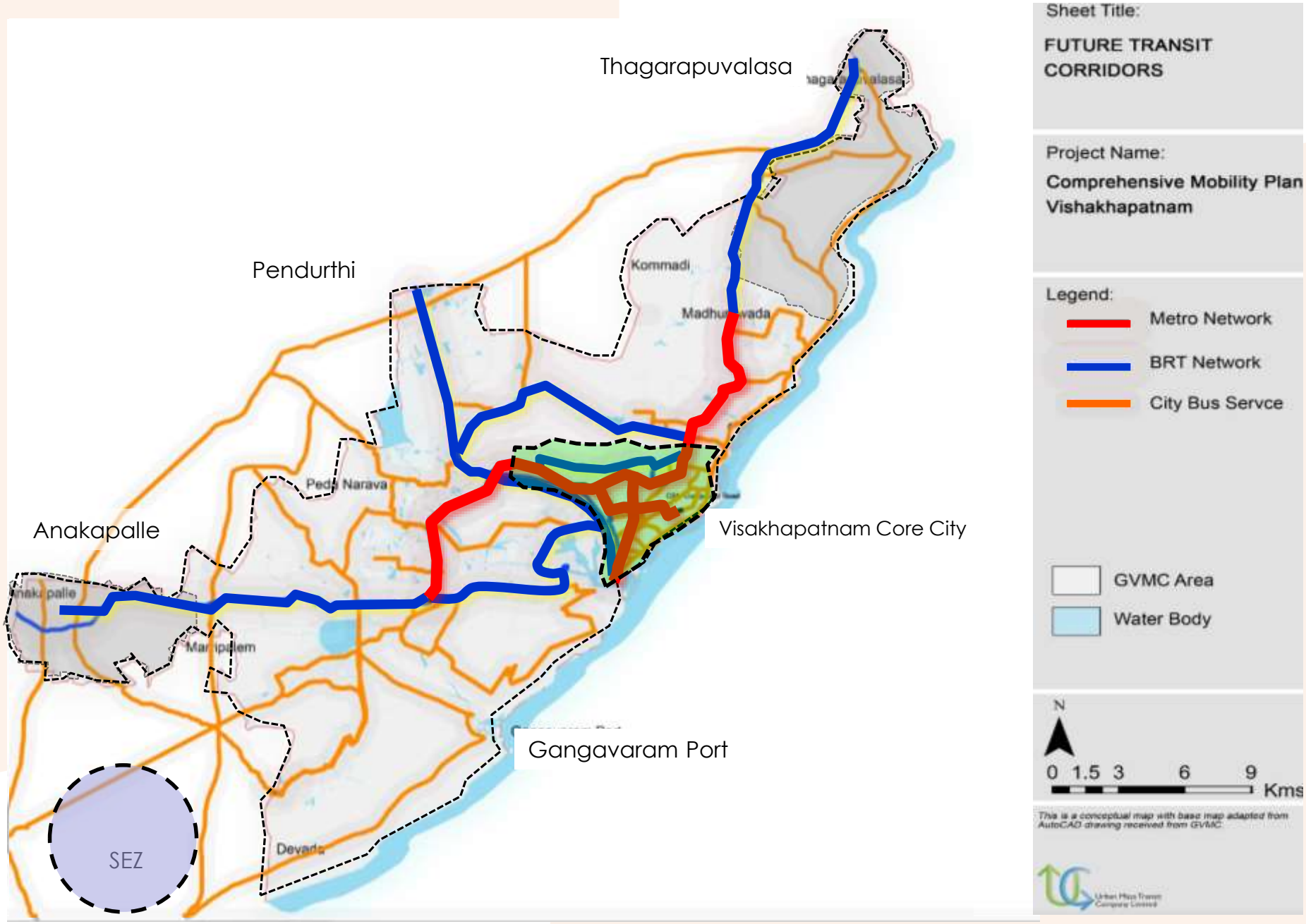


Figure 6.14: Proposed Transit network for Visakhapatnam

6.3.4 Non-Motorized Transport Strategy

Large number of pedestrian movement is observed along roads in and around the city. Footpaths are available on majority of the radial roads but the secondary network needs substantial improvement for NMT infrastructure. Wherever available, these have been encroached upon by shopkeepers or by hawkers, forcing people to walk on pavement. Further, bicycles traverse in mixed traffic, exposing them to accidents. In fact it is mainly the bicyclists and pedestrians who are the victims of road accidents.

The cycle share in Visakhapatnam is about 3 % in overall trips and there is no cycle track facility in the city. The proposed measures to develop facilities for pedestrians and bicyclists on the streets include:

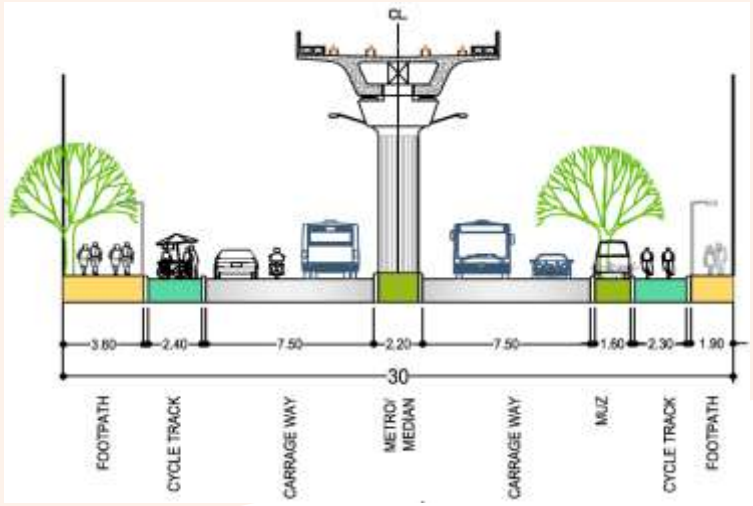
- Development of NMT network for full width;
- Incorporating all essential elements including pedestrian paths;
- Provide grade separated facilities for pedestrian crossing designed for the convenience of pedestrians at appropriate locations;
- Specific measures for facilitating safe bicycle use;
- Cycle track network Plan

Figure 6.15: Dedicated Footpath and cycle track (Source: Wikimedia Commons)

Construction of Cycle Track, Foot-Paths and Zebra Crossings

The unplanned foot-paths and zebra crossings makes the pedestrians use normal road stretch for commuting. Many a time it has been observed that the pedestrians use the road with least concern for vehicular traffic. This leads to accidents and loss of precious human life. It is proposed that foot-paths should be urgently constructed. Zebra crossings should be provided at major intersections for safe crossing of pedestrians. Regular painting of the Zebra crossing also needs to be ensured.

NMT Only Corridor



Dedicated NMT Corridor

Figure 6.16: NMT Corridor design

Foot Over Bridges and Walkways

Providing grade separated pedestrian crossing is an efficient way of improving safety for pedestrians, particularly at locations with high traffic volumes or on the corridors with larger widths. Busy junctions like NAD, Hanumanthawaka, LIC junction etc. can be provided with well-designed circular pathways to ensure safety for pedestrian movement. The details for proposed walkways are presented in the next chapter.

Figure 6.17: Indira nagar foot overbridge, Chennai (Source: Wikimedia Commons)

Provision of the pedestrian zone

Looking at the number of pedestrians and the associated commercial activities; Town main road. Poorna Market etc are proposed as vehicle restricted zones (in certain hours) where only pedestrian movement will be allowed. The location map for these vehicle restricted zones is presented in Chapter 9.

This will be further supported with identification of off-street parking facilities within nearby areas where people can park the vehicle and access the pedestrian zones easily. If required, the bus route alignment and bus stop location will be reframed for robust public transport connectivity to these areas.

Bike Sharing Scheme

The bike sharing scheme is a part of non-motorized transport scheme in which the cycle can be used to reach different destinations on the rental basis. The cycling as an activity itself has a benefit of both at a personal as well as at a social level. Riding a bicycle every day is good exercise and improves one"s health. It is very much environmentally and socially sustainable mode of transport. However, it is important to provide an infrastructure which can take care of the safety issues associated with cycling. Many of the cyclists feel that it is unsafe because of other vehicles on the road for which the running speed is immensely different. Hence the scheme is more effective with dedicated cycle tracks which can segregate cyclists from rest of the traffic.

Conceptually, the system works on a hub-and-spoke model. Typically, there is a main docking station and 6-7 sub-stations within a catchment area of 2.5 to 3 km. The main docking station can accommodate around 25-30 bicycles and is usually installed next to a transit node. The sub-stations are located nearby in residential colonies, work centers or commercial hubs, as the case may be. A person willing to rent a cycle, goes to either the main docking station or any of the sub-stations, pays a membership fee and fills in a membership form containing certain details of the user, (both being a one-time affair), swipes a smart-card issued to him, and takes the cycle. To deposit the cycle, he goes to any docking station and swipes the card which deducts the rent for his usage period and deposits the cycle. To avail of the membership, he can go to any docking station, fill up the membership form and pay the membership fees or otherwise do it through the internet as per his convenience.

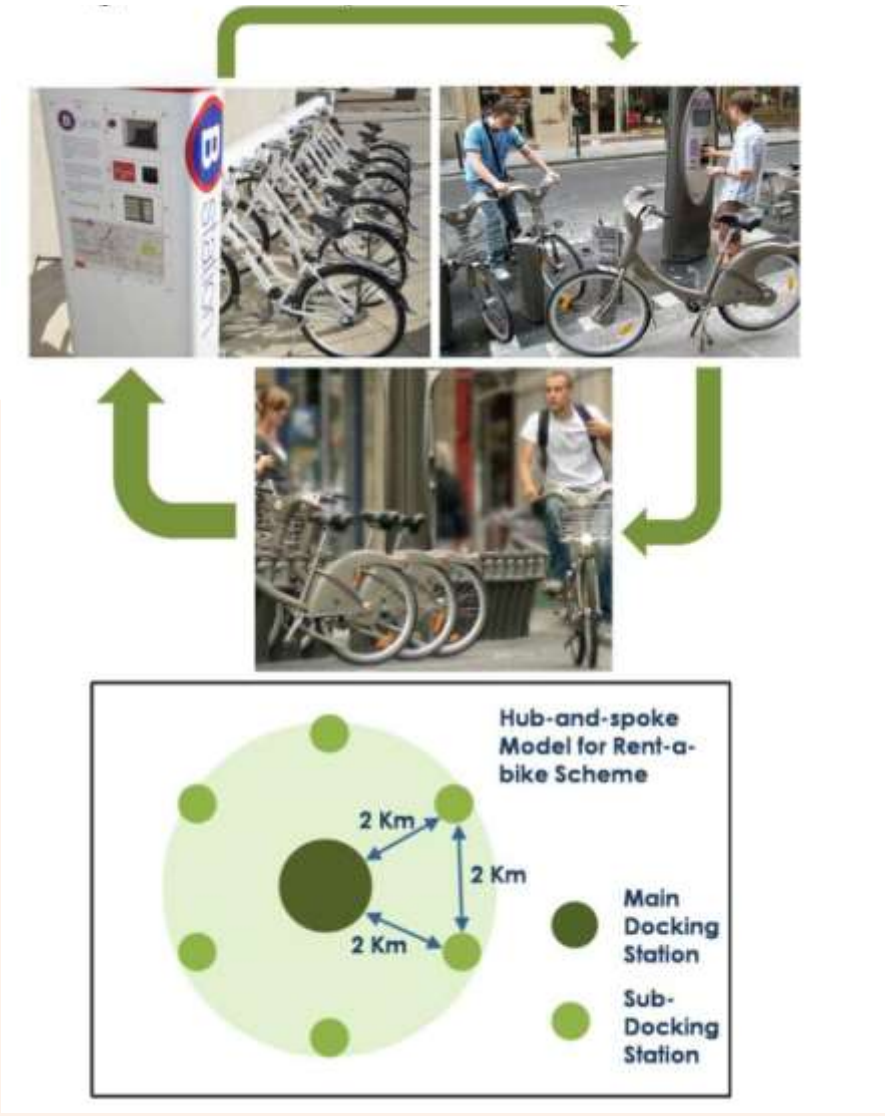


Figure 6.18: Concept of Bike Sharing

In Visakhapatnam, the scheme can be proposed on the identified mobility corridors with the provision of appropriate infrastructure for cycling. Some of the essential components of the scheme are listed below.

Main Docking Station (at least 17m x 3m)

- Sheltered space for proper docking of at least 30 customized cycles
- A small cabin for the Docking Station manager and space for smart card/ mobility card reader and support system for transactions
- Space for washing of cycles and minor repair and maintenance of cycles

Sub Station (at least 7m x 3m)

- Sheltered space for proper docking of at least 10 customized cycles
- A small cabin for the Docking Station manager and space for smart card/ mobility card reader and support system for transactions
- Space for washing of cycles and minor repair and maintenance of cycles

Cycles

- State-of-the-art bicycles
- In-built hidden GPS devices for tracking

Figure 6.19: Docking stations

Most of the substations can be located near activity centers including institutional buildings, hospitals, banks, commercial complex etc. The distance between two sub stations should be kept lower than 1 km. The location list for main docking station and substations is presented in the next section of this report

6.3.5 Parking Strategy

Development of a parking strategy is necessary in order to shape the framework for the future provision, management and maintenance of parking facilities. The development of this Parking Strategy has been based on an understanding of the parking supply and demand position in Visakhapatnam City.

The parking strategies that would be considered for Vizag include

- Off Street parking facilities
- Parking Pricing
- Restriction of on street parking on mobility corridors

The central city area of Visakhatpatnam (Town main road, Daba Garden road, Raja Ram Mohan Rai road, Waltair main road etc) is developed with commercial as a predominant activity. Lack of land availability for off street parking is forcing vehicles to park on streets. The list of recommended off-street parking locations is presented in the next chapter. To encourage the use of off street parking facility, the on street parking charges should be kept higher than off street parking fees. The pricing should be based on three aspects viz type of parking, location and demand management. At introductory level, fees can be kept at Rs 10 for first two hours for on street parking and Rs 5 for off street parking. However, a detailed parking demand management study is recommended which may incorporate the financial viability and funding options for off street multistory parking schemes

Figure 6.20: MLCP and Paid On street parking

- Provision of Off Street parking facilities (Parking Plazas and MLCP)
- Competitive Parking Pricing
- Restrictive Parking Strategies (No on-street parking on mobility corridors etc.)

6.3.6 Traffic Engineering and Management Measures

Traffic Engineering Measures generally qualify as short term measures for bringing in immediate relief from traffic problems. A combination of several measures can prove to be effective means of problem solving. These measures are generally not very capital intensive and give instant results.

Figure 6.21: Typical TEM measures

Table 6.22: Typical TEM measures

Road Markings	Signages	Intersection improvements
Traffic separator/ channelizer	Traffic Calming Techniques	Delineators
Footpath repair works	Signalization of intersections	One way streets
Road rectification-patch repair	Resurfacing/ strengthening of road stretch	Speed limits

Convent junction, LIC junction, Saraswati junction, Jagdamba junction etc are few of them which can be considered for short term improvement plans. The construction or widening of rail over bridges can also be given consideration as a part of short term improvement measures. The detail list comprising traffic engineering projects is presented in the next chapter.

ITS Management

Another important area that will assist and help significantly is the development of electronics in traffic management. The total ITS package however is very intricate and may not find applicability immediately in true mixed traffic (Indian) conditions. However it will be essential to pursue the following:

- Set up a traffic management center
- Install Video cameras at key locations
- Set up a communication system with local policemen
- Set up a communication with the traffic signal controller.

At present in Vizag, CCTV system is not in place. For better traffic management, all important junctions presented in junction analysis need appropriate number of cameras and should further be monitored from central traffic management centre.

IPT Management

The main IPT in Vizag are the share auto rickshaws. They do not have designated parking places at most of the areas in the city which is causing an unsafe scenario for the road user. Hence it is recommended to have dedicated auto-rickshaw parking bays. The RTO must identify these locations for the orderly parking of auto-rickshaws. Besides at all the bus stops, terminals and railway stations, integration with IPT should be achieved for smooth interchange. It is also important to relook into the auto permits and restrict them on the public transport routes (Mainly on the bus routes) to avoid conflict of interest. To support environmental friendly development, the new auto permits or renewal of auto permits should be restricted to the less emission vehicles.

5.3.7 Traffic and Travel Demand Management

Travel demand management is an intervention,(excluding provision of major infrastructure), to modify travel decisions so that more desirable transport, social, economic and/or environmental objectives can be achieved, and the adverse impact of travel can be reduced. A combination of TDM strategies and policies help reduce travel demand or redistribute this demand in space or in time. A demand management approach to transport has the potential to deliver better environmental outcomes, improved public health and stronger communities, and more prosperous and livable cities. A broad range of demand management strategies are available and can be brought to use depending on the situation and suitability. Some of the "tools" used for TDM are listed below.

- Subsidizing transit costs for employees or residents.
- Car parking controls and pricing
- Flex-time work schedules with employers to reduce congestion at peak times
- Congestion pricing tolls during peak hours.
- Road space rationing by restricting travel at certain times and places.
- Workplace travel plans
- Road space reallocation, aiming to re-balance provision between private cars and other sustainable modes
- Introducing active trip reduction programs

The city can choose and implement any of these strategies, as they do not have any financial implications

Congestion cess can clean up CP, says study

Will Force Many To Take Public Transport

Dipak.Dash@timesgroup.com

New Delhi: A one-of-its-kind study on Delhi has found how imposition of congestion charge on private vehicles around Connaught Place would compel between 13% and 23% people to leave their vehicle back home and use public transport.

The study, conducted by Ahmedabad-based Centre for Environmental Planning and Technology (CEPT) University in February, suggests that while imposing Rs 160 per trip per vehicle congestion charge could make 13% car users shift to public transport, increasing it to Rs 200 would shift around 18% car users to use public transport.

"We interviewed about 300 car users and gave them four options. We concentrated only on those users who take work and business trips as those trips are quite frequent compared to social and recreational trips. We found congestion charge of Rs 240 would lead to maximum number of shift of mode from private cars to public transport (13%)," Minoti Rawat, who did the study told **TOI**.

The study was presented at the recently concluded urban mobility summit organised by the Union urban development ministry. The ministry in the past has suggested states including Delhi to look into congestion charging.

PREPARING FOR FUTURE RUSH

Roads	Vehicle capacity (in PCUs*)	Present volume	Likely by 2018
Janpath	6,000	5,350	6,126
K G Marg	4,000	5,543	6,346
Barakhamba Rd	4,000	6,839	7,830
Vivekananda Rd	4,000	5,723	6,552
Panchkuian Rd	6,000	4,856	5,560
Kharak Singh Marg	4,000	7,334	8,396
Sansad Marg	4,000	3,815	4,368
Chelmsford Rd	4,000	3,319	3,800

*Passenger car units per day

The study, conducted by Ahmedabad-based Centre for Environmental Planning and Technology (CEPT) University in February, suggests that while imposing ₹160 per trip per vehicle congestion charge could make 13% car users shift to public transport, increasing it to ₹200 would help switch around 18% car users to public transport

Figure 6.22: Congestion Cess case study for Delhi CP area

6.4 Social and Environmental Impact

The impact of the proposed projects from the social angle is analyzed at a broader perspective. It is found that most of the projects have significantly less impact with respect to Rehabilitation and Resettlement. Land acquisition for some of the projects is inevitable. The proposed projects significantly improve mobility with reduced travel time. The broad impacts have been compiled in Table 6.23.

Table 6.23: Impacts of CMP projects

Project	Right of way / Land Acquisition	Requirement of Rehabilitation & Resettlement	Improve Mobility	Reduction in Travel Time
Bus Fleet Augmentation	No	No	Yes	Yes
High Order Transit System	Yes	Yes	Yes	Yes
Intermodal Stations	Yes	Yes	Yes	Yes
Bus Terminals	Yes	Yes	Yes	N/A
TTMC / Transport Hub	Yes	Yes	Yes	N/A
Freight Terminals	Yes	Yes	Yes	N/A
Bus Shelters & Bus bays	Yes	Yes	Yes	Yes
ROBs / New Roads	Yes	Yes	Yes	Yes
Foot Path	No	No	Yes	N/A
Pedestrian FoB /Subway	No	No	Yes	N/A
Major Junction Improvements	No	No	Yes	Yes

Environmental and social screening is intended to provide inputs into identification of potential impacts with the implementation of the CMP. Screening is conducted by identifying the interaction of environmental components on the project activities for various projects. Screening conducted for the identified projects and respective impacts identified are presented in Table 86

Table 6.24: Impacts of CMP projects' Activities

Activities	Impact
Regional Hubs based on Transit Oriented Development principles	
• Development of serviced land for high density development • Public transport interchange hubs	• Land acquisition from farmers • Construction activity around the highway
Pedestrian / NMT Infrastructure Improvement	
Land acquisition for road widening and creation of service lane where ever necessary	• Relocation of existing vending activity • Removal of squatters and encroachers from the footpaths • Loss of shelter for temporary shops / residences for squatters and encroachers
Construction of new footpaths	• Improvement in safety of pedestrians due to measures proposed
Pedestrian Infrastructure development like subways/foot over bridges/ signals etc	• Improvement in pedestrian safety • Slowing of traffic at the time of constructing and erecting structures across major intersections
Public Transport Planning	
Dedicated public transport network	• Land acquisition for dedicated lanes will cause Rehabilitation &Resettlement issues • Use of existing pavement width for dedicated bus lanes will • cause removal of squatters and encroachments from roadsides causing loss of livelihood and loss of shelter • Construction / improvement of bus lanes will be causing construction issues as: • Generation of noxious gases during construction increasing air pollution • Temporary increase in noise pollution during construction • Contamination of road runoff with construction material stacked on road side • Traffic diversions causing lengthening of routes increasing air emissions and exposing previously unexposed neighborhoods. to noise • Reduction of additional lane width for other traffic if existing road width is used for demarcating the dedicated bus lanes • Reduction in private vehicles causing reduction in air / noise pollution

Activities	Impact
Terminals/Depots/TTMC/ Transport Hubs/ Commuter Amenity Centers	• Acquisition of land for the facilities causes Rehabilitation &Resettlement issues as loss of livelihood, loss of shelter, severance of community & social ties • Increase of noise and air pollution in the areas of terminals and depots • Improvement in approaches to the terminals and depots causing impacts on adjacent landuses and land acquisition • Additional land acquisition, if any for the approach road improvement will lead to R&R issues along the roads and cause impacts on livelihood and shelter • Construction stage impacts include the increase in air and noise pollution • Contamination of road runoff with stacked construction materials • Improvement of traffic conditions during operation stage causing reduction in air and noise pollution
Bus-Stops and FOBs/Sub-ways	• Temporary interruption to traffic and increase of emissions from vehicles due to higher idling times • Temporary increase of noise levels due to idling and traffic snarls • Alternate traffic diversion routes increasing route length and consequently emissions • Alternate traffic diversion routes exposing previously low traffic routes to higher urban traffic and increasing air / noise pollution • Removal of squatters and encroachers from the footpaths causing livelihood losses at approaches to the sub-ways / FOBs • Loss of shelter for temporary shops / residences for squatters and encroachers at approaches to the sub-ways / FOBs
Others Road Infrastructure	
Junction Improvements	• May cause removal / displacement of squatters & Encroachers . • Air and noise pollution from construction impacts • Contamination of runoff from road with construction material as sand / cement / silt from stacked excavated earth

6.4.1 Location Impacts

The location Impacts being analyzed are associated with site selection and project location on environment and resettlement or livelihood related impacts on communities. Some of the generic impacts associated with location of project facilities that involves construction activities either by acquiring additional land and / or public land encroached by residents are as below:

• Major environmental features such as lake fronts, parks etc., in the urban areas would generally be avoided and hence environmental impacts on these areas would be minimal to absent.

• Projects do not have any major environmental features that are sensitive to acquisition of land as it is nominal in case of the conceived projects.

• Removal of encroachments and squatters lead to loss of livelihood and / or shelters, further impacted by the pressure of relocation as well as loss of income and their removal.

• Breakup of established social fabric and cause severance of established relationships amongst the community.

Some of the specific impacts associated with construction of flyovers involve disruption to existing traffic flow, especially, if located in the congested urban stretches. These would also involve land acquisition (either temporary or permanent) and would also impact the squatters and encroachers affecting residences and / or livelihood. Project interventions such as ITS application, improvement in public transport infrastructure would only improve the environment rather than causing pollution though resettlement impacts would be present to a limited extent

6.4.2 Construction Impacts

Impacts resulting from pre-construction and construction activities including site clearance, earthworks, civil works, etc are identified in this section. Pre-construction and construction impacts arise due to dismantling of existing facilities, use of heavy construction machinery, spillage / disposal of construction debris, runoff from construction site, inadequate or inappropriate drainage of the construction site, inadequate safety measures etc. These are some of the direct impacts of construction in the project area.

In addition to the above, there are few indirect impacts or impacts that result from construction activities though not causing the impacts, support to cause the impacts. The above environmental impacts are generic in nature occurring along all the project activities where civil works are involved. Impacts that are specific to the construction activities in a project intervention are presented below.

• Construction activities in case of reconstruction of footpaths or construction of new foot paths would cause temporary interruption to traffic and increase of emissions from vehicles due to higher idling times apart from temporary increase of noise levels due to idling and traffic snarls

• Loss of adequate frontage in few cases of foot path construction or provision of additional cycle lanes and bus lanes

• Relocation of utilities in the pre-construction stage causing temporary disruption to services. These impacts would be more severe in case of construction of exclusive bus lanes and foot paths

- Safety of pedestrians and traffic in the area is likely to be affected due to the progress of construction activities
- Construction activities elevate the air pollution and noise pollution in the project area temporarily. Air pollution is due to generation of noxious gases emanating from construction equipment, crushers etc., while noise pollution is due to operation of various types of construction equipment
- Stacking of construction waste causing interruption to traffic and pedestrian movements.
- Runoff from staked construction waste entering the water bodies and existing drainage systems causing clogging of drain outlets as well as the drains themselves

Project interventions as procurement of low emission vehicle fleets, traffic signal prioritization, ITS, provision of signage etc., involve minimal construction activities and hence, environmental and social benefits from these activities will outweigh any minimal impacts that may occur.

6.4.3 Operations Impact

These are the Impacts associated with the operation and maintenance of the infrastructure built in the project. The project interventions are conceived to provide maximum benefits to the community with the implementation of the project. The project interventions as could be judged from the discussion so far involve environmental and resettlement impacts during pre-construction and construction stages of the project and appropriate mitigation and management measures would be undertaken to avoid the same.

Negative environmental / social impacts in the operation stage would mostly be limited to air and noise pollution along the improved road infrastructure as well as the parking areas. While there would be loss of usual transport routes for provision of pedestrian routes or NMT, overall improvement in environmental quality is anticipated in the operation stage.

While in previously polluted and congested core city areas / heritage areas would be experiencing better environmental quality than before the project implementation due to pedestrianization and encouraging NMT. Pedestrian safety would also be improved with the implementation of the project.

Implementation of ITS and traffic signal prioritization interventions would also aid in better management of traffic leading to improvements in air and noise quality.

6.4.4 Emissions

The vehicular emissions for both the scenarios were calculated from the model and are shown in table 6.25 - 6.27 The assumptions related to vehicular exhaust were taken from CPCB Norms and are given in annexure.

Table 6.25: Reduction in vehicular exhaust (2021) in Gms

Reduction in vehicular exhaust (2021) in Gms	Bus	Auto-Rickshaw	Shared Auto / Tata Magic	Two Wheeler	Four Wheeler	Total
CO	56425	322561	40895	778754	111597	**1310232**
HC + Nox(G/KM)	177336	322561	40895	778754	16982	**1336528**
PM	2687	-	-	-	-	**2687**

Table 6.26: Reduction in vehicular exhaust (2031) in Gms

Reduction in vehicular exhaust (2031) in Gms	Bus	Auto-Rickshaw	Shared Auto / Tata Magic	Two Wheeler	Four Wheeler	Total
CO	365394	436867	55216	1030796	64340	**1952613**
HC + Nox(G/KM)	1096183	436867	55216	1030796	11581	**2630643**
PM	4872					**4872**

Table 6.27: Reduction in vehicular exhaust (2041) in Gms

Reduction in vehicular exhaust (2041) in Gms	Bus	Auto-Rickshaw	Shared Auto / Tata Magic	Two Wheeler	Four Wheeler	Total
CO	461701	668497	84638	1597783	99629	**2912247**
HC + Nox	1385102	668497	84638	1597783	17933	**3753953**
PM	6156					**6156**

Chapter 7

Comprehensive Mobility Plan

7 Comprehensive Mobility Plan

7.1 The CMP (Project Proposals)

The previous chapter described transport strategies and measures for Visakhapatnam. This chapter describes strategy wise recommended projects

7.1.1 Public transportation proposals

7.1.1.1 City Bus System Improvement

To achieve the best level of service in public transport parameter as per SLB handbook the city bus system improvement plan is proposed for Visakhapatnam. The bus fleet augmentation is proposed to achieve the LoS-1 in supply of public transport, thus augmenting the fleet as per desired quantity of 60 buses per lakh population. The proposed city bus fleet size for future years based on projected population is in Table 7.1.

Table 7.1: Number of buses required in GVMC area

Year	Urban population (GVMC Area)	No of buses required (LoS-1)
2016	2044257	1227
2021	2607388	1565
2031	3789111	2274
2041	4773343	2864

It is also proposed to develop the city bus infrastructure in line with the fleet augmentation plan proposed above. To carry out daily maintenance and workshop activities for buses, Bus depots are required to be developed.

The suggested locations act as origin or destination points for the future routes to minimize the dead mileage. Also the terminals are required to be developed. The location suggested for same are shown in figure 7.2. At each proposed location, minimum 5 acre land is required to accommodate sufficient number (at least 100 each location) of buses for depot and maintenance activity. In absence of sufficient land, the possibility of multistory bus parking could be explored with detail study.

Route rationalization and expansion also need to be carried out in future years for expanding reach of public transport in future years.

7.1.1.2 Mass Rapid Transit Systems

To High demand mobility corridors which are eligible for a mass rapid transit systems are presented below. Based on the model results, they are categorized into Light Rail Transit System corridors and Bus Rapid Transit System corridors. The same are shown in table 7.2.

Table 7.2: Proposed Metro corridors

Corridor Name	PPHPD (2041)	Length
Kommadi Junction to Gajuwaka Junction	13000	30.3
Gurudwara to Old Post Office	11000	5.2
Chinvalteru (East Point) to Thatichetlapalem	6000	6.9

Table 7.3: Proposed BRTS corridors

Corridor Name	PPHPD (2041)	Length
Kommadi Junction to Thagarpuvalasa	4800	16
Gajuwaka Junction to Anakapalle	4500	22
Scindia road and Gajuwaka Scinidia road via RTC Complex to Port Area	6000 -7500	20

Table 7.3: Up gradation of existing BRTS Infrastructure

Corridor Name	PPHPD (2041)	Length
Simhachalem Transit corridor	4500	14.5
Pendurthi Transit corridor	6000	10.5

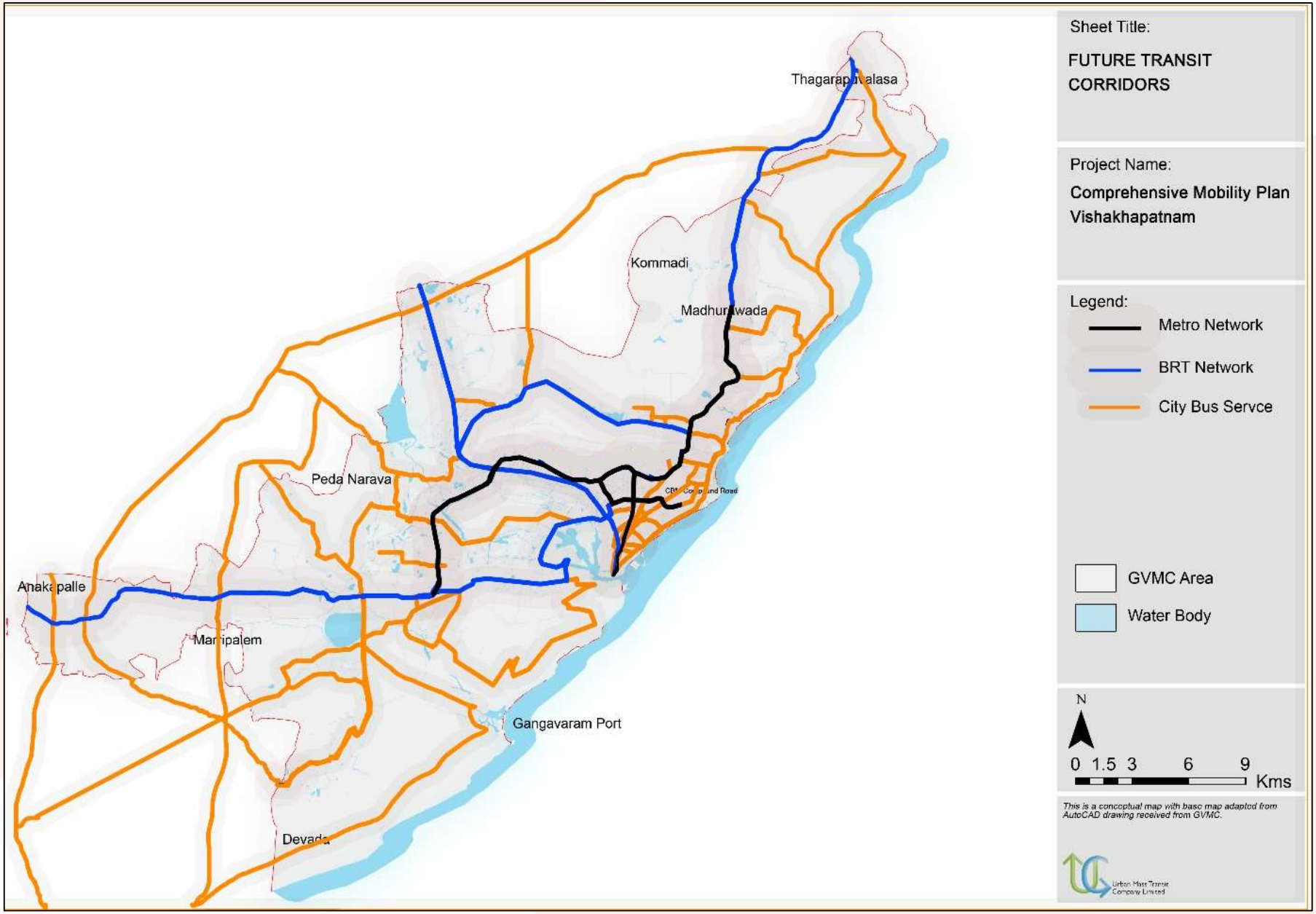


Figure 7.1 Proposed Transit Corridors

7.1.1.3 Multi Modal Integration Hubs Development

At the intersection of each mobility corridor, a transfer terminal should be facilitated. The transfer terminal is technically called as Multi-Modal Integration Hub. The proposed multimodal hubs will act as transfer station for all PT modes in addition to parking facility and NMT main docking station. The proposed Multimodal Hub locations are given in Table 7.4 and are represented in Figure 7.2

Table 7.4: Proposed Multimodal Hub locations

Name	Number of modes	Modes	Remarks
Visakhapatnam Airport	4	• Airport • Mass Transit System (Metro) • IPT / Airport Connectors	Regional Service to City transport
Visakhapatnam Railway Station	4	• Regional rail • Mass Transit System (Metro) • Bus Rapid Transit System • City Bus Service	
RTC Complex	4	• Regional Bus Service • Mass Transit System (Metro) • Bus Rapid Transit System • City Bus Service	
Pendurthi regional rail station	2	• Regional rail • Bus Rapid Transit System • City Bus Service	
Simahachalem regional rail station	2		
Anakapalle railway station	2		
Gajuwaka Junction	3	• Mass Transit System (Metro) • Bus Rapid Transit System • City Bus Service	Within City Transport Modes
NAD junction	3		
Hanumanthawaka junction	3		
Kommadi junction	3		

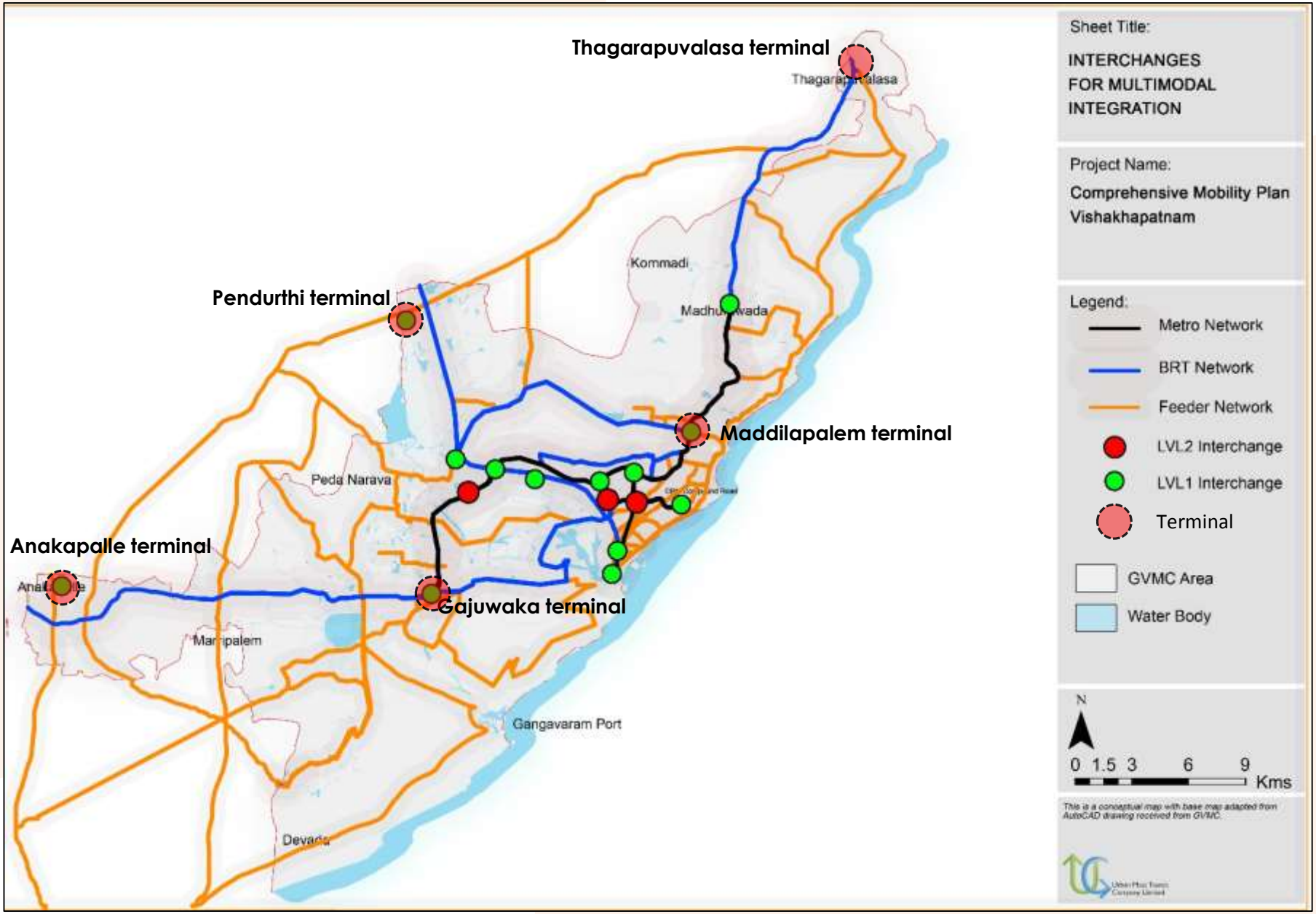


Figure 7.2 Interchanges and Terminals for Multimodal Integration

7.1.1.4 Intelligent Transport System (ITS)

Intelligent Transportation System (ITS) implementation for Visakhapatnam essentially offers a highly capable and automated transit management platform, which could pave way for proposed city bus services, to provide high service delivery standards and operational efficiency. ITS will play a key role in improving the efficiency of City Bus Services.

The critical sphere of ITS are given as per following:

1. Automatic Fare Collection (AFCS) system

The proposed AFCS system consists of the following sub-systems:

- Card Issuer Module
- the AFCS backend sub-system
- Depot Stock Management System
- Point of Sale Terminal sub-system
- the interconnectivity between the above sub-systems
- Any other module which can be specified at a later stage

2. Validators (One per bus)

One Validator, located at suitable place inside bus with a fire resistant wired interconnection is needed. The Validators possess suitable non-volatile memory for storing the captured AFC transactions as well as the fare structures and other necessary parameters.

3. Electronic Ticketing Machine (ETM)

The Electronic Ticketing Machine will be used by the conductor on-board

- To issue paper tickets
- To validate Smart Cards for trip and passes and deduct money from the ewallet of the AFCS card based on the concept of fare stages.

Further, the ETM possesses a GPRS interface for communication to the AFCS backend via a suitable service provider's infrastructure.

4. Security Access Modules (SAM)

In order to ensure the security of the transactions being captured, the ETM and Validator support the use of Security Access Modules (SAM) in slots for SIM cards.

5. Integrated Control Unit (ICU)

The primary function of the ICU is to establish communication between the bus onboard AFCS equipments and the concerned backend equipment. It has the
following features:

- GPRS connectivity to connect to the AFCS backend through a suitable service provider's infrastructure
- USB port, as a backup, for communicating with a computer at the bus terminus/depot for uploading transactions and downloading new fare structures and other important parameters

6. Backend Sub-System

The backend sub-system typically consists of the following:

- The Communication/transaction server that connects to the GPRS service provider's infrastructure for
- Acquiring AFCS related transactions from the ETMs/ validators of all buses and sending it to the CSTC server.
- Sending the necessary new fare structures and parameters available on the CSTC server to the ETMs and Validators.

The components are as follows:

a) The Centralized Data Server, which holds the complete AFCS system's database.

b) The CCC workstations that are used to obtain information and generate reports relevant for the CSTC from the AFCS server

c) The backend sub-system provides a wide variety of MIS reports.

d) The AFCS backend includes a software module, which interfaces with the backend server for mapping the initialized smart card data.

7.1.2 Road Network proposals

Certain missing links in the road network need to be bridged which shall thereafter ensure proper distribution of traffic on all links and prevent too much convergence of trips and resulting congestion on certain links, as it happens currently. The missing links need to be created so as to complete the inner ring road in the short term as well as to create additional links in the form of outer ring road for future scenarios when the inner ring road shall get saturated.

Major Rings

A. Gangavam Yarada Road – NH16
B. Simhachalem BRTS Corridor connected to NH16 & Steel Plant
C. Erukunaidupalem to Kalapaka (via Lankelapalem)
D. Chennai – Srikakulam Highway

Major Radials

1. Beach Road
2. NH-16
3. Simhachalem Sontyam Road
4. Araku Visakhapatnam Road
5. Pedanarava road
6. NH-16 till Anakapalle
7. Gajuwaka Bye pass road
8. Gangavaram Port to Thallapalem

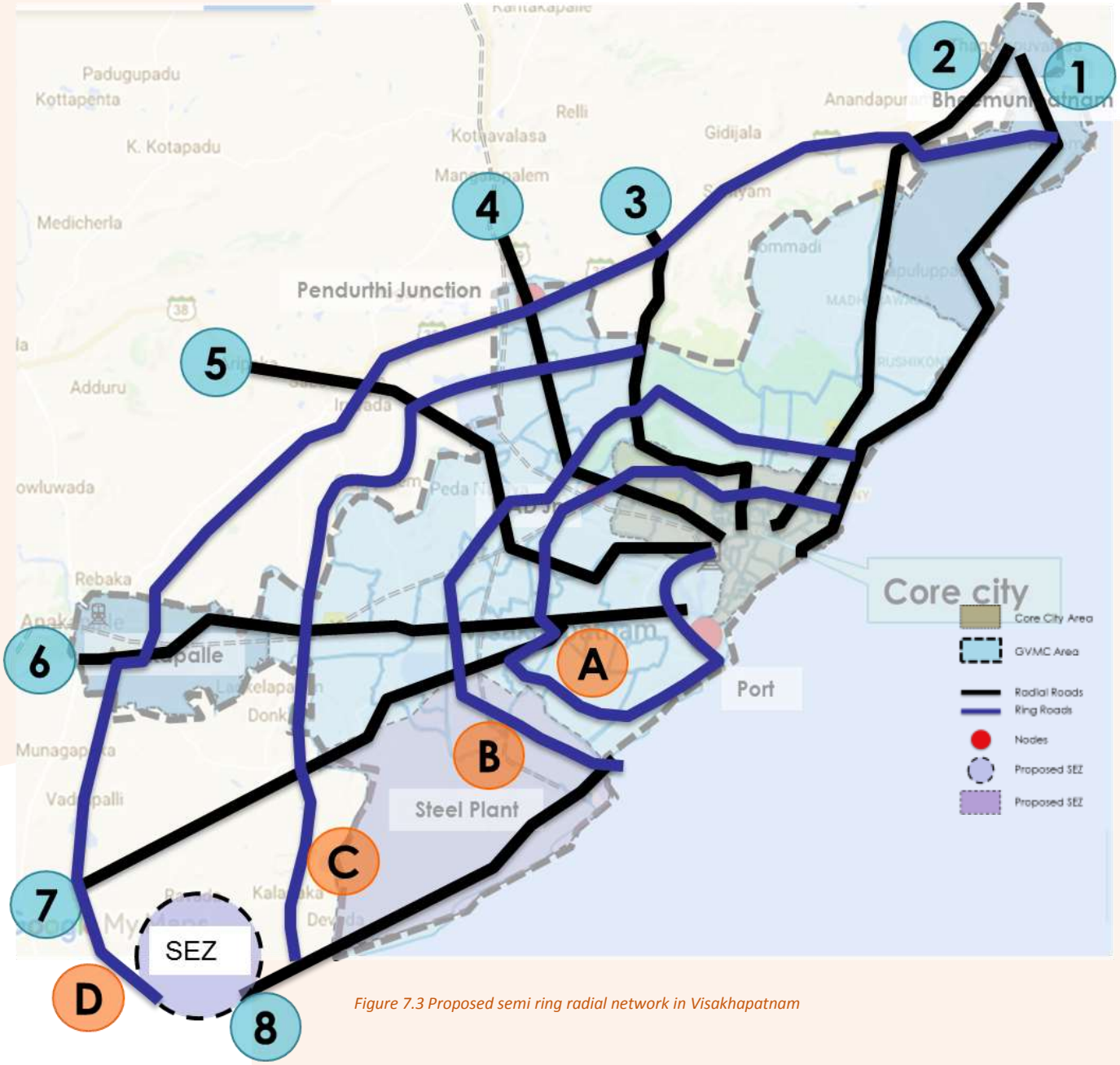


Figure 7.3 Proposed semi ring radial network in Visakhapatnam

Further, to supplement the missing links, the present capacities of various existing links on the proposed mobility corridors need to be enhanced. This needs to be done on corridors through removal of encroachment and repossession of ROW besides creation of grade separated roads wherever necessary.

Road Widening

A. Chennai Srikakulam highway (6 lane) Bheemunipatanam to Anakapalle to Thallapalem
B. Pedanarava Road (4 lane) Sheela junction to Chennai Srikakulam Highway
C. Vizag Srikakulam highway (6 Lane) Sheela junction to Kurmanpalem Jn.
D. Gajuwaka Bye pass road (6 lane) Gajuwala Junction to Atchutapuram
E. Gangavaram Yarada Road (6 lane) Scindia Jn. To Gajuwaka Jn.
F. Link II to Gymkhana Club Road (6 lane) Convent Jn to Old Post Office Jn.
G. Simhachalem Sontyam Road (6 lane) Old Adavivaram to Sontyam Jn.

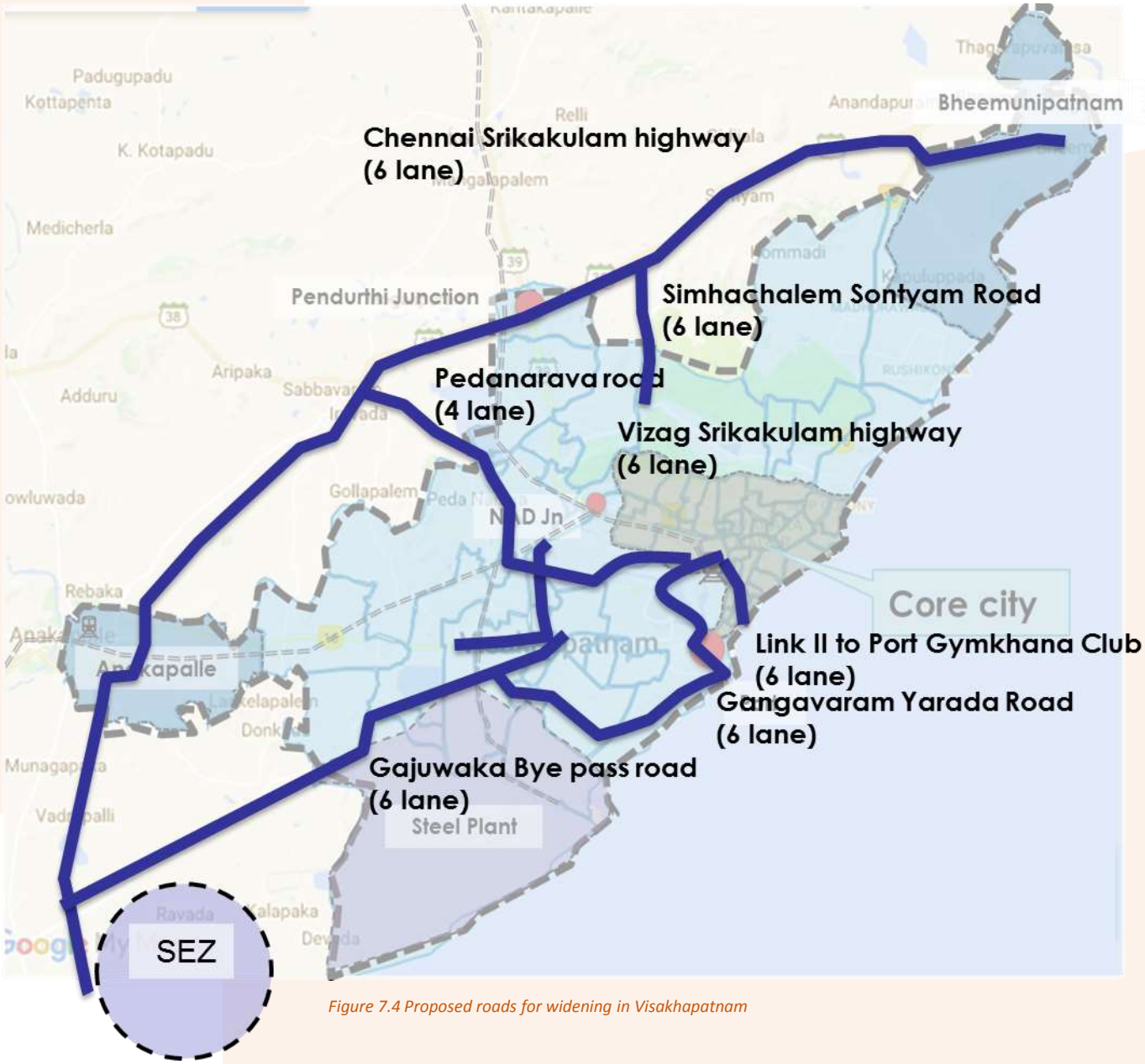


Figure 7.4 Proposed roads for widening in Visakhapatnam

New Roads

A. Kalapaka (Devada) (via Lankelapalem) to Simhachalem-Sntyam Road (4 Lane)
B. Gangavaram Port to Thallapalem (6 Lane)
C. Sheela Junction to Kurmannapalem (6 Lane)

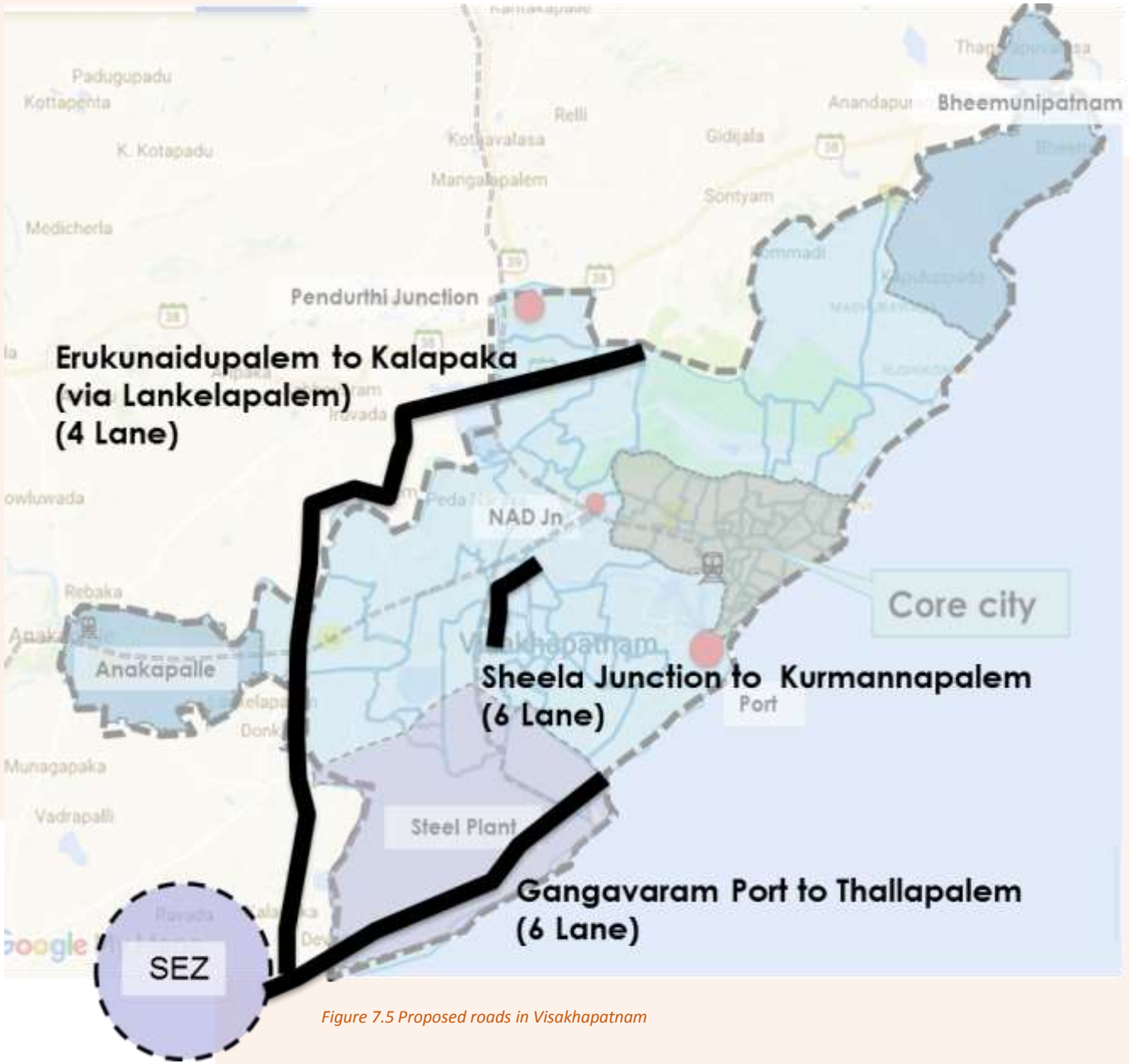


Figure 7.5 Proposed roads in Visakhapatnam

7.1.3 Non-Motorized Transport Proposal

Construction of Footpaths

With careful understanding of availability of footpath on major corridor, it was observed that nearly 190 km stretch comprising major trunk network require pavement improvement. This can be considered as a short term proposal with immediate attention for pedestrian safety. The proposed footpath network is given in Figure 7.6

Construction of Cycle Track

The corridors identified as mobility corridors in Vizag can also be considered for providing cycle track on both side of the road. The same are listed in the Table 7.5

Table 7.5: Proposed Cycling Network

Cycle track along proposed Metro corridors (Phase 1)	
Corridor Name	Length
Kommadi Junction to Gajuwaka Junction	30.3
Gurudwara to Old Post Office	5.2
Chinvalteru (East Point) to Thatichetlapalem	6.9
Cycle track along proposed BRTS corridors (Phase 1)	
Corridor Name	Length
Pendurthi Transit Corridor	10.5
Simhachalem Transit corrridor	14.5
Cycle track along proposed BRTS corridors (Phase 2)	
Kommadi Junction to Thagarpuvalasa	16
Gajuwaka Junction to Anakapalle	22
Scindia road and Gajuwaka Scinidia road via RTC Complex to Port Area	20

Apart from the primary road network mentioned in the Table 90, some of the secondary and tertiary roads are also proposed for cycle track provision. The detail network is highlighted in the Figure below. Considering both primary and secondary road network, almost 190 km network length is proposed for cycle track provision. The approximate length of total cycle track network is around 380 running km.

Bike Sharing Project

Majority of the mobility corridors are recommended for dedicated cycle tracks on both side of the roads. As part of their infrastructure requirement and bike sharing scheme, the major docking stations are proposed at each Transit station (Metro, BRTS station and Interchanges etc). The detail list is presented in the 7.6.

Table 7.6: Proposed cycle docking stations

Docking stations at proposed Metro corridors (Phase 1)	
Kommadi Junction	Sheela Nagar
Shilaparamam	Auto Nagar
Yendada	Gurudwara
Adarsh Nagar	RTC Complex
Venkojipalem	Sarswati Circle
Maddilapalem	Old Post Office
Akkayapalem	Andhra University
Kancharapalem	RTC Complex
Murli Nagar	Vishakhapattnam Railway Station
NAD Junction	Thatichetlapalem
Docking stations at proposed BRTS corridors	
Docking stations spaced at 3 kms	

Figure 7.6 Proposed NMT network in Visakhapatnam

Foot Over Bridges and Walkways

Busy junctions can be provided with well-designed circular pathways to ensure safety for pedestrian movement. The details for proposed walkways are in Table 7.6

Table 7.6: PV^2 Analysis and proposls

	Vehicular Volume	Vehicular Volume	Pedestrian Volume	Pedestrian Volume	PV^2 (N-S)	PV^2 (E-W)	Proposal
	(N-S)	(E-W)	(E-W)	(N-S)			
Assilmetta Junction	1639	1898	2097	1888	56 x 10^8	68 x 10^8	Since PV^2 Value is greater than 10^8, Free flowing speed is greater than 65 kmph, FOB is required in all the junctions.
Dolphin Circle	961	534	914	1297	8 x 10^8	4 x 10^8	
Gajuwaka junction	418	1900	1815	1918	3 x 10^8	69 x 10^8	
Gopalpatnam Petrol Bunk Junction	2100	2300	916	1017	40 x 10^8	54 x 10^8	
Gurudwara junction	2800	1008	1243	1218	97 x 10^8	12 x 10^8	
Hanumanthawaka Junction	790	3200	1417	1519	9 x 10^8	156 x 10^8	
Jagadamba junction	1008	273	2174	1924	22 x 10^8	1 x 10^8	
NAD Junction	2300	857	2095	2329	111 x 10^8	17 x 10^8	
Old Jail Road junction	1100	843	2270	2298	27 x 10^8	16 x 10^8	
Siripuram junction	1500	1267	647	612	15 x 10^8	10 x 10^8	
Thatichetlapalem junction	3200	1300	1668	1507	171 x 10^8	25 x 10^8	

7.1.4 Freight Management

Freight Management is proposed through following ways

1). Dedicated freight corridor development

The Chennai Srikakulam highway and Dedicated Freight corridor (Port to Thallapalem to SEZ) are proposed to carry major freight transport. The details of divertible traffic is listed in annexure 8.5.

2). Freight terminals

The dedicated freight terminals are required at the city periphery on these dedicated freight corridors.

During Phase II (2021-2031), 1 Freight Terminal is proposed for development in 'Devada' and a trans-shipment point on Road between the SEZ (Near Atchutapuram) and Gangavaram Port. Pre development of the said infrastructure under Phase I. The proposal is represented in Figure 7.7.

During Phase II and III (2021- 31), the area near steel plant and proposed freight terminal is proposed to be converted to an Integrated Freight Complex. The location is suitable owing to its proximity and connectivity to 'Visakhapatnam–Chennai Industrial Corridor (VCIC)' as well as its vicinity to the proposed SEZ (industrial areas) of Master Plan for Vizag, 2021

3). Tax/Octroi

Tax can be imposed on freight vehicles during day time to shift the freight traffic outside the city and HCVs shall be restricted in the city during 7 am to 1 pm and 4 pm to 9 pm.

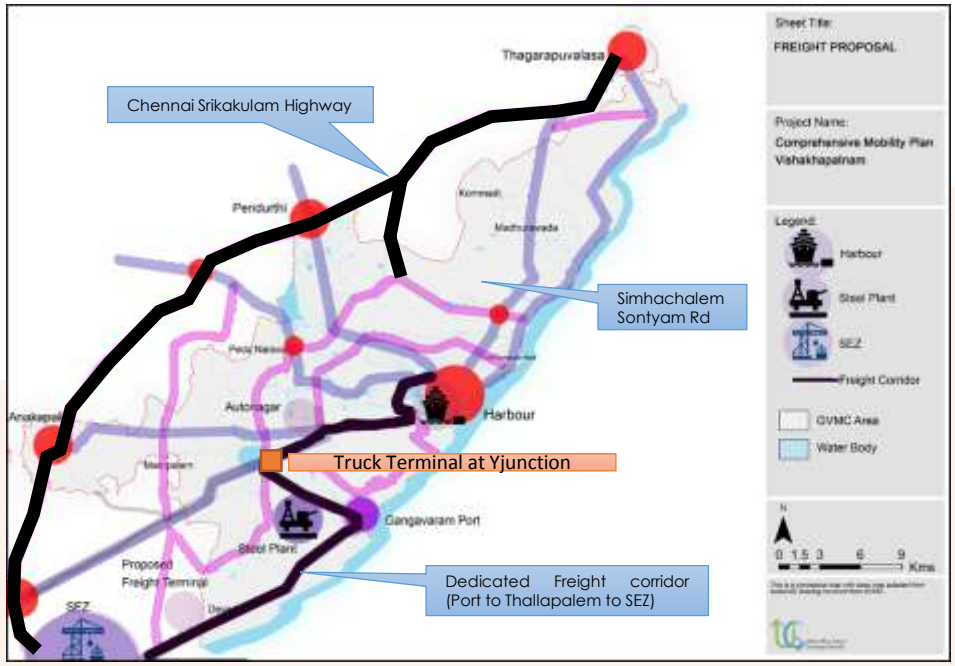


Figure 7.7 Proposed Freight corridors and Freight Terminal

The Chennai Srikakulam highway and Dedicated Freight corridor (Port to Thallapalem to SEZ) are proposed to carry major freight transport. Approximately 35 – 40% freight traffic is directly divertible to these corridors.

Figure 7.8 Existing and proposed routes for goods traffic

A : Durga nagar, Mudasarlova park, Arilova colony, Chinna gadhili

B : Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa

Current Route: National Highway 16

New Route: Simhachalem Sontyam road and Chennai Srkakulam highway

Total Divertible Volume: 2228 PCUs

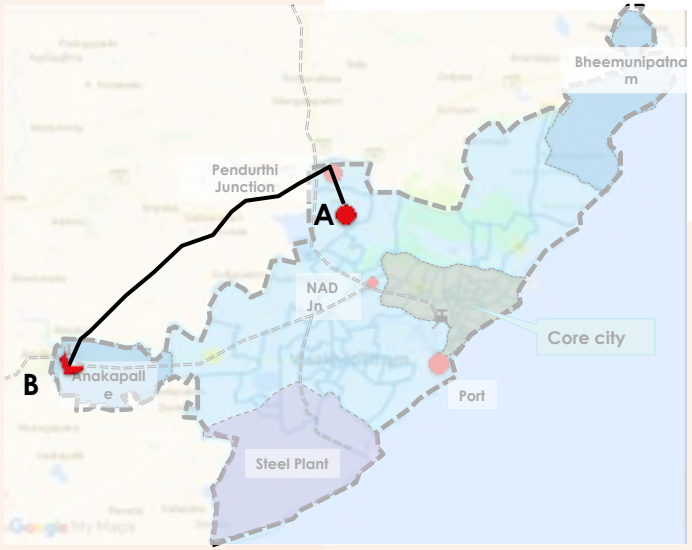
A : Visakha Container terminal and adjoining areas

B : Towards Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad

Current Route: Port main road, Scindia road and Lankalapalem Simhadri NTPC power plant road

New Route: Dedicated Freight corridor (Port to Thallapalem to SEZ)

Total Divertible Volume: 9008 PCUs



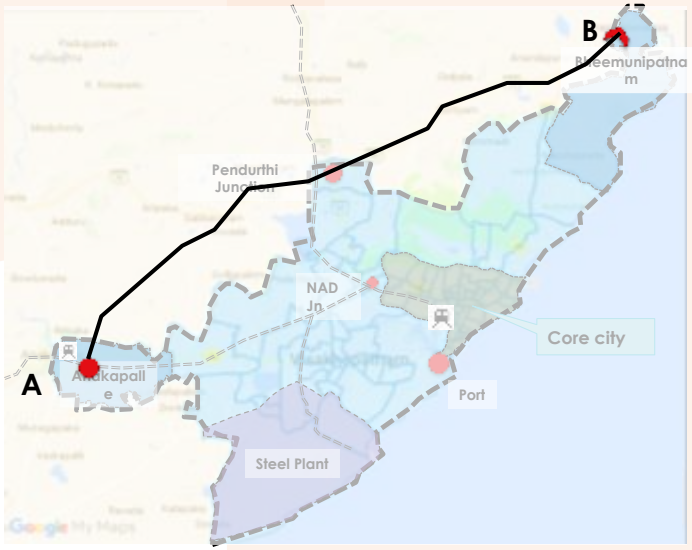
A: Ratnagiri nagar, N.A.D. Vuda layout, Valimeraka, Purushottapuram, Kavali, Port colony

B : Anakapalle, Sankaram, Gopalapuram, Konda kopakka, Kannuru, Maredupudi Agraharam, Bhatlapudi, Golagam, Rajupalem, Mantripalem

Current Route: National Highway 16

New Route: Chennai Srkakulam highway

Total Divertible Volume: 1327 PCUs



A : Anakapalle, Sankaram, Gopalapuram, Konda kopakka, Kannuru, Maredupudi Agraharam, Bhatlapudi, Golagam, Rajupalem, Mantripalem

B : Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa

Current Route: National Highway 16

New Route: Chennai Srikakulam Highway

Total Divertible Volume: 3603 PCUs

Figure 7.9 Existing and proposed routes for goods traffic

A : Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad

B : Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa

Current Route: NH16 and Lankalapalem Simhadri NTPC power plant road

New Route: Chennai Srkakulam highway

Total Divertible Volume: 23090 PCUs

A : Pedamusidivada, Ajanagiri, Gangavaram, Nanginarapadu,

B : Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad

Current Route: Lankalapalem Simhadri NTPC power plant road

New Route: Dedicated Freight corridor (Port to Thallapalem to SEZ)

Total Divertible Volume: 2655 PCUs

Figure 7.10 Existing and proposed routes for goods traffic

7.1.5 Parking Proposal

Table 7.6 list the sites which may be considered for the off-street parking locations. The detailed feasibility study shall be undertaken for finalizing the locations. The assumptions related to vehicle growth rate are shown in annexure

Table 7.6: Parking demand analysis and proposals

	Current Supply (PCUs)	Parking Demand / hour (PCUs)				Phasing
location Name		**2017**	**2021**	**2031**	**2041**	
Marripalem Kancharapalem	None	65	84	163	319	Phase 1
Dwarkanagar road	None	69	89	173	339	Phase 1
Rama Talkies Road	None	71	92	178	349	Phase 1
CBM Compound road	None	90	117	225	442	Phase 1
NAD Gopalapatnam Road	None	99	128	248	487	Phase 1
Dwarka Complex road	None	101	131	253	496	Phase 1
Kailashgiri	205	109	141	273	536	Phase 2
Maddilapalem Jn	230	110	143	275	541	Phase 2
Daba Garden road	210	127	165	318	624	Phase 2
RK Beach	455	187	242	468	919	Phase 2
Jagdamba Jn	290 **	190+	246	476	934	Phase 2
Siripuram Junction	*	200+	259	501	983	Phase 1
Poorna Market	175	210	272	526	1032	Phase 2
Simhachalem	365	220	285	551	1081	Phase 2
Vizag Railway Station	1355	220	285	551	1081	Phase 2
Gajuwaka Jn	385	300	389	751	1475	Phase 2

7.1.6 Traffic Engineering and Management Proposals

Proposed junctions for improvement

The traffic level at important junctions shown in Table 7.7 has already reached the range of 7000 to 24000 PCU during peak hour. The situation will become more considerable in Horizon years. Based on this, the junction improvement plan (Alignment and Geometry) can be considered as a part of short term improvement plan

Signage and Marking

The infrastructure improvement like ROB (as in interchange design), construction of new links will be more effective with the provision of proper signage and road markings. This will increase the safety and will bring discipline in driving conditions. As per the inventory analysis, 30 % of surveyed network (approx. 75 km) requires substantial improvements in providing proper signage and markings.

Table 7.7: Proposed Junctions for Improvements

ID	Name	Peak PCUS
TMC 1	Gurudwara Junction	13783
TMC 2	Jail Road Junction	15217
TMC 3	Thatichetapalyem Junction	12961
TMC 4	NAD Junction	31557
TMC 5	Hanumanthwaka Junction	24727
TMC 6	Petrol Bunk Junction	10923
TMC 7	Gajuwaka Junction	17733
TMC 8	Dolphin Hotel Junction	3539
TMC 9	Siripuram Junction	7873
TMC 10	Jagadamba Junction	4143
TMC 11	Asilmetta Junction	7186
TMC 12	Dwarka Nagar Junction	5131
TMC 13	Maddilapalem Junction	7064
TMC 14	Convent Junction	3621

Figure 7.11 Junction Improvement proposals

7.1.7 Short, Medium and Long Term Improvements

All the proposals discussed so far can be broadly grouped under three categories:

- Long Term Improvement: the usefulness for these improvements will last for more than 10-15 years
- Medium Term Improvements: the usefulness of these improvements will last for about 5-10 years
- Short Term Improvements: these are short term proposals that need to be reviewed and revised within 5 years as per the requirement.

Accordingly, long term, medium term and short term proposals for Vizag are shown in the Table 95. The breakup of quantities and cost are given in Table 96.

Table 7.8: Short , Medium and Long Term Improvements

Short Term Improvements	Medium Term Improvements	Long Term Improvements
Traffic and Pedestrian Management measures - Road Markings/ Signage	Off Street Parking Development	Metro Transit System
Junction Improvements and Management Measures	Bus Rapid Transit System	Redevelopment of City Bus Terminus
Construction of Footpaths	Traffic Management Centres	Rail Over Bridges (ROB)
On street Parking management	Bike sharing system	Truck Terminals
	Intelligent Transport System (ITS / ICT)	Flyovers
	City Bus System Augmentation	Intermodal Hubs
	New Roads	
	Elevated Walkway (FOB) / Underpass	
	Provision of Cycle Track	

7.2 Implementation/Phasing Plan

The projects identified in the earlier section are divided into three categories based on the urgency and duration of the implementation. The long term projects are came as the output of transportation model built specifically to understand the future demand and system requirement. Some of these evolved projects have potential to enter into Public Private Partnership (PPP); however detail case to case project reports are required for validating feasibility. The total cost of the proposed project is around 28,800 crores. It is important to highlight that the CMP serves only to identify schemes and once these schemes are detailed for feasibility and engineering purpose, some of these costs may vary. The tentative block cost estimation is done in reference with the district scheduled rates for year 2016-2017

The overall short term project cost is estimated to be 255 crores. All junction improvement schemes, footpath implementation, cycle track network development etc. will fall into this category. While implementation of ROB, developing main and sub docking station for cycle network, TTMC, off-street parking / multistory parking will fall under medium term projects. The approximate cost of medium and long term projects, which mainly comprise rapid transit systems including Metro and BRTS is 28500 crores. The detail costing is shown in Table XXX:

Project Phasing:

The projects proposed are to be implemented in three phases.

Phase 1 - To be implemented between 2017-2021

Phase 2 – To implemented between 2021-2031

Phase 3 - To implemented between 2031- 2036

Table 7.9: Phase wise Costing of the CMP Projects

Sl.No	Projects	Unit	Quantity (Total)	Rates (in Cr)	Total Cost (in Cr)	Quantity			Cost(In Cr)		
						Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
	Short Term Improvements										
1	Traffic and Pedestrian Management measures - Road Markings/ Signage	Km	150	0.05	7.5	150			7.5	0	0
2	Junction Improvements and Management Measures	Nos	14	0.2	2.8	14			2.8	0	0
3	Construction of Footpaths	Km	360	0.2	72	225	120	15	45	24	3
4	Road network Improvement Plan (New roads)	Kms	64.2		3000	64.2			3000	0	0
5	New Roads (Ring and Radials)	Kms	135	8	1080	0	120	15	0	960	120
				Cost	4162						
	Medium Term Improvements										
5	Provision of cycle track	Km	286	0.5	143	286			143	0	0
6	Provision of Pedestrian Zones and Pedestrian Infrastructure	Nos	0	-	-				0	0	0
7	FOB/ Walkways	Nos	11	10	110	11			110		
8	Bus Augmentation	Nos	5838	3	17514	700	2274	2864	2100	6822	8592
9	Bus transport Plan - Bus shelters	Nos	204	1	204	204			204		
10	Off Street Parking Locations	Nos	5	10	50	5			50	0	0
11	ITS (Control room / PIS and Traffic Information System)	Ls	1	2.5	2.5	1			3	0	0
12	Multimodal Hub	Nos	10	10	100	7	3		70	30	0
13	Bus Depot and Workshop	Nos	10	2.5	25	3	5	2	8	13	5
14	Bike Sharing Plan : Main Docking Station	Nos	20	0.5	10	20			10		
15	Bike Sharing Plan : Substations	Nos	60	0.1	6	60			6		
16	Bus Rapid Transit System	Km	82.5	20	1650	24.5	38	20	490	760	400
				Cost	**19815**						
	Long Term Improvements										
17	Metro	Km	42	250	10500	42			10500		
18	Redevelopment of City Bus Terminus (RTC Complex)	Nos	1	50	50	1			250		
19	Rail Over Bridges	Nos			0				0		
20	Truck Terminal	Nos			0				0		
				Cost	10550				10750		
Total Cost (Short, Medium and Long term Projects)					**34527**				**16998**	**8609**	**9120**

7.3 Financing Options

As per the Recommendations of Working Group on Urban Transport for 12th Five Year Plan, the financing of urban transport projects in the country has largely been confined to gross budgetary support from the government and the user charges. Due to heavy investment needs of urban transport and conflicting demands on the general exchequer, the investment in urban transport in past has not kept pace with the rapidly increasing requirement of the sector.

The current level of user charges of limited urban transport facilities, do not make the system self sustainable. At the same time, providing safe, comfortable, speedy and affordable public urban transport to all has to be a necessary goal of the governance.

The key funding sources besides GBS and fare box can be dedicated levies, land monetization, recovery from non-user beneficiaries, debt and private investments. The paradigm of financing has to clearly move towards non-users pay principle and the polluters pay principle. There is a need for long-term sustainable dedicating financing mechanism to address fast worsening scenario in the field of urban transport. All the various components in which the investment would be required in the 12th Five Year Plan would need to be funded through a combination of funding from Govt. of India, State Govt./urban local body, development agencies, property development, loan from domestic and financial institutions as well as PPP. Thus, it is imperative to identify projects that are amenable to Government funding or PPP.

7.3.1 Public Private Partnership

Public-Private Partnerships is cooperation between a public authority and private companies, created to carry out a specific project. They can take on a number of forms, and can be a useful method of capturing property value gains generated by transport infrastructure In a PPP for a new transport infrastructure development project, the public authority creates a secure environment for the private sector to carry out the project, and the private partner offers its industry know-how, provides funding and shares in the project's risk.

The objectives of the public and private sector partners appear to be quite different. The public sector aims to best serve the interests of taxpayers. The aim is not to use public money to obtain a return on capital investments. The private sector, on the other hand, aims to ensure a return on investment for its shareholders and to be as profitable as possible and yet these two contrasting goals can function perfectly well together in the framework of a PPP. The types of project to be developed are given below:

•The project context may influence the type of PPP to be implemented. The public partner must evaluate the total cost of the project, its importance in terms of public need, the time frame, the number of actors involved and the geographic area in question. Does providing this public service require a major infrastructure? Will it require high levels of human and financial resources to provide this service? Before a decision can be made, it is necessary to fully understand the context of the proposed project.

• The cost of the project is of course a critical factor, which will weigh on the choice. Many PPP concern projects for underground systems, LRT and BRT requiring significant levels of financing which the local authorities would have difficulty assuming alone.

• A well-structured institutional framework and the local authority's experience in developing transport projects are also decisive factors. Urban transport is an industrial and commercial activity, which involves financial risk. Bringing in experienced partners is one way of compensating for a lack of certain skills in this field, though a good PPP should call upon other forms of expertise on the part of the public authority. This can sometimes facilitate obtaining a loan, in particular from international funding agencies

• The tasks entrusted to the private sector (design, construction, development, operation, maintenance) will influence the type of contract.

• The sharing of responsibilities and risks will determine the degree of involvement of each partner and the type and clauses of the contract. There are many types of contracts but it is primarily the sharing of financial risk, which will determine the key characteristics. There are two categories of risk: commercial risk, related to trends in revenue, and industrial risk, related to the cost of construction and trends in operating and maintenance expenses. if both types of risk are covered by the public partner, then it would be a management contract in which the private partner is merely performing the work. The private partner must meet the specifications but will not be motivated to improve the service nor propose innovative techniques or management;

7.3.2 Government sources of funding

One of the particularities of the urban transport sector is that it depends on funding from several sources and involves various partners, public and private, individual and collective

a) Viability Gap Funding

In a recent initiative, the Government of India has established a special financing facility called "Viability Gap Funding" under the Department of Economic Affairs, Ministry of Finance, to provide support to PPP infrastructure projects that have at least 40% private equity committed to each such project. Viability Gap Funding can take various forms such as capital grants, subordinated loans, O&M support grants and interest subsidies. However, the Ministry of Finance guidelines require that the total government support to such a project, including Viability Gap Funding and the financial support of other Ministries and agencies of the Government of India, must not exceed 20% of the total project cost as estimated in the preliminary project appraisal, or the actual project cost, whichever is lower. Projects in the following sectors implemented by the Private Sector are eligible for funding:

• Roads and bridges, railways, seaports, airports, inland waterways

• Power

•Urban transport, water supply, sewerage, solid waste management and other physical infrastructure in urban areas

•Infrastructure projects in Special Economic Zones

•International convention centers and other tourism infrastructure projects

b) Smart Cities Funding

The Smart City Mission will be operated as a Centrally Sponsored Scheme (CSS) and the Central Government proposes to give financial support to the Mission to the extent of Rs. 48,000 crores over five years i.e. on an average Rs. 100 crore per city per year. An equal amount, on a matching basis, will have to be contributed by the State/ULB; therefore, nearly Rupees one lakh crore of Government/ULB funds will be available for Smart Cities development.

The GOI funds and the matching contribution by the States/ULB will meet only a part of the project cost. Balance funds are expected to be mobilized from:

i. States/ ULBs own resources from collection of user fees, beneficiary charges and impact fees, land monetization, debt, loans, etc.

ii. Additional resources transferred due to acceptance of the recommendations of the Fourteenth Finance Commission (FFC).

iii. Innovative finance mechanisms such as municipal bonds with credit rating of ULBs, Pooled Finance Mechanism, Tax Increment Financing (TIF).

iv. Other Central Government schemes like Swachh Bharat Mission, AMRUT, National Heritage City Development and Augmentation Yojana (HRIDAY).

v. Leverage borrowings from financial institutions, including bilateral and multilateral institutions, both domestic and external sources.

vi. States/UTs may also access the National Investment and Infrastructure Fund (NIIF), which was announced by the Finance Minister in his 2015 Budget Speech, and is likely to be set up this year.

vii. Private sector through PPPs

The distribution of funds under the Scheme will be as follows:

I. 93% project funds.

II. 5% Administrative and Office Expenses (A&OE) funds for state/ULB (towards preparation of SCPs and for PMCs, Pilot studies connected to area-based developments and deployment and generation of Smart Solutions, capacity building as approved in the Challenge and online services).

III. 2% A&OE funds for MoUD (Mission Directorate and connected activities/structures, Research, Pilot studies, Capacity Building, and concurrent evaluation).

7.3.3 Dedicated Urban Transport fund at City level

For the projects, which are not admissible under Smart Cities Mission, or viability gap funding, the alternative sources of funding that a city could avail by setting up a dedicated urban transport fund at city level are given below:

A dedicated urban transport fund would need to be created at the city level through other sources, especially land monetization, betterment levy, land value tax, enhanced property tax or grant of development rights, advertisement, employment tax, congestion, a cess on the sales tax, parking charges reflecting a true value of the land, traffic challans etc.

Case Studies: Pimpri-Chinchwad Municipal Corporation has already set up a dedicated urban transport fund through land monetization and advertisement rights. Similarly, Karnataka has set up a dedicated urban transport fund through MRTS cess on petrol and diesel sold in Bangalore, which is being used to fund the metro rail projects. The various sources of funding that can be used to set up the urban transport fund is given below:

(a) Anticipated purchase of land

This method involves public authorities buying land before announcing that an infrastructure will be built or where the route will run. In this way, the purchase can be made at market price without the infrastructure. The strategy then consists in:

- Directly selling the land to private developers including the estimated added value in the sale price, such as was done in Aguas Claras on the periphery of Brasilia, or in Copenhagen;
- Developing the area as part of an urban renewal project and then selling it at market price, as was done in Copenhagen or in Japan, where rail companies were the first to use this method to finance their operation
- A city can also levy additional stamp duty (5%) on registration of property.

(b) Betterment Tax

A betterment tax is not the same as a property tax, because the increase in value of property is not due to the action of the owner (such as would be the case with renovations and improvements) but from a community action, thus justifying the public authorities to impose such a tax. However, it is not easy to implement, which no doubt explains why this financing mechanism is still underused.

This tax must be levied on all areas that benefit from the new transport infrastructure. The land is valued each year based on an optimal use of each site, without taking into account the existing facilities. A tax based on the value of the land is then levied in order to generate funds for the public sector. Thus, if the value of the land increases, the tax collected also increases. This means that a vacant plot of land in the city centre which has been earmarked for building a residential and commercial complex will pay the same tax as an identical site which has already been developed in a similar manner. Likewise, taxes are not increased if the site is built upon. Landowners will therefore to seek to capitalise on the use of their land.

(c) Land Value Tax

Once an area is well connected by public transport and is accessible to the commercial area and also the liveability of the area increases it is possible that the price of the land will increase. Such increase in price can be source revenue for the municipality. Similar to parking, the obtained revenue needs to be utilized for improvement of the area and other areas in the vicinity. A substantial amount of revenue could be generated through cess on turnover, particularly in cities, based on industry, trade and commerce activities. Such cess has already been levied for Bangalore MRTS project. Bangalore has also levied luxury tax and professional tax towards the metro fund.

(d) Advertising

This is another important source of revenue for the city. When properly utilised this source can be of immense value in supporting sustainable urban transport measures in a city. The revenues from advertising in the city can be used to improve the existing transport system and/or create new schemes in sustainable transport.

Paris, France has used the advertising money in developing a public bike scheme, which is now a well renowned model. Similarly, Transport for London (TFL) has made a deal with the advertising specialist, Clear Channel, for the regular maintenance and design of the street furniture in return for the advertising space on bus shelters. One important aspect that needs to be considered is that the advertising money needs to be utilized for improving the transport system rather than spending it on building more roads. In the similar way, the advertising should not be overdone to avoid visual pollution.

7.3.4 External Funding Agencies

A majority of the urban transport projects such as the development of a complete public bus systems, BRT, urban rail projects, etc. are capital intensive and require ongoing funding for operations, routine maintenance and asset management. Generally, funding for such projects is arranged through commercial borrowings and loan from international lending agencies such as the World Bank, Asian Development Bank, Department for International Development, and Japan International Cooperation Agency etc.

A fund with an assured revenue stream dedicated to the development of the urban transport system would facilitate the process of raising funds from the market and international funding institutions. The stream of revenue could be potentially utilized for debt servicing. For the same reason, the UTF could also raise funds from the open market by floating bonds.

7.4 Institutional Options

City transport system generally involves several organizations that look after various forms and aspects of the transport system and network and have overlapping functions and areas of work. Therefore to delineate areas and to remove ambiguity of functions the institutional framework has been proposed.

With the formation of a State level UMTA, part of the problem has been sorted. However, this would have a macroscopic view of resolving policy issues for all urban centres within the state. There still remains a need to set up a localized organization that results in coordinated strategic level planning at the city level and deal with more day to day issues of urban transport.

Following is the list of departments and Organizations involved in urban affairs and urban transport in Vizag:

- Greater Vizag Municipal Corporation (GVMC)
- Visakhapatnam Urban Development Authority (VUDA)
- Regional Transport Office (RTO)
- Pollution Control Board (PCB)
- Traffic Police
- District Supplies Office (DSO)
- Andhra Pradesh State Road Transport Corporation (APSRTC)
- AMRCL

7.4.1 City Level Unified Metropolitan Transport Authority

In view of bringing the institutional setup in a proper structure, it is important to understand the Issues with the present Institutional set up, listed below.

- No clear segregation between the planning and implementing bodies
- Lack of coordination amongst all the departments in the urban transport sector.
- Road projects are implemented in isolation with other projects which should otherwise be an integral part of road development like footpath, cycle tracks, pedestrian facilities etc.
- No control over mushrooming IPT modes in the city, which lead to issues of congestion along with contesting with the buses for passengers.
- Operation issues in public transport due to poor route and service planning.
- No dedicated organization that is in charge of long term urban transport planning for the city.

With a view to coordinate all urban transport activities in the city, it is recommended that a UMTA be set up at the city level that acts as a planning and decision making body for all matters related to urban transport in the city.

It is recommended that the city level UMTA be set up on an executive order for the ease of formation however, it must be given a legal backing so that it's functioning falls under an act and commands greater authority.

7.4.2 Broad Functions of UMTA

The following functions are proposed to fall under the purview of the city level UMTA

- Undertake overall planning for public transport in the city, covering all modes - road, rail, water and air transport systems
- Allocate routes amongst different operators
- Procure public bus services for different routes through contracting, concessioning, etc.
- Ensure compliance of terms and conditions of license
- Recommend revocation of license for non-compliance of terms and conditions of the license
- Co-ordinate fare integration among different operators of public transport and determine the basis for sharing of revenues earned from common tickets or passes.
- Operate a scheme of passes for the users of public transport and channelize subsidies to operators for any concessions that are offered in accordance with government policy.
- regulate the arrangement amongst operators for the sharing of their revenue derived from the use of passes
- promote efficiency in public transport operation
- settle disputes between different operators and between operators and infrastructure providers
- levy fees and other charges at such rates and in respect of such services as may be determined by regulations;

7.4.3 Legal backing of UMTA

In view of bringing the institutional setup in a proper structure, it is important to understand the Issues with the present Institutional set up, listed below.

- No clear segregation between the planning and implementing bodies
- Lack of coordination amongst all the departments in the urban transport sector.
- Road projects are implemented in isolation with other projects which should otherwise be an integral part of road development like footpath, cycle tracks, pedestrian facilities etc.
- No control over mushrooming IPT modes in the city, which lead to issues of congestion along with contesting with the buses for passengers.
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It is recommended that the city level UMTA be set up on an executive order for the ease of formation however, it must be given a legal backing so that it's functioning falls under an act and commands greater authority.

Chapter 8

Annexures

8.1 Traffic surveys

8.1.1 Classified Volume Count Surveys at Outer cordon and Mid-Blocks

Objective of the Survey: To assess the traffic flowing within and outside the study area from the adjoining areas/regions.

Scope of the Survey: Counting of vehicles classified by the type of vehicle during the specified duration.

Conduct of the Survey: Manual traffic counts were carried out on a typical working day at all locations listed below. At each identified station, both directional counts were counted by vehicle type, i.e. fast moving passenger vehicles, goods vehicles and slow moving non-motorized transit.

No. of Locations: List of outer cordon count locations are presented in table 8.1:

Table 8.1 Classified Volume Count Surveys at Outer cordon and Mid-Blocks locations

ID	Name of the Road	Name of the Location
OC-1	Vishakhapatnam to Kolkata road	At Vemulavalasa check post
OC-2	Vishakhapatnam Araku Road	At Saripalle
OC-3	Chennai Srikakulam Road	At petrol bunk
OC-4	Vishakhapatnam Chennai road	At Aganampudi junction
OC-5	Vishakhapatnam Achutapuram road	At Indira Gandhi park
MB - 1	National Highway 16	At Birla Bus Stop
MB - 2	National Highway 16	At YSR Stadium, Srinivas Nagar

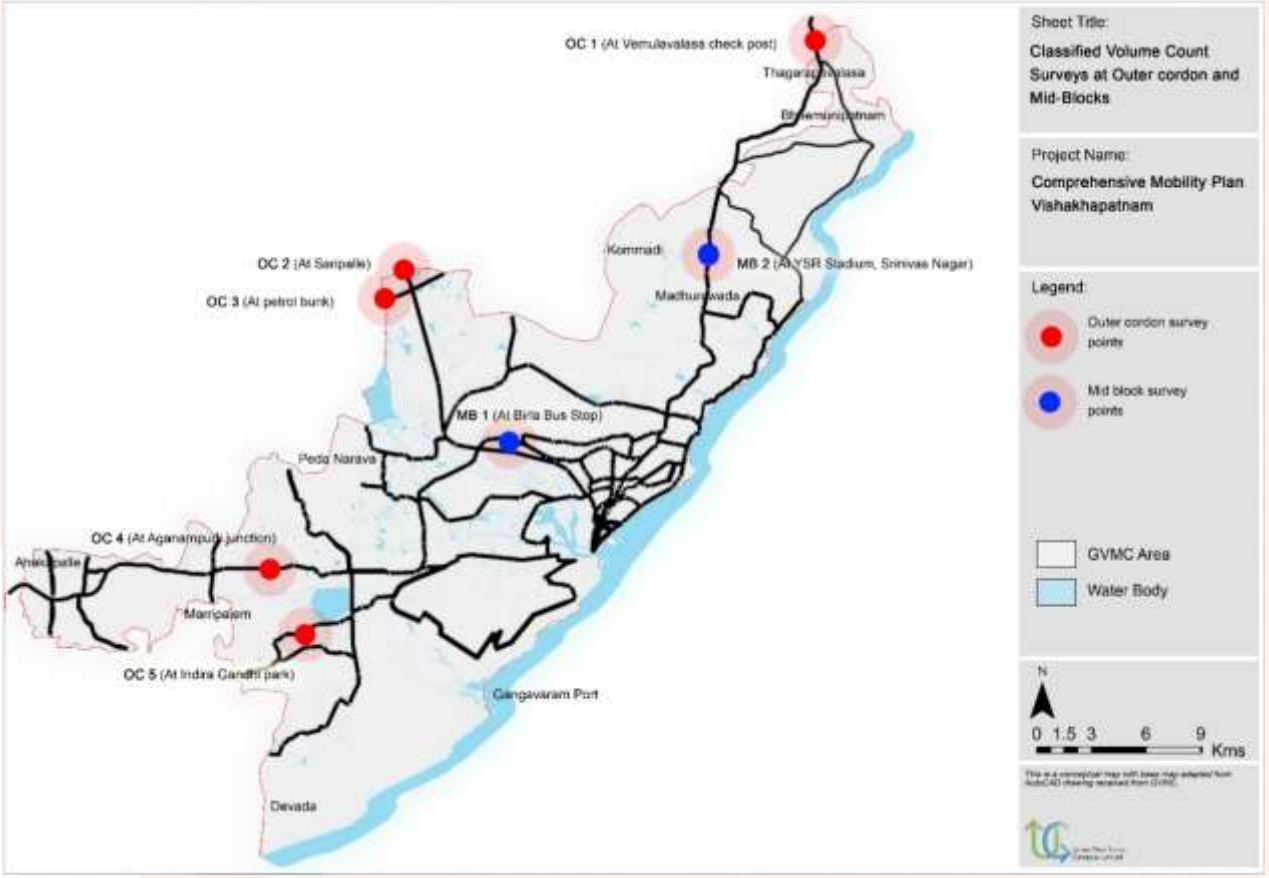

Figure 8.1 Classified Volume Count Surveys at Outer cordon and Mid-Blocks locations

8.1.2 Occupancy Surveys – Outer Cordon/ Mid-block locations

Objective of the Survey: To assess the Occupancy of traffic flowing within and outside the study area from the adjoining areas/regions.

Scope of the Survey: Assessment of vehicle occupancy classified by the type of vehicle during the specified duration.

Conduct of the Survey: These surveys were conducted at outer cordon and Mid-block locations, Manual counts of occupancy were carried out on a typical working day

No. of Locations: List of outer cordon count locations are presented in Table 8.2

Table 8.2 Occupancy Surveys – Outer Cordon/ Mid-block locations

ID	Name of the Road	Name of the Location
OC-1	Vishakhapatnam to Kolkata road	At Vemulavalasa check post
OC-2	Vishakhapatnam Araku Road	At Saripalle
OC-3	Chennai Srikakulam Road	At petrol bunk
OC-4	Vishakhapatnam Chennai road	At Aganampudi junction
OC-5	Vishakhapatnam Achutapuram road	At Indira Gandhi park
MB - 1	National Highway 16	At Birla Bus Stop
MB - 2	National Highway 16	At YSR Stadium, Srinivas Nagar

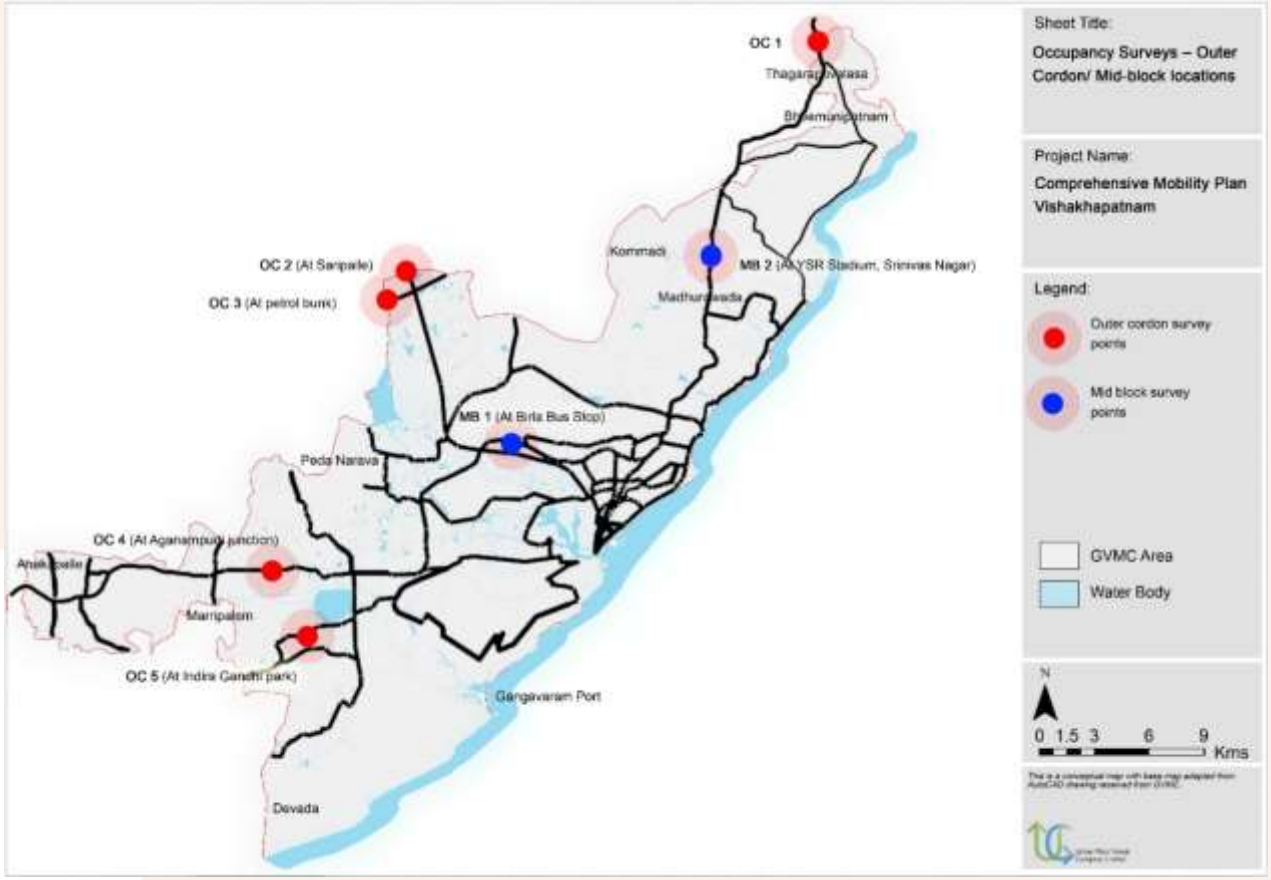

Figure 8.2 Occupancy Surveys – Outer Cordon/ Mid-block locations

8.1.3 Classified Turning Movement Count Surveys at Junctions

Objectives: Surveys were conducted at critical intersections identified within the city.

Scope of Survey: Counting vehicles, classified by the type of vehicle, at selected locations, over 16 hours (06:00 to 22:00), covering all turning movements.

Conduct of the Survey: Manual traffic counts were carried out on a typical working day at all locations listed below. At each identified Intersections, all possible turning movements were counted by vehicle type, i.e. i.e. fast moving passenger vehicles, goods vehicles and slow moving non-motorized transit.

No. of Locations: List of turning movement count locations are presented in Table 8.3 :

Table 8.3 Locations of Classified Turning Movement Count Surveys at Junctions

ID	Name of the Junction	Type
TMC 1	Gurudwra Junction	3- arm
TMC 2	Jail Road Junction	4- arm
TMC 3	Thatichetapalyem Junction	3- arm
TMC 4	NAD Junction	4- arm
TMC 5	Hanumanthwaka Junction	4- arm
TMC 6	Petrol Bunk Junction	3- arm
TMC 7	Gajuwaka Junction	4- arm
TMC 8	Dolphin Hotel Junction	4- arm
TMC 9	Siripuram Junction	4- arm
TMC 10	Jagadamba Junction	4- arm
TMC 11	Asilmetta Junction	4- arm
TMC 12	Dwarka Nagar Junction	
TMC 13	Maddilapalem Junction	3- arm
TMC 14	Convent Junction	4- arm

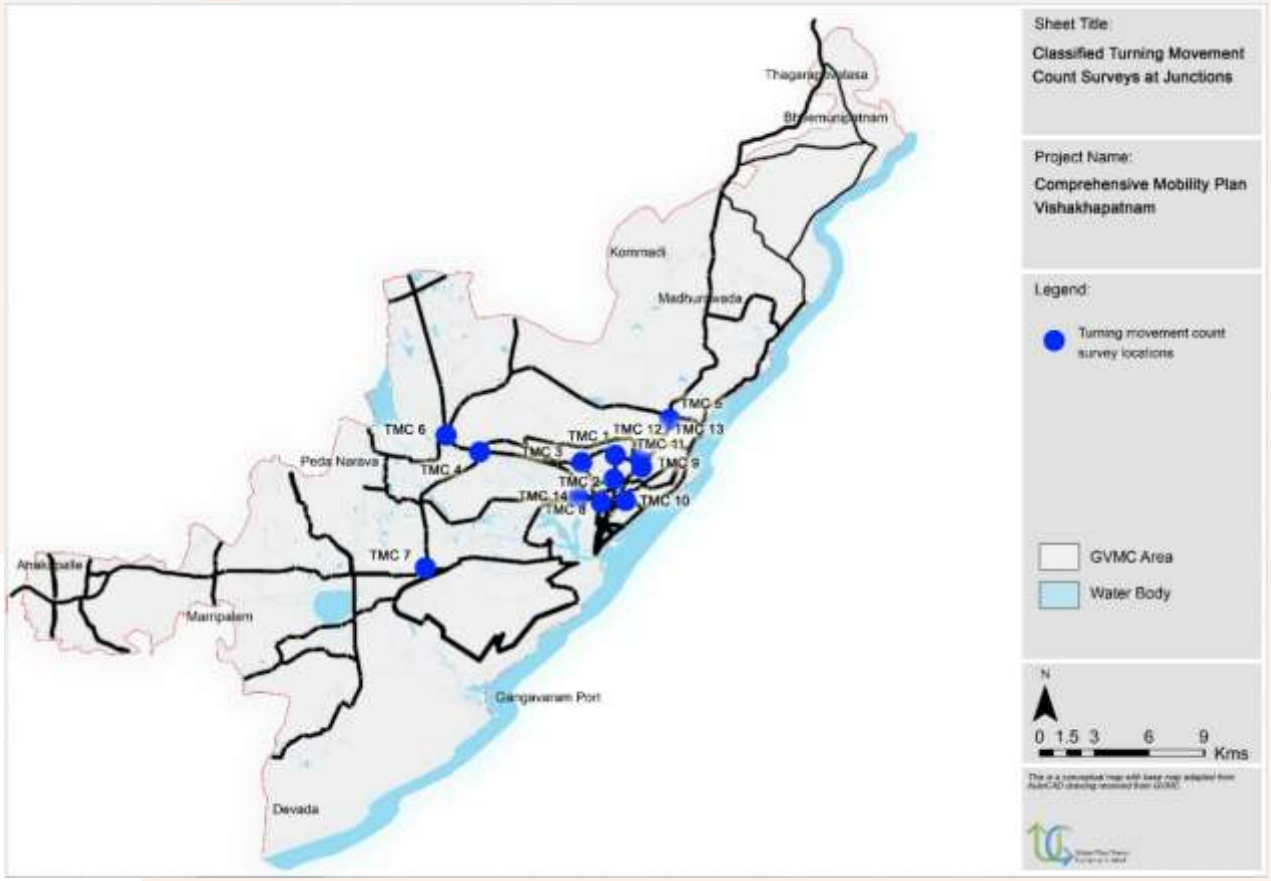

Figure 8.3 Locations of Classified Turning Movement Count Surveys at Junctions

8.1.4 Road Side Interview at Outer Cordon

Objective of the Survey: to access the travel Characteristics (Assessment of Origin Destination i.e. interaction of Internal-External zones) of passengers entering /leaving city (at outer cordons) during the specified duration.

Scope of the Survey: Interviews are carried out on a sample basis on a typical working day by stopping the vehicles with the help of police.

Conduct of the Survey: These surveys were conducted at 5 outer cordon for 16 hrs (06:00 to 22:00). At each identified location, the origin and destination along with other trip characteristics of the passengers by vehicle type was recorded.

No. of Locations: Outer Cordon Locations: 5

Table 8.4 Road Side Interview locations

ID	Name of the Road	Name of the Location
RS-1	Vishakhapatnam to Kolkata road	At Vemulavalasa check post
RS-2	Vishakhapatnam Araku Road	At Saripalle
RS-3	Chennai Srikakulam Road	At petrol bunk
RS-4	Vishakhapatnam Chennai road	At Aganampudi junction
RS-5	Vishakhapatnam Achutapuram road	At Indira Gandhi park

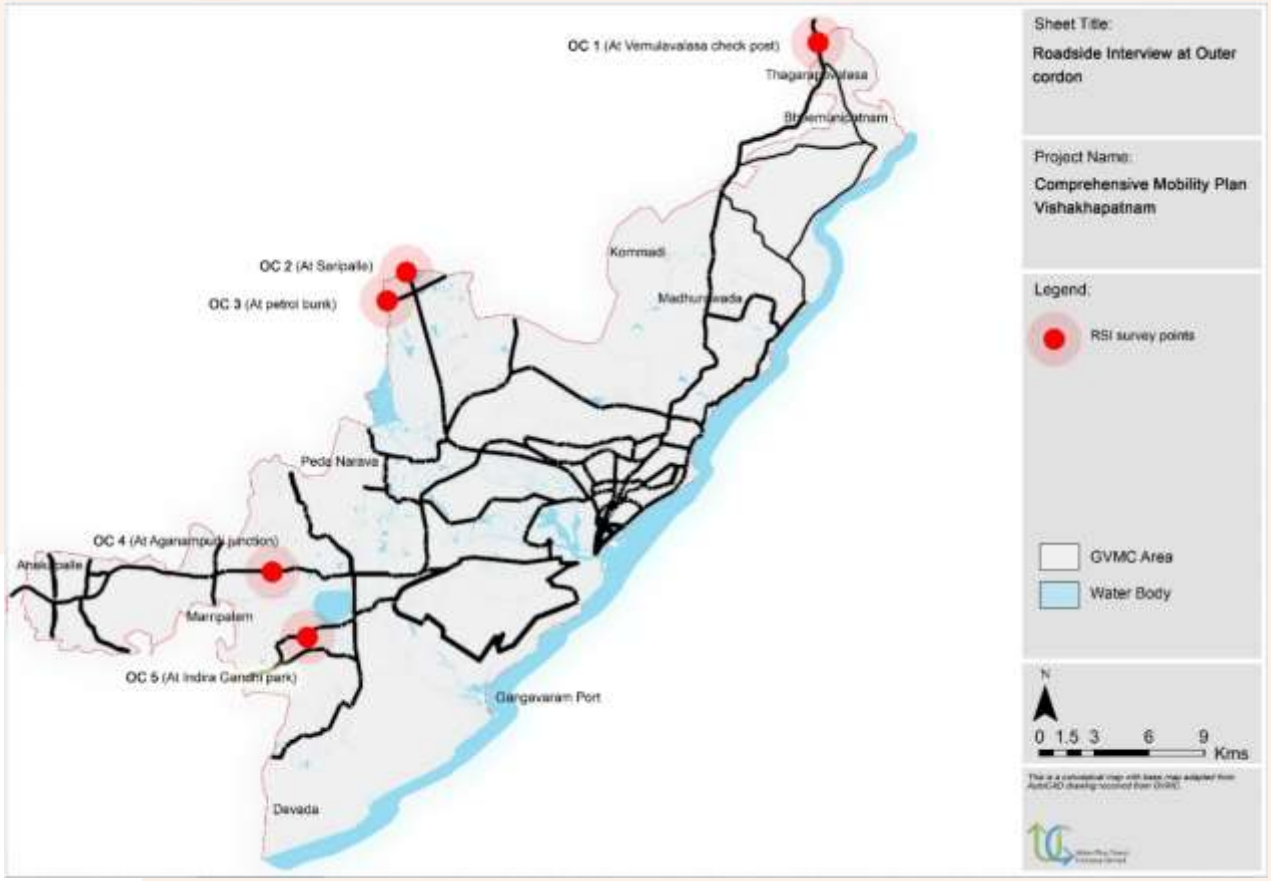

Figure 8.4 Road Side Interview locations

8.1.5 Bus Stop Waiting, boarding and alighting survey

Objective of the Survey: To evaluate the waiting, Boarding and alighting volume of the bus users.

Scope of the Survey: Travel volume analysis i.e. Assessment of boarding and alighting passengers during the specified duration.

Conduct of the Survey: These surveys were conducted at 10 bus stops for 16 hrs (06:00 to 22:00). At each identified location, the boarding and alighting along with other trip characteristics of the passengers was recorded.

No. of Locations: 10

Table 8.5 Bus Stop Waiting, boarding and alighting survey locations

ID	Location
BA-1	Madhurwada
BA-2	Zoo Park
BA-3	Gurudwara
BA-4	Thatichetapalyem
BA-5	R & B
BA-6	Gajuwaka
BA-7	LIC
BA-8	OLD CBI
BA-9	Railway Station
BA-10	Poorna Market

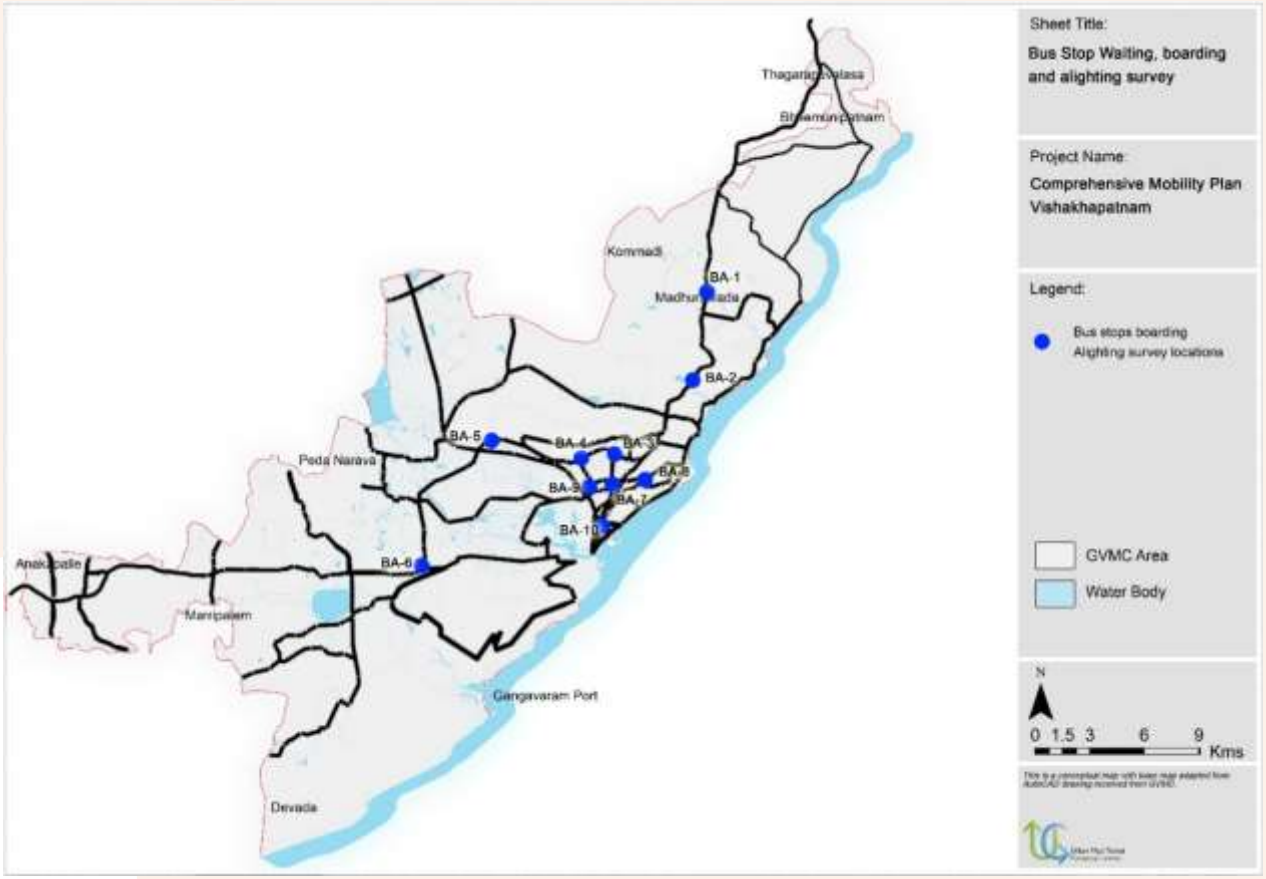

Figure 8.5 Bus Stop Waiting, boarding and alighting survey locations

8.1.6 Bus Stop OD surveys including the Stated Preference surveys of bus users

Objective of the Survey: To evaluate the percentage of people using bus transport and to identify the characteristics of inter- city travelers using the public transport system. Also the stated preference of the bus user regarding the quality of transport system was accessed.

Scope of the Survey: Travel Characteristics (Assessment of Origin Destination i.e. interaction of Internal-External zones) of bus users passengers during the specified duration.

Conduct of the Survey: These surveys were conducted at 10 bus stops for 16 hrs (06:00 to 22:00). At each identified location, the origin and destination along with other trip characteristics and stated preference of the passengers by vehicle type were recorded.

No. of Locations: 10

Table 8.6 Bus Stop OD survey location

ID	Location
BA-1	Madhurwada
BA-2	Zoo Park
BA-3	Gurudwara
BA-4	Thatichetapalyem
BA-5	R & B
BA-6	Gajuwaka
BA-7	LIC
BA-8	OLD CBI
BA-9	Railway Station
BA-10	Poorna Market

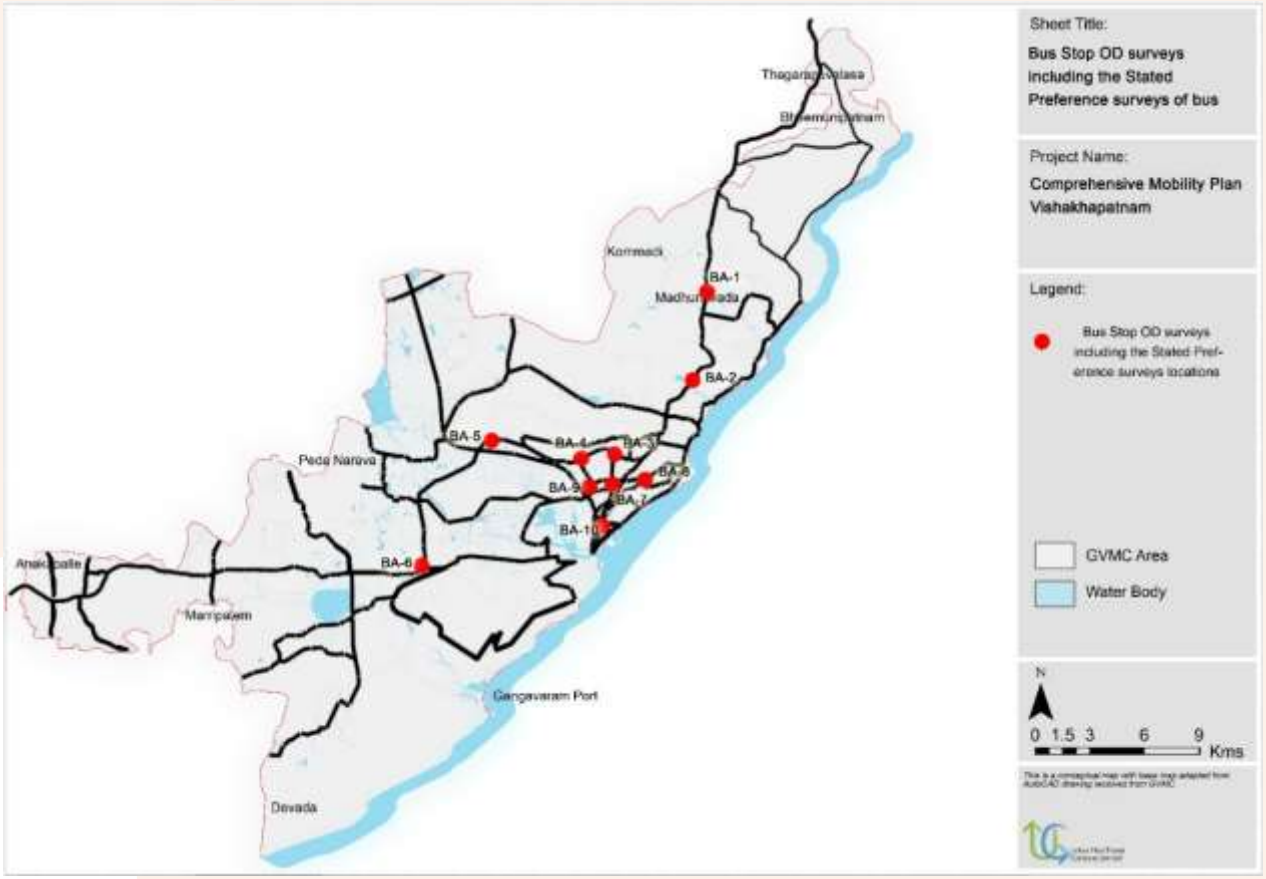

Figure 8.6 Bus Stop OD survey location

8.1.7 PT & IPT Stated Preference Surveys along major activity centers

Objective of the Survey: To access the current trip characteristics and willingness to shift towards proposed public transport system.

Scope of the Survey: The survey captured the data regarding socio economic profile, travel preferences, stated choice and preference for willingness to shift to new transit mode.

Conduct of the Survey: These surveys were conducted at 10 major locations in normal working day. At each identified location, trip characteristics and stated preference of the commuters was recorded.

No. of Locations: 10 (500 samples)

Table 8.7 PT & IPT Stated Preference Survey locations

ID	Location
SP-1	Siripuram junction
SP-2	Dolphin junction
SP-3	Jagdamba junction
SP-4	RTC complex/Dwarka Bus stand
SP-5	Vizag Railway station
SP-6	Maddilapalem Bus stand
SP-7	Daba Gardens road
SP-8	Purna Market
SP-9	Thatichetnapalem junction
SP-10	NAD junction

8.1.8 Pedestrian Volume Count Survey

Objective of the Survey: The objective of the survey is to quantify the extent of pedestrian movement in order to design facilities for such movement.

Scope of the survey: The survey was conducted for a period of 12 hours covering peak period on important locations where there is heavy pedestrian movement.

Conduct of survey: Pedestrian count surveys were conducted at locations where heavy pedestrian movement is observed. The survey also covered locations abutting major traffic attraction zones like malls and major work centers and important junctions. The pedestrian count was taken along and across each arm of the junction.

No. of Locations: 13

Table 8.8 Pedestrian Volume Count Survey locations

Code	Location Name
PVC 1	Gurudwara Junction
PVC 2	Old Jail Road Junction
PVC 3	Thatichetlapalem Junction
PVC 4	NAD Junction
PVC 5	Hanumanthawaka Junction
PVC 6	Gopalpatnam Petrol Bunk Junction
PVC 7	Gajuwaka Junction
PVC 8	Dolphin Hotel Junction
PVC 9	Siripuram Junction
PVC 10	Jagadamba Junction
PVC 11	NTR Circle R K Beach junction
PVC 12	Assilmetta Junction
PVC 13	Ramatakies Junction

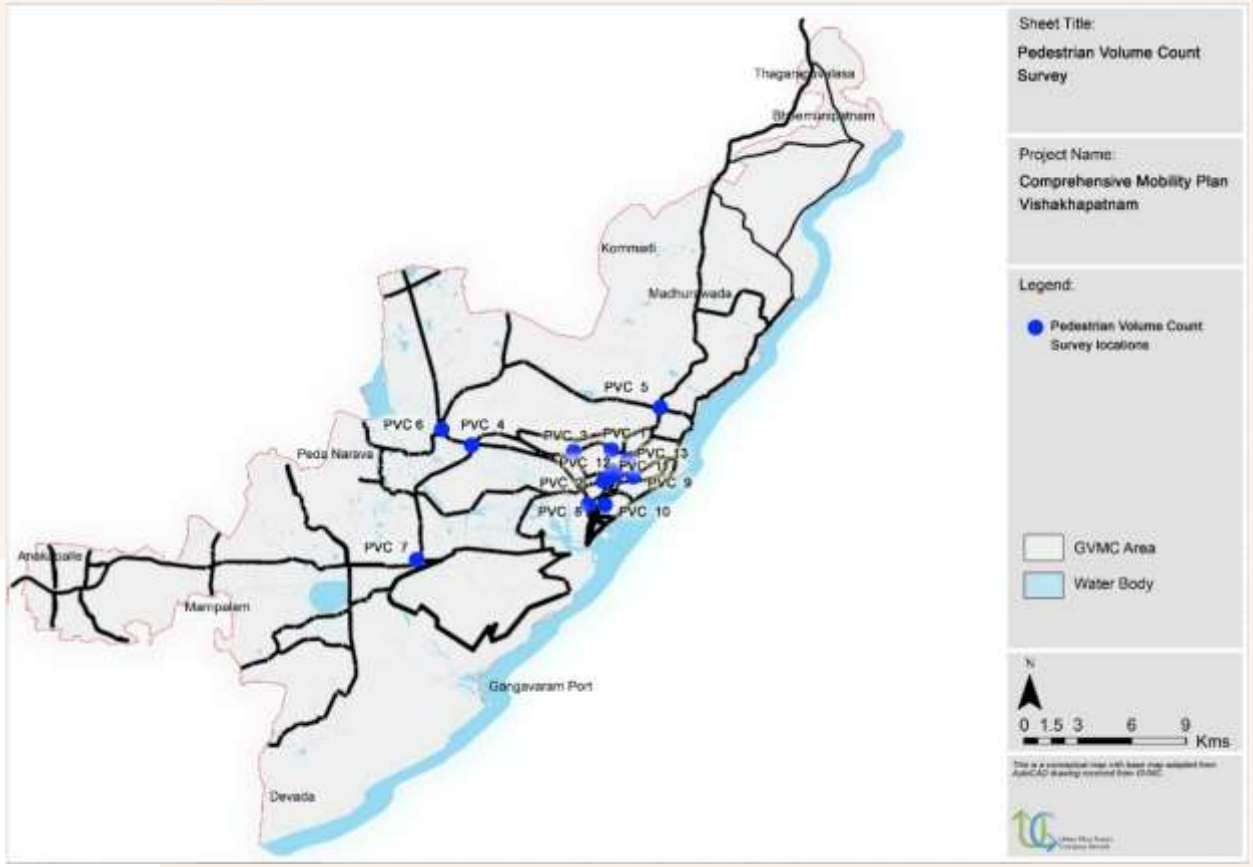

Figure 8.8 Pedestrian Volume Count Survey locations

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PVC 6	Gopalpatnam Petrol Bunk Junction
PVC 7	Gajuwaka Junction
PVC 8	Dolphin Hotel Junction
PVC 9	Siripuram Junction
PVC 10	Jagadamba Junction
PVC 11	NTR Circle R K Beach junction
PVC 12	Assilmetta Junction
PVC 13	Ramatakies Junction

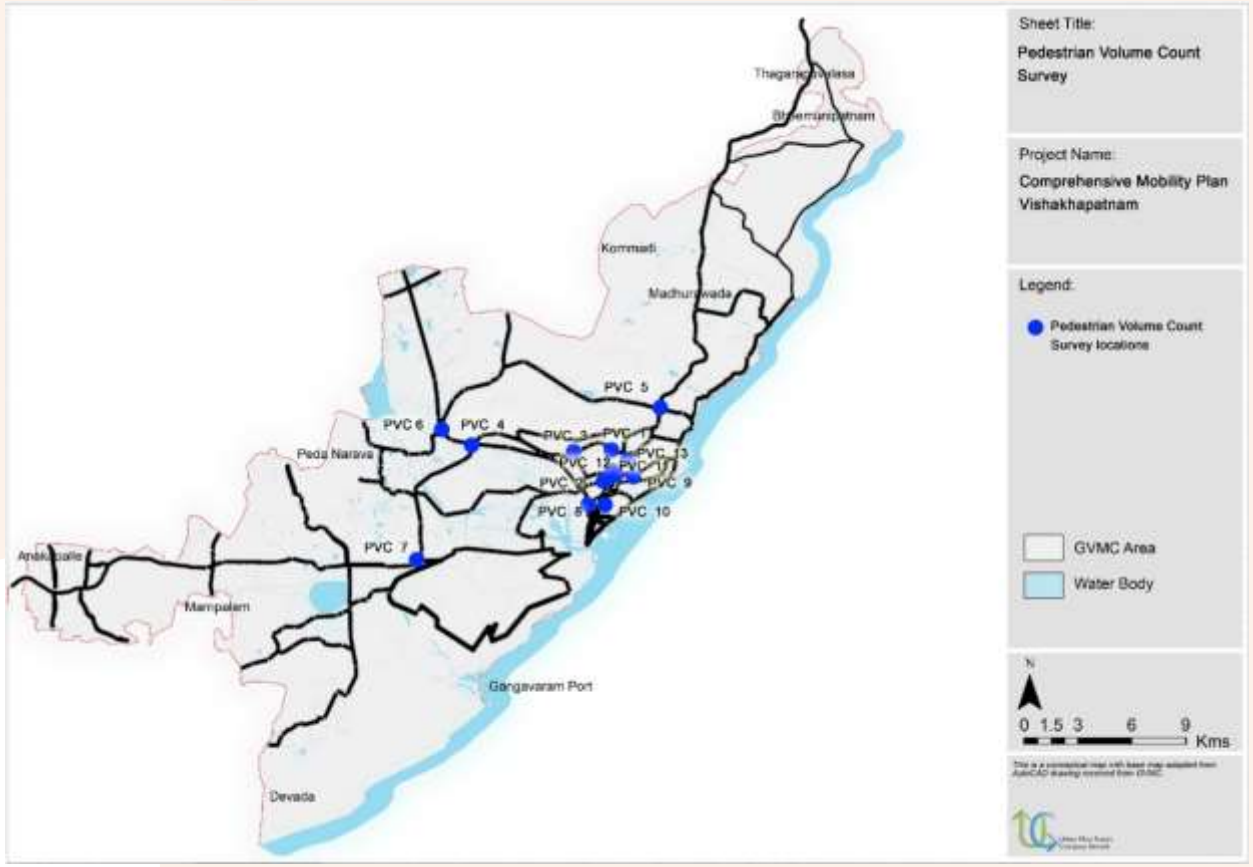


Figure 8.8 Pedestrian Volume Count Survey locations

8.1.9 Vehicle Operator Survey (IPT and Goods)

Objective of the Survey: To elicit information on the issues connected to operators in a city – their facilities and requirements.

Scope of Work: The survey was conducted by interviewing the truck/taxi/ shared auto operators.

Survey outputs: Key issues connected to truck and taxi/shared auto operators. For GVMC area, a sample of 50 truck operators and 50 IPT Operators were surveyed.

8.1.10 Parking Survey (Off-Street and On-Street)

Survey Objective: The principal objective of the study is to assess the demand for parking and characteristics of the parked vehicles.

Scope of the Survey: The survey was conducted for a period of 16 hours on important commercial areas where parking is predominant and is needed to plan facilities.

Conduct of the Survey: On/off street parking surveys were carried out on all important locations comprising of work centers, business centers, shopping complexes and tourist places. Enumerators were asked to note the vehicle type and registration number of parked vehicles every 1/2 hour.

Key Outputs: Peak Parking Demand Period by Location, vehicle type and Duration

Locations: The On street parking surveys were conducted at 15 locations mentioned below:

Table 8.9 On street parking survey locations

Code	Locations Name
PS-ON-1	Visakhapatnam Railway Station
PS-ON-2	Dwaraka Bus Stand
PS-ON-3	Maddilapalem Bus Stand
PS-ON-4	Jagadamba Junction
PS-ON-5	Gajuwaka Junction
PS-ON-6	Purna Market
PS-ON-7	RK Beach
PS-ON-8	Daba Gardens
PS-ON-9	Simhachalam
PS-ON-10	Kailashgiri
PS-ON-11	CBM Compound road
PS-ON-12	Dwarkanagar road
PS-ON-13	Marripalem Kancharapalem
PS-ON-14	NAD Gopalapatnam Road
PS-ON-15	Rama Talkies Road

Table 8.10 Off street parking survey locations

Code	Locations Name
PS-OFF-1	Visakhapatnam Railway Station
PS-OFF-2	Dwaraka Bus Stand
PS-OFF-3	Maddilapalem Bus Stand
PS-OFF-4	Jagadamba Junction
PS-OFF-5	Gajuwaka Junction
PS-OFF-6	Purna Market
PS-OFF-7	RK Beach
PS-OFF-8	Daba Gardens
PS-OFF-9	Simhachalam
PS-OFF-10	Kailashgiri
PS-OFF-11	Dwarka Bus Stand (Outgate side parking)
PS-OFF-12	Gajuwaka Jn. near Kutimamba Gudi

8.1.11 Parking Willingness to pay Survey

Survey Objective: The principal objective of the study is to assess the willingness of commuter to pay for On/Off street parking.

Scope of the Survey: The survey was conducted in peak hours on important roads and commercial areas where parking is predominant and is needed to plan facilities. The survey also assessed the need of and willingness to pay for rental bicycles.

Conduct of the Survey: Enumerators were asked to note Information on parking fees (if any) and further asking about willingness to pay for better/planned parking facilities. The survey was conducted on selected stretches of major corridors and other prime off street locations in the study area.

Locations: The parking willingness to pay surveys were conducted on 15 locations mentioned below

Table 8.11 Parking Willingness to pay Survey locations

Code	Locations Name
PS-ON-1	CBM Compound road
PS-ON-2	Daba Garden road
PS-ON-3	Dwarka Complex road
PS-ON-4	Dwarkanagar road
PS-ON-5	Gajuwaka Jn
PS-ON-6	Jagdamba Jn
PS-ON-7	Kailashgiri
PS-ON-8	Maddilapalem Jn
PS-ON-9	Marripalem Kancharapalem
PS-ON-10	NAD Gopalapatnam Road
PS-ON-11	Poorna Market
PS-ON-12	Rama Talkies Road
PS-ON-13	RK Beach
PS-ON-14	Simhachalem
PS-ON-15	Vizag Railway Station

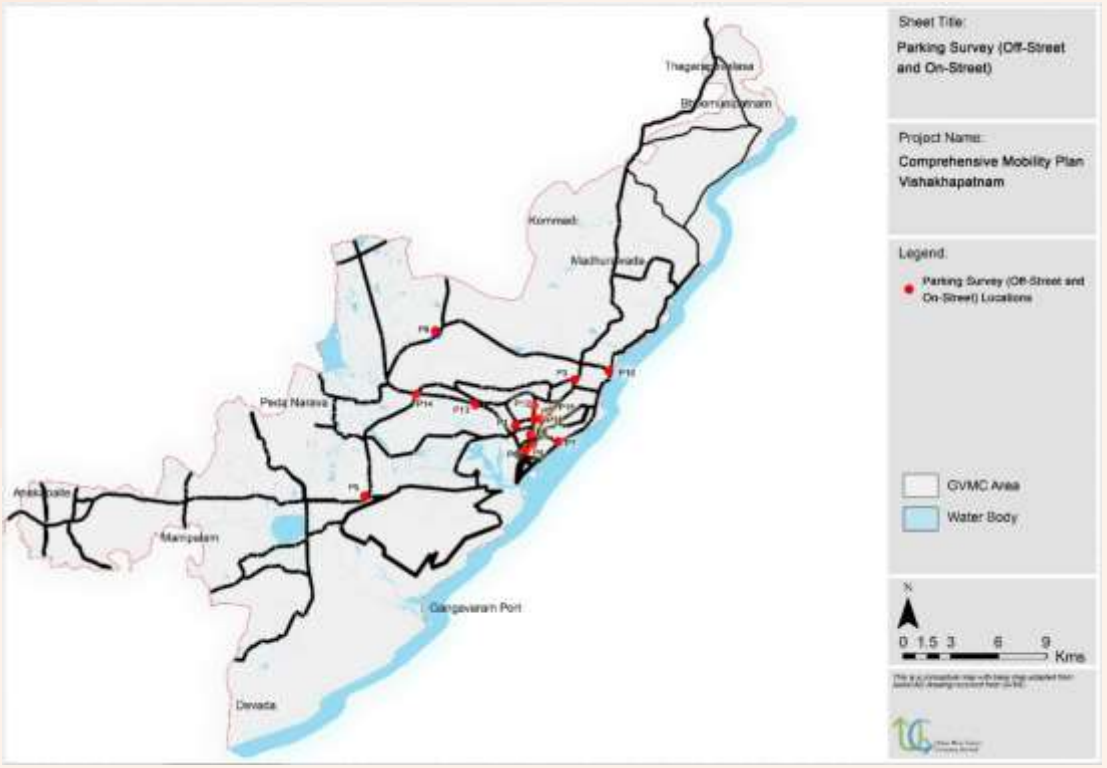


Figure 8.9 Parking Willingness to pay Survey locations

8.1.12 Household Survey

Objective of the Survey: The house hold survey was carried out to collect the socio economic and travel data assessing the travel patterns and preferences of city's residents.

Scope of the survey: Collection of data on socio-economic characteristics, household members and their travel diary covering a size of 5000 samples.

Conduct of the Survey: The survey questionnaire comprises of three sections, a) Socio-economic datasheet, b) Household member characteristic datasheet, and c) the travel diary of each individual member of the household. The travel diary section requests information of all trips made by each person in the household on the previous day. This information includes the time of the trip, the trip purpose, the address of the trip starting, ending place and the mode of travel. This data was collected by visiting a fixed sample in each area of the city (zone). Each Household constitutes a sample.

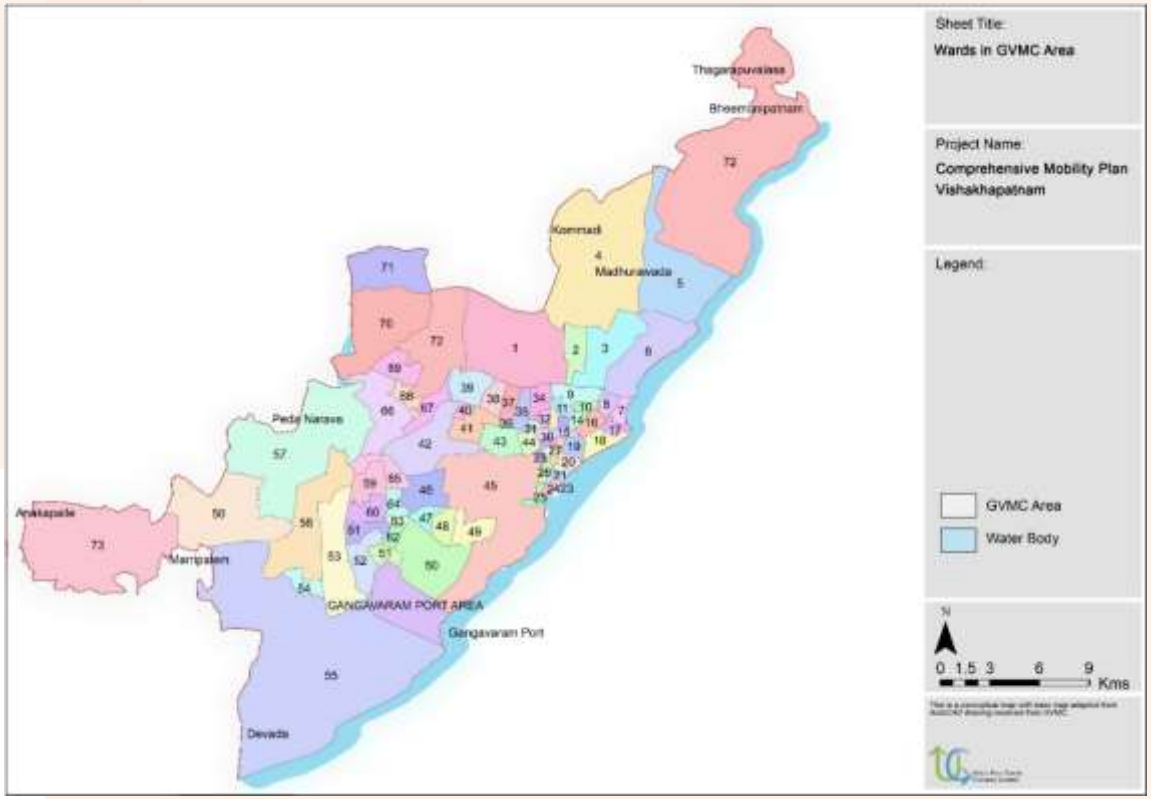


Figure 8.10 Household survey wards

8.1.13 Road Inventory Survey

Objective of the Survey: Road network inventory aims at updating the network database with the existing features of roadway sections covering all arterial, sub arterial and other important local/connecting links in the GVMC region. The survey validates existing road network data available for the region and collects the road network details for the roadway sections

Conduct of the Survey: For all the major road sections in the study area, a full-scale inventory surveys is undertaken to create a road network database. Inventories of Road Geometry (Section length, Effective Road width, Median width and type etc), Roads Quality (riding surface, Road markings and Signages etc), Adjoining Land use and available access control, Parking Facilities, Details about encroachments, PT/IPT passenger collection points etc were recorded.

Key Outputs: Road transport Network database of the study area

For GVMC area, all major road stretches were picked up for road inventory survey covering 250 kms.

Figure 8.11 Major Roads in GVMC area

8.2 Traffic survey Analysis

The following section includes the preliminary data analysis of the primary data collected through surveys described in the previous section.

8.2.1 Classified Volume Count Surveys at Outer cordon and Mid-Blocks

The daily and peak hour traffic volume at all the mid-block locations is presented in Table 8.12. It is evident from the table that peak hour share at Mid-block locations is varying between 9-10%

Table 8.12 Classified Volume Count Surveys at Outer cordon and Mid-Blocks locations

ID	Location	Daily Traffic			Peak Hour Share %	Peak Hour
		Vehicles	PCU	Pax		
MB1	Chennai-Kolkata Road (NH-5) at Birla Bus Stop	19893	29621	168192	10.1 % (2620 PCUs)	5:00PM – 6:00PM
MB-2	Chennai-Kolkata Road (NH-5) at YSR Stadium, Srinivas Nagar	22940	30966	171311	9.6% (2741 PCUs)	6:00PM – 7:00PM

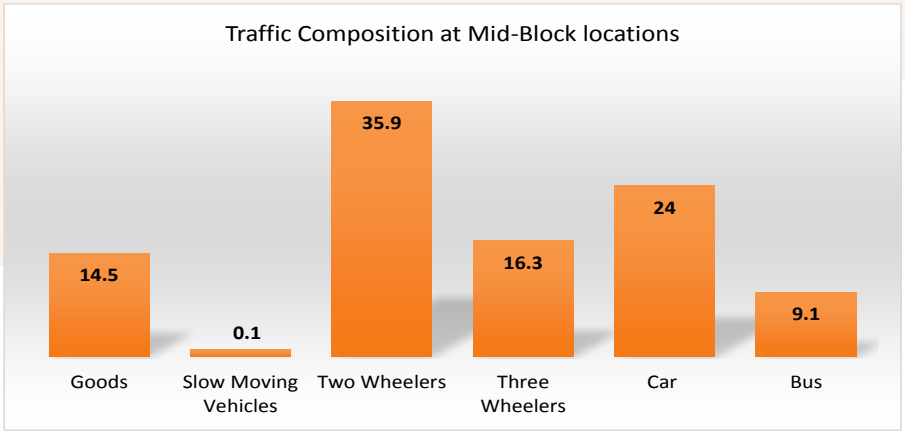


Figure 8.12 Traffic composition at mid-block locations

Analysis of traffic composition shows that major modes at this location are two wheelers and cars (over 60%). The other prominent modes are three wheelers and goods. The composition of Slow Moving Vehicles i.e. Non-motorized transit is very low.

The traffic flows at all outer cordons is presented in table below. Heavy traffic is observed at Vishakhapatnam-Chennai road with 28,853 PCUs followed by Vishakhapatnam to Kolkata road with 23,260 PCUs. Peak hour share at outer cordon locations is varying from 8.2% to 9.5%.

Table 8.13 Outer cordon survey data analysis

ID	Location	Daily Traffic			Peak Hour Share %	Peak Hour
		Vehicles	PCU	Passengers		
OC-1	Vishakhapatnam to Kolkata road	15088	23260	75824	8.3%	6:00PM-7:00PM
OC-2	Vishakhapatnam Araku Road	10388	15174	28862	8.2%	4:00PM-5:00PM
OC-3	Chennai Srikakulam Road	10077	19041	44268	9.5%	10:00AM-11:00AM
OC-4	Vishakhapatnam Chennai road	17439	28853	86794	8.8%	11:00AM-12:00PM
OC-5	Vishakhapatnam Achutapuram road	8439	10821	19329	8.6%	4:00PM-5:00PM
Outer Cordon Locations - Total		**61431**	**97148**	**255077**	**8.7%**	

Analysis of traffic composition showed that major modes at outer cordons are two wheelers and goods (over 53%). The other prominent modes are car and three wheelers. The composition of Slow Moving Vehicles i.e. Non-motorized transit is very low.

8.2.2 Occupancy Surveys – Outer Cordon/ Mid-block locations

Average vehicle occupancy has been estimated from the occupancy survey at outer cordon and mid-block locations. The detail of average occupancy for all modes is presented in table below:

Table 8.14 Average Occupancy at Outer Cordon/ Mid-block locations

Location type	Two - Wheeler	Car	Three Wheeler	Shared Auto	City Bus	Private Bus	Mini Bus
Outer Cordon	1.7	2.7	3.5	4.9	39.3	36.7	17.1
Mid-block	1.6	2.2	1.9	6.3	50.6	46.1	20.6

8.1.3 Classified Turning Movement Count Surveys at Junctions

The traffic flows at all the intersections is presented in table below. It is observed that highest flow is at NAD junction with 3,57,876 PCUs per day. Peak hour share at intersections is varying from 7.9% to 8.8%.

Analysis of traffic composition shows that major modes at junctions are two-wheelers and three wheelers (over 69%). The other prominent modes are cars and goods. The composition of Slow Moving Vehicles i.e. Non-motorized transit is very low i.e. 1 %.

Analysis of traffic composition shows that major modes at this location are two wheelers and cars (over 60%). The other prominent modes are three wheelers and goods. The

Table 8.15 Turning Movement Count analysis

ID	Daily Vehicles	Daily PCUs	Peak PCUS	Peak Hour Share %	Peak Hour
TMC 1	131500	162741	13783	8.4%	09.00-10.00
TMC 2	148518	176161	15217	8.7%	17.00-18.00
TMC 3	157922	161507	12961	8.0%	10.00-11.00
TMC 4	310884	357876	31557	8.8%	18.00-19.00
TMC 5	246040	298254	24727	8.5%	09.00-10.00
TMC 6	105088	126793	10923	8.6%	08.00-09.00
TMC 7	150004	188705	17733	7.9%	09.00-10.00
TMC 8	53817	42102	3539	8.4%	18.30-19.30
TMC 9	103878	88436	7873	8.9%	17.45-18.45
TMC 10	59824	51136	4143	8.1%	17.45-18.45
TMC 11	87942	76479	7186	9.4%	10.30-11.30
TMC 12	73211	59475	5131	9.3%	10.30-11.30
TMC 13	73248	77308	7064	10.3%	10.30-11.30
TMC 14	47113	46185	3621	9.8%	08.30-09.30

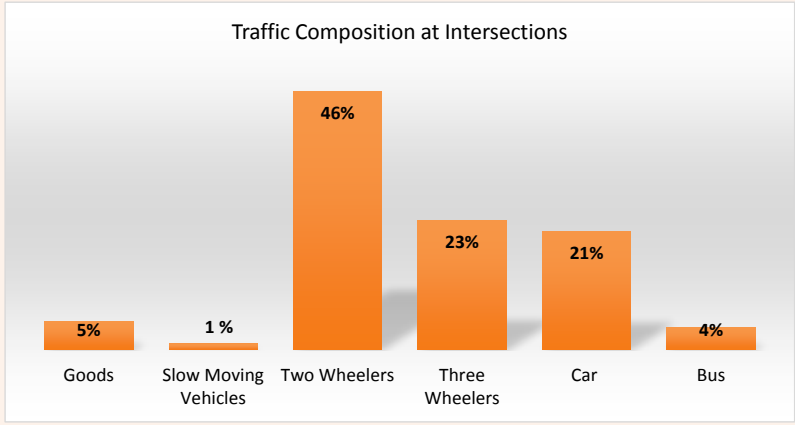


Figure 8.13 Traffic composition at Intersections

8.2.3 Road Side Interview at Outer Cordon

Passenger Vehicles

Trip Frequency: Analysis of the trip frequency of passenger vehicles shows that majority of the trips are daily trips (up and down), which constitutes 41% of the total trips whereas Daily one way trips are 29% of the total trips.

Trip Purpose: Analysis of trip purpose of passenger vehicles revealed that majority of passengers make work trips constitutes 44% of the total trips, education constitutes the next highest share at 22%. Table 20 below presents the passenger trip purpose at outer cordon locations.

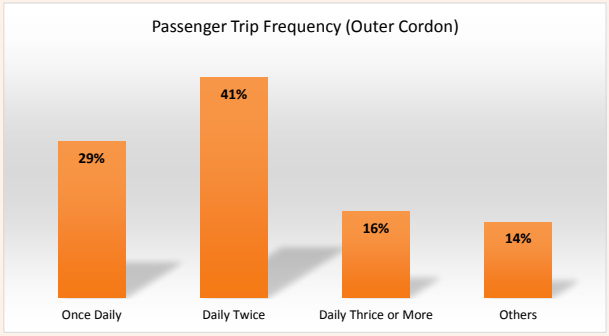


Figure 8.14 Passenger Trip frequency (Outer Cordon)

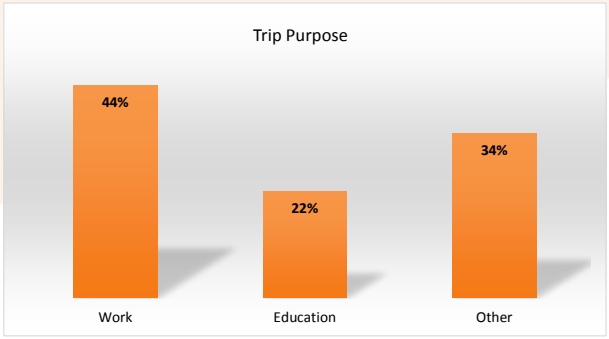


Figure 8.15 Trip Purpose (Outer Cordon)

The average trip length for two wheelers is 22 km, whereas for four wheelers is 62 km. The average trip length of other passenger vehicles (Auto, shared Auto and Cycle) is found to be less i.e. 16-19 Kms.

Table 8.16 Average Travel Distance (km)

Vehicle Type	Average Travel Distance (km)
Car/ Jeep/ Van/ Taxi	62
Two wheeler	22
Auto Rickshaw	19
Shared Auto	16
Cycle	1

Goods Vehicles

Trip Frequency: Analysis of the trip frequency (Figure 5 6) of good vehicles shows that majority of the trips are occasional trips, constituting 47% of the total trips whereas Weekly trips are 38% of the total trips.

Analysis of goods vehicle trips by commodity Type revealed that majority of goods vehicles carry building materials contributing 25 % of the total trips followed by empty goods vehicle trips at 17%.

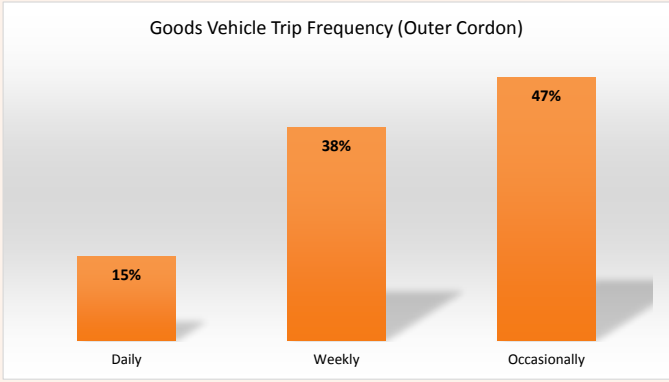


Figure 8.16 Goods vehicle trip frequency (Outer cordon)

Table 8.17 Average travel distance of goods vehicles

Vehicle Type	Average Travel Distance (km)
LCV/Tempo	70
2-Axle Truck	184
3-Axle Truck	490
Multi-Axle Truck	809

Trip length: The average trip length for multi-axle truck is 809 km. The average trip length of LCV is very low i.e. 70 km. The average travel length of other goods vehicles is presented in table

8.2.4 Bus Stop Waiting, boarding and alighting survey

The results from the boarding alighting surveys at bus stops are shown in Table below. Maximum volume was seen at Gajuwaka junction followed by Madhuwada junction.

Table 8.18 Bus Stop Waiting, boarding and alighting survey results

ID	Daily Loadings		
	Boarding	Alighting	Boarding+ Alighting
BA-1	2073	3096	5169
BA-2	1955	1249	3204
BA-3	2562	1748	4310
BA-4	1028	875	1903
BA-5	1896	1410	3306
BA-6	4155	3822	7977
BA-7	2609	1663	4272
BA-8	2523	2068	4591
BA-9	1622	1351	2973
BA-10	1805	1665	3470

8.2.5 Bus Stop OD surveys including the Stated Preference surveys of bus users

Analysis of O-D survey at bus stops reveal that about 88% of trips are made within study area whereas only 0.5% of trips are through traffic

8.2.6 PT & IPT Stated Preference Surveys for private users along major activity centers

Socio economic Characteristics

- About 90 % of public transport users are males
- About 89% of public transport users lies in the age group of 20 to 50 years of age.
- About 37% of PT users belong to monthly family income group of Rs 10,000 to Rs 15,000 followed by 23% belongs to monthly family income group of Rs. 15,000 to Rs. 20,000.
- Average household size of PT user is 3.7 with 1.2 students per household.

Travel Characteristics

- Average distance of a PT user from residence to place of work is 19 km.
- Average travel distance of a PT user is 18 km
- Average waiting time of a PT user is 8 min
- Average travel time of a PT user is 30 min

The following table shows the willingness to shift to 'improved public transport system' under various scenarios of waiting time, travel time, comfort, travel cost scenarios

Table 8.19 Willingness to shift for Option 1 - 4

	Option 1	Option 2	Option 3	Option 4
Waiting Time (min.)	5	5	5	5
Travel Time (min.)	Reduced by 25%	Reduced by 50%	Reduced by 25%	Reduced by 50%
Travel Cost (Rs.)	Reduced by 25%	Reduced by 50%	Reduced by 25%	Reduced by 50%
Comfort	Same as Existing Bus	Same as Existing Bus	More	More
	Willingness to use mode			
Definitely Existing	6%	15%	10%	19%
Probably Existing	69%	58%	45%	48%
Can't Say	22%	2%	16%	2%
Probably Improved PT System	3%	6%	20%	21%
Definitely Improved PT System	0%	19%	9%	11%

Table 8.20 Willingness to shift for Option 5 - 8

	Option 5	Option 6	Option 7	Option 8
Waiting Time (min.)	10	10	10	10
Travel Time (min.)	Reduced by 25%	Reduced by 50%	Reduced by 25%	Reduced by 50%
Travel Cost (Rs.)	Reduced by 25%	Reduced by 50%	Reduced by 25%	Reduced by 50%
Comfort	Same as Existing Bus	Same as Existing Bus	More	More
	Willingness to use mode			
Definitely Existing	14%	16%	5%	6%
Probably Existing	11%	6%	20%	18%
Can't Say	44%	26%	19%	1%
Probably Improved PT System	28%	48%	40%	19%
Definitely Improved PT System	3%	6%	16%	56%

It is evident from the above survey data that cbommuters are more sensitive towards the 'comfort factor'. if the proposed public transport is more convenient, the modal shift of 30% can be achieved. If waiting time is increased, then 'comfort factor' as well as travel time/cost reduction are important criterion for mode choice.

8.2.7 Pedestrian Volume Count

Pedestrian counts were carried out for a period of 16 hours on a normal working day at 13 major intersections within the city area and the results are presented below. The pedestrian count summary at the surveyed locations is presented in Table below.

Table 8.21 Peak Volume and Peak hour for Pedestrian Volume at various intersections

	Peak Volume (Combine)	Peak Hour
Assilmetta Junction	1387	1715 – 1815 Hrs
Dolphin Circle	930	0830 – 0930 Hrs
Gajuwaka junction	1105	1745 – 1845 Hrs
Gopalpatnam Petrol Bunk Junction	814	1715 – 1815 Hrs
Gurudwara junction	698	1845 – 1945 Hrs
Hanumanthawaka Junction	2215	0930 – 1030 hrs
Jagadamba junction	1104	1715 – 1815 Hrs
NAD Junction	1216	1615 – 1715 Hrs
NTR Circle R K Beach junction	1063	1730 – 1830 Hrs
Old Jail Road junction	1137	1845 – 1945 Hrs
Ramatakies Junction	1564	1200 – 1300 Hrs
Siripuram junction	383	1900 – 2000 Hrs
Thatichetlapalem junction	1151	1715 – 1815 Hrs

8.2.8 Vehicle Operator Survey (IPT and Goods)

Analysis of the age group of IPT vehicle operator's shows that majority of the operators are of age group 30-34, followed by age group of 35 – 39 (22.8 % operators). The operators ageing between 40-44 and 45 above are very less. Auto Rickshaw is the most prevalent IPT mode used in the city, whereas the Tata Magic (Auto rickshaw) of slightly higher size is also being used. The Private taxis are least in the count.

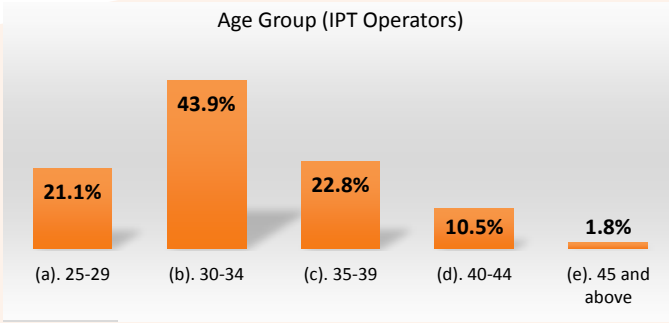


Figure 8.17 Age group of IPT operators

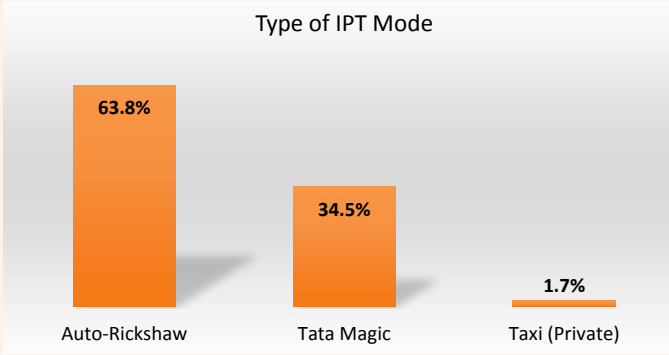


Figure 8.18 Type of IPT mode

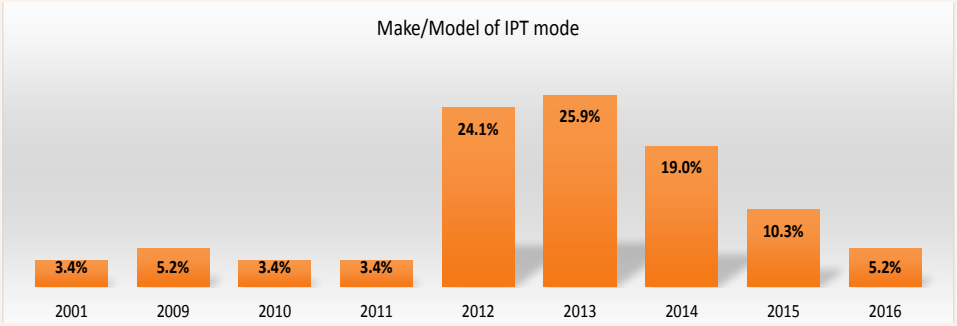


Figure 8.19 Model (Year) of IPT mode

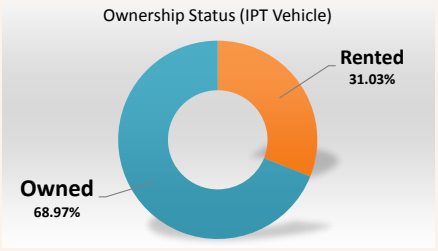


Figure 8.20 Ownership status of IPT vehicles

Most of the IPT modes currently in operations are of 2012-13 model (i.e. manufactured in 2012 or 2013) and most of them are self-owned

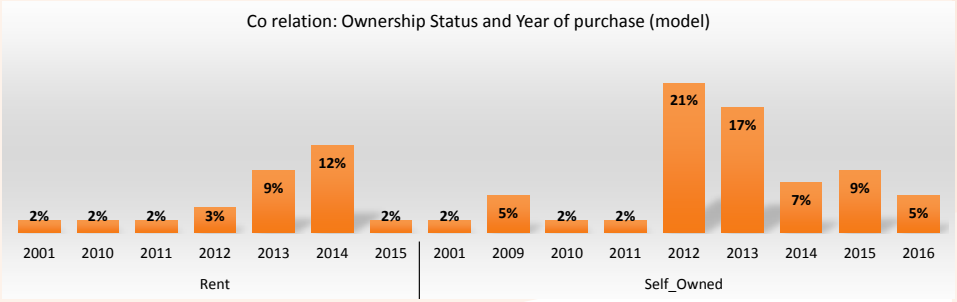


Figure 8.21 Co relation: Ownership Status and Year of purchase (model)

Correlating the ownership status and Year of purchase (model), it can be concluded that the in comparison to rented out –type vehicle ownership, self-owned have increased with time. The maximum growth can be seen in 2012-2013.

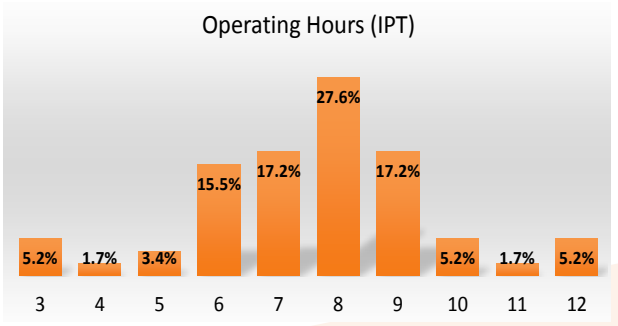


Figure 8.22 Operating hours (IPT)

Majorly, the Intermediate para transit mode i.e. Shared Autos and Tata magic are operated for 7-9 hours, , but the number of drivers operating for 10-12 hours are very less. IPT operators spent upto Rs. 1000/day including rent, fuel cost and maintenance, whereas for self-owned vehicles the expenditure is less i.e. upto Rs. 500/day. For more than 50% operators, the expenditure is upto Rs. 250/day, whereas the revenue is Rs. 250 – 1000/day.

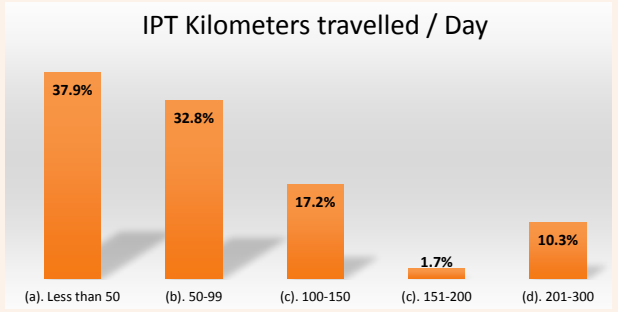


Figure 8.23 Kilometers travelled/day (IPT)

8.2.9 Parking Survey (Off-Street and On-Street)

The following section shows the analysis of parking surveys. Table below represents the peak hour volume (incoming) and peak hour of various locations for on street parking survey. The maximum incoming peak volume was seen at Jagdamba junction followed by Vizag Railway station.

Table 8.24 parking volume counts (On street Parking)

Junction Name	LHS		RHS	
	Peak Hour	*Peak Incoming Volume*	*Peak Hour*	*Peak Incoming Volume*
CBM Compound road	1500 – 1600	76	2030 – 2130	72
Daba Garden road	1800 – 1900	63	1930 – 2030	52
Dwarka Complex road	1230 – 1330	64	2130 – 2230	88
Dwarkanagar road	1930 – 2030	52	1900 – 2000	47
Gajuwaka Jn	0800 – 0900	49	1930 – 2030	37
Jagdamba Jn	1830 – 1930	91	1930 – 2030	95
Kailashgiri	1930 – 2030	58	1900 – 2000	33
Maddilapalem Jn	1700 – 1800	42	1800 – 1900	22
Marripalem Kancharapalem	1100 – 1200	58	1800 – 1900	55
NAD Gopalapatnam Road	1000 – 1100	74	2130 – 2230	115
Poorna Market	1830 – 1930	42	1830 – 1930	33
Rama Talkies Road	1400 – 1500	51	2130 – 2230	76
RK Beach	1730 – 1820	54	1900 – 2000	27
Simhachalem	1930 – 2030	66	1800 – 1900	41
Vizag Railway Station	1300 – 1400	82	1900 – 2000	58

Table below represents the peak hour volume (incoming) and peak hour of various locations for on street parking survey. The maximum incoming peak volume was seen at Dwarka Bus stand and Maddilapalem compound followed by Purna market.

Table 8.25 Off street parking survey results

Junction Name	*Vehicle type*	*Peak Incoming Volume*	*Peak Hour*
Dabagarden complex	Two Wheeler	24	1600 hrs
Dwarka Bus Stand (Backside complex)	Two Wheelers	22	0900 hrs
Dwarka Bus Stand (Outgate side parking)	Two and Four wheelers	66	2130 hrs
Gajuwaka Jn. near Kutimamba Gudi	Two and Four wheelers	52	0700 hrs
Gajuwaka Jn. Road	Two and Four wheelers	33	1900 hrs
Jagdamba Compound	Two and Four wheelers	44	0930 hrs
Kailashgiri Compund	Two and Four wheelers	31	1200 hrs
Maddilapalem compound	Two and Four wheelers	66	2000 hrs
Purna Market	Two and Four wheelers	64	1230 hrs
RK Beach Compound	Two and Four wheelers	40	1830 hrs
Simhachalem Compound	Two wheelers	20	1830 hrs
Vizag Railway Station	Two wheelers	56	2130 hrs

8.2.10 Parking Willingness to pay Survey

Majority of the commuters are willing to pay for parking if 'good parking management' system is been provided. in case of Off-Street parking 49% of the respondents were willing to pay Rs. 10/day, followed by 37% respondents which said Rs. 5/day is optimum.

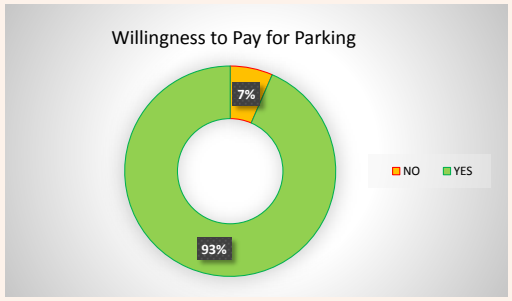


Figure 8.24 Willingness to pay for parking

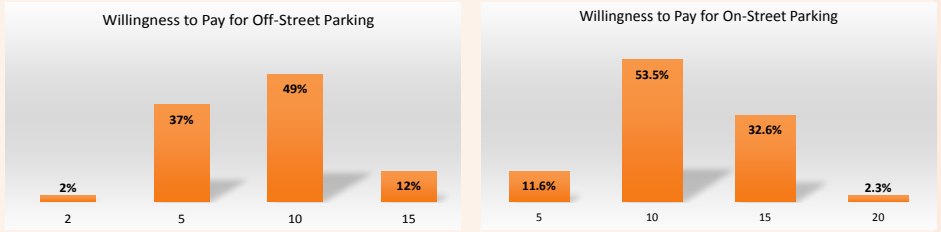


Figure 8.25 Willingness to pay for off and on street parking

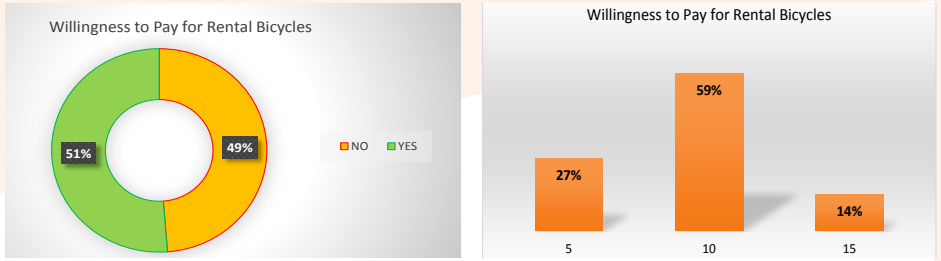


Figure 8.26 Willingness to pay for Rental Bicycle (in Rs.)

For managed on street parking more than 53% respondents were willing to pay Rs. 10/day followed by 33% respondents who opted for Rs. 15/day.

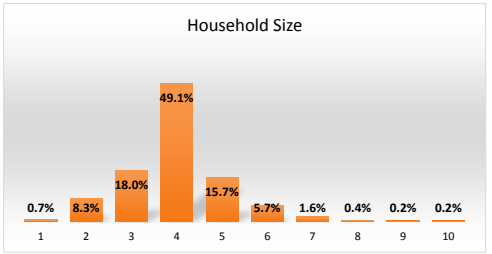
Commuters have neutral response towards usage of rental bicycle. Though they are willing to pay rs 5 or 10, if suitable public transport is provided which can significantly save time and money.

8.2.11 Household Survey

The data obtained from the interview forms were converted into numerical codes according to the predetermined code lists and were used as inputs for analysis. Data collected from the sample household were expanded to represent the whole population of the respective zone with the expansion factor arrived at for each traffic zone. The expansion factor was obtained by dividing the total number of estimated households in the survey area for each traffic zone by the total number of successful households interviewed in the respective zone.

Demographic and Socio Economic Characteristics

The size of household in terms of total members in it would have a significant influence on the quantum of trip made by the household. Similarly the household and vehicle ownership could be important factors in the determination of travel modes used by the households for trip making. The population, its distribution in an area and its composition in terms of age, sex, working members and students constitute as equally important factors influencing trip making rates of a household as family size and household income. The number of vehicles available for use by the household would also influence the trip making and mode of travel. Some socio economic characteristics are shown below. Details regarding travel behavior etc. will be illustrated in detail in the Travel Demand Model analysis.



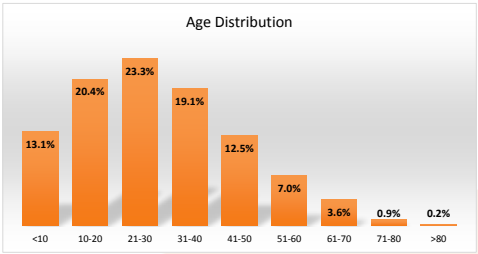
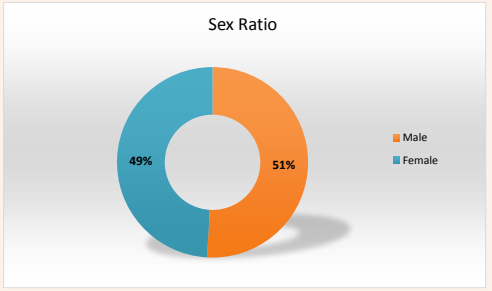


Figure 8.27 Household size and Age distribution

- The average household size is 4.
- 23% residents are in the age group of 21-30 and 19% lies in the range of 31-40,
- Population less than 20 i.e. age groups <10 and 10-20 comprises of 13.1% and 20.4 % respectively.



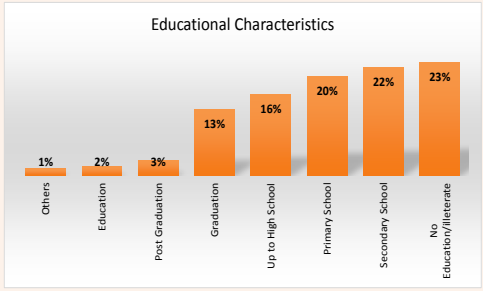


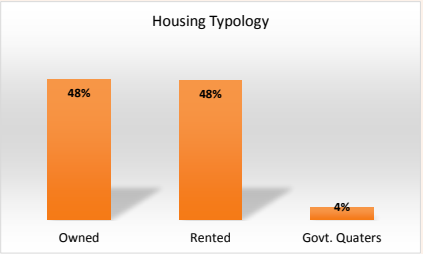
Figure 8.28 Sex ratio and Educational Characteristics

- Household data revealed uniform gender distribution across the city.
- 77 % of the population has some formal education.
- Most of the residents are earning upto 20,000.

Housing Characteristics

The section describes the housing typology, rental profiles and availability of parking spaces in the households of GVMC areas.

- The rented and Self owned properties are equally distributed (48% each), whereas the Govt. quarters comprises of 4% only.
- 55% of rental properties have a rental values between 2001- 4000.
- 43% of the households have parking facility.



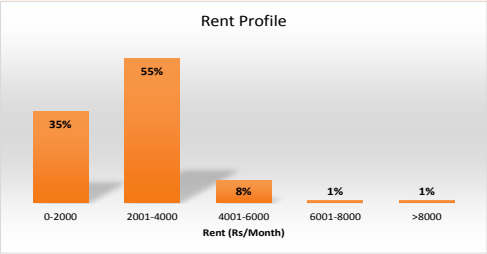
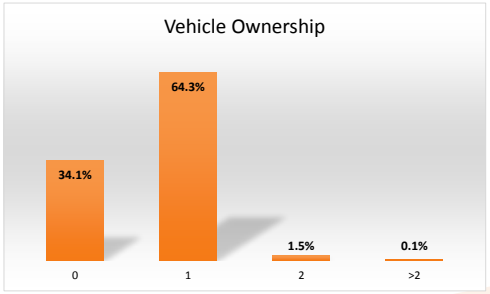


Figure 8.29 Housing typology in GVMC and rental profile

Vehicle Ownership and Travel Characteristics

The section describes the vehicle characteristics i.e. Ownership, vehicle type, vehicle age, fuel typology etc. of vehicles owned by the residents of GVMC area.

- Most of the households have only one vehicle i.e. Two Wheeler.
- 34% household doesn't own any vehicle.
- Car ownership is very less i.e. 7.7% only.



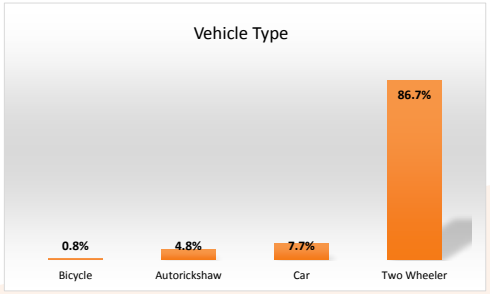
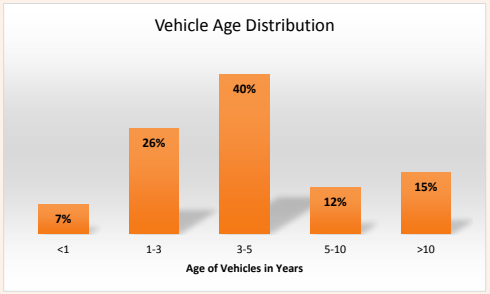


Figure 8.30 Household size and Age distribution

- Most of the registered vehicles are 3-5 years old.
- 90% of the vehicles are petrol driven.



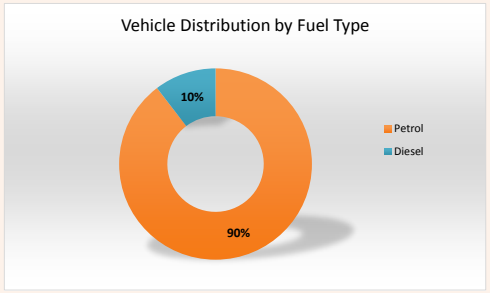


Figure 8.31 Vehicle Age distribution and fuel type

Travel Mode Characteristics

The section describes the travel characteristics i.e modes used for access, egress and main mode, Trip purpose, Trip frequency etc.

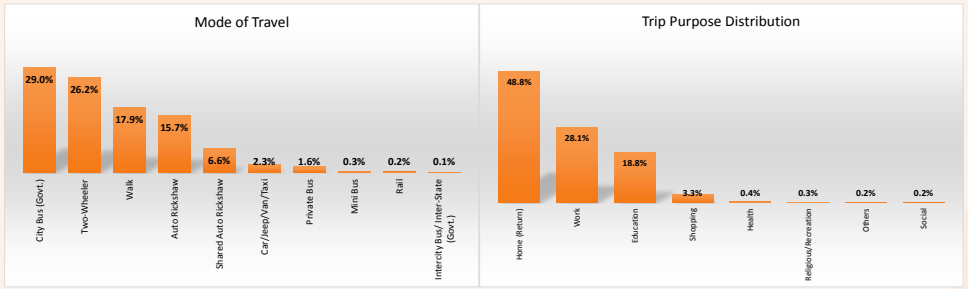


Figure 8.32 Mode of travel and trip purpose distribution

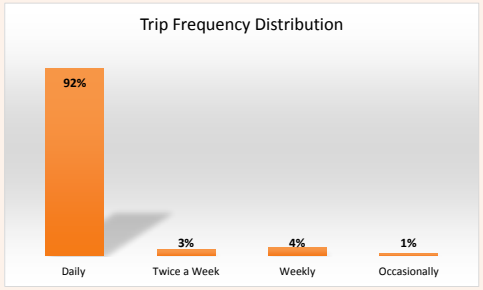


Figure 8.33 Trip frequency distribution

- City bus is mostly used mode and serves 29% of the trips.
- Majority of residents owns two wheelers i.e. 26 %.
- Walk trips are 17% only.
- 28% of the trips are home based work trips and 18.8 % trips are home based education trips.
- The access and egress mode used for IPT and Bus is walk

Travel Time and Cost Characteristics

The section describes the travel time characteristics i.e. access time, waiting time at transit stop, main mode travel time and egress time.

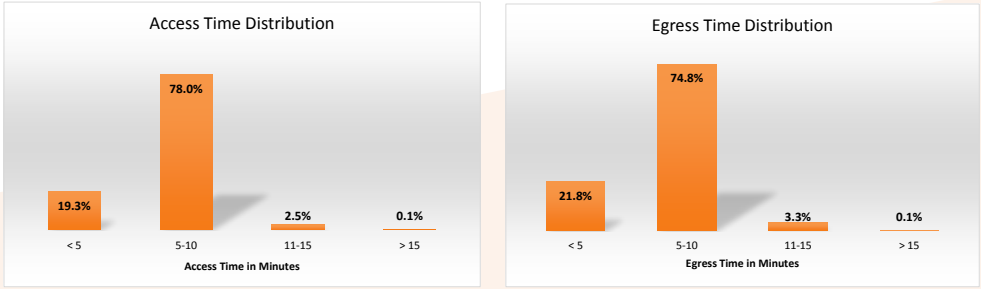


Figure 8.34 Access and Egress time distribution

- Most of the city is covered with city bus service network therefor the access and egress time is 5 -10 minutes by walk.
- 2.5 – 3.3% commuters walk for 11-15 mins to access/egress the main mode.

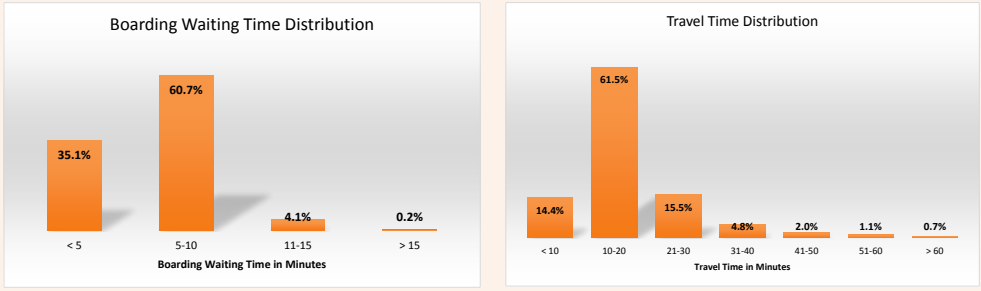
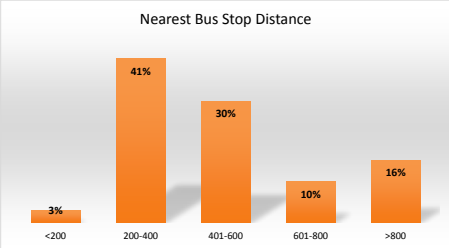


Figure 8.35 Waiting and travel time Distribution

- For 60% of the trips, the waiting time to use the main transit mode is 5-10 mins.
- The average travel time is 10 – 20 mins.

Public Transport Characteristics

The section describes the characteristics of public transport i.e. city bus service operated by APSRTC 's characteristics.



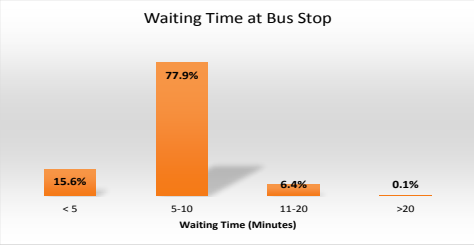


Figure 8.36 Nearest Bus Stop Distance and Waiting time

- 70 –75 % of the commuters responded that nearest bus stop is at 5-10 minute walkable distance i.e. 0 – 600 m.
- The perceived waiting time at the bus stop is 5-10 minutes.
- The average travel cost is Rs. 10 – 20.

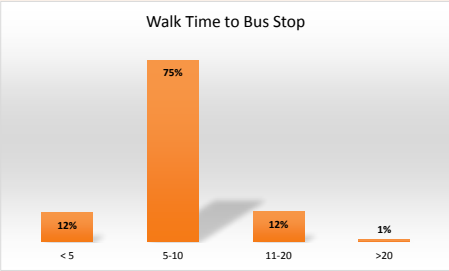
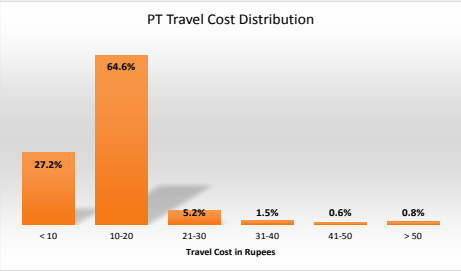


Figure 8.37 Walk time to bus stop



b). PT cost distribution

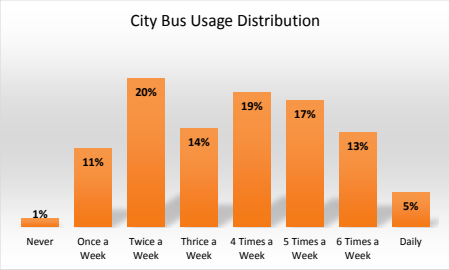
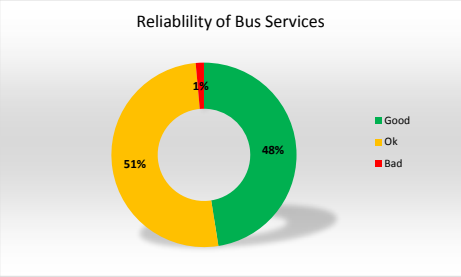


Figure 8.38 a). City bus usage distribution



b). Reliability of Bus service

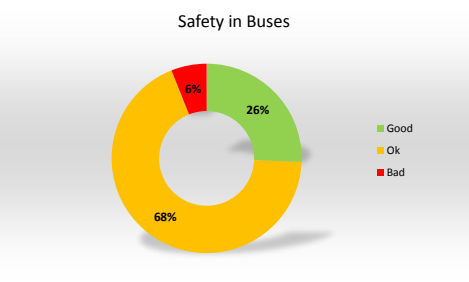
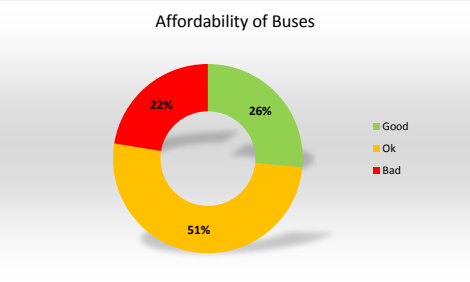


Figure 8.39 Safety in buses

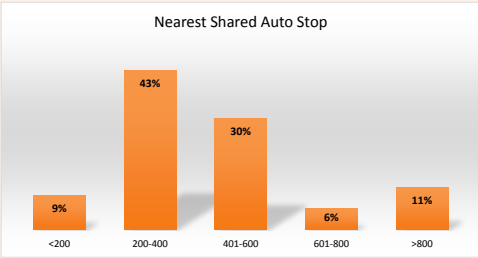


b). Affordability of buses

- Most of the respondent felt good regarding the safety whereas 6% considered it to be an issue.
- 22% of the respondents felt that bus service is expensive, whereas remaining termed it as 'good' or 'ok'.

IPT Characteristics

The section describes the intermediate para transport i.e. three wheelers operated within he city.



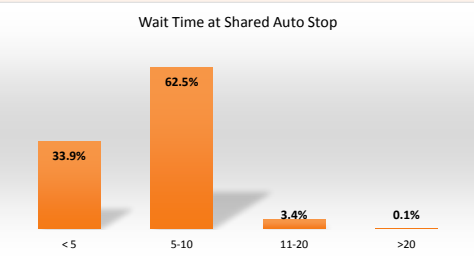


Figure 8.40 Nearest shared Auto Stop and Wait time

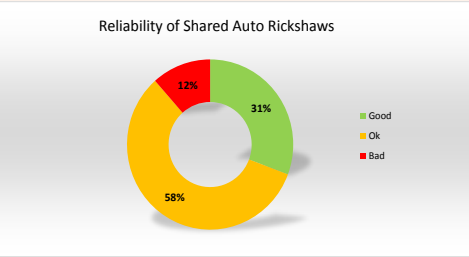
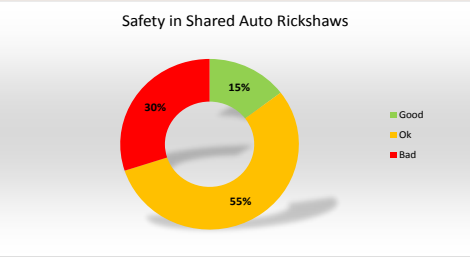


Figure 8.41 Reliability of shared auto rickshaw



b). Safety in shared auto rickshaw

8.2.12 Road Inventory Survey

A Road Inventory survey was carried out on all major stretches of roads in GVMC Area, for a total of about 250 kms. Based on the survey results, an analysis has been carried out with respect to the type of carriageway (upto 2 lanes, 2-4 lanes, 4-6 lanes & more than 6 lanes), availability of median (divided/undivided Carriageway), availability of footpath, total Right-of-Way (ROW) etc and the results are presented below

Types of carriage-way

Of the total roads covered in the inventory, nearly half of the roads (55%) have four lane carriageway, while 41 % is with two lane carriageway. Six lane roads account to only 1% of the total road network. Carriageway type of the roads in GVMC is presented in Table below

Table 8.26 Lane width of GVMC major roads

Nos of lane	% share
1.0	3%
2.0	41%
4.0	55%
6.0	1%

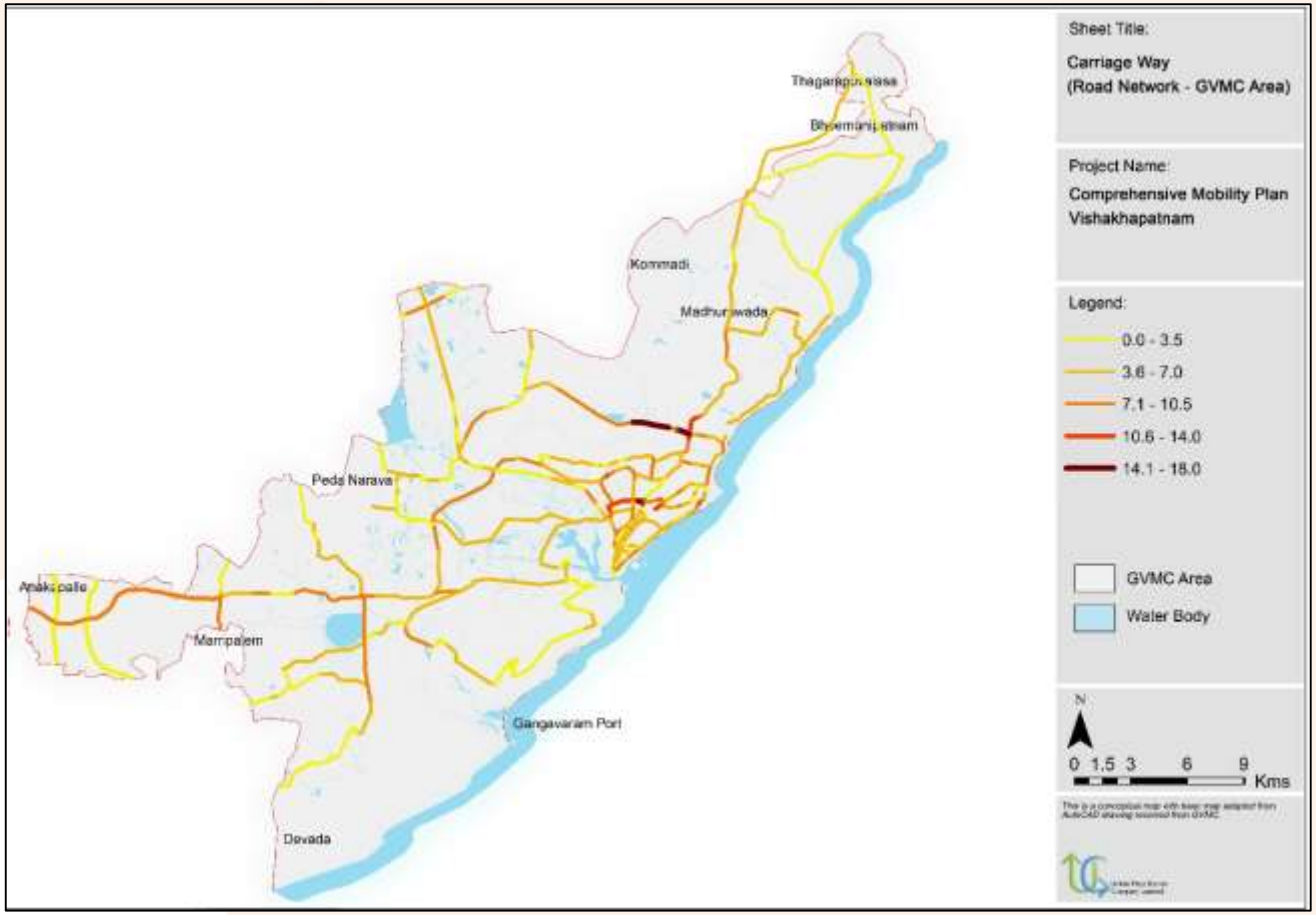


Figure 8.42 Carriage way of GVMC roads

Median Availability

Majority of roads in GVMC area have median and it is available only for 68% of roads. For most of the road median width is very small i.e. 0.1 to 0.6 m, where 30% roads have a median of 1.6 –7.0 m.

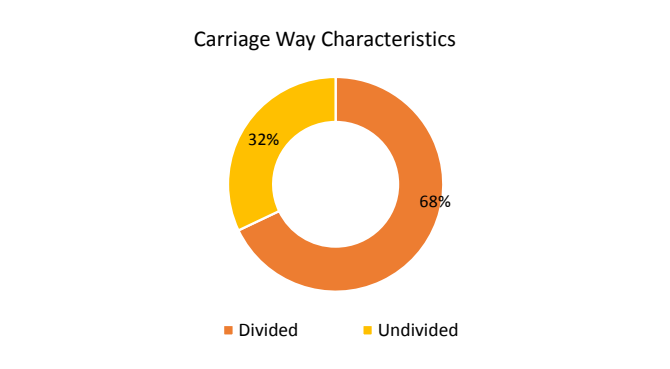


Figure 8.43 Carriage way characteristics

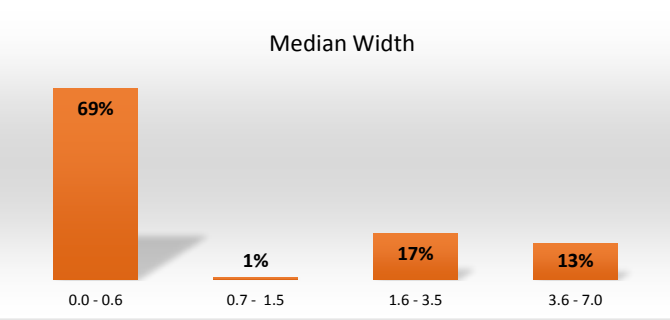


Figure 8.44 Median width in GVMC major roads

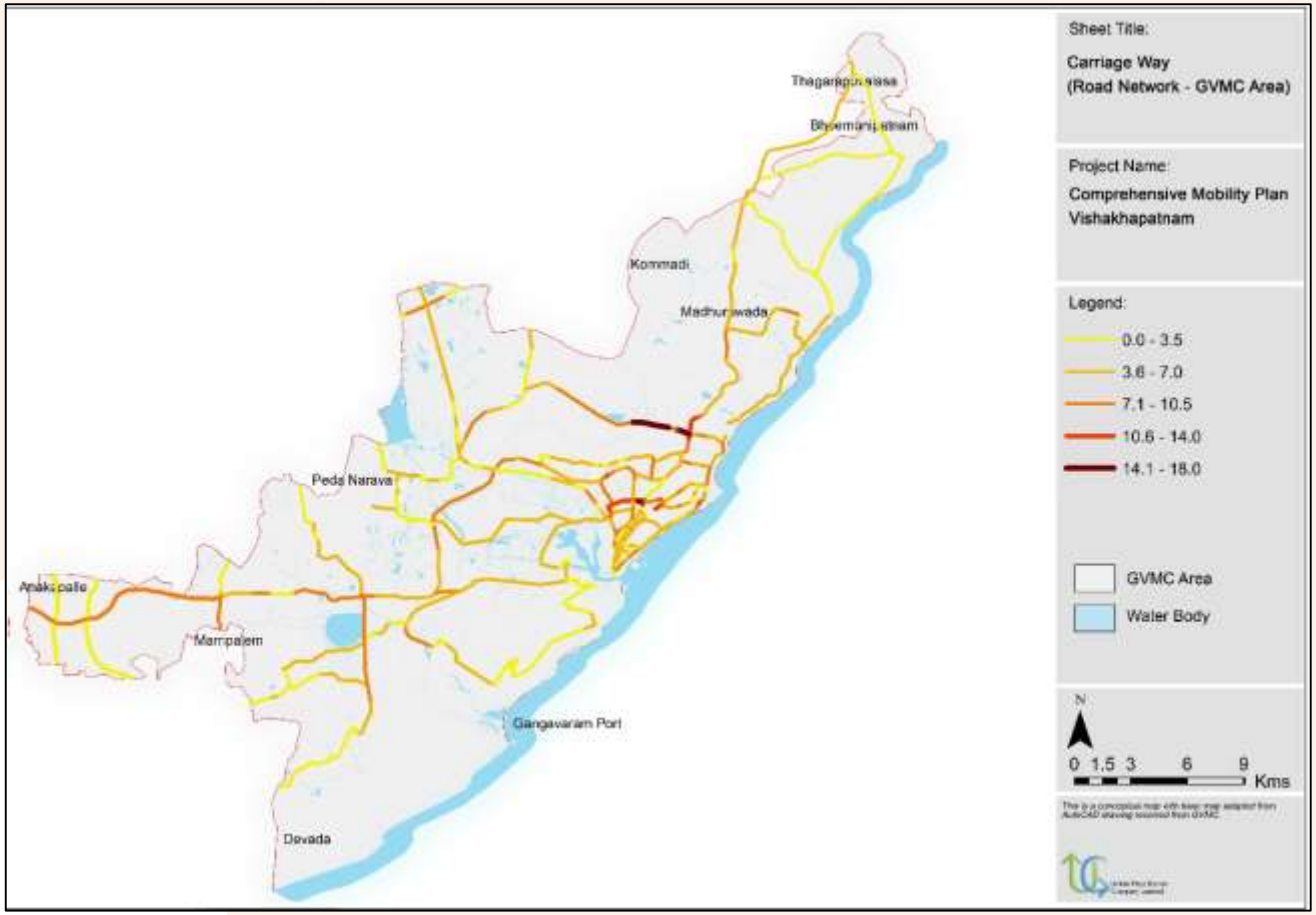


Figure 8.45 Carriage way of GVMC roads

Availability of Footpath

Availability of footpath in the study area is presented in figure below. Most of the roads (73%) are not having footpath. 4% roads are having unpaved footpath. Only 23% roads are having footpath in desirable condition.

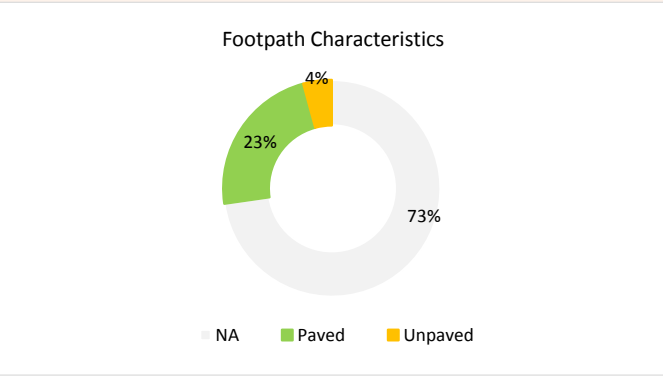


Figure 8.46 Footpath characteristics of GVMC major roads

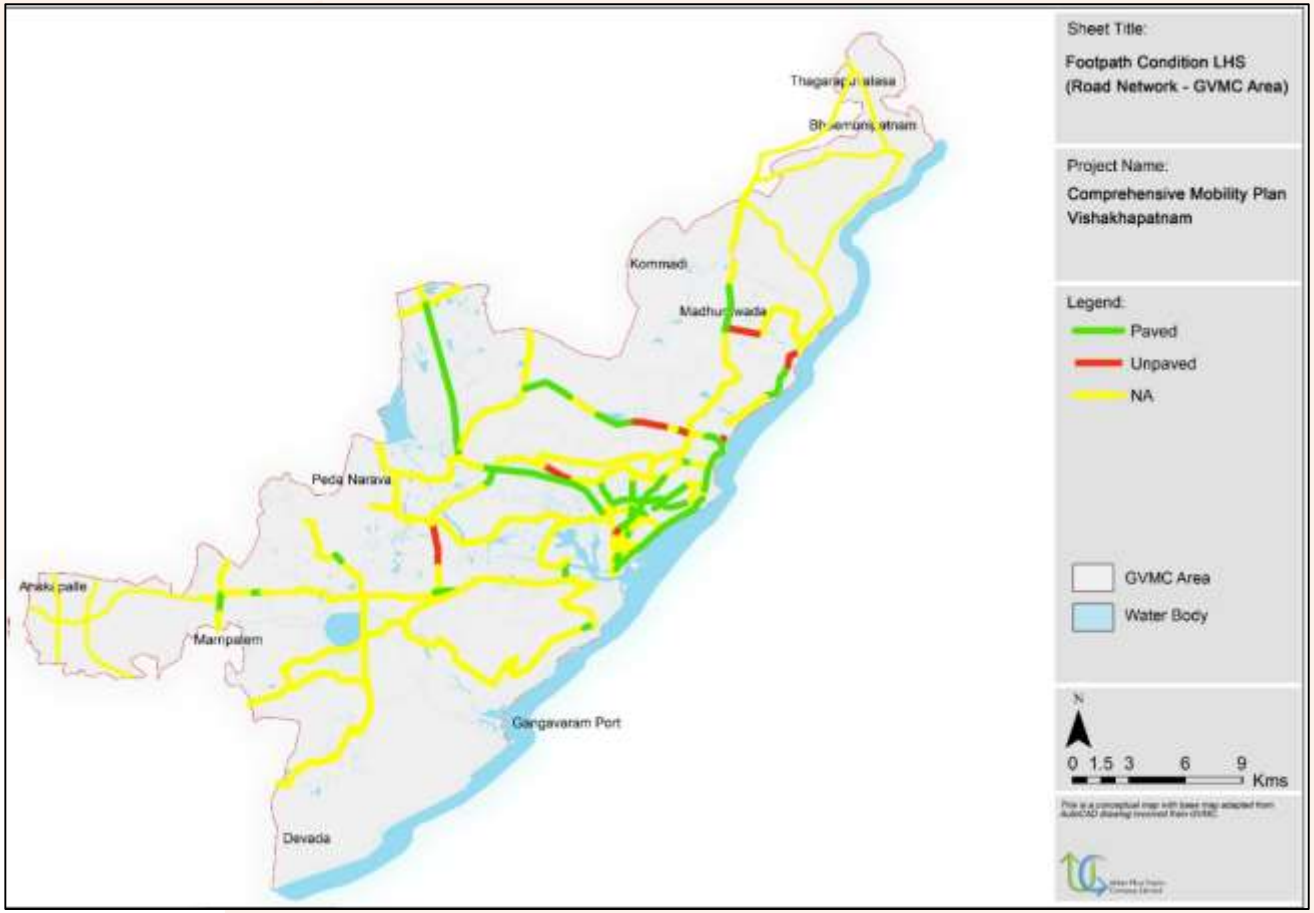


Figure 8.47 Footpath condition (LHS) of GVMC major roads

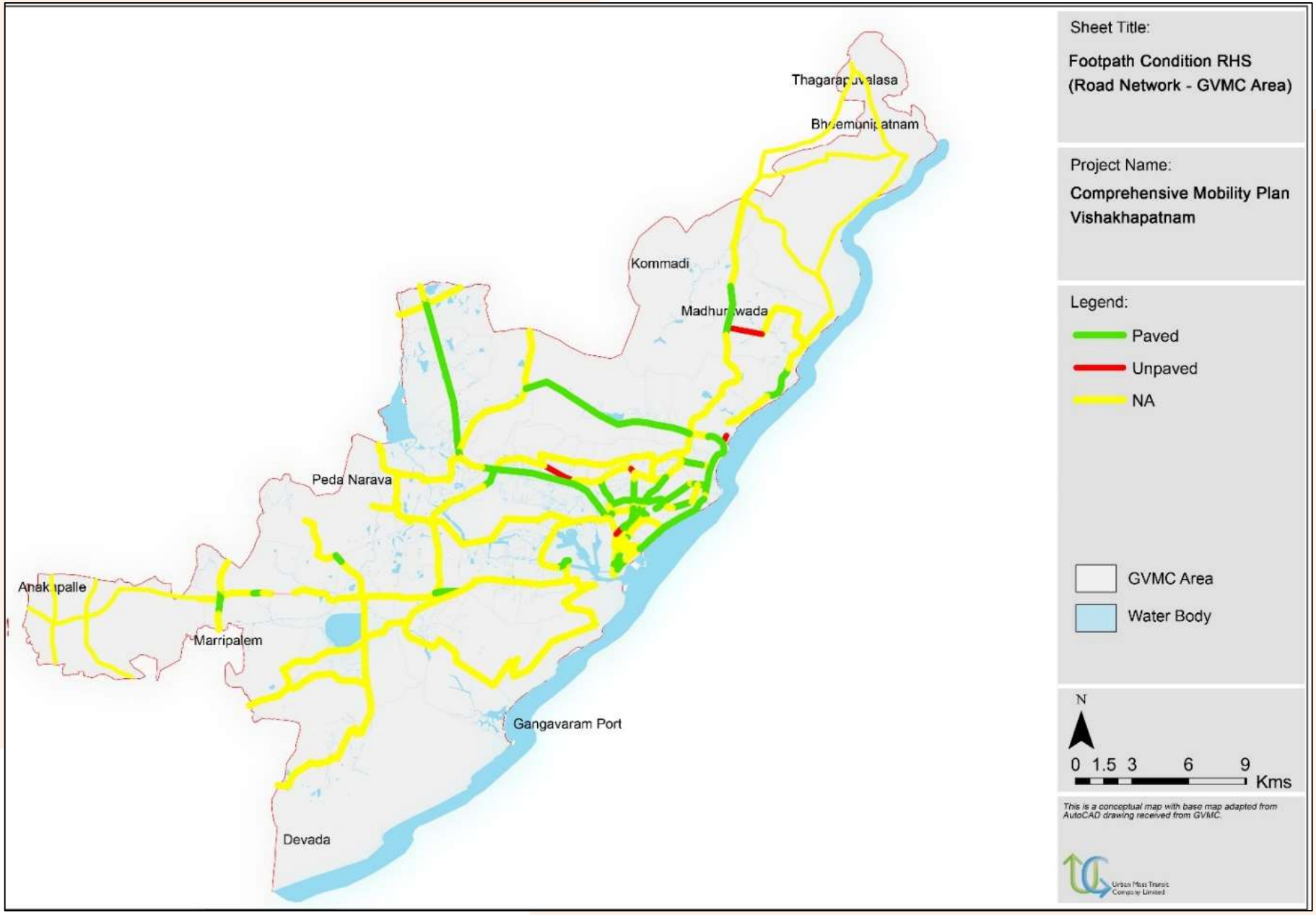


Figure 8.48 Footpath condition (RHS) of GVMC major roads

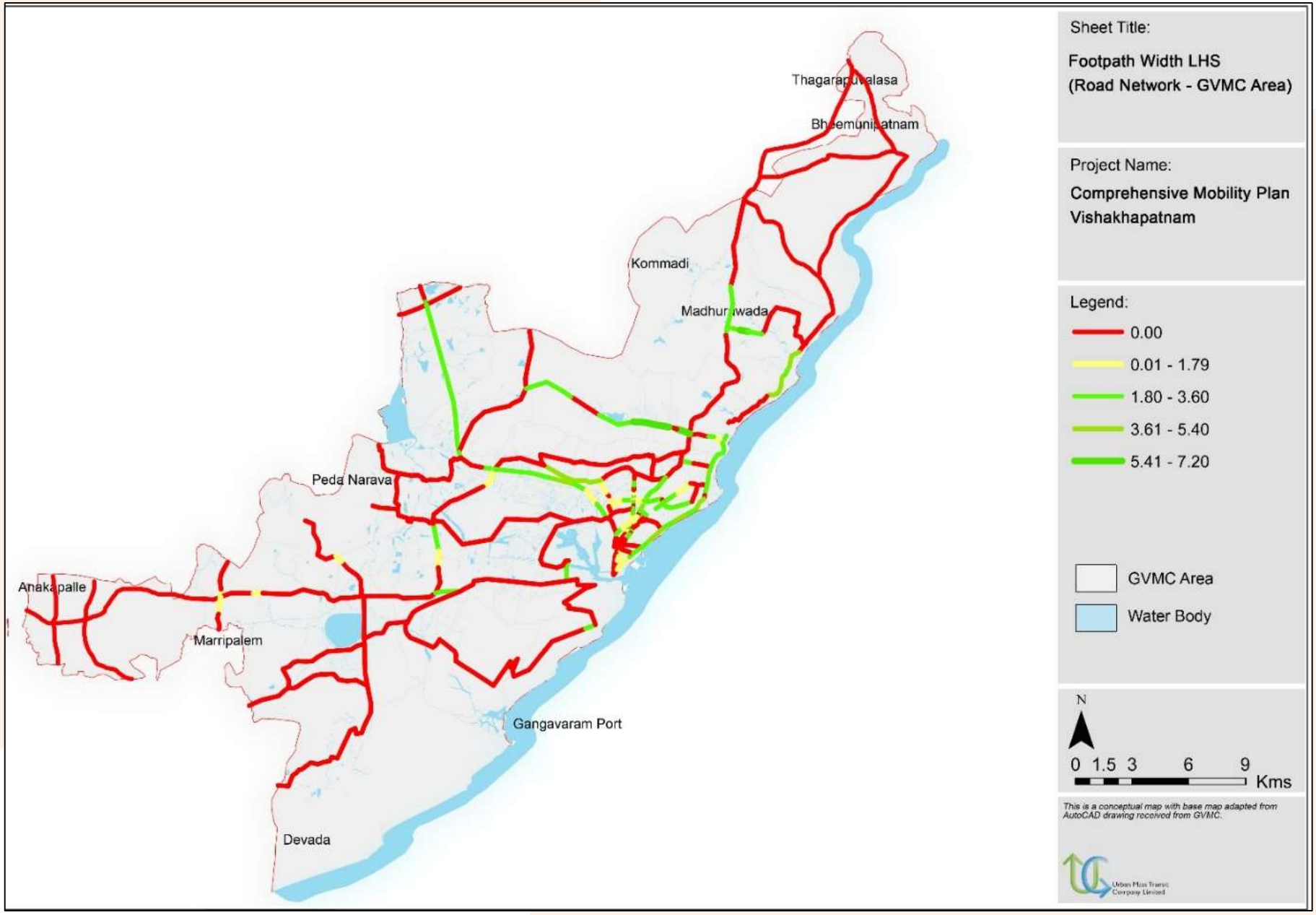


Figure 8.49 Footpath width of GVMC major roads

Right of Way availability

Most of the major roads are 15 – 30 m wide, 20% of the roads are having width ranging between 30m- 45m.

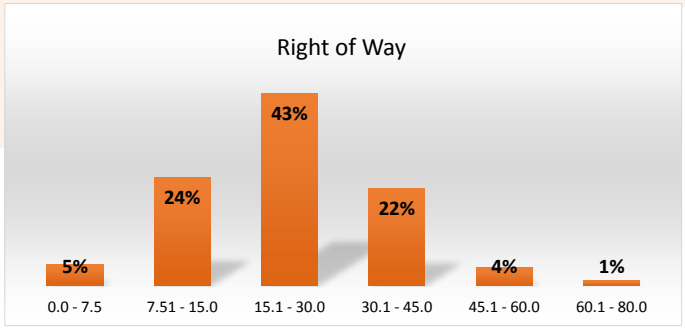


Figure 8.50 Right of Way Footpath of GVMC major roads (% share)

Figure 8.51 Right of Way Footpath of GVMC major roads

Encroachment

Encroachments are classified into three categories such as heavy i.e., encroachments are present on both sides of the road heavily causing problems for the movement of traffic and pedestrians, Moderate i.e., encroachments are present partially on either sides of the road and Nil i.e., they are absent on the both sides of the road in the study area. In GVMC region, encroachments are moderately present for about 4 %..

Table 8.27 Encroachment on GVMC major roads

Encroachment	% Share
0.0 - 1.0	95.4%
1.1 - 2.0	3.8%
2.1 - 3.0	0.3%
3.1 - 4.0	0.4%
4.1 - 5.0	0.2%
5.1 or more	0.0%

Figure 8.52 Encroachment on GVMC major roads

Presence of Road Markings/ Signboards

Availability and quality of markings has been classified into four categories such as good i.e., markings are as per IRC specifications, fair i.e., as per standards but fairly visible and poor i.e., not as per IRC specifications and not visible. Road markings are not available for about 7% of total network length in the study area. Presence of road marking is presented in figures below:

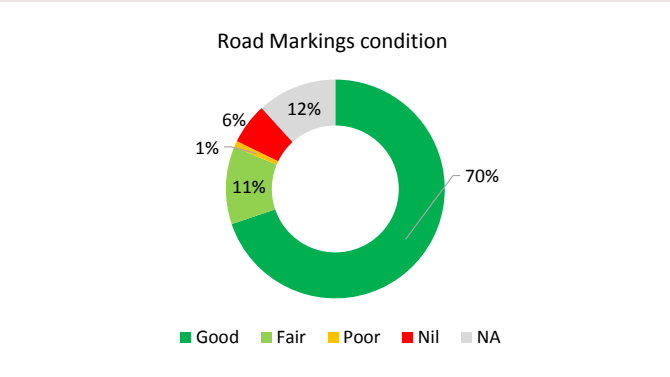


Figure 8.53 Road markings on GVMC major roads (% share)

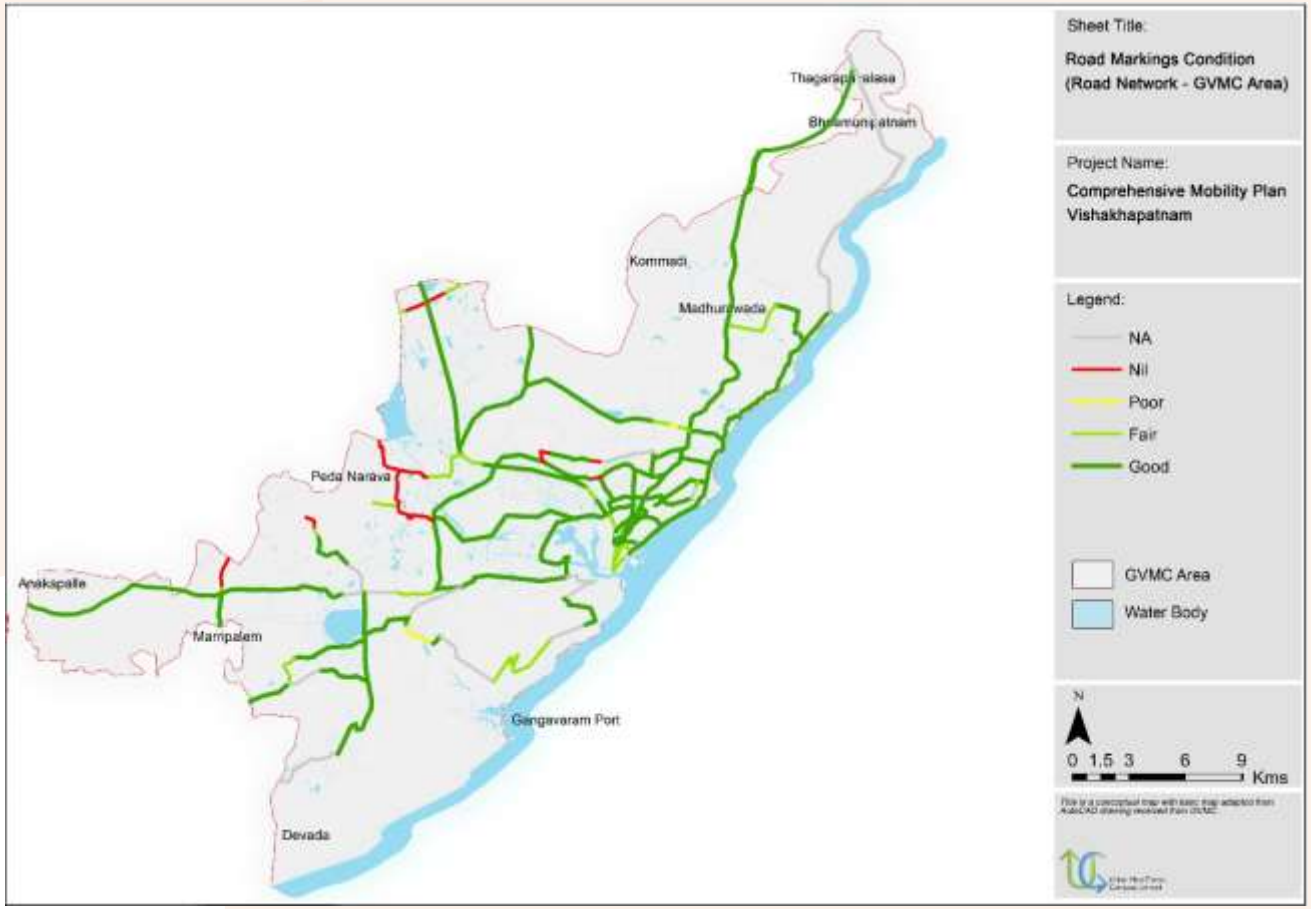


Figure 8.54 Road markings on GVMC major roads

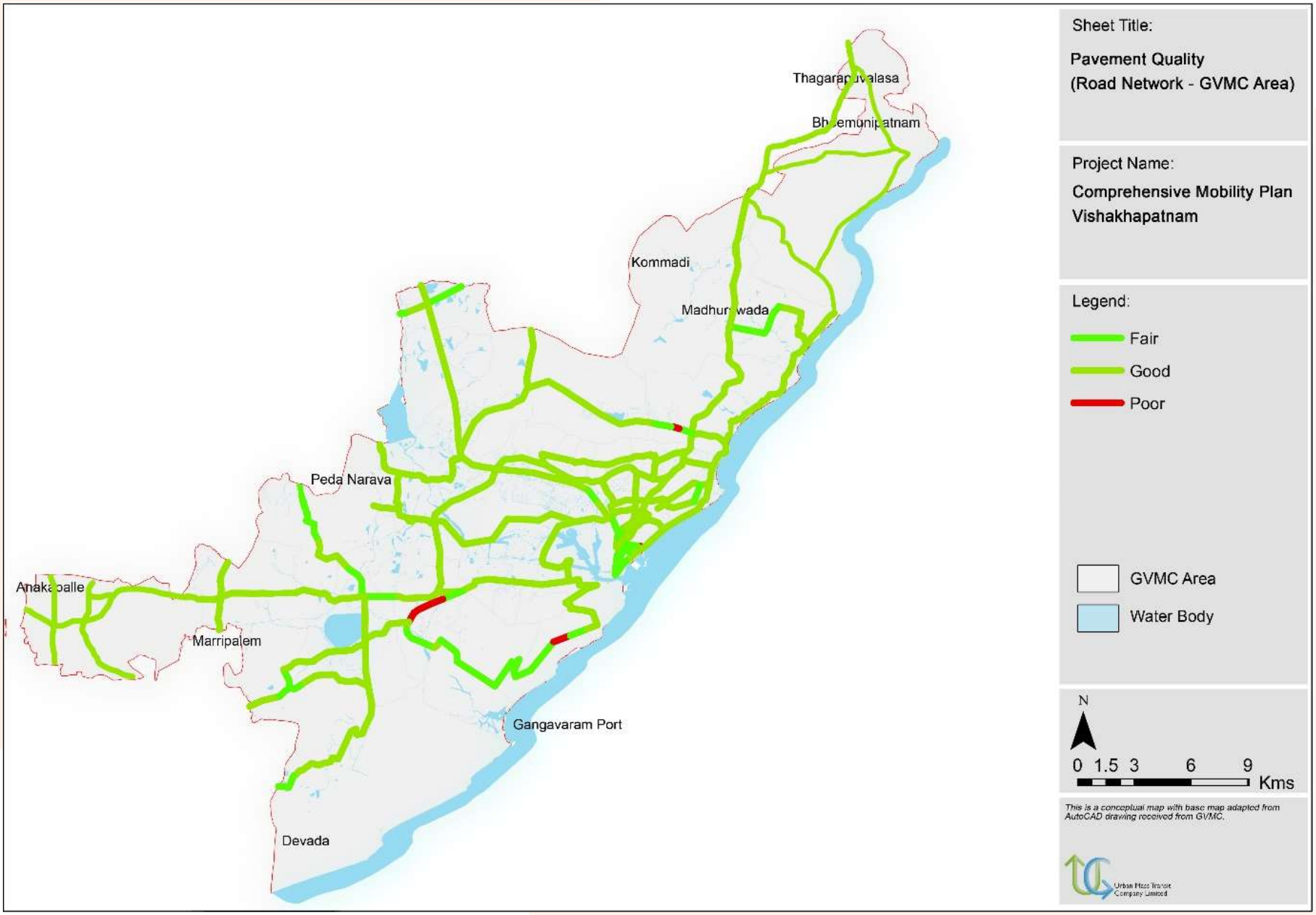


Figure 8.55 Pavement quality of GVMC major roads

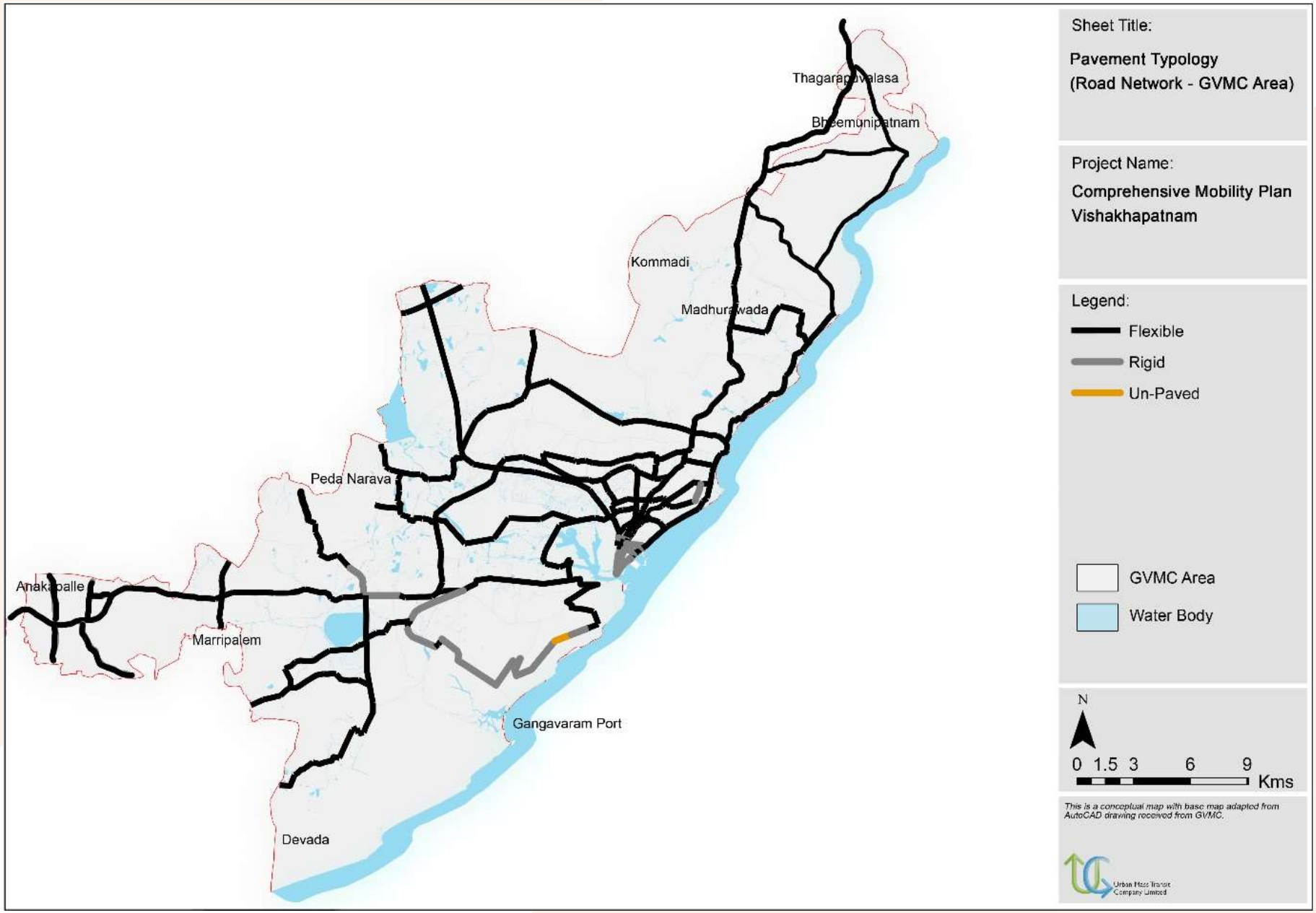


Figure 8.56 Pavement typology of GVMC major roads

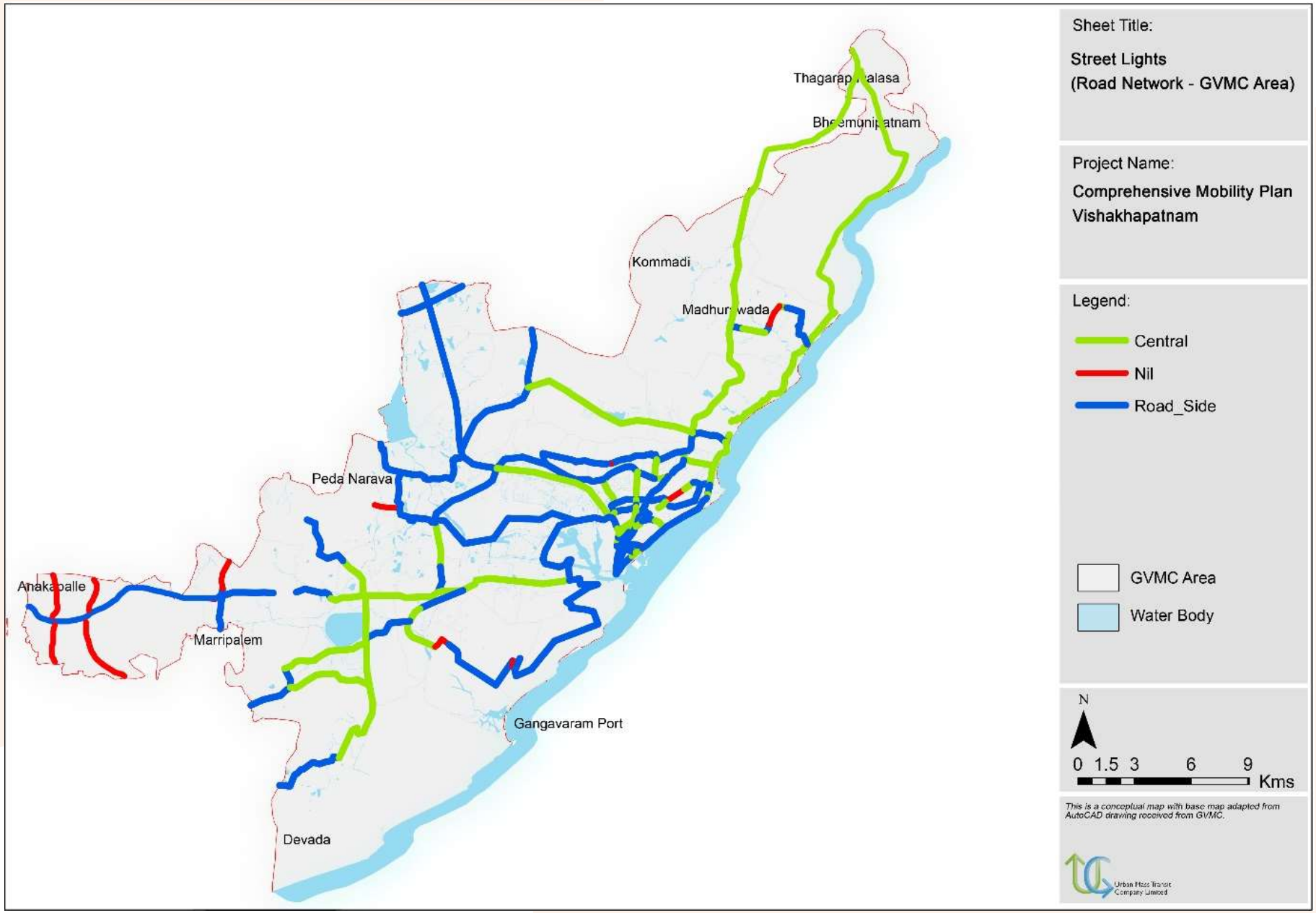


Figure 8.57 Street lights typology of GVMC major roads

8.3 Parking demand supply analysis

The Parking demand at identifies location is direct function of the vehicular and population growth. For future scenarios, the vehicular growth is calculated by incremental increase method.

The rate for four wheeler increase is assumed to be 9% (average of past five years)

The rate for two wheeler increase is assumed to be 6%.

Table 8.28: Vehicle population Projection (GVMC)

	2017	2021	2031	2041
Four Wheelers	88299	124641	295071	698541
Two Wheelers	610580	770843	690231	2472199
PCUs (4W)	88299	124641	295071	698541
PCUs (2W)	305290	385422	690231	1236099

8.4: Emissions calculations

The vehicular emissions for both the scenarios were calculated from the model. The assumptions taken from CPCB Norms are as follows.

- The private vehicles and IPT in 2021 scenario are having fuel technology BS III
- The private vehicles and IPT in 2031 and 2041 scenario are having fuel technology BS IV
- The buses in 2031 and 2041 are fully electric with 0 tail pipe emissions. The buses recommended are given in public transport proposals.

Table 8.29 : Emissions in Do Nothing Scenario - 2021

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	356203	2560916	323488	6016331	864012
Total HC + Nox(G/KM)	1119495	2560916	323488	6016331	131480
Total PM	16962				

Table 8.30: Emissions in SUT Scenario - 2021

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	56425	322561	40895	778754	111597
Total HC + Nox(G/KM)	177336	322561	40895	778754	16982
Total PM	2687				

Table 8.31: Emissions in Do Nothing Scenario - 2031

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	365394	3690251	465276	8548287	534355
Total HC + Nox(G/KM)	1096183	3690251	465276	8548287	96184
Total PM	4871				

Table 8.32: Emissions in SUT Scenario - 2031

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	0	3253384	410060	7517491	470015
Total HC + Nox(G/KM)	0	3253384	410060	7517491	84603
Total PM	0				

Table 8.33 : Emissions in Do Nothing Scenario - 2041

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	461701	4669525	589774	10960529	684418
Total HC + Nox(G/KM)	1385102	4669525	589774	10960529	123195
Total PM	6156				

Table 8.34 : Emissions in SUT Scenario - 2041

	Bus	Auto-Rickshaw	Shared Auto	Two Wheeler	Four Wheelers
Total CO	0	668497	84638	1597783	99629
Total HC + Nox(G/KM)	0	668497	84638	1597783	17933
Total PM	0				

8.5 Freight Details

Top 20% OD pairs comprise of 70-75% of the freight traffic. Same has been listed in table below. Around 60% of the traffic is divertible on the new freight corridor and Chennai Srkakulam highway.

Table 8.35 : Freight traffic details

	Origin Areas	Destination Areas	Roads used	Divertable on	Total PCUs	%
A	Durga nagar, Mudasarlova park, Arilova colony, Chinna gadhili	Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa	NH16	Simhachalem Sontyam road and Chennai Srkakulam highway	2228	3%
B	Visakha Container terminal and adjoining areas	Anakapalle, Sankaram, Gopalapuram, Konda kopakka, Kannuru, Maredupudi Agraharam, Bhatlapudi, Golagam, Rajupalem, Mantripalem	Port main road, unnamed raod and nh16		3319	5%
C	Visakha Container terminal and adjoining areas	Towards Achutapuram, Nagavaram, Mamidiwada	Jail road, Rama talkies road and nh16		2703	4%
D	Visakha Container terminal and adjoining areas	Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa	Jail road, Rama talkies road and nh17		13892	20%
E	Visakha Container terminal and adjoining areas	Towards Araku, Bowdara, Srungavarupu Kota, Lakkavarapu kota, Kothavalasa	Bowdra ring road, Penduthi NAD BRTS expressway		2892	4%
F	Visakha Container terminal and adjoining areas	Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad	Port main road, Scindia road and Lankalapalem Simhadri NTPC power plant road	DEDICATED FRIEGHT CORRIDOR	9008	13%
G	Ratnagiri nagar, N.A.D. Vuda layout, Valimeraka, Purushottapuram, Kavali, Port colony,	Towards Araku, Bowdara, Srungavarupu Kota, Lakkavarapu kota, Kothavalasa	Penduthi NAD BRTS expressway		4078	6%
H	Anakapalle, Sankaram, Gopalapuram, Konda kopakka, Kannuru, Maredupudi Agraharam, Bhatlapudi, Golagam, Rajupalem, Mantripalem	Ratnagiri nagar, N.A.D. Vuda layout, Valimeraka, Purushottapuram, Kavali, Port colony,	NH16	Chennai Srikakulam highway	1328	2%
I	Anakapalle, Sankaram, Gopalapuram, Konda kopakka, Kannuru, Maredupudi Agraharam, Bhatlapudi, Golagam, Rajupalem, Mantripalem	Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa	NH16	Chennai Srikakulam highway	3603	5%
J	Towards Modavalasa, Manglapalem, Kothavalasa, Ananthagiri, Vizianagaram, Orissa	Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad	NH16 and Lankalapalem - Simhadri NTPC Power Plant road	Chennai Srikakulam Highway	23090	34%
K	Towards Thallapalem, Rambili, Nakkapali, Tuni, Kathipudi, Hyderabad	Pedamusidivada, Ajanagiri, Gangavaram, Nanginarapadu,	0	Dedicated frieght corridor	2655	4%

8.5 Base Year Planning Variables

Table 8.36 : Planning Variables (Base Year)

Wards	Population_ 2016	Employment_ 2016	Resident Students_2016	Student Enrolment
1	28976	3788	8700	1128
2	25393	796	6800	9900
3	36386	3139	10200	2632
4	31453	11074	6600	7143
5	50711	14143	12700	7770
6	30404	4674	6100	8396
7	29100	2787	8500	13659
8	29119	10271	10500	4386
9	32108	3377	6500	8396
10	31245	18347	7100	21679
11	20975	6100	7100	2256
12	24435	17020	4200	11153
13	21225	12815	7700	18296
14	24468	23735	8200	3885
15	25363	5337	6500	23309
16	31654	9812	8900	7519
17	30445	7939	12500	2757
18	18090	4616	6100	3885
19	29593	8130	8500	9775
20	25549	2559	6900	4386
21	21600	22363	6300	501
22	23201	1359	5500	1754
23	23066	1517	6000	9900
24	19240	4201	5700	3133
25	21654	2922	5000	4762
26	27331	13270	7400	4637
27	22473	30595	5100	19298
28	22491	7016	5600	10401
29	20202	1387	4000	1000
30	14718	4056	3000	1000

Wards	Population_ 2016	Employment_ 2016	Resident Students_2016	Student Enrolment
31	24800	8633	7700	627
32	30331	1002	8600	3759
33	25143	1256	7000	3008
34	28130	1671	9200	3258
35	36327	1748	6200	501
36	19453	11505	5200	15038
37	30736	2261	7200	2256
38	29771	2692	8300	10276
39	33952	2574	9100	2005
40	30126	5990	7400	8271
41	28100	2983	6900	2256
42	27497	24206	7300	3383
43	14414	672	4400	501
44	19062	6819	6400	14411
45	42033	52553	11200	7644
46	21032	2695	6400	2130
47	28893	4227	8700	10276
48	30005	9348	8900	9649
49	31572	766	9400	1003
50	37802	1119	12700	1504
51	25185	3770	7700	877
52	27540	909	8600	2130
53	25213	6741	6500	376
54	27410	3907	5700	1754
55	23015	33818	6800	5263
56	33899	5281	6800	1128
57	27942	7885	10200	6892
58	24304	1401	8900	4261
59	20096	3015	5700	2130
60	31040	27228	10400	4261

Wards	Population _2016	Employment _2016	Resident Students_2016	Student Enrolment
60	31040	27228	10400	4261
61	35947	2896	11200	6266
62	27285	519	7300	501
63	24865	25591	6100	4386
64	28489	20771	8900	61154
65	23671	2442	6700	2632
66	33131	1892	10000	3509
67	31912	6410	10100	37720
68	30259	10359	5300	12406
69	37006	1299	10300	1128
70	42129	6063	10000	8020
71	28517	11956	7500	1253
72	32672	4138	6400	1504
73	14592	5000	5700	8396
74	26291	5000	4600	1880
75	0	-	7800	1128
E1	0	-	-	7018
E2	0	-	-	6516
E3	0	-	-	3759
E4	0	-	-	1253
E5	0	-	-	1629
E6	0	-	-	1754
E7	0	-	-	35965
	2044257	***602155***	***567300***	***567300***

8.6 Survey Formats

8.6.1 Classified Volume Count Surveys at Outer cordon and Mid-Blocks

CMP Vizag

Classified Traffic Volume Count Survey

Name of the Road:	Name of Supervisor/Enumerator :	Date :
Location:	Shift No :	Day:
Direction:	Weather (Sunny/ Cloudy/ Rainy):	Sheet No:

Time Period	Car / Jeep / Van / Taxi	2-Wheeler	Auto-Rickshaw	Shared Auto / Tata Magic	City Bus (Govt.)	Intercity bus/ Inter-state (Govt.)	Private Bus	Mini Bus	Goods Auto	LCV	Truck (2-Axle)	Truck (3-Axle)	MAV	Agricultural Tractor Trailer	Cycle	Cycle Rickshaw	Animal Drawn	Hand Cart
:00 to :15																		
:15 to :30																		
:30 to :45																		
:45 to :00																		

8.6.2 Occupancy Surveys – Outer Cordon/ Mid-block locations

CMP VIZAG

Road Side Passenger Occupancy Survey

Name of the Road:	**Name of Supervisor/Enumerator :**	**Date :**
Location:	**Shift No :**	**Day:**
Direction:	**Weather (Sunny/ Cloudy/ Rainy):**	**Sheet No:**

S.No	Time of Interview	VehicleType	Origin			Destination			Travel Distance (km)	Travel Time (hh:mm)	Travel Cost (Rs.)	Trip Purpose	Trip Frequency	Occupancy	Ownership of Vehicle
			Village/Town /City	District :	State :	Village/Town /City	District :	State :							

Code	VehicleType
1	Car / Jeep / Van / Taxi
2	2-Wheeler
3	Auto-Rickshaw
4	Shared Auto / Tata Magic
5	Cycle
6	Cycle Rickshaw

Code	Trip Frequency
1	Daily once (one-way)
2	Daily twice (up & down)
3	Daily thrice or more
4	Others

Code	Ownership of Vehicle
1	Own
2	Hired

Code	Trip Purpose
1	Work
2	Education
3	Shopping
4	Social
5	Religious/Recreation
6	Health
7	Home (Return)
8	Others.....

8.6.3 Classified Turning Movement Count Surveys at Junctions

CMP vizag

Classified Turning Movement Count Survey

Name of the Junction: Name of Supervisor/Enumerator : Date :

Location: Shift No : Day:

Direction: Weather (Sunny/ Cloudy/ Rainy): Sheet No:

Time Period	Car / Jeep / Van / Taxi	2-Wheeler	Auto-Rickshaw	Shared Auto / Tata Magic	City Bus (Govt.)	Intercity bus/ Inter-state (Govt.)	Private Bus	Mini Bus	Goods Auto	LCV	Truck (2-Axle)	Truck (3-Axle)	MAV	Agricultural Tractor Trailer	Cycle	Cycle Rickshaw	Animal Drawn	Hand Cart
:00 to :15																		
:15 to :30																		
:30 to :45																		
:45 to :00																		

8.6.4 Road Side Interview at Outer Cordon

CMP VIZAG

Road Side Passenger OD Survey

Name of the Road: **Name of Supervisor/Enumerator :** **Date :**
Location: **Shift No :** **Day:**
Direction: **Weather (Sunny/ Cloudy/ Rainy):** **Sheet No:**

S.No	Time of Interview	VehicleType	Origin			Destination			Travel Distance (km)	Travel Time (hh:mm)	Travel Cost (Rs.)	Trip Purpose	Trip Frequency	Occupancy	Ownership of Vehicle
			Village/Town /City	District :	State :	Village/Town /City	District :	State :							

Code	VehicleType
1	Car / Jeep / Van / Taxi
2	2-Wheeler
3	Auto-Rickshaw
4	Shared Auto / Tata Magic
5	Cycle
6	Cycle Rickshaw

Code	Trip Frequency
1	Daily once (one-way)
2	Daily twice (up & down)
3	Daily thrice or more
4	Others

Code	Ownership of Vehicle
1	Own
2	Hired

Code	Trip Purpose
1	Work
2	Education
3	Shopping
4	Social
5	Religious/Recreation
6	Health
7	Home (Return)
8	Others.....

CMP VIZAG

Road Side Interview (O-D Survey): Goods Vehicle

Outer Cordon Line/ Inner Cordon Line

Location Name:______________________ **Sheet No:**

Location_ID:__________________ **Day:**___________

Direction: From:_____________________**To:**______________________ **Date:**_________

S.No	Time of Interview	Vehicle Type	Origin	Destination	Distance/ Travel Time/ Travel Cost	Commodity Type	Pay Load (Tonnes)	Trip Frequency	Ownership Of Vehicle
		9. LCV/Tempo **10.** 2-Axle Truck **11.** 3-Axle Truck **12.** Multi-Axle Truck **13.** Tractor with Trailor **14.** Tractor without Trailor	Resident of Tiruchirappalli City District: State: If withinVisag City: Location: Landmark1: Landmark2:	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Distance (km) : Travel Time (hh:mm) : Cost (Rs.) :	1. Food grains 2. Fruits and Vegetables 3. Household Goods 4. Chemicals and Fertilisers 5. Petroleum 6. Building Materials 7. Textile 8. Ore / Mineral 9. Timber 10. Manufactured Goods 11. Empty 12. Others (Specify)		**1.** ____ Times per day **2.** Daily (Up/Dn) **3.** Weekly **4.** Occasionally	**1.** Self Owned **2.** Owned by Other person
		9. LCV/Tempo **10.** 2-Axle Truck **11.** 3-Axle Truck **12.** Multi-Axle Truck **13.** Tractor with Trailor **14.** Tractor without Trailor **16.** Cycle Rickshaw	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Distance (km) : Travel Time (hh:mm) : Cost(Rs.) :	1. Food grains 2. Fruits and Vegetables 3. Household Goods 4. Chemicals and Fertilisers 5. Petroleum 6. Building Materials 7. Textile 8. Ore / Mineral 9. Timber 10. Manufactured Goods 11. Empty 12. Others (Specify)		**1.** ____ Times per day **2.** Daily (Up/Dn) **3.** Weekly **4.** Occasionally	**1.** Self Owned **2.** Owned by Other person
		9. LCV/Tempo **10.** 2-Axle Truck **11.** 3-Axle Truck **12.** Multi-Axle Truck **13.** Tractor with Trailor **14.** Tractor without Trailor **16.** Cycle Rickshaw	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Distance (km) : Travel Time (hh:mm) : Cost(Rs.) :	1. Food grains 2. Fruits and Vegetables 3. Household Goods 4. Chemicals and Fertilisers 5. Petroleum 6. Building Materials 7. Textile 8. Ore / Mineral 9. Timber 10. Manufactured Goods 11. Empty 12. Others (Specify)		**1.** ____ Times per day **2.** Daily (Up/Dn) **3.** Weekly **4.** Occasionally	**1.** Self Owned **2.** Owned by Other person
		9. LCV/Tempo **10.** 2-Axle Truck **11.** 3-Axle Truck **12.** Multi-Axle Truck **13.** Tractor with Trailor **14.** Tractor without Trailor **16.** Cycle Rickshaw	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Location (Village/Mandal): District: State: If within Visag City: Location: Landmark1: Landmark2:	Distance (km) : Travel Time (hh:mm) : Cost(Rs.) :	1. Food grains 2. Fruits and Vegetables 3. Household Goods 4. Chemicals and Fertilisers 5. Petroleum 6. Building Materials 7. Textile 8. Ore / Mineral 9. Timber 10. Manufactured Goods 11. Empty 12. Others (Specify)		**1.** Times per day **2.** Daily (Up/Dn) **3.** Weekly **4.** Occasionally	**1.** Self Owned **2.** Owned by Other person

Name of Enumerator: **Supervisor:**

8.6.5 Bus Stop Waiting, boarding and alighting survey

CMP VIZAG

Passenger Boarding and Alighting Survey

Location: | **Name of Supervisor/Enumerator :** | **Date :**
Name of Bus Stop : | **Shift No :** | **Day:**
Direction : | **Weather (Sunny/ Cloudy/ Rainy):**

Operator Code: 1. City Bus (Govt.) 2. Intercity bus/ Inter-state (Govt.) 3. Private Bus 4. Mini Bus 5. Auto-Rickshaw 6. Shared Auto

Operator Code	Route No.	Route Details		Passengers Boarding	Passengers Alighting	Total (Passengers Boarding + Passengers Alighting)	Arrival Time (Hr:Min)	Departure Time (Hr:Min)	Passenger Load	
		From	To						Sitting	Standing

8.6.6 Bus Stop OD surveys including the Stated Preference surveys of bus users

CMP VIZAG

Passenger Origin-Destination Survey

Location:		Name of Supervisor/Enumerator :	Date :
Name of PT Terminal :		Shift No :	Day:
Direction :		Weather (Sunny/ Cloudy/ Rainy):	
Passenger Type:	1. Entry Passenger 2. Exit Passenger		

Time (Hr:Min)	Main Mode Trip Information								Access/Dispersal Trip information (within Study Area)			
	Origin			Destination			Trip Purpose	Trip Frequency	Mode	Travel Time (hh:mm)	Travel Cost (Rs.)	Travel Distance (km)
	Village/Town/City	District :	State :	Village/Town/City	District :	State :						

8.6.7 PT& IPT Stated Preference Surveys for private users along major activity centers

CM VIZAG

Work Place / Opinion / Willingness Survey

Name of the Road :
Location Name:
Date of Interview :
Name of Interviewer:
Time of Interview :
Name of Interviewer:

A. SOCIO - ECONOMIC BACKGROUND

1. Home Address :

Tel No.:

2. Sex : Male ☐ Female ☐

3. Age : ☐ Years

4. Monthly family income in Rs. (Please tick in the appropriate box)

i. Upto Rs 2,500	☐ 1	vi. Rs 20,001 - Rs. 30,000	☐ 6
ii. Rs. 2,501 - Rs. 5,000	☐ 2	vii. Rs 30,001 - Rs. 40,000	☐ 7
iii. Rs. 5,001 - Rs. 10,000	☐ 3	viii. Rs. 40,000-Rs.50,000	☐ 8
iv. Rs 10,001 - Rs. 15,000	☐ 4	ix. Above Rs. 50,000	☐ 9
v. Rs 15,001 - Rs. 20,000	☐ 5		

5. Number of members in your family

Working Members	☐	Retired	☐
Students	☐	Total	☐

6. Vehicle Ownership:

No. of Car/s	☐	Cycles	☐
No. of 2-Wheelers	☐	Others	☐
		Total	☐

B. DETAILS OF NORMAL MODE OF TRAVEL TO WORK

10. Place of work

Address:

14. What is the approximate Distance from your Residence to the the Place of Work ____ Km

Existing Travel Characteristics

Stage No.	Stage Description	Start of Stage (Location)	Mode of Travel	Time (Mins.) Waiting	Time (Mins.) Travel	Travel Cost (Rs.)	Travel Distance(km)
1	Residence To 1st Halt						
2	2. 1st Halt to 2nd Halt						
3	2st Halt to 3rd Halt						
4	3rd Halt to 4th Halt						
5	4rth Halt to 5th Halt						
6	5th Halt to 6th Halt						

Codes for Mode of Travel:

Car / Jeep / Van / Taxi	1	2-Wheeler	2	Auto-Rickshaw	3	Shared Auto / Tata Magic	4
City Bus (Govt.)	5	Intercity bus/ Inter-state (Govt.)	6	Private Bus	7	Mini Bus	8
Cycle	9	Cycle	9	Walk	10	Rail	12

C. Establishment Details (It it is Work Place)

Type of Establishment		Pvt/Public/Semipublic
Employment Sector		
Plot Area (Sqm)		
Floor Area (Sqm)		
No. of Employees		

Employment Sector	
1	Agriculture
2	Construction/Mining
3	Manufacturing (Household)
4	Manufacturing (Others)
5	Service Sector
6	Retail/Whole Sale Trade
7	Transport/Communication/Utilities
8	Finance/Insurance/Real Estate
9	Educational
10	Informal Sector

Project Description:	**CMP VIZAG**										
	Convenient frequency of Bus & Feeder Services during the peak hours enabling Lesser Waiting Time										
	Comfortable sitting/standing facilities in Public Transit Stations										
	Higher Comfort Level and Safety										
	On Board and Off Board Passenger Information Display, Public Address Systems at all Bus Stations, Terminals										
D. Public Transport Opinion Survey											
1	**Do you travel by Public Transport**							1	Yes		
								2	No		
2	**How far is the nearest public transport/shared transport station from your house?**										
	No.	**Mode**	**Nearest stop (distance) (km)**	**Walking Time taken to reach (hh:mm)**	**Avg. Waiting time (minutes)**	**How often do you use it in a week?** (no. of times per week)	**Is it reliable service?**	**Is it safe?**	**Is it too expensive?**	**Overall Opinion**	**Suggestions/ Improvements**
							Good / Ok / Bad				
	1	Public Bus									
3	**What are the main reasons for not using Bus ?**							1	Bus Stop/Station is not near to home		
								2	Bus Stop/Station is not near to destination		
								3	Uncomfortable Travel		
								4	Irregular services		
								5	Lack of proper Infrasturture facilities		
								6	Lack of clean and hygenic public transport vehicles		

E. Willingness to shift to PT

Existing Mode	
Waiting Time (min.)	
Travel Time (min.)	
Travel Cost (Rs.)	
Comfort	
Willingness	

Choice Scale
1. Definitely Existing
2. Probably Existing
3. Can't Say
4. Probably Improved PT System
5. Definitely Improved PT System

Stated Preference : Option 1	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	5
Travel Time (min.)	Reduced by 25%
Travel Cost (Rs.)	Reduced by 25%
Comfort	Same as Existing Bus
Willingness	

Stated Preference : Option 5	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	10
Travel Time (min.)	Reduced by 25%
Travel Cost (Rs.)	Reduced by 25%
Comfort	Same as Existing Bus
Willingness	

Stated Preference : Option 2	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	5
Travel Time (min.)	Reduced by 50%
Travel Cost (Rs.)	Reduced by 50%
Comfort	Same as Existing Bus
Willingness	

Stated Preference : Option 6	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	10
Travel Time (min.)	Reduced by 50%
Travel Cost (Rs.)	Reduced by 50%
Comfort	Same as Existing Bus
Willingness	

Stated Preference : Option 3	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	5
Travel Time (min.)	Reduced by 25%
Travel Cost (Rs.)	Reduced by 25%
Comfort	More
Willingness	

Stated Preference : Option 7	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	10
Travel Time (min.)	Reduced by 25%
Travel Cost (Rs.)	Reduced by 25%
Comfort	More
Willingness	

Stated Preference : Option 4	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	5
Travel Time (min.)	Reduced by 50%
Travel Cost (Rs.)	Reduced by 50%
Comfort	More
Willingness	

Stated Preference : Option 8	
Improved PT System/ New Mode (Dedicated PT Lane)	
Waiting Time (min.)	10
Travel Time (min.)	Reduced by 50%
Travel Cost (Rs.)	Reduced by 50%
Comfort	More
Willingness	

8.6.8 Pedestrian Volume Count

CMP VIZAG

Pedestrian Volume Count Survey

Junction Name:		**Name of Enumerator :**		**Date :**	
Junction Type:	3 Arm/ 4 Arm / 5 Arm/6 Arm/……..	**Shift No :**		**Day:**	
Direction:		**Weather (Sunny/ Cloudy/ Rainy):**		**Sheet No:**	

Time Period	Across the Road		Along the Road/Foot path		Total Across	Total Along	Total Across + Total Along
	Towards RHS - LHS	Towards LHS - RHS	LHS	RHS			

8.6.9 Vehicle Operator Survey (IPT and Goods)

CMP VIZAG

Intermediate Public Transport (IPT) Operators Survey

Name of the Road:
Location:
Direction:
Name of Supervisor/Enumerator :
Shift No :
Weather (Sunny/ Cloudy/ Rainy):
Date :
Day:
Sheet No:

S.no	Time of Interview	Name of the vehicle operator	Age	Gender*	Type of IPT mode*	Registration Numer	Make/Model	Ownership*	Fuel Type*	Routes/Areas of Operation in the city	No of Hours Operated (Previous day)	No of Trips	Trip Frequency*	Kilometers travelled (previous day)	Expenditure (in RS.)			Revenue in Rs. (Previous Day)
															Rent	Fuel cost	Maintenance costs	
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								
										1. 2. 3.								

Code	Gender
M	Male
F	Female

Code	Type of IPT Mode
1	Auto-Rickshaw
2	Shared Auto / Tata Magic
3	Taxi

Code	Ownership
1	Self-owned
2	Hired/Rent

Code	Fuel
1	Petrol
2	Diesel
3	LPG
4	CNG
5	Electric

Code	Trip Frequency
1	Times per day
2	Daily
3	Weekly
4	Occassionally

8.6.10 Parking Survey (On street)

CMP VIZAG

On-Street Parking Survey

Road Name :						Date:			
Parking Starting From :						Day:			
Parking Ending At:						Weather (Sunny/ Cloudy/ Rainy):			
Parking Type	Authorised/ Unauthorised					LHS/RHS:			
	Paid / Free								
Type of Parking	Parallel/ Angular/ Perpendicular								
Length of Parking:						Width of Parking:			
Vehcile Type Code:		1. Two Wheeler		2. Car			3. Bicycle		

S.No	Time	Vehicle Type	Registration Plate Number		S.No	Time	Vehicle Type	Registration Plate Number

8.6.11 Parking Survey (Off street)

	CMP VIZAG		
	Off-Street Parking Survey		
Location :			**Date:**
Parking Type	**Authorised/ Unauthorised** **Paid / Free**		**Day:** **Weather (Sunny/ Cloudy/ Rainy):** **In/Out:**
Type of Parking	**Parallel/ Angular/ Perpendicular**		
Length of Parking:			**Width of Parking:**
Vehcile Type Code:	**1. Two Wheeler**	**2. Car**	**3. Bicycle**

S.No	Time	Vehicle Type	Registration Plate Number

8.6.12 Parking willingness to pay survey

	CMP VIZAG								
	Willingness to Pay for Parking								
1	**Are you willing to pay more for imporved public transport facilities**				1	Yes			
					2	No			
	If Yes, how much are you willing to pay for reduction in your travel time per trip for usual trip?								
	Travel Time Saving (minutes)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
	Willing to Pay for Improved Public Transport per Trip (in Rs.)								
2	**Are you willing to pay for on street and off street parking**				1	Yes			
					2	No			
	If Yes, how much are you willing to pay for on street and off street parking?								
	Parking Cost (Rs./Hr) for On-Street	**5**	**10**	**15**	**20**	**25**	**30**		
	Parking Cost (Rs./Hr) for Off-Street	**5**	**10**	**15**	**20**	**25**	**30**		
3	**Are you willing to pay for rental bicycles**				1	Yes			
					2	No			
	If Yes, how much are you willing to pay for for rental bicycles?								
	Cost of Rental Bicycles (Rs./Hr)	**5**	**10**	**15**	**20**	**25**	**30**		

8.6.13 Household Survey

CMP VIZAG

Household Survey

Form No.	Date:	Surveyor name:	
Ward No:	Area:	Address	
Traffic zone:	Contact number of respondent (Landline and mobile):	E mail ID:	

Part-I: Household Socio-Economic Information

1. Housing Type: (a) Owned, (b) Rented, (c) Govt. Quaters (d) Others	
2. If it is Rented, What is the rent you pay for it? (Rs. ..... Per Month)	
3. What is the area of the house in sq.ft?	
4. Availability of Parking Space within the Dwelling Unit (Y/N)	
5 Total No. of members in household	
6 Total No. of members in household aged lessthan 5 years old	
7 Total No. of earning members in household	
8 Total No. of students in household	
9 Total No. of Members of Household Who Make Regular Trips Per Day	

10. Household Personal Information

S.No.	Name	Relation with head	Sex (M/F)	Age	Education (Completed)*	Occupation*	Employment Sector*	Location of Work/Study	Monthly Income	Vehicle Ownership*
	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

11. Vehicle Ownership in the household

	Present				Before 2 year			
	Type	Make (Year)	Mileage	Fuel	Type	Make (Year)	Mileage	Fuel
1								
2								
3								
4								
5								

Type: Car, MTW, Bicycle, Auto (3-seater), Auto (7-seater), Cycle Rickshaw, Bus

12. Accessibility to important destination

	Distance (km)	Walking minutes	
Daily need shop			
School			
Hospital			
Others (specify)			

Codes for 10 Household Information

Relation with the head of the family (2)		Education (5)		Occupation (6)		Employment Sector (7)	
1	Self	1	Education	1	Service (Govt. Sector)	1	Agriculture
2	Wife/Husband	2	No Education/illeterate	2	Service (Pvt. Sector)	2	Construction/Mining
3	Son/Daughter	3	Primary School	3	Business	3	Manufacturing (Household)
4	Mother/Father	4	Secondary School	4	Self Employed	4	Manufacturing (Others)
5	Others	5	Up to High School	5	Farmer	5	Service Sector
		6	Graduation	6	Worker / Labour	6	Retail/Whole Sale Trade
		7	Post Graduation	7	Student	7	Transport/Communication/Utilities
		8	Others (Specify)	8	Unemployed	8	Finance/Insurance/Real Estate
				9	Retired	9	Educational
						10	Informal Sector

Part-II: Household Travel Information

Day of Trip: *(Tick the appropriate option)* | Monday | Tuesday | Wednesday | Thursday | Friday

Member No. (as in Part-I)	Trip No.	Trip Purpose	Trip Frquency	Stage Information										
				Stage No.	Starting Address	Staring Time (Hr:Min)	Finishing Address	Finishing Time (Hr:Min)	Mode	Travel Distance (kms)	Waiting Time (mins)	Travel Time (mins)	Travel Cost (Rs)	Parking Fee (Incase of Personal Mode) (In Rs)

Note:

Please specify the trip details of each member of the household for the previous day, including the return home trips

Please add consequetive sheets on Trip Information depending upon the No. of members in the household

Code	Trip Purpose
1	Work
2	Education
3	Shopping
4	Social
5	Religious/Recreation
6	Health
7	Home (Return)
8	Others.....

Code	Mode of Travel
1	Walk
2	Car / Jeep / Van / Taxi
3	2-Wheeler
4	Auto-Rickshaw
5	Shared Auto / Tata Magic
6	City Bus (Govt.)
7	Intercity bus/ Inter-state (Govt.)
8	Private Bus
9	Mini Bus
10	Cycle
11	Cycle Rickshaw
12	Rail

Code	Trip
1	Daily once (one-way)
2	Daily twice (up & down)
3	Daily thrice or more
4	Others

Part-III: Household Choices and Options

How far is the nearest public transport/shared transport station from your house?

No.	Mode	Nearest stop (distance) (km)	Walking Time taken to reach (hh:mm)	Avg. Waiting time (minutes)	How often do you use it in a week? (no. of times per week)	Is it reliable service?	Is it safe?	Is it too expensive ?	Suggestions/ Improvements
						Good / Ok / Bad			
1	Public Bus								
2	Shared Auto								
3	Cycle Rickshaw								
4	Do you think it is safe and convenient to walk on roads of **Vizag** city?	Good / Ok / Bad							
5	Are you satisfied with the way you travel in the city?	Yes / No							
6	If No, What do you think needs to be improved?								

8.6.14 Road Inventory Survey

CMP VIZAG

Road Network Inventory Survey

Name of Enumerator : **Shift No :**

Weather (Sunny/ Cloudy/ Rainy): **Sheet No:**

Link No	Name of the Road	Name of the Starting Point	Name of the Ending Point	Total Length (KM)	Travel Time	Road Classification (Arterial, Sub-Arterial, Collector, Local)	Pavement Type	Pavement Condition	No. of Lanes	Right of way width (m)	Divided/ Undivided	Oneway/ Twoway	Carriage Way Width (mts) (Curb to Median)			Service Lanes width (m)		Shoulder				Footpath			
																		LHS		RHS		LHS		RHS	
							Flexible/ Rigid/ Unpaved	(Good/Fair /Poor)					LHS Width (m)	Median Width (m)	RHS Width (m)	LHS Width (m)	RHS Width (m)	Type (Paved/ Unpaved)	Width (m)	Type (Paved/ Unpaved)	Width (m)	Type (Paved/ Unpaved)	Width (m)	Type (Paved/ Unpaved)	Width (m)

Date :
Day:

Drainage				Right of Way Width (m)	Posted Speed Limit (Present/ Absent) (KMPH)	On Steet Parking Length (m)		Any Auto Stand	Any Taxi Stand	Is it a Bus Route (Y/N)	Number of Deisgnated Bus Stops		Enchroachment Width (m)	Encroachments on footpaths/Shoulders (m)		Street Lighting	Junction Details		Land Use (R-Residential, C-Commecial, I-Institutional, O-Others)		Road Markings	Remarks (If Vehicle restriction, VUP/ PUP, Please mention)
LHS		RHS																				
(Opened/ Closed)	Width (m)	(Opened/ Closed)	Width (m)			LHS	RHS	(On Street/ Off Street)	(On Street/ Off Street)		LHS	RHS		LHS: Heavy/ Moderate/ Nill	RHS: Heavy/ Moderate/ Nill	Central/ Road Side/ Nil	Type	Signalized/ Nonsignalized	LHS	RHS	(Good/Fair/ Poor/NA)	