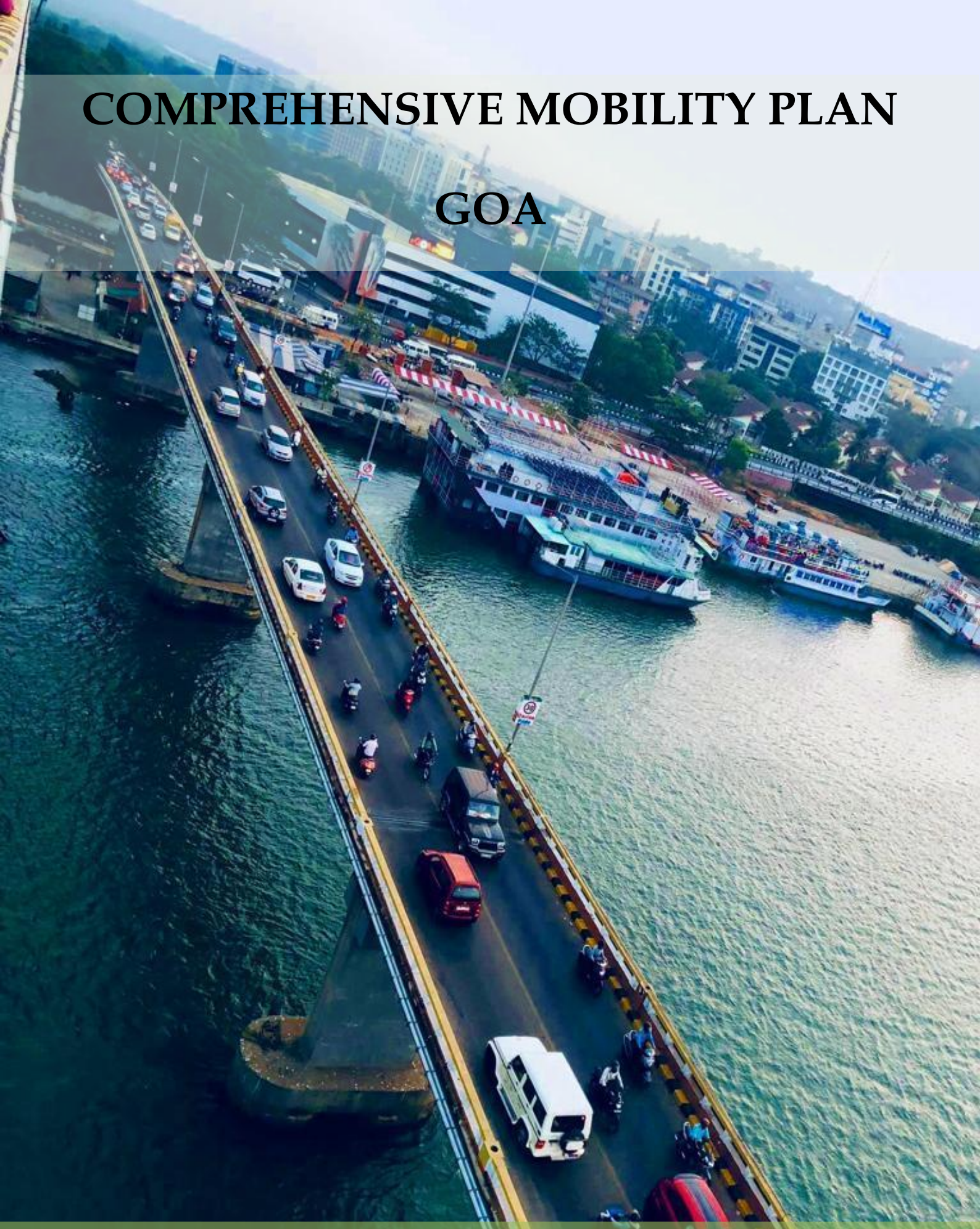
COMPREHENSIVE MOBILITY PLAN

GOA



IMAGINE panaji SMART CITY DEVELOPMENT LTD.

FINAL REPORT

Urban Mass Transit Company Limited

COMPREHENSIVE MOBILITY PLAN GOA

FINAL REPORT

June 2020

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Comprehensive Mobility Plan for Goa

Comprehensive Mobility Plan – Goa

Final Report

June 2020

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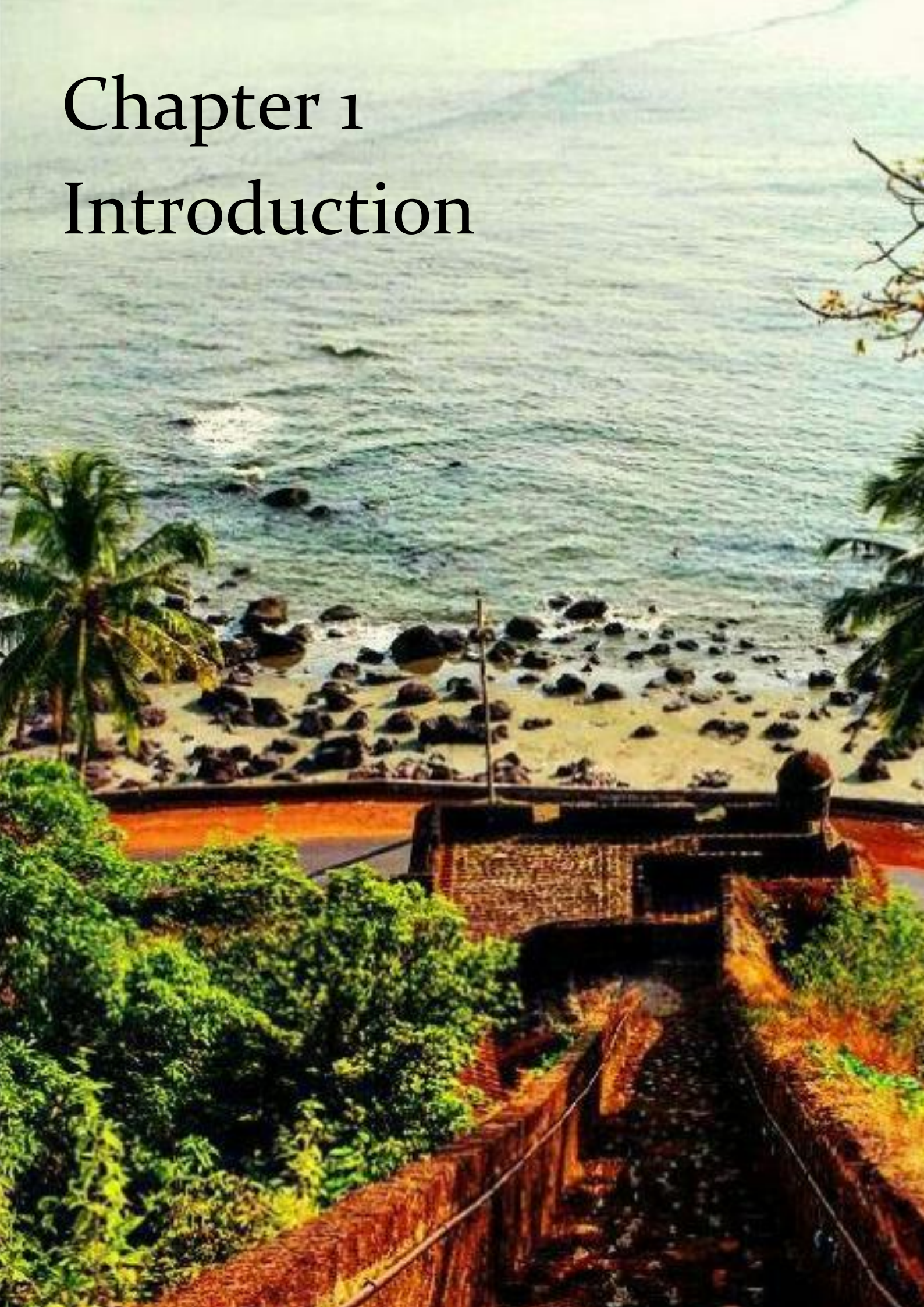
List of Abbreviations:

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
APTS	Advanced Public Transportation System
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
BEV	Battery Electric Vehicle
BOOT	Build, Own, Operate and Transfer
BOT	Build, Operate and Transfer
BRT	Bus Rapid Transit
CIRT	Central Institute of Road Transport
CMP	Comprehensive Mobility Plan
CVO	Commercial Vehicle Operation
DBFOT	Design, Build, Finance, Operate and Transfer
DMRB	Design Manual for Roads and Bridges
EV	Electric Vehicle
GBS	Gross Budgetary Support
GDP	Gross Domestic Product
GIDC	Goa Industrial Development Corporation
IPSDL	Imagine Panaji Smart City Development Limited
IPT	Intermediate Public Transport
ITS	Intelligent Transportation System
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KMPL	Kilometer per litre
KTC	Kadamba Transport Corporation
LRT	Light Rail Transit
LVUP	Light Vehicular Underpass
MLCP	Multi Level Car Parking
MMLP	Multi Modal Logistics Park
MNL	Multi Nomial Logit Model
MOUD	Ministry of Urban Development
MRT	Mass Rapid Transit
NMSH	National Mission on Sustainable Habitat
NMT	Non-Motorized Transport
NUTP	National Urban Transport Policy
NW	National Waterways
O-D	Origin Destination
O & M	Operation and Maintenance
PBS	Public Bicycle Sharing

PCU	Passenger Car Unit
PPHPD	Passenger Per Hour Per Direction
PPP	Public Private Partnership
PUP	Pedestrian Underpass
ROB	Rail Over Bridge
ROW	Right of Way
RP	Revealed Preference
RSA	Road Safety Audit
RUB	Rail Under Bridge
SGDPA	South Goa Planning and Development Authority
TAZ	Traffic Analysis Zone
TDM	Travel Demand Management
TOD	Transit Oriented Development
TP	Transport Planning
UDPFI	Urban Development Plan Formulation and Implementation
UMTA	Unified Metropolitan Transport Authority
UMTC	Urban Mass Transit Company Ltd.,
VGF	Viability Gap Funding
VOP	Vehicular Overpass
VUP	Vehicular Underpass

Chapter 1
Introduction



CHAPTER 1: INTRODUCTION

1.1: Background

Urban growth is a global phenomenon presenting major challenges to the city. The central idea is that transport modes need to use space efficiently in order to meet the demands of an increasing number of people's transportation needs. Trips have to be as short as possible and transport must be managed with as little resources as possible i.e., money, space and energy.

"Sustainable urban mobility planning contributes to the movement of people and goods within an urban region in a way that delivers the environmental, economic and social dimensions of sustainability."

Equitable access to mobility can only be ensured by means of multiple modes of transportation. The encouragement of public transport, pedestrian and bicycle to enable mobility in growing cities is internationally recognized as a concept for which there is no alternative. Decades of concentration on segregated functions and car-oriented growth in cities has not produced the desired results and caused decision-makers throughout the world to reconsider their approach.

Existing capacities in the local governments for undertaking systematic urban transport planning are still insufficient. Especially, the following problems can be seen:

- *One of the main planning issues is that most cities do not have a long-term comprehensive urban transport strategy. Accordingly, the proposals for specific projects are often not integrated with other urban transport measures or with land use patterns.*
- *Transport planning in most cities is usually a piece meal approach with main focus on the vehicular movement rather than on the mobility of people and goods.*

After the Government of India launched the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in December 2005, The Government of India in 2006, announced the first ever policy on urban transport, the National Urban Transport Policy (NUTP) with a focus to promote overall sustainability of transport sector in cities.

Some of the policy objectives in the NUTP are being realized as proposals and projects under the JNNURM and are being implemented as urban reforms agenda of which urban transport is a significant component. The Mission now makes it conditional upon the cities to take up transport projects in line with the recommendations made in the NUTP (which is driven by the principle of moving people not vehicles), in order to receive funding and grants. Each of the cities has to come up with a Comprehensive Mobility Plan (CMP) for the city, and currently, many cities are engaged in preparing the same.

The CMP is a key document providing the rationale for transport proposals. It is also a useful document to facilitate funding from other National or International sources of funding. The CMP has to be an integral part of Master Planning Process for development of city.

The Comprehensive Mobility Plan for the State of Goa is the first of its kind where a mobility vision will be prepared for an entire state with focus on regional connectivity between the various urban centres within the State.

In this regard, **Imagine Panaji Smart City Development Limited (IPSCDL)** along with the Government of Goa has awarded the study of Comprehensive Mobility Plan (CMP) to **Urban Mass Transit Company Limited (UMTC).**

1.2: Need for a Comprehensive Mobility Plan

Any unplanned city suffers primarily from a lack of a proper integration of land use and transport system. Increasing urbanization leads to haphazard increase in travel demand. Till the time the city authorities realize and wake up to the fact, the urban citizen goes for the obvious option of personal mobility, in the form of an automobile. This is again driven by the increasing

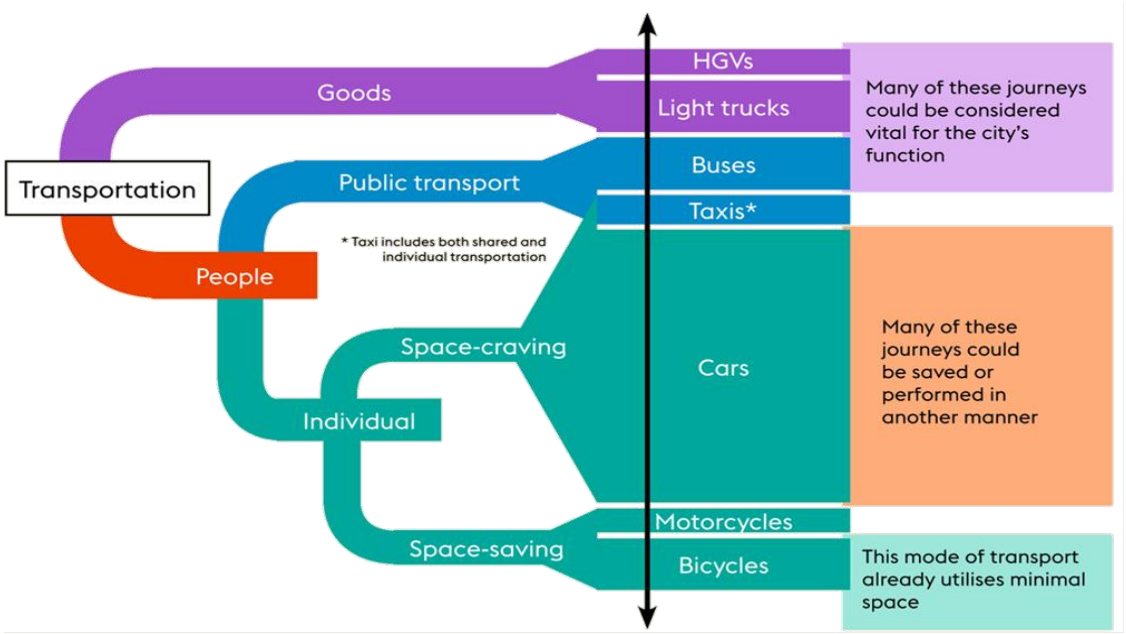
prosperity brought on by increasing urbanization. All in all, the private vehicular ownership pattern of the city rises and its usage takes its toll on the urban transport system.

Increasing usage of the automobile will eventually result in congestion, which creates varying dimensions of problems for different stakeholders of the system. The consumer suffers from increased travel time; urban environment suffers from pollution; and the city authorities suffer from an inefficient usage of the transport system supply and face with the only prospect of increased investment on transport systems (which in most cases goes on increasing and widening the existing road network to alleviate congestion). Absence of suitable infrastructure and system for freight drives up the production cost of manufacturers. The region suffers from obstacles to regional traffic that has to invariably negotiate with the local urban traffic and congestion.

To counter the above problem of congestion and its various dimensions, the city authorities resort to an increased supply of transport systems (in the form of roads or public transport corridors) on an as-and-when-needed basis. This leads to an increase in public investment on urban transport sector as well as an increased footprint of transport systems on the city. Increased footprint of transport systems, however, only leads to increased usage of the automobile, thus adding to overall congestion. On the other hand, the supply-demand gap leads to proliferation of informal systems of transport – Intermediate Public Transport (IPT) such as auto rickshaws and taxis, which further add to the traffic and congestion on roads. To accommodate regional traffic, bypasses at the city edge are provided, which in the absence of suitable land use control, lead to development of undesirable nature along the corridors. A similar phenomenon has happened over the years in the city and region, leading to the current traffic and transportation issues and thereby, affecting the mobility of the people.

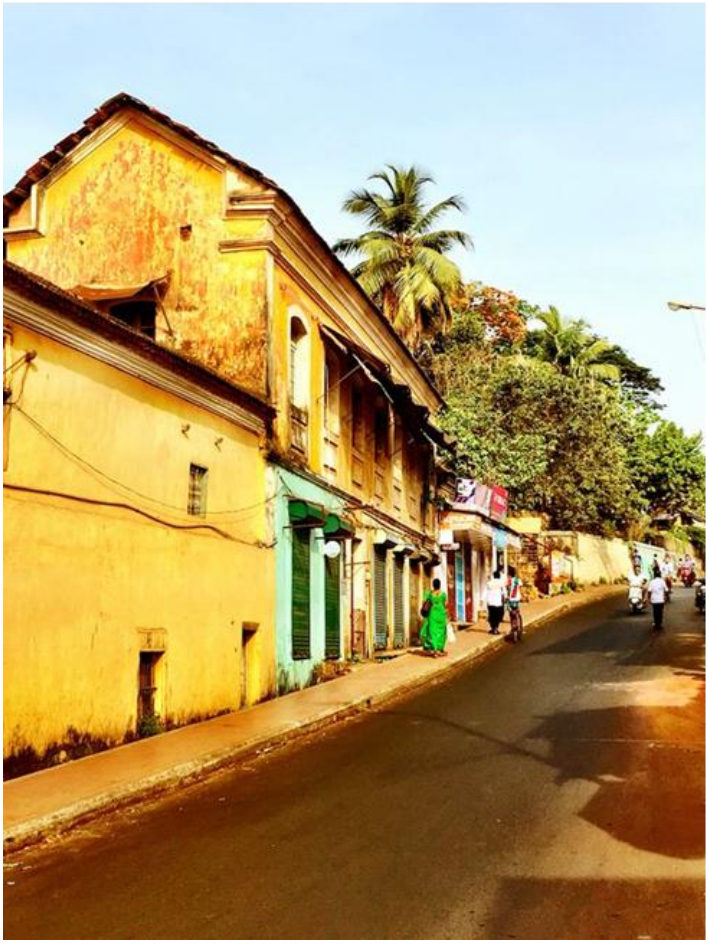
Hence, a Comprehensive Mobility Plan is needed to address the mobility needs of the people focusing on non-motorized and public transport, rather than catering to the needs of private automobiles. A CMP optimizes the "mobility pattern of people and goods" and acts as an effective platform for integrating land use and transport planning.

1.3: Main Objectives of CMP for Goa



- To understand the present and changed travel demands and characteristics, forecast future transport demands and characteristics for State of Goa.
- To identify socio-economic background of different groups and the travel pattern of residents of Goa.
- To understand the current economic, social and environmental, energy demand, land use and transport development situation and trends in Goa.
- To create a vision for Mobility in Goa addressing the movement of people and goods within, into and out of the state, in accordance with the National Urban Transport Policy (NUTP), Sustainable Habitat Mission Guidelines and other policies governing the transport sector in the country.

- To select, develop and operationalize a Transport Planning (TP) model using state of the art modelling software's like CUBE/VISUM.
- To assess the relevance of the existing strategy, identify the consequences of pursuing alternative transportation strategies and recommend short term, medium term and long–term comprehensive transportation strategies for the study area up to next twenty years.
- To strategize transport policy and parking policy as an integrated planning.
- To generate a comprehensive mobility plan for decision makers focusing on following elements:
- Integrating transport and land use actions to provide seamless and sustainable system with a focus on encouraging low-carbon mobility.
- Developing an Integrated Public Transport Plan considering all modes of transit in the State like ferry services, buses, taxi services etc. and giving suggestions regarding mass rapid transit systems for seamless connectivity of urban centres.



- Preparing Non-motorized Transport (NMT) Plans to encourage use of more sustainable transport modes.
- Promoting sustainable transport by reducing dependence on private transport through improved land use and transport integration and creation of more non motorized and public transport friendly environment.
- Connecting all tourist destinations.

- Completing the street network through spatial analysis.
- Improving the network connectivity by improving the existing road network.
- Establishing integrated passenger terminals and freight terminals to cater to the transportation needs of passengers and freight.
- Mobility Management Measures including junction improvement plans.
- Establishing efficient inland water transport network.
- Suggesting Intelligent Transportation System (ITS) technologies.
- Providing parking management solutions.
- Giving suggestions to reduce road fatalities by improving road safety.
- To identify for all modes a phased program of appropriate and affordable investments and policy proposals and also integration of various modes of mass transits as well as public transport with Intermediate Public Transport (IPT) System.

1.4: Summary of the Report

This document presents the existing and future transportation scenarios along with the list of proposals identified for the State of Goa. The report also gives transport strategies which can be used to overcome the transportation deficiencies in the coming years within the study area.

All the recommendations in the form of short, medium and long term proposals along with their block cost estimates are presented in the report.

CHAPTER 2

Goa Today – An Overview

CHAPTER 2: GOA TODAY - AN OVERVIEW

2.1: Introduction

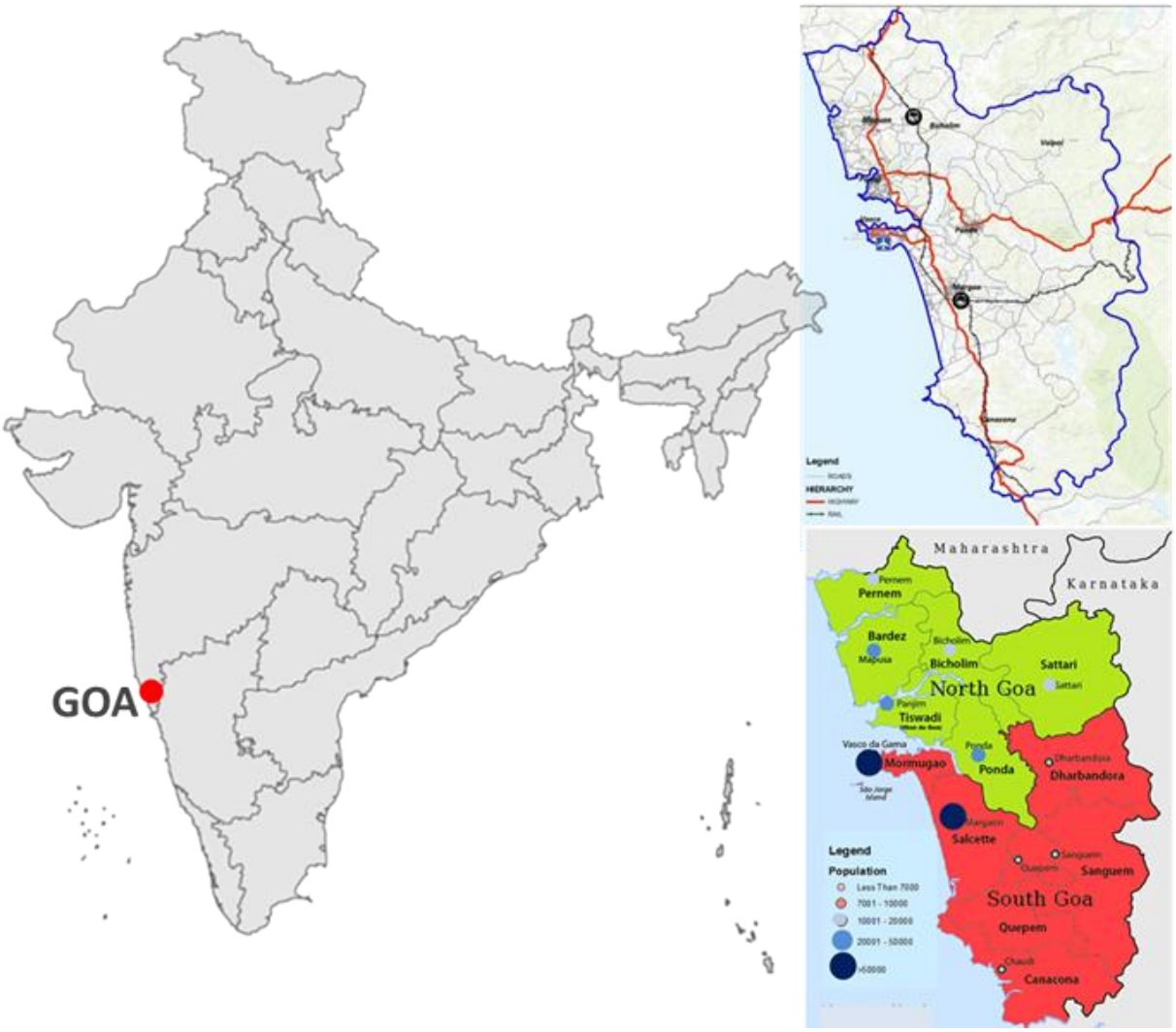


Figure 2.1: Location of Goa

Goa is a State on the Western Coast of India, within the region known as the Konkan. It is bounded by Maharashtra in the North and Karnataka in the East and South and with the Arabian Sea forming its western coast (Figure 2.1). It is India's smallest State by area and the fourth-smallest by population. Goa has the highest GDP per capita among all Indian States, two and a half times that of the country.

Panaji is the State's Capital, while Vasco da Gama is its largest city. The historic city of Margao still exhibits the cultural influence of the Portuguese, who first landed in the early 16th century as merchants and conquered it

soon thereafter. Goa was a former Portuguese province and it remained its territory for about 450 years until it was annexed by India in 1961. Goa, a paradise of scenic charm, nestled beautifully amidst seas and lush greeneries, is a dream destination of millions of travellers across the globe.

Goa is visited by large numbers of international and domestic tourists each year for its sparkling sands, exotic beaches and the architectural splendours of its temples, churches, old houses and rich culture.

2.2: Study Area

The Government of Goa has taken up the task of preparation of CMP for the entire state which comprises a total area of 3702 sq.km with a population of 14.58 Lakhs as per Census 2011. It has a coastline of 101 Km.

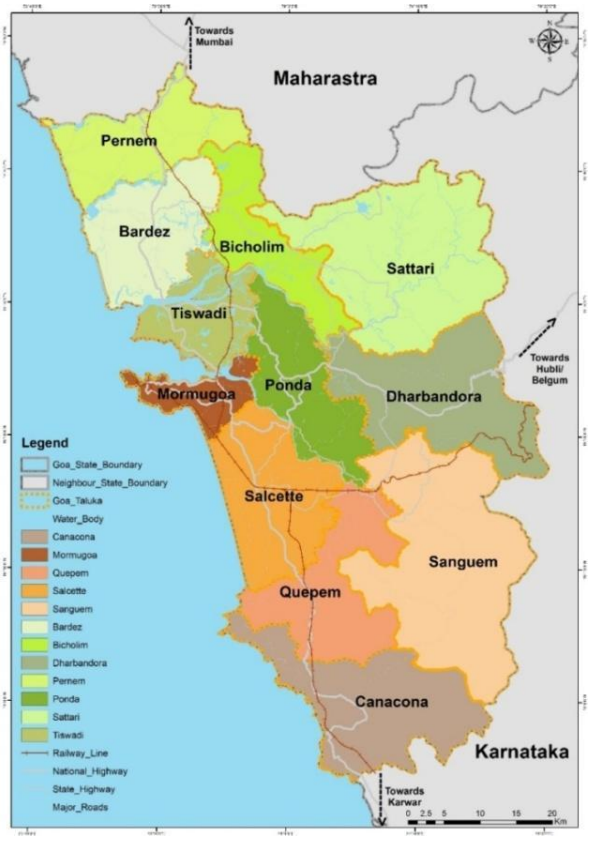


Figure 2.2: Administrative Talukas of Goa State

The State is divided into two administrative sections, namely the North and South Goa. The State comprises of 70 Towns in which 56 are Census Towns, 13 Municipal Councils and 1 Municipal Corporation. There are 3 urban agglomerations in the State. Goa has 334 villages in which 320 are inhabited villages, 9 are un-inhabited and 5 submerged villages. The study area is shown in Figure 2.2.

2.3: Climate

Climate is a critical factor in the lives and livelihoods of the people and socioeconomic development as a whole. The territory, which is situated well within the tropics and flanked by the Arabian Sea to the West and the Western Ghats (Sahyadri) rising to an average height of 1 km to the East, has tropical-maritime and monsoon type of climate, with profound topographic influence. Accordingly the climate is moist throughout the year. Other features of the climate are the regular and sufficient rainfall of 320 cm during the southwest monsoon season, mainly from June to September.

The climate is generally pleasant. Due to proximity of the seas, the territory is generally humid, with a further rise in humidity during the monsoon weather. During summers the relative humidity is above 60 percent.

Temperature variations through the seasons are also not much.

- Summer: 24˚C – 32˚C
- Winter: 21.3˚C – 32.2˚C
- Rainfall: 32 cm (June to September)

2.4: Demographics

For the State of Goa, the last Portuguese census was in 1960 whereas the first decadal enumeration by the Census of India was in 1971. Goa has a population of 14,85,545 as per 2011 census which makes it India's fourth smallest (after Sikkim, Mizoram and Arunachal Pradesh) State. It constitutes 0.12% of the country's population. The population has a growth rate of 8.23% per decade. There are 394 people for each square kilometre of land which is higher than national average 382 per km. Goa is the State

with highest proportion of urban population with 62.17% of the population living in urban areas.

The population of North Goa is 8,17,761 and South Goa is 6,39,962. The population of North Goa is approximately 2 lakhs higher than that of South Goa. However, the growth rate of South Goa is higher than North Goa over the last decade. It was at an all-time high during 1960-71 for both the districts and declined constantly. The growth was lower in South Goa during 1981-1991 but gradually increased around 1995 and continues to be higher since, which can be attributed to increased tourism in South Goa. The same is as presented in Table 2.1 below.

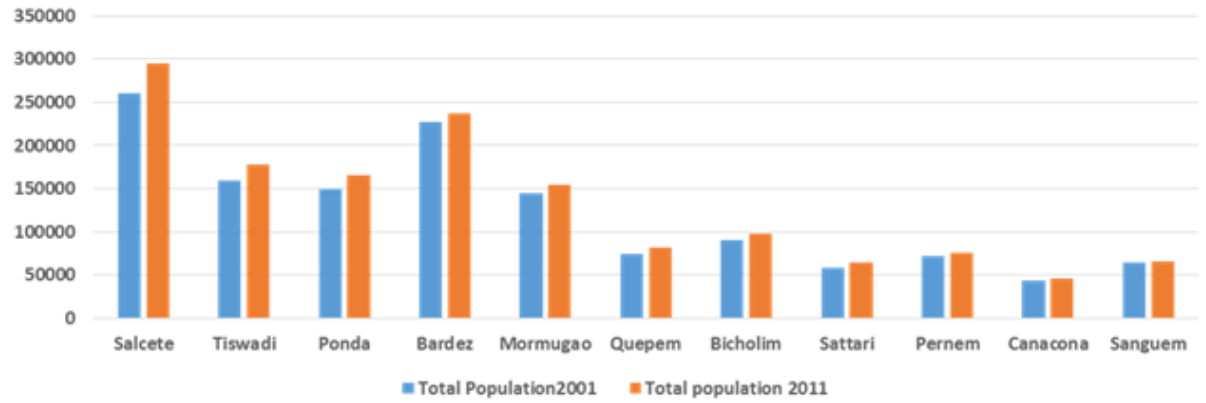
Table 2.1: Population in Goa from 1900

Year	Total Population	Decadal Growth
1900	4,75,513	
1910	4,86,752	2.36%
1921	4,69,494	-3.55%
1931	5,05,281	7.62%
1940	5,40,925	7.05%
1950	5,47,448	1.21%
1960	5,89,997	7.77%
1971	7,95,120	34.77%
1981	10,07,749	26.74%
1991	11,69,793	16.08%
2001	13,47,668	15.21%
2011	14,58,545	8.23%

(Source: Census, 2011)

Goa has the highest percentage of urban population compared to the other smaller States in India. Heavy urbanization has been prevalent in the State since liberation. As per 2011 Census, 62% of the total population is living in urban centres. Being a small State, the average density of population of the State is 394 persons per sq. km. which is higher than the National average of 382, as per 2011 census. The density of population of the State has increased from 364 persons per sq. km. in 2001 to 394 persons per sq. km. in 2011. However, within the urbanized area, the density is estimated as

1990 persons per sq.km. This is also due to out-migration of regular population exceeding immigration. Salcete Taluka has seen a highest increase in population followed by Tiswadi, Ponda and Bardez Taluka respectively. Population of different talukas within Goa is shown in Figure 2-3.



Source: Census, 2011

Figure 2.3: Talukawise Total Population of Goa for year 2001 and year 2011

2.5: Transportation Network

The various transport networks available in the State are represented in Figure 2.4.

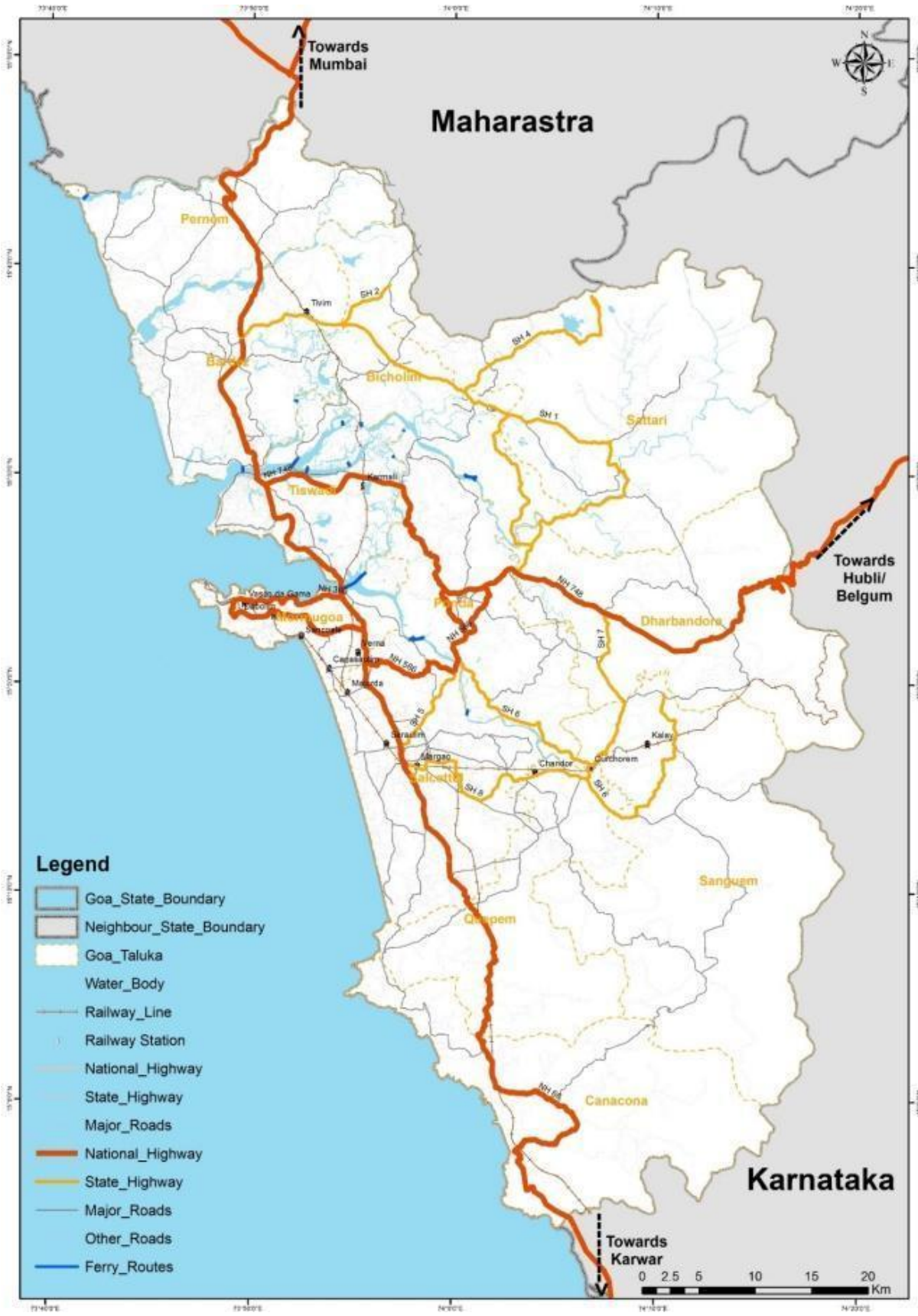


Figure 2.4: Transportation Network of Goa

2.5.1: Road Network

Goa has a total of 224 kms of National Highways, 232 kms of State Highways and 815 kms of Major District Roads. NH-66 (ex NH-17) runs along India's West Coast and links Goa to Mumbai in the North and to Mangalore in the South. NH-4A running across the State connects the capital Panaji to Belgaum in East, linking Goa to cities in the Deccan. NH-366 (ex NH-17A) connects NH-66 to Mormugao Port from Cortalim. The new NH-566 (ex NH-17B) is a four-lane highway connecting Mormugao Port to NH-66 at Verna via Dabolim Airport, primarily built to ease pressure on the NH-366 for traffic to Dabolim Airport and Vasco da Gama. NH-768 (ex NH-4A) links Panaji and Ponda to Belgaum and NH-4. SH-1 connects Mapusa with Sanvorcem via Bicholim and Sanquelim.

2.5.2: Railway Network

Goa has two railway zones namely the South Western Railway and the Konkan Railway. These lines run by the South Western Railway were built during the colonial era linking the port town of Vasco da Gama, with Belgaum and Hubli of Karnataka via Margao. The Konkan Railway line, which was built during the 1990s, runs parallel to the coast connecting major cities on the Western Coast.

Goa has three major railway stations — Margao, Vasco-da-Gama and Thivim. The first two stations are located in the southern area of the State and Thivim located in North Goa. The South Central Railway terminus is at Vasco-da-Gama and the Konkan Railway terminus is at Margao. There are 26 railway stations within the state of Goa, of which 16 stations comes under South Western Railway and 10 stations under Konkan railways.

2.5.3: River Network

Goa has wide spread network of inland water ways since Portuguese era with two main rivers Zuari and Mandovi and other small rivers such as Terekhol, Chapora, Mapusa and Sal having sufficient draft for navigation.

2.5.4: Air Link

Goa International Airport is a Naval airfield located at Dabolim near Vasco da Gama and it is the only airport in Goa. It is 4 km from the nearest city Vasco da Gama, 23 kms from Margao and 30 kms from the State Capital Panjim. In the fiscal year 2017-18, the airport handled over 7.6 million passengers. Due to capacity constraints at the terminal and air traffic congestion due to strong military and naval presence, a second airport is proposed at Mopa in Pernem Taluka near Goa Maharashtra Border and it is already under early stages of construction with scheduled completion in 2020 (Source: en.wikipedia.org/wiki/Dabolim_Airport).

2.5.5: Sea Link

Mormugao Harbor handles the major cargo traffic. A minor port is also available in Panjim on the bank of river Mandovi. Mormugao is one of the major ports of India. It has well connected broad gauge connectivity to South Western Railway through which it is also linked to Konkan Railway. Major commodities handled at the port are coal, iron ore, POL and general cargo items. The port has 7 cargo handling berths out of which two are dedicated coal berths, one dedicated iron ore berth and a dedicated POL berth and the remaining are general cargo berths.

2.6: Public Transportation System in Goa

Goa has two major modes of public transportation systems that includes bus transportation and ferry transportation. The details of the different routes for each mode of transport system are shown in the Figure 2.5:

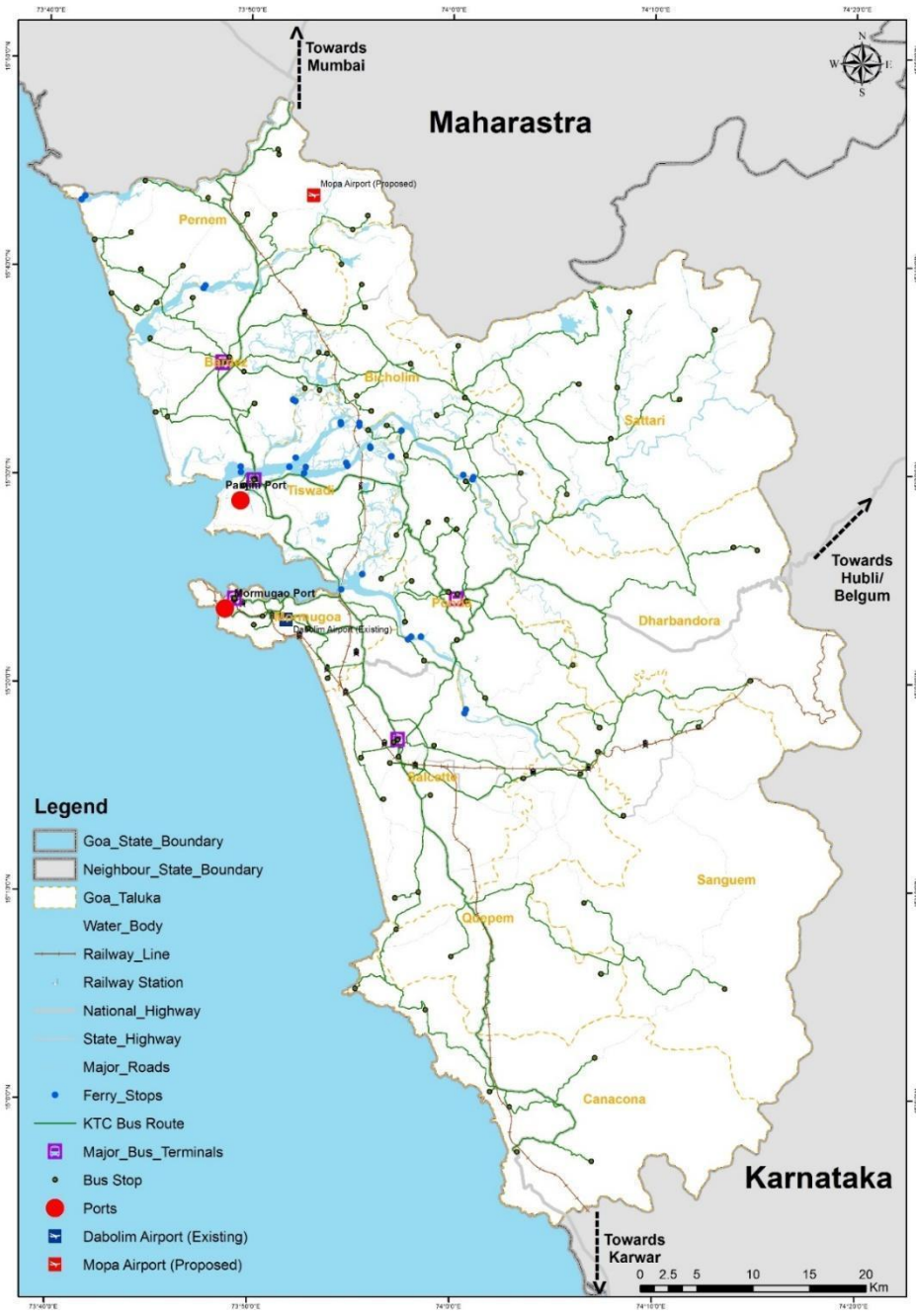


Figure 2.5: Transportation Systems in Goa

2.6.1: Kadamba Transport Corporation (KTC)

Kadamba Transport Corporation (KTC) Limited operated by the Government of Goa is a company with the objective of providing safe, reliable, time saving, efficient, comfortable and affordable public transport service to the commuters. The KTC serves both interstate and intercity with a fleet size of 565 buses. The Kadamba Transport Corporation operates 220 routes with its fleet, which consists of Luxury, Semi Luxury and Deluxe buses.

Image Source: The Neutral View

The Corporation has four major depots at Margao, Panaji, Porvorim and Vasco with a Central workshop at Porvorim. The Corporation is operating nonstop shuttle service on routes, Panaji - Margao, Panaji - Vasco, Margao - Vasco, Panaji - Ponda, Panaji- Mapusa and Margao-Curchorem on heavy demand from the public.

2.6.2: Private Buses (The Public Transit System of Goa)

Privately owned buses with permits issued by the RTO of Goa are the most commonly used public transport services in Goa. These services are operational both intra city as well as intercity. Intercity buses also avail express services.

The services are available from 7 AM to 7 PM and become scarce post 7 PM. The services are frequent at an average of 10-15 min frequency during the peak hours and 15-20 min frequency during the odd peaks. The services are very competitive and vary in size. Currently, all bus services share the KTC bus terminals along with few privately owned land parcels for the convenience of the commuters.

2.6.3: Inland Transport

The River Navigation Department, Government of Goa, is instrumental in providing transport service to the commuters across the rivers especially for

the islanders in the State of Goa where there are no road accesses. Following points highlights the major characteristics of the Inland transport in Goa:

Navigable Length: An approximate length of 371 Km of navigable length is available to cater to the inland water transport.

Fleet Size: The River Navigation Dept. provides ferry services to the commuters in its 18 ferry routes with 30 ferries spread all over Goa. The total fleet size is about 39 ferry boats. The ferry services provide reliable and affordable transport facilities for passengers, vehicles and cargo traffic.

Ridership: These services cater to approx. 31,000 passengers per day with daily revenue of around Rs. 80 Lakhs.

Fare System: The Fare structure is minimal. Free rides are offered to passengers and two wheelers, while four wheelers are charged between Rs. 7 to Rs. 27/- . Heavy Vehicles and cargos are charged between Rs.15– Rs. 45/ depending upon the load carried.

2.7: Primary Surveys & Existing Transport Scenario of Goa

In any transport planning exercise, data collection is the cornerstone and is the very foundation on which rests the super structure of planning. Historically and even in this study, we treat this with utmost seriousness, as it rightly should be. The data collected is used to analyze the existing transport and traffic situation in the study area and to develop urban transport demand model for the study area. The activity is undertaken to

understand traffic and travel characteristics and highlight cities specific problems. Table 2.2 lists out the surveys which were carried out to meet the above objectives.

Table 2.2: List of Primary Surveys for CMP- Goa

SN	Particulars of Survey	Unit	Quantity
Part A			
1	Road Network Inventory	Km	250
2	Classified Volume counts surveys at Screen Line locations (24 hours)	Location	9
3	Turning Volume Counts at Junctions (16 hours)	Location	40
4	Classified Volume count surveys at Cordon locations (24 hours)	Location	34
5	RSI at Cordon locations (10% sample size; 24 hours)	Location	34
6	Bus Stop/Ferry Station Waiting, boarding and alighting survey (16 hours)	Location	40
7	Speed and Delay Study at peak and off peak hours (Pvt Vehicles and Public Transport)	Km	150
8	Bus Stop/Ferry Station OD surveys including the Stated Preference surveys of bus users (at 10%; 16 hours)	Location	40
9	Bus / Rail/Port/Airport Terminal Passenger Count survey (boarding & alighting) 16 hours	Location	10
10	Bus/Rail/Port/Airport Terminal passenger OD Surveys (16 hours)	Location	10
11	Pedestrian Volume Counts at critical junctions (16 hours)	Location	20
Part B			
1	Vehicle Operator Survey (Taxi/auto/goods)		
	Taxi & Auto	Sample	50
	Goods	Sample	20
2	NMT Opinion Survey	Sample	400
3	Parking Inventory Survey	Km	25
4	Parking Number Plate Survey (Off Street; 16 hrs)	Location	5
5	Parking Number Plate Survey (On Street; 16 hrs) (Both LHS & RHS)	Km	25
6	Parking - Willingness to Pay Survey (8 hours)	Sample	300
7	Terminal Area Parking Surveys	Location	10
8	House Hold Interview	Sample	13000
9	Vehicle Survey at Petrol Pump	Location	10
10	PT & IPT Stated Preference Surveys for private users along major activity centres	Sample	2000

2.8: Road Network Characteristics

Road inventory survey was carried out on major roadway network in the State of Goa. The survey captured the details like actual carriage way width, ROW, shoulder width, footpath condition and width, drainage facilities, parking etc. A detailed analysis was carried out and the key results are presented below:

- Non-Motorized Transport (Pedestrians and Cyclists) are the vulnerable road users. Emphasis on safety and provision of basic infrastructure should be made.
- About 73% of the roadway segments in the city don't have dedicated walkways for pedestrians.
- Most of the roadway segments are undivided. This has led to many accidents due to speeding and overtaking.
- Bus shelters need immediate interventions as more that 90% of the road network lack good public transport infrastructure.
- Average speed of private vehicles is 21.73 kmph during peak hour
- Average speed of public transport is 14.03 kmph during peak hour.

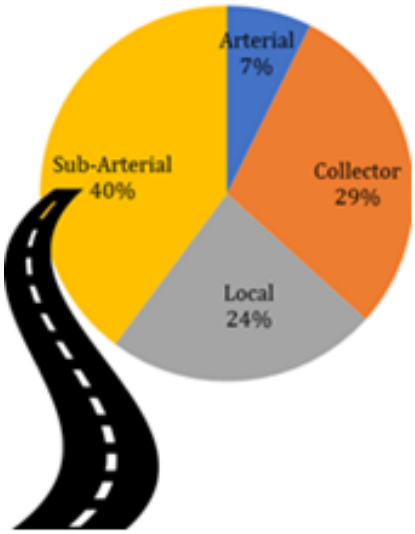


Figure 2.6: Percentage Distribution of Road Type

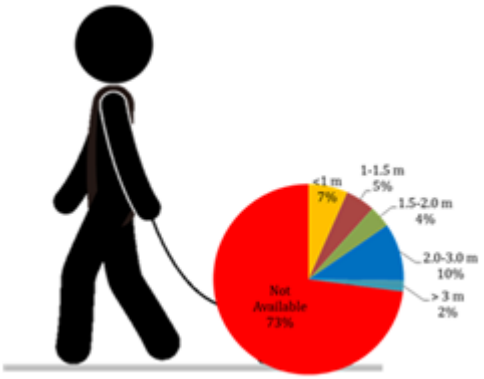


Figure 2.7: Percentage Distribution of Footpath

2.9: Traffic Characteristics

i. The personal motorized (two wheelers and cars) vehicles constitute a phenomenal 92%, (includes 2-Wheeler and 4-Wheeler Taxis) whereas, the public transport vehicles (buses) constitute only 2% of the total vehicles.

ii. The percentage share of public transport and NMT is negligible. This indicates the high dependency of private vehicles by the residents of Goa. Based on the survey analysis, the major intersections which carry high volumes of traffic within the cities are:

a. Panaji: KTC bus stand followed by Diuvja Circle.

b. Vasco: St. Andrews Church Junction followed by Chicalim Park.

c. Ponda: Dada Vaidya Chowk followed by Varkhande, Khadpabandh.

d. Mapusa: Guirim Bypass Junction followed by Mapusa Municipal Council.

e. Margao: Margao Old Collectorate followed by Colva Beach Circle.

iii. The major locations which have observed high pedestrian volume include: market areas (Panaji, Margao, O'Coqueiro Circle) as well as tourist locations (Candolim Beach Road).

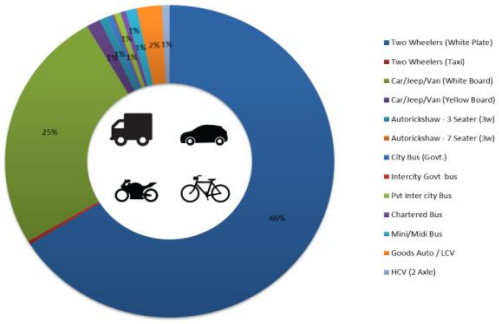


Figure 2.8: Average Traffic Composition at TVC Locations

Figure 2.9: Trip Purpose Information from Household Survey

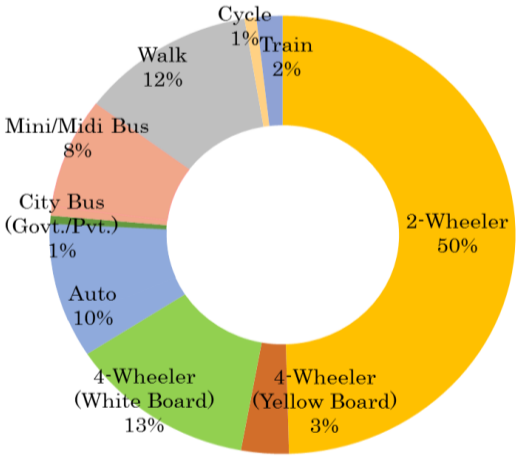


Figure 2.10: All Mode trips Information

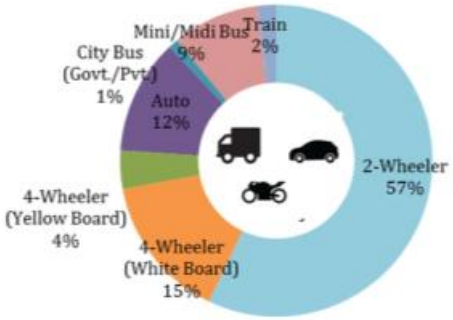


Figure 2.11: Motorized Trip Information (Excluding NMT)

The detailed analysis of the primary surveys is presented in the **Interim Report** of the Comprehensive Mobility Plan.

2.10: Current Emissions

Most of the cities in India are highly polluted due to vehicular and industrial pollution and cities of Goa are no exception. As per the State Government Survey, the pollution level in major cities in Goa has exceeded permissible limits with the port town of Vasco emerging as the most polluted city in Goa. In its annual report 2017-18, the Goa State Pollution Control Board (GSPCB) has stated that the pollution levels in cities like Panaji, Ponda, Mapusa and Margao are higher than the permissible limits. As per a study conducted by GSPCB, The levels of PM_{10} and $PM_{2.5}$ are found to be much above the permissible limits in these cities. Vasco, which is home for port and other establishments recorded the maximum pollution, Ponda stood second, Panaji stood third, Mapusa stood fourth and finally Margao as per the report. GSPCB has attributed the high level of air pollution due to increasing vehicular movement in Panaji, Mapusa, Vasco and Margao (www.indiatoday.in, June 6, 2018).

GSPCB has set up ambient air quality monitoring stations at 18 locations which includes Panaji, Fuse Call Office – Vasco, Fire Brigade Station – MPT – Vasco, Assanora, Amona, Bicholim, Codli, Curchorem, Honda, Kundaim Industrial Area, Mapusa, Margao, Ponda, Sanguem, Titamol – Quepem and Usgoan and monitors the air quality. Table 1.1 shows the ambient air quality data collected by GSPCB at Panaji Station for the year 2013-14. Figure 1.1 shows the Ambient Air Quality Monitoring Stations.

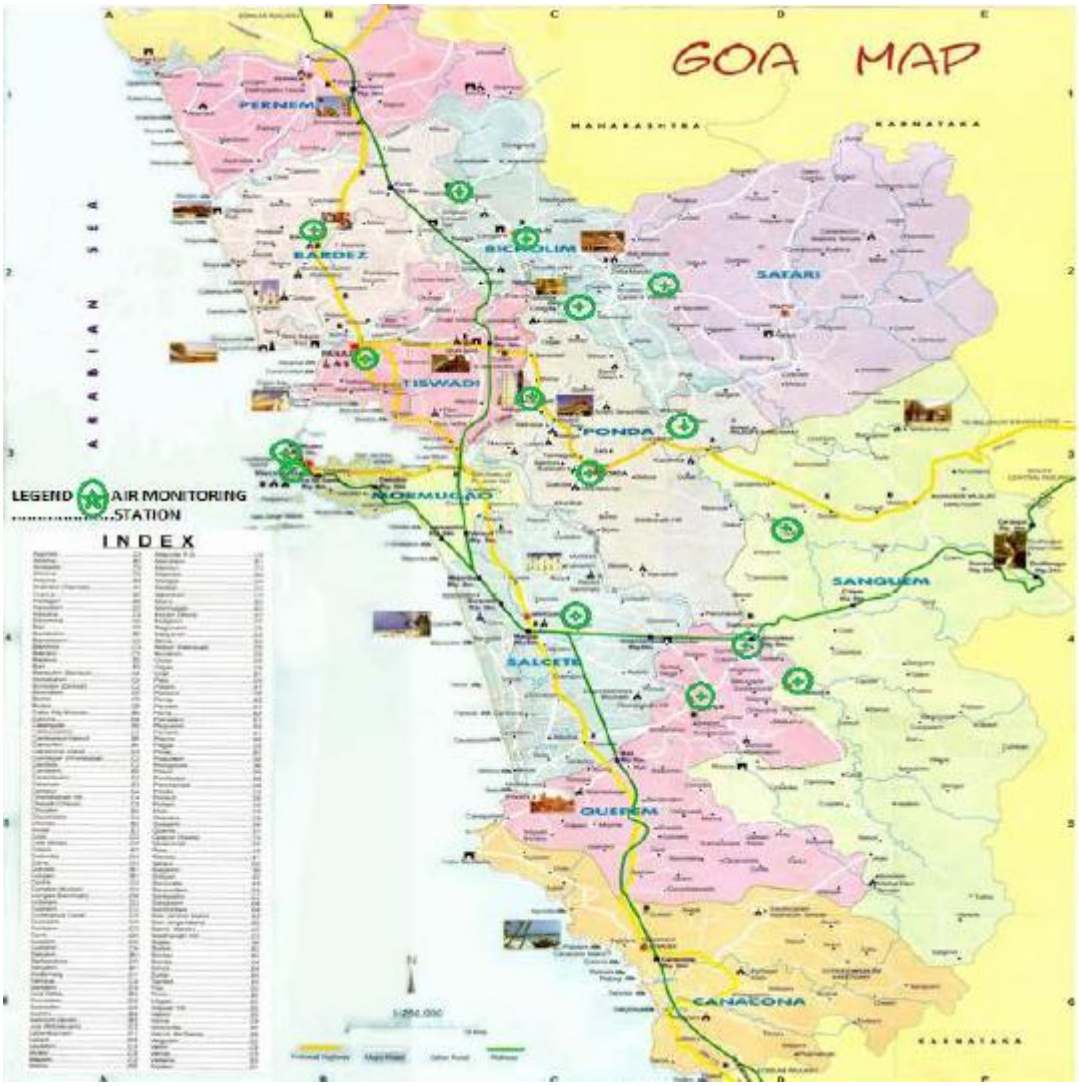
Table 2.3: Ambient Air Quality Data – Panaji Station

Month	RSPM	SPM	NO_2	SO_2
	µg/m3	µg/m3	µg/m3	µg/m3
April 2013	46.0	88.0	11.0	7.0
May 2013	30.0	61.0	14.0	4.0
June 2013	34.8	70.8	14.2	5.2
July 2013	18.0	40.0	10.0	9.0
August 2013	21.0	52.0	9.0	BDL

September 2013	30.0	70.0	BDL	8.0
October 2013	33.0	74.0	BDL	9.0
November 2013	59.0	121.0	BDL	4.0
December 2013	71.0	99.0	BDL	6.0
January 2014	67.0	100.6	9.0	BDL
February 2014	56.2	99.7	BDL	BDL
March 2014	56.0	81.3	BDL	BDL

Source: GSPCB Note: BDL = Below Detection Limit

Figure 2.12: Map of Goa Showing the Ambient Air Quality Monitoring Stations under the National Air Monitoring Programme (NAMP)



Source: GSPCB

PANAJI

The emissions of SO2 and NOx are within the limits during the period of April 2018 to March 2019 in Panaji. The PM2.5 emissions are within the limits in Panaji in April and May 2018 and the data for the months of June 2018 to October 2018 has not been collected due to rains. The PM2.5 emissions data has been collected from November 2018 to March 2019 and it is higher than the limit (60 µg/m3) on certain days of these months. The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of August 2018, October 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019. The emissions of PM10 are high from October 2018 to March 2019 and the emissions of PM 2.5 are high from November 2018 to March 2019. Table 1.2 shows the PM 10 Emissions Exceeding the limits on certain days of the months in Panaji in 2018-19. Figure 1.2 shows the emissions of PM10 exceeding limit from May 2018 to December 2018 and Figure 1.3 shows the emissions of PM10 exceeding limit from January 2019 to March 2019. Table 1.3 shows the PM 2.5 Emissions Exceeding the Limits on certain days of the months in Panaji in 2018-19. Figure 1.4 shows the emissions of PM2.5 from November 2018 to March 2019.

Table 2.4: PM10 Emissions Exceeding the Limits on Certain Days of the Month in Panaji in 2018-19

Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3
5/2/2018	118	11/4/2018	278	2/1/2019	139
7/4/2018	127	12/14/2018	111	2/6/2019	116
8/1/2018	121	12/21/2018	155	2/8/2019	116
8/3/2018	134	12/28/2018	209	2/13/2019	141
8/8/2018	133	1/2/2019	100	2/15/2019	100
8/24/2018	128	1/9/2019	233	2/27/2019	128
10/12/2018	107	1/11/2019	128	3/1/2019	100
10/19/2018	117	1/16/2019	120	3/8/2019	135
10/26/2018	118	1/18/2019	173	3/13/2019	117
11/1/2018	128	1/30/2019	169	3/15/2019	107

Source: GSPCB

Figure 2.13

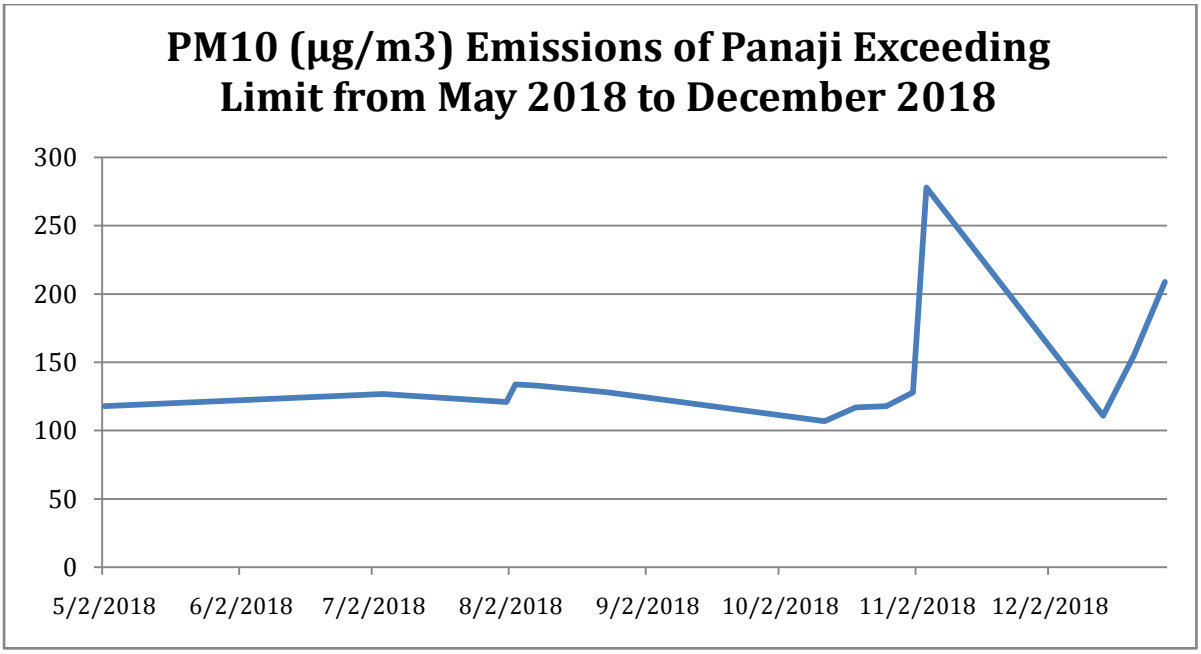


Figure 2.14

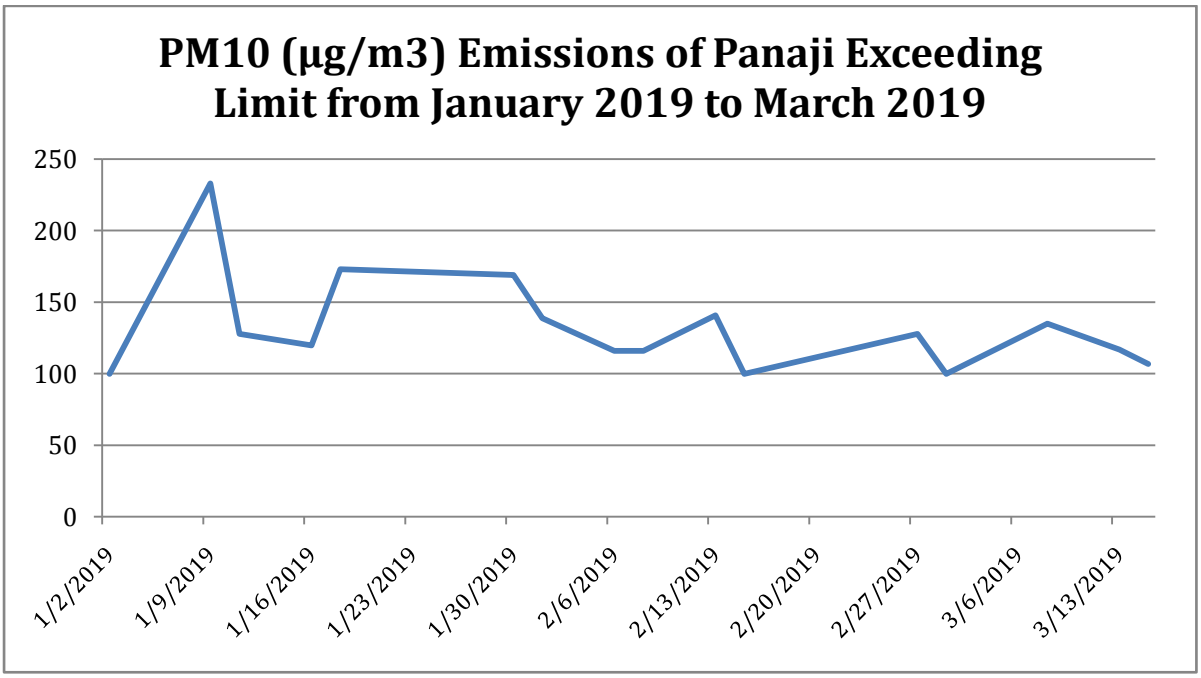
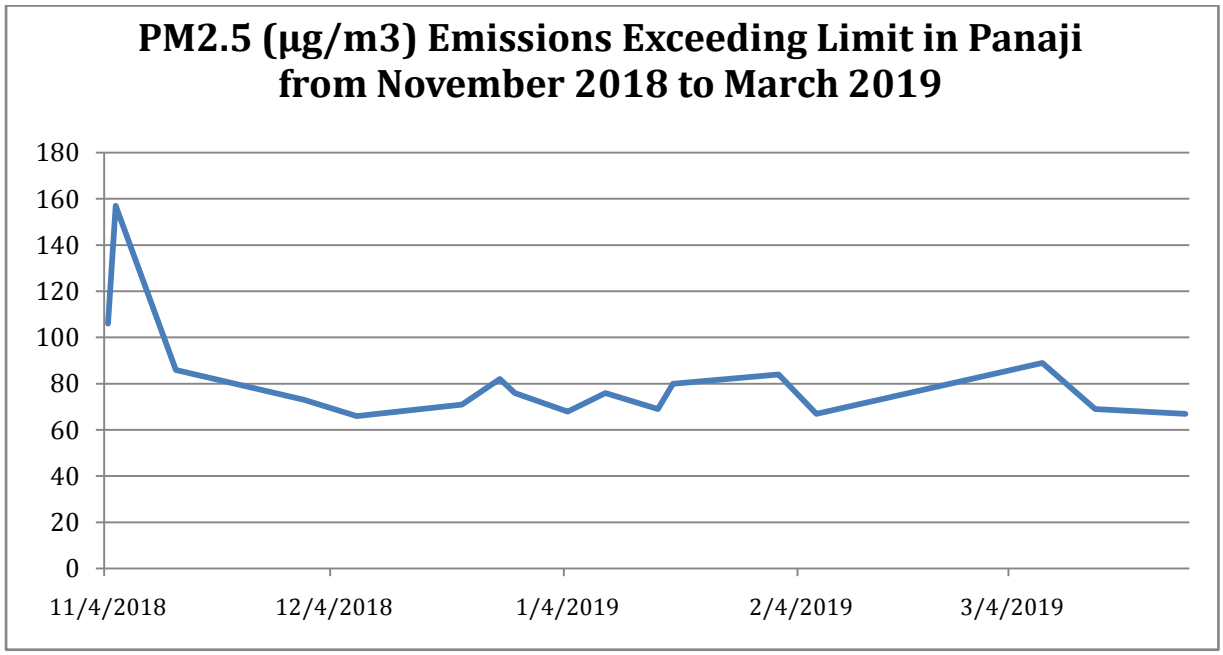


Table 2.4: PM2.5 Emissions Exceeding the Limits on Certain Days of the Month in Panaji in 2018-19

Sampling Date	PM2.5 µg/m3	Sampling Date	PM2.5 µg/m3	Sampling Date	PM2.5 µg/m3
11/4/2018	106	12/26/2018	82	2/1/2019	84
11/5/2018	157	12/28/2018	76	2/6/2019	67
11/13/2018	86	1/4/2019	68	3/8/2019	89
11/30/2018	73	1/9/2019	76	3/15/2019	69
12/7/2018	66	1/16/2019	69	3/27/2019	67
12/21/2018	71	1/18/2019	80		

Source: GSPCB

Figure 2.15



VASCO (FUSE CALL OFFICE)

The emissions of SO2 and NOx are within the limits during the period of April 2018 to March 2019 in Vasco (Fuse Call Office). The PM2.5 emissions data was not collected for the months of April, May and June 2018 due to non functioning of the instrument and the data was not collected for the months of July, August, September and October 2018 due to rains. The PM2.5 emissions data has been collected from November 2018 to March 2019 and it is higher than the limit (60 µg/m3) on certain days of these months. The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of September 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019. The emissions of PM10 are high from September 2018 to March 2019 and the emissions of

PM 2.5 are high from November 2018 to March 2019. Table 1.4 shows the PM10 Emissions Exceeding the Limits on Certain Days of the Month in Vasco in 2018-19. Figure 1.5 shows the emissions of PM10 exceeding limit from April 2018 to December 2018 and Figure 1.6 shows the emissions of PM10 exceeding limit from January 2019 to March 2019. Table 1.5 shows the PM2.5 Emissions Exceeding the Limits on certain days of the month in Vasco in 2019-19. Figure 1.7 shows the emissions of PM2.5 from November 2018 to March 2019.

Table 2.5: PM10 Emissions Exceeding the Limits on Certain Days of the Month in Vasco in 2018-19

Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3
4/18/2018	178	12/4/2018	187	2/5/2019	249
6/15/2018	249	12/6/2018	221	2/7/2019	126
9/6/2018	102	12/27/2018	304	2/13/2019	116
9/25/2018	117	12/29/2018	180	2/25/2019	109
9/27/2018	105	1/1/2019	169	2/27/2019	126
11/8/2018	100	1/8/2019	222	3/5/2019	148
11/14/2018	159	1/10/2019	116	3/7/2019	124
11/16/2018	112	1/15/2019	208	3/11/2019	181
11/27/2018	150	1/17/2019	123	3/13/2019	263
11/29/2018	155	1/29/2019	112	3/22/2019	215

Source: GSPCB

Figure 2.16

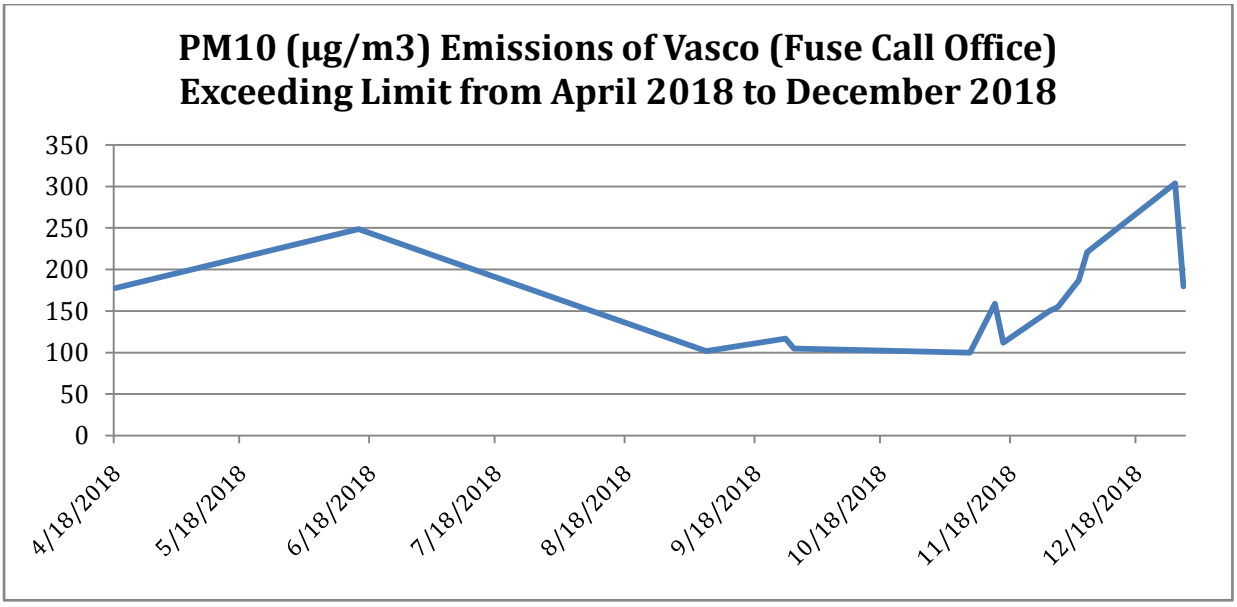


Figure 2.17

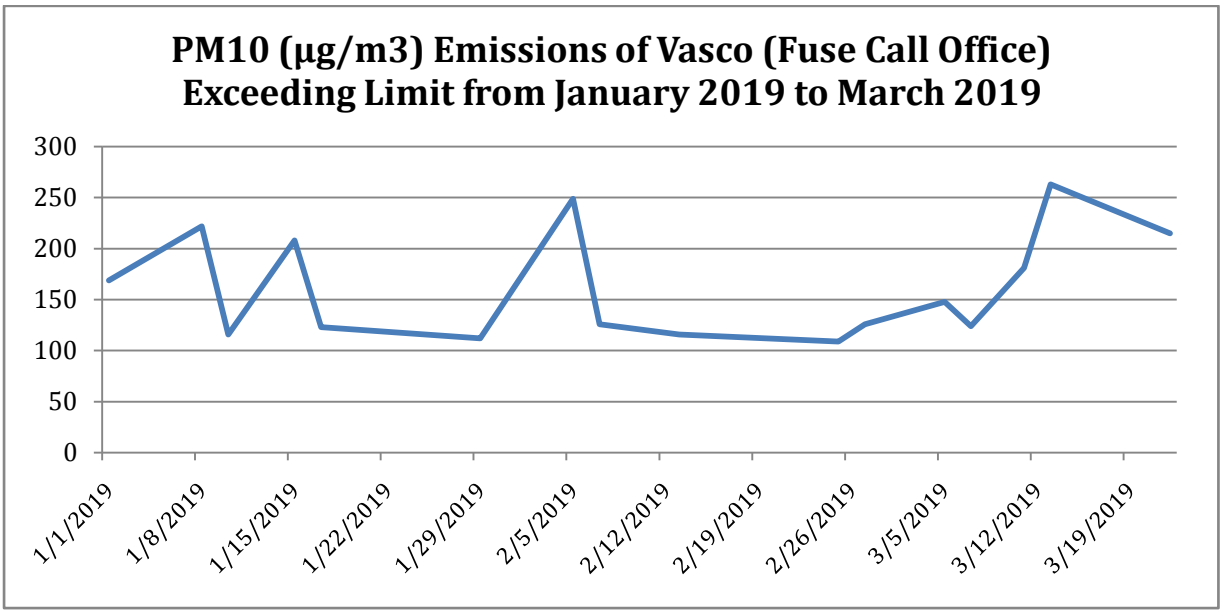
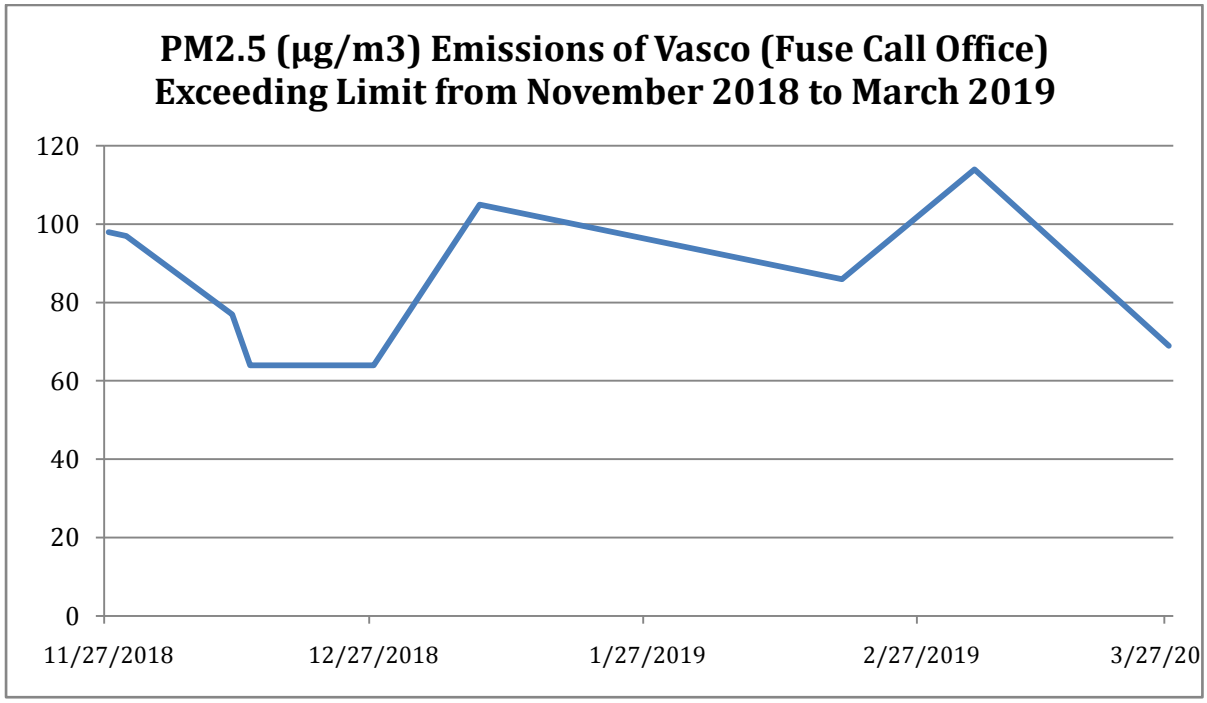


Table 2.6: PM2.5 Emissions Exceeding the Limits on Certain Days of the Month in Vasco in 2018-19

Sampling Date	PM2.5 µg/m3	Sampling Date	PM2.5 µg/m3
11/27/2018	98	1/8/2019	105
11/29/2018	97	2/18/2019	86
12/11/2018	77	3/5/2019	114
12/13/2018	64	3/27/2019	69
12/27/2018	64		

Source: GSPCB

Figure 2.18



MPT (FIRE STATION)

The emissions of SO2 and NOx are within the limits during the period of April 2018 to March 2019 in MPT (Fire Station). The PM2.5 emissions data was not collected for the months of April 2018 due to non functioning of the instrument and the data was not collected from May 2018 to October 2018 due to rains. The data of PM2.5 was collected for the months of November 2018, December 2018, January 2019, February 2019 and March 2019 and it is higher than the limit (60 µg/m3) on certain days of these months. The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of April 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019. Table 1.6 shows the PM10 Emissions Exceeding the Limits on Certain Days of the month in MPT in

2018-19. Figure 1.8 shows the emissions of PM10 exceeding limit from April 2018 to December 2018 and Figure 1.9 shows the emissions of PM10 exceeding limit from January 2019 to March 2019. Table 1.7 shows the PM 2.5 Emissions Exceeding the Limits on Certain Days of the Month in MPT in 2018-19. Figure 1.10 shows the emissions of PM2.5 from November 2018 to March 2019.

Table 2.7: PM10 Emissions Exceeding the Limits on Certain Days of the Month in MPT (Fire Station) in 2018-19

Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3
4/11/2018	162	11/29/2018	156	2/5/2019	390
4/13/2018	140	12/4/2018	296	2/7/2019	437
4/20/2018	147	12/6/2018	113	2/13/2019	106
4/25/2018	142	12/11/2018	153	2/27/2019	146
6/22/2018	195	12/20/2018	181	3/5/2019	118
8/2/2018	111	12/27/2018	297	3/7/2019	148
11/2/2018	230	12/29/2018	257	3/11/2019	140
11/8/2018	134	1/8/2019	256	3/13/2019	272
11/14/2018	272	1/10/2019	153	3/20/2019	228
11/16/2018	296	1/15/2019	262	3/22/2019	137
11/27/2018	134	1/17/2019	253	3/29/2019	135

Source: GSPCB

Figure 2.19

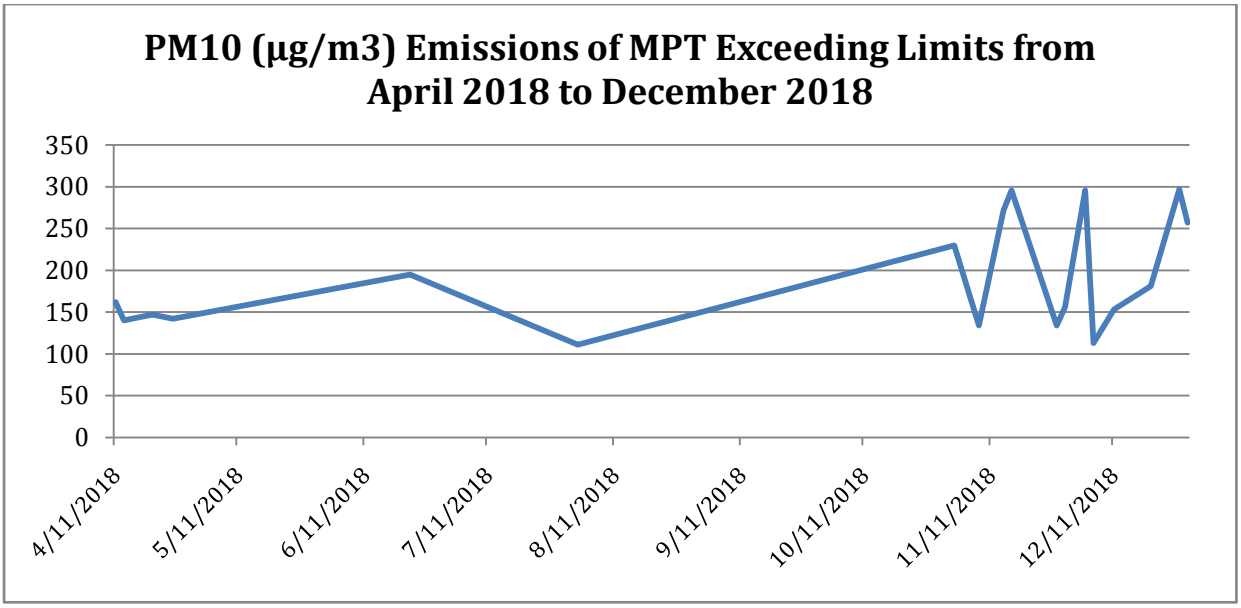

PM10 (µg/m3) Emissions of MPT Exceeding Limits from April 2018 to December 2018
350
300
250
200
150
100
50
0
4/11/2018
5/11/2018
6/11/2018
7/11/2018
8/11/2018
9/11/2018
10/11/2018
11/11/2018
12/11/2018

Figure 2.20

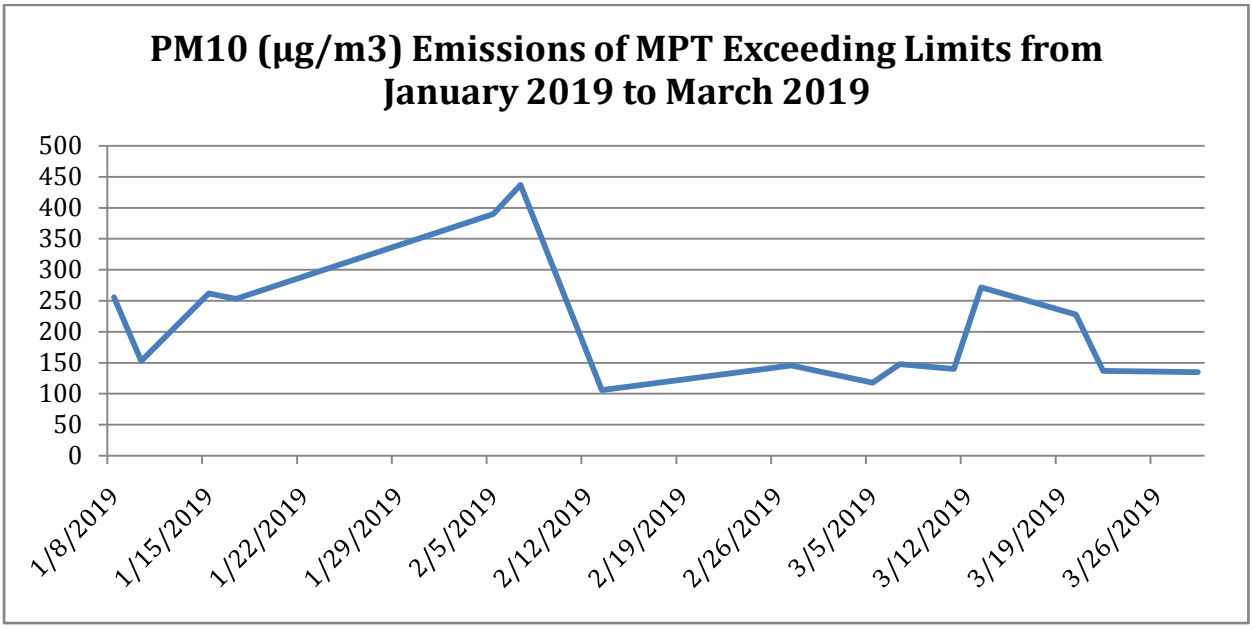
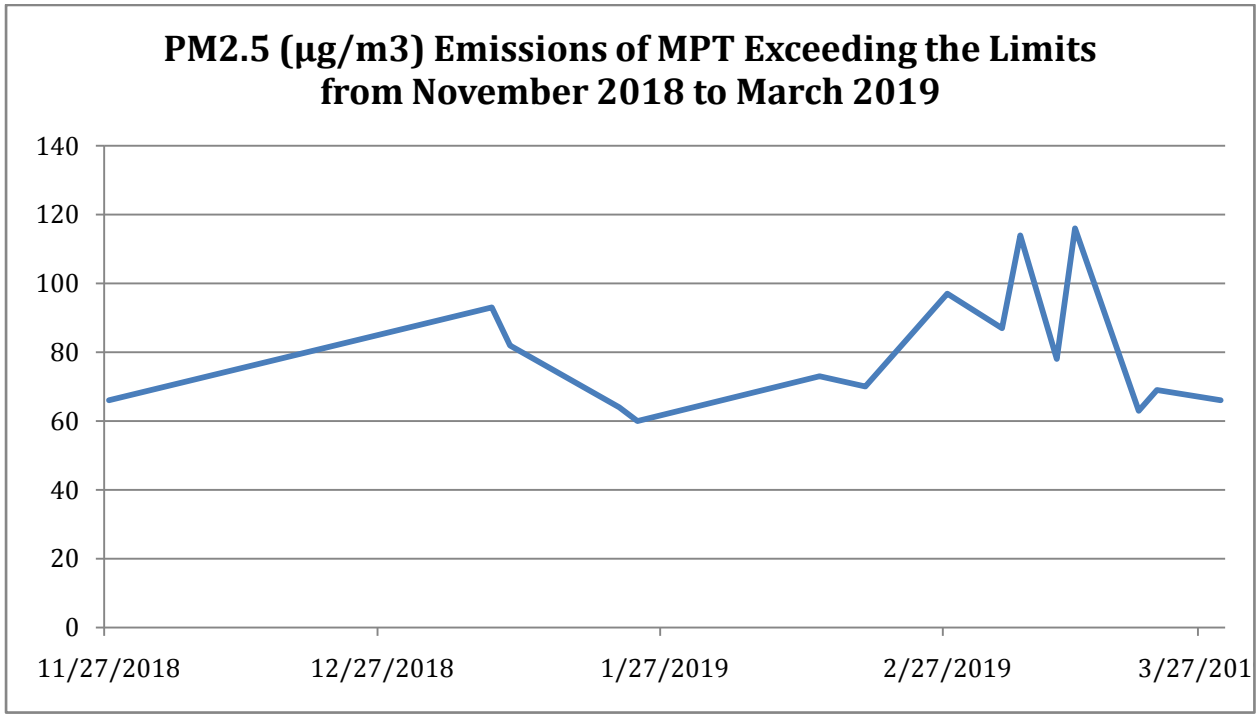

PM10 (µg/m3) Emissions of MPT Exceeding Limits from January 2019 to March 2019
500
450
400
350
300
250
200
150
100
50
0
1/8/2019
1/15/2019
1/22/2019
1/29/2019
2/5/2019
2/12/2019
2/19/2019
2/26/2019
3/5/2019
3/12/2019
3/19/2019
3/26/2019

Table 2.8: PM2.5 Emissions Exceeding the Limits on Certain Days of the Month in MPT (Fire Station) in 2018-19

Sampling Date	PM2.5 µg/m3	Sampling Date	PM2.5 µg/m3	Sampling Date	PM2.5 µg/m3
11/27/2018	66	2/13/2019	73	3/11/2019	78
1/8/2019	93	2/18/2019	70	3/13/2019	116
1/10/2019	82	2/27/2019	97	3/20/2019	63
1/22/2019	64	3/5/2019	87	3/22/2019	69
1/24/2019	60	3/7/2019	114	3/29/2019	66

Source: GSPCB

Figure 2.21



MAPUSA

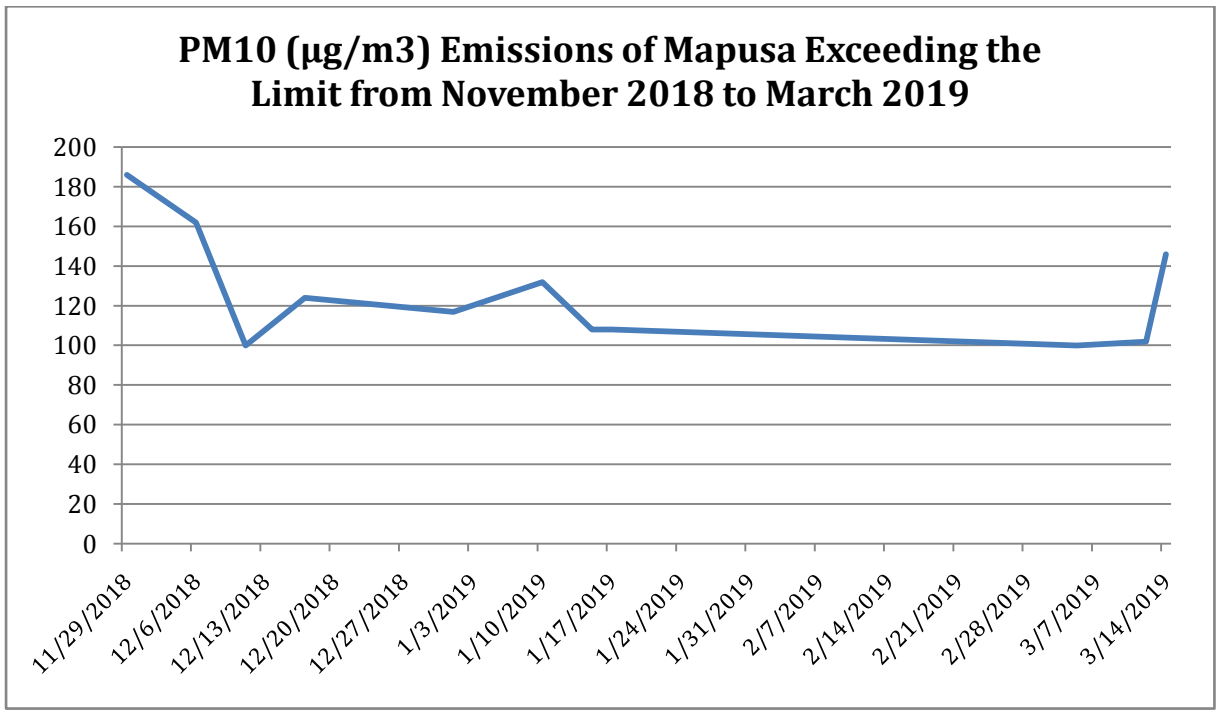
The emissions of SO2 and NOx are within the limits during the period of April 2018 to March 2019 in Mapusa. The PM2.5 emissions data was not collected from April 2018 to March 2019 due to construction activity. The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of November 2018, December 2018, January 2019 and March 2019. Table 1.8 shows the PM10 Emissions Exceeding the Limits on Certain Days of the Month in Mapusa in 2018-19. Figure 1.11 shows the emissions of PM10 exceeding limit from November 2018 to March 2019.

Table 2.9: PM10 Emissions Exceeding the Limits on Certain Days of the Month in Mapusa in 2018-19

Sampling Date	PM10 µg/m3	Sampling Date	PM10 µg/m3
11/29/2018	186	1/15/2019	108
12/6/2018	162	1/17/2019	108
12/11/2018	100	3/5/2019	100
12/17/2018	124	3/12/2019	102
1/1/2019	117	3/14/2019	146
1/10/2019	132		

Source: GSPCB

Figure 2.22



PONDA

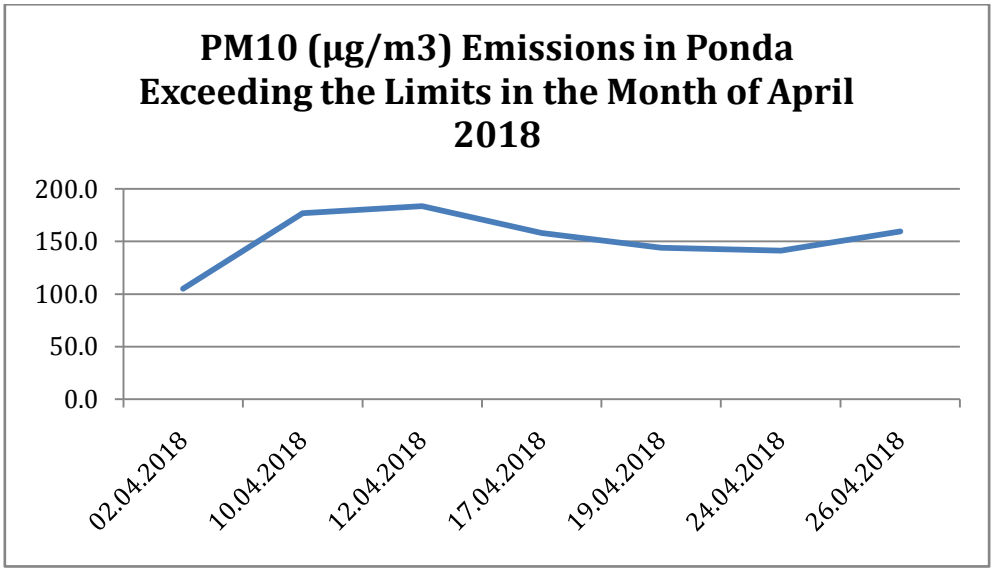
The emission data has been collected from April 2018 to August 2018 and the emissions of SO2, NOx, Ozone, Pb and Carbon Monoxide are within the limits during the period. The emission of PM10 is very high in the month of April 2018. The PM2.5 emissions are within the limits in Ponda. Table 1.9 shows the PM10 Emissions Exceeding the Limits on Certain Days of the Month in Ponda in 2018-19. Figure 1.12 shows the PM10 Emissions Exceeding the Limits in the month of April 2018.

Table 2.10: PM10 Emissions Exceeding the Limits on Certain Days of the Month in Ponda in 2018-19

SAMPLING DATE	PM_{10} µg/m³
02.04.2018	105.1
10.04.2018	177.0
12.04.2018	183.6
17.04.2018	158.1
19.04.2018	143.9
24.04.2018	141.3
26.04.2018	159.7

Source: GSPCB

Figure 2.23



CONCLUSIONS

GSPCB has 18 Ambient Air Quality Monitoring Stations in Goa. The air quality data was collected for certain days in a month and the data was not collected for the entire 30 or 31 days of the month for the year 2018-19. The day on which the air quality has exceeded the limits has been taken for analysis. The following is the conclusion,

1) The emissions of SO2 and NO2 are within the limits for all the five cities.
2) The emissions of PM10 have exceeded the limits in August 2018, October 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019 for Panaji.
3) The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of September 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019 for Vasco.
4) The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of April 2018, November 2018, December 2018 and January 2019, February 2019 and March 2019 for MPT.
5) The emissions of PM10 are higher than the limit (100 µg/m3) in certain days of the months of November 2018, December 2018, January 2019 and March 2019 in Mapusa.
6) The emission of PM10 is very high in the month of April 2018 in Ponda.
7) The emissions of PM2.5 are high from November 2018 to March 2019 in Panaji.
8) The emissions of PM2.5 are high from November 2018 to March 2019 in Vasco.
9) The emissions of PM2.5 are high from November 2018 to March 2019 in MPT.
10) The emissions of PM2.5 are high from November 2018 to March 2019 in Mapusa.
11) The emissions of PM2.5 are within the limits in Ponda.

Overall it shows that the emissions of SO2 and NO2 are within the limits in all the five cities but the emissions of PM10 and PM2.5 are exceeding in the months of November, December, January, February, March and April and there is a need to control these emissions.

Chapter 3

Goa Tomorrow

CHAPTER 3: GOA TOMORROW

3.1: Introduction

This chapter deals with forecasting of population, vehicles and tourists for the future years based on primary and secondary data. The chapter also describes the Transport Demand Model development and the future travel pattern forecasts from the developed model.

3.2: Growth of Goa

In the process of preparing the mobility plan, the entire state of Goa is subdivided into a total of 366 Traffic Analysis Zones. These Traffic Analysis Zones (TAZs) vary in size based on census block information and are used in the development of transportation model by providing demographic and socio-economic data.

About 366 zones have been categorized within the state, while zones 367 to 376 are considered for Airport / Rail Terminal / KTC Bus stands and zones 377 to 384 are external zones. This results in a total of 384 zones. The zoning helps in understanding the trips and it patterns like trip production and trip attraction within these zones.

The study area zoning is represented in Figure 3.1.

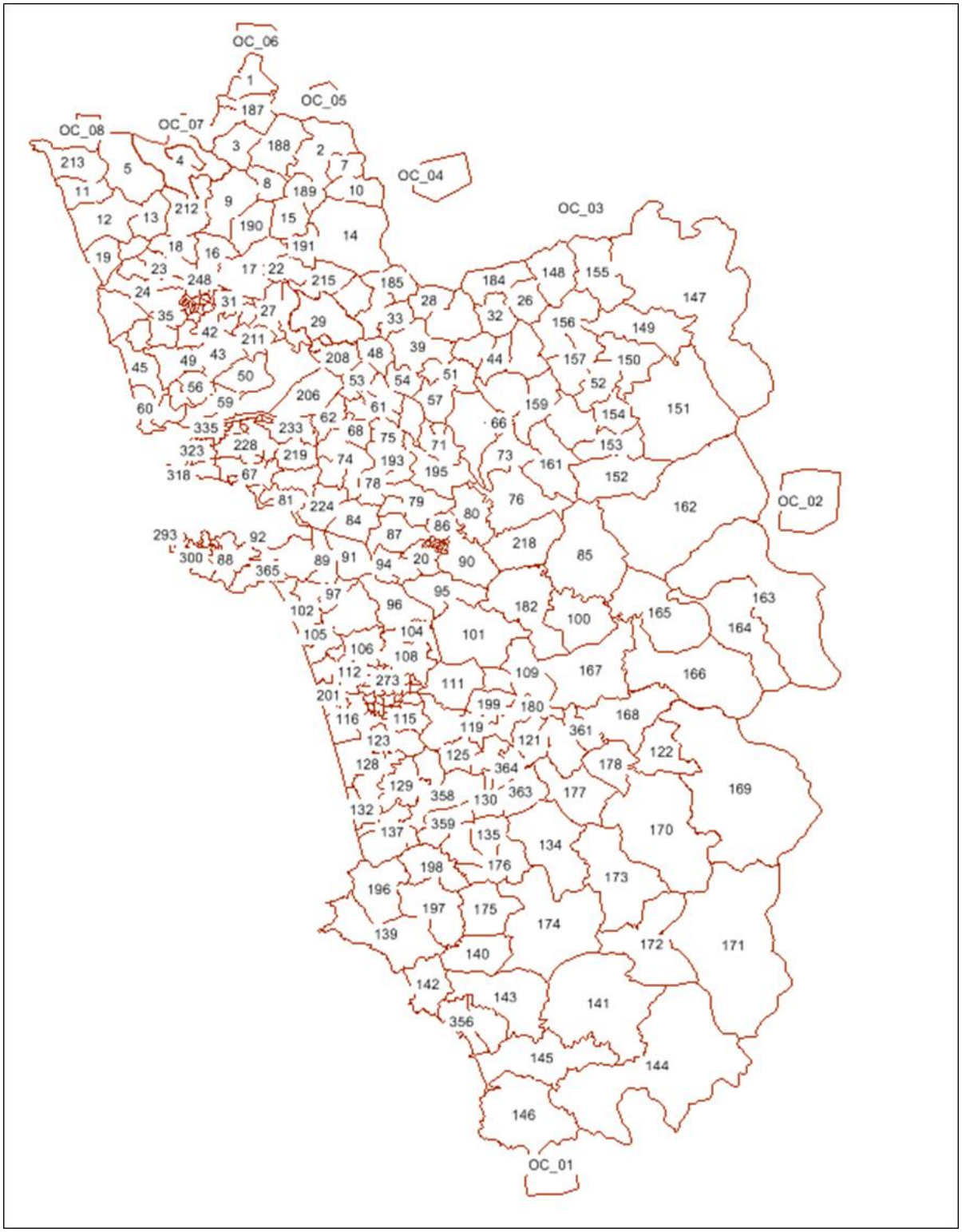


Figure 3.1: Study Area Zoning

3.2.1: Population Forecast

Since Goa's liberation in December 19, 1961, Goa recorded the highest population growth rate of 34.77% in 1970's followed by 26% in 80's, 16% in 90's, 15% in 2000 and recorded the lowest population growth of 8.23% in the year 2011. As per the census 2011, Goa's population stands at 14,58,545 of which male population is 7,39,140 and female population is 719,405 respectively. With fast urbanization, the population is growing at a very high rate in the State of Goa with 35.23% rise in population in the cities over the last decade, while that in the rural parts it has registered a negative growth of -18.51%. Out of total population of Goa, 62.17% people live in urban areas. The total figure of population living in urban areas is 9,06,814, out of which 4,63,704 are male population and while remaining 4,43,110 are female population.

The projection of future population was done TAZ wise by considering the growth rate differently for each Sub district (Or Taluka) and not the average growth for the entire state. The basic objective of making TAZ wise estimates is that such data can serve as a guide for better understanding of performance of each Traffic Analysis Zones (TAZ). In the absence of detailed statistics on the above, Mathematical methods have been applied to get the aggregate estimates of population projection for each TAZ. The decadal growth rate is erratic and no clear trend in the growth rates is discernable.

For projecting population, employees/workers and tourists, all three methods namely (i) arithmetic progression; (2) geometric progression; and (3) incremental increase methods have been carried out. However, considering the fact that Goa stands substantially developed already (i.e. with substantial base population and employees/workers), arithmetic progression method has been adopted as the most suitable one.

3.2.2: Methodology for ascertaining and projecting number of employees in each TAZ, Goa

In the absence of detailed land use map indicating plot level employment generating land uses (such as offices, industries, commercial areas etc.),

total number of employment in each TAZ has been calculated on the basis of the Household Interview surveys that also captured the pattern of work trips. Total 12,986 number of households have been surveyed, which have covered aspects such as number of trips; trip frequency; trip starting address/TAZ (trip origin); trip ending address/TAZ (trip destination); time of trip; travel distance, etc.

Accordingly, the following methodology has been adopted in ascertaining number of workers/employees in a particular TAZ:

1. Number of employees/workers making work trip from a particular TAZ to other TAZs taken from the Household Interview survey (which is about 3-5% of total households in a particular TAZ).

2. Percentage of trips made from a particular TAZ to other TAZs is calculated.

3. Total number of workers ascertained by multiplying the above proportion with number of workers in that particular TAZ.

The population and employment projections TAZ wise for the base year, 2028 and 2038 are given in Table 3.1:

Table 3.1: Population and Employment Projection-2038

Zone No	Population			Employment		
	2018	2028	2038	2018	2028	2038
1	2540	3127	4127	740	889	1131
2	2799	3446	4549	636	765	972
3	2332	2870	3789	559	671	854
4	2852	3511	4635	609	732	931
5	7011	8631	11393	1673	2010	2557
6	4886	4951	5198	1037	1246	1585
7	2565	3158	4168	871	1047	1332
8	1762	2170	2864	556	669	850
9	6015	7405	9774	1722	2069	2632
10	3619	4455	5881	930	1117	1421
11	5620	6653	8449	1324	1591	2023

12	8803	10420	13233	2681	3222	4098
13	5302	6276	7971	1222	1468	1868
14	7098	8739	11535	2046	2458	3127
15	2712	3338	4407	1032	1241	1578
16	5088	6023	7649	1774	2131	2711
17	9584	11345	14408	3476	4178	5313
18	3184	3769	4786	714	858	1091
19	7138	8450	10732	2227	2676	3403
20	7235	7332	7698	4249	5106	6494
21	2950	2990	3139	665	799	1017
22	3010	3563	4524	826	992	1262
23	11548	13670	17361	956	1148	1460
24	4611	5677	7494	1773	2131	2710
25	1303	1604	2118	446	536	682
26	2377	2926	3863	689	827	1052
27	6621	7838	9954	2497	3001	3817
28	2157	2656	3506	425	510	649
29	7966	9807	12946	1620	1947	2477
30	10175	12045	15297	3398	4083	5193
31	4540	5374	6825	1486	1786	2271
32	3474	4277	5646	1247	1498	1906
33	3787	4483	5693	797	958	1218
34	2878	2916	3062	873	1049	1334
35	3891	3943	4140	1060	1274	1621
36	4164	4219	4430	1614	1940	2467
37	3750	3800	3990	1696	2038	2592
38	4698	5561	7063	1748	2100	2671
39	5808	7150	9438	1329	1596	2030
40	3437	4069	5167	1376	1654	2103
41	5318	5389	5658	875	1051	1337
42	2931	2970	3119	872	1048	1333
43	13630	13812	14502	3931	4724	6008
44	6191	7329	9308	1618	1945	2473
45	14583	14777	15516	4648	5585	7103
46	14415	14607	15337	3745	4500	5723
47	373	459	606	800	961	1223
48	2791	3436	4535	581	699	889
49	4677	4739	4976	1830	2199	2797

50	6730	7966	10117	1992	2393	3044
51	3493	4300	5677	873	1049	1335
52	9010	10665	13545	1722	2070	2632
53	4365	5168	6563	1431	1720	2187
54	3129	3704	4704	1005	1208	1536
55	5654	6693	8499	1564	1879	2390
56	6153	7284	9250	4264	5124	6517
57	2854	3514	4638	716	860	1094
58	2099	2485	3156	795	956	1215
59	16201	16416	17237	7618	9154	11643
60	8976	9095	9550	1222	1468	1867
61	4860	4924	5170	2234	2685	3415
62	5673	6715	8528	2606	3132	3983
63	5324	5395	5665	3078	3699	4705
64	1803	2219	2929	2500	3004	3821
65	8504	8617	9048	3747	4503	5727
66	2763	3271	4154	846	1016	1293
67	7270	7367	7735	1196	1437	1828
68	6936	7028	7379	2463	2960	3764
69	1983	2348	2981	688	826	1051
70	1585	1876	2383	764	918	1167
71	3365	4143	5469	1195	1436	1827
72	1945	1971	2069	320	385	490
73	6381	7554	9593	2332	2803	3565
74	5469	6733	8887	2072	2489	3166
75	1782	2110	2680	607	729	927
76	13132	15545	19742	4614	5544	7052
77	2659	3148	3997	795	956	1215
78	4075	4824	6126	1304	1567	1993
79	8621	10205	12960	2068	2484	3160
80	3979	4898	6466	1406	1690	2149
81	4564	5403	6861	928	1115	1418
82	2552	2586	2715	770	926	1177
83	2029	2401	3050	534	641	816
84	6563	7769	9866	1461	1755	2233
85	3158	4487	6281	185	223	283
86	17302	17532	18409	3904	4691	5966
87	13434	13613	14293	3825	4596	5845

88	7321	7418	7789	1514	1819	2314
89	9588	9716	10201	1673	2010	2556
90	6476	7973	10524	1487	1787	2272
91	3445	4241	5598	1061	1275	1621
92	206	209	219	111	134	170
93	6364	6449	6771	3398	4084	5194
94	3636	4304	5466	1271	1528	1943
95	8719	10321	13108	2443	2935	3733
96	6464	7957	10504	2279	2738	3483
97	4090	4841	6148	1592	1913	2433
98	1876	2310	3049	345	414	527
99	7003	8290	10528	3024	3634	4622
100	4014	4941	6523	1994	2396	3047
101	14827	17551	22290	4512	5422	6896
102	2343	2374	2493	502	603	767
103	1817	2151	2732	450	541	688
104	2373	2809	3567	819	985	1252
105	2131	2523	3204	505	606	771
106	9808	11610	14745	2362	2838	3610
107	1780	2108	2677	395	475	604
108	11305	13383	16996	3002	3607	4588
109	4535	5584	7370	1007	1211	1540
110	1836	1861	1954	395	475	604
111	13607	16108	20457	3579	4301	5471
112	790	935	1187	321	385	490
113	2082	2564	3384	506	608	774
114	3432	3478	3651	986	1184	1506
115	6875	6967	7315	1754	2108	2681
116	12586	12753	13391	6318	7592	9656
117	10801	12786	16239	3082	3704	4710
118	13013	13186	13845	3187	3830	4871
119	2353	2785	3537	690	829	1054
120	3228	3271	3435	691	831	1056
121	7850	9293	11801	2124	2552	3246
122	2700	3324	4388	772	928	1181
123	3074	3639	4621	794	954	1213
124	3634	4301	5463	794	954	1214
125	2956	3639	4803	1066	1281	1630

126	5743	6799	8634	451	542	689
127	2397	2951	3895	581	698	888
128	2164	2561	3253	506	608	773
129	7295	8635	10966	2418	2905	3695
130	3154	3734	4742	978	1175	1495
131	4080	4830	6134	1482	1781	2265
132	2064	2542	3355	898	1079	1373
133	3601	4263	5413	1375	1652	2101
134	3824	5432	7604	772	928	1180
135	1750	2154	2843	481	578	735
136	3109	3827	5052	1220	1466	1865
137	3013	3566	4529	898	1079	1373
138	6288	7444	9454	2180	2620	3332
139	5683	6997	9236	1432	1720	2188
140	2835	3491	4607	532	639	813
141	5223	7419	10387	1090	1310	1666
142	4014	4941	6523	1170	1405	1787
143	4801	5911	7803	1409	1694	2154
144	2788	3960	5544	613	737	937
145	6996	8613	11369	2677	3216	4091
146	5065	6236	8232	2968	3567	4537
147	1918	2724	3814	534	642	816
148	7235	8565	10878	1779	2138	2720
149	2146	3048	4267	501	603	766
150	2088	2570	3393	554	665	846
151	3251	4619	6466	610	734	933
152	2300	3267	4574	500	601	764
153	1554	1914	2526	455	547	695
154	2364	2911	3842	533	641	815
155	3071	3780	4990	634	762	970
156	2418	2977	3930	533	640	814
157	3112	3831	5057	717	861	1096
158	2521	3103	4096	318	382	486
159	1422	2021	2829	106	127	161
160	2559	3150	4158	719	864	1099
161	3208	3949	5213	506	608	774
162	4344	6171	8639	770	925	1176
163	1903	2703	3784	875	1051	1337

164	4430	5454	7199	1859	2233	2841
165	2964	4211	5895	1200	1442	1834
166	2833	4025	5634	1100	1322	1681
167	3973	5643	7900	1060	1273	1620
168	2626	3731	5223	688	827	1051
169	3842	5457	7640	1195	1436	1826
170	3208	4557	6380	799	961	1222
171	2404	3416	4782	609	732	931
172	2197	3122	4370	160	192	245
173	3496	4967	6953	1165	1401	1781
174	2384	3387	4742	638	766	974
175	1990	2828	3959	717	861	1096
176	1615	1988	2624	633	760	967
177	3572	4398	5805	1678	2017	2565
178	7988	9456	12009	2230	2679	3408
179	2696	3319	4381	957	1150	1463
180	2422	2868	3642	880	1058	1345
181	2478	3051	4027	880	1058	1345
182	2905	4127	5777	1614	1939	2466
183	2855	3515	4640	663	796	1013
184	3656	4501	5941	719	864	1099
185	2262	2785	3676	846	1017	1293
186	2606	3208	4235	372	446	568
187	1767	2175	2871	478	574	731
188	2676	3294	4348	667	801	1019
189	1771	2180	2878	266	320	407
190	4105	5053	6670	1597	1920	2441
191	1654	2036	2687	584	702	892
192	5445	6703	8848	1196	1437	1828
193	4427	5240	6655	1512	1817	2311
194	4656	5732	7566	664	798	1015
195	4225	5201	6866	1272	1528	1944
196	2177	3093	4330	449	540	687
197	3454	4252	5613	984	1182	1504
198	3132	3856	5090	1006	1209	1538
199	4571	5411	6872	1965	2362	3004
200	2712	2748	2885	1244	1495	1902
201	4951	5861	7444	1748	2101	2672

202	4212	4986	6333	1516	1822	2317
203	3205	3794	4818	1145	1376	1750
204	2454	2905	3689	1136	1365	1736
205	5510	5583	5862	1987	2387	3036
206	4485	5521	7288	1327	1595	2028
207	6017	7407	9778	1617	1943	2471
208	2496	3073	4057	80	96	122
209	8168	8276	8690	2791	3354	4266
210	2050	2426	3081	1197	1438	1829
211	3964	4693	5959	932	1120	1424
212	4369	5378	7099	1114	1338	1702
213	4879	6006	7928	1274	1532	1948
214	2589	3065	3893	533	641	815
215	5817	6886	8746	1404	1687	2145
216	4995	5061	5314	2710	3257	4143
217	3231	3825	4858	985	1183	1505
218	5059	6228	8221	1668	2004	2549
219	1492	1837	2425	427	513	652
220	2120	2610	3446	661	794	1010
221	4493	5319	6755	798	959	1219
222	3718	4401	5590	1006	1209	1538
223	3706	4388	5572	2287	2748	3495
224	6769	8013	10176	3073	3692	4696
225	8712	10725	14157	2149	2582	3284
226	3430	4222	5574	985	1184	1506
227	1298	1536	1951	800	961	1223
228	7938	8043	8445	1966	2362	3004
229	983	1164	1478	319	384	488
230	528	535	562	211	253	322
231	1608	1980	2613	454	546	694
232	16145	16359	17177	4194	5040	6410
233	1035	1225	1556	344	414	526
234	720	730	766	210	252	321
235	1691	1714	1799	27	32	41
236	1632	1653	1736	453	544	692
237	4902	4967	5215	1857	2231	2838
238	2900	2939	3086	853	1025	1304
239	1072	1086	1141	347	417	531

240	1367	1386	1455	396	476	606
241	1295	1312	1378	373	448	570
242	1139	1154	1212	421	506	644
243	1176	1192	1251	451	542	689
244	1480	1499	1574	476	572	727
245	1064	1078	1132	795	955	1215
246	1348	1366	1434	479	575	731
247	2147	2176	2284	53	63	81
248	5446	5519	5795	1675	2013	2560
249	2123	2151	2259	661	795	1011
250	4460	4520	4746	1913	2298	2923
251	1435	1454	1527	426	512	652
252	2616	2651	2783	826	992	1262
253	4174	4230	4441	902	1084	1379
254	4095	4149	4357	1169	1404	1786
255	1395	1414	1485	396	476	606
256	1884	1909	2005	692	832	1058
257	739	749	787	215	259	329
258	978	991	1040	265	318	404
259	1403	1422	1493	266	319	406
260	739	749	787	188	226	288
261	743	753	791	183	219	279
262	390	395	414	158	190	242
263	632	641	673	208	250	318
264	457	463	486	379	455	579
265	2179	2208	2318	661	795	1011
266	3610	3658	3841	1855	2229	2835
267	2699	2735	2872	746	896	1139
268	4079	4133	4340	1005	1208	1537
269	4743	4806	5046	1329	1597	2031
270	3935	3988	4187	879	1056	1343
271	4737	4800	5040	2150	2584	3286
272	4180	4235	4447	930	1117	1421
273	3898	3950	4148	770	926	1177
274	3877	3929	4125	1011	1215	1545
275	3824	3875	4069	905	1088	1384
276	2868	2906	3051	852	1024	1302
277	5523	5597	5877	1354	1627	2070

278	4265	4321	4537	1116	1341	1706
279	4414	4472	4696	1164	1399	1779
280	3192	3234	3396	345	414	527
281	3558	3606	3786	849	1020	1298
282	3718	3767	3956	1112	1336	1699
283	4026	4079	4283	900	1082	1376
284	2895	2933	3080	1410	1695	2156
285	5577	5651	5933	663	797	1014
286	2374	2406	2526	926	1112	1415
287	2294	2325	2441	636	764	972
288	4700	4763	5001	1272	1528	1944
289	2666	2702	2837	452	543	691
290	1577	1598	1678	454	545	693
291	2852	2890	3034	900	1082	1376
292	2783	2820	2961	692	832	1058
293	3131	3173	3331	2356	2831	3601
294	3051	3092	3246	800	961	1223
295	3288	3331	3498	1277	1535	1952
296	3372	3417	3588	2342	2814	3579
297	3363	3408	3578	504	606	771
298	3545	3593	3772	1533	1842	2343
299	3755	3805	3995	2521	3029	3853
300	3902	3954	4152	1143	1374	1747
301	3979	4032	4234	800	961	1223
302	4712	4774	5013	1434	1723	2192
303	4327	4385	4604	800	961	1223
304	5070	5138	5394	557	669	851
305	3982	4035	4237	27	32	41
306	4457	4516	4742	1248	1499	1907
307	3654	3702	3888	1011	1215	1546
308	5114	5182	5441	1703	2046	2603
309	4532	4593	4822	2729	3279	4171
310	4663	4725	4962	1037	1247	1586
311	4326	4383	4603	1197	1439	1830
312	3065	3105	3261	700	841	1070
313	3993	4046	4248	1012	1216	1546
314	4321	4379	4598	2604	3129	3980
315	4526	4586	4816	1085	1303	1658

316	3931	3983	4183	1596	1917	2439
317	3615	3663	3846	770	925	1176
318	1199	1215	1276	476	571	727
319	1436	1455	1527	560	672	855
320	935	948	995	564	678	862
321	1826	1850	1943	150	180	229
322	1326	1344	1411	241	289	368
323	1686	1709	1794	426	512	651
324	1818	1842	1934	556	668	850
325	1098	1113	1168	240	288	367
326	1360	1378	1447	289	347	442
327	1357	1375	1443	214	257	327
328	1534	1554	1632	211	254	323
329	965	978	1026	323	388	493
330	1551	1572	1651	347	417	531
331	1812	1836	1928	264	317	403
332	2454	2487	2611	1056	1269	1615
333	1259	1276	1340	583	701	891
334	1657	1679	1763	399	479	610
335	2149	2177	2286	317	381	485
336	2212	2242	2354	424	510	648
337	1387	1405	1475	402	483	614
338	2266	2296	2411	636	764	972
339	1135	1150	1208	472	567	721
340	1231	1248	1310	583	701	891
341	2110	2138	2245	613	736	936
342	253	256	269	53	64	82
343	527	534	560	368	442	562
344	408	413	434	489	588	747
345	1197	1213	1273	1291	1551	1973
346	978	991	1040	26	32	40
347	1131	1146	1203	428	515	655
348	8968	9088	9542	1964	2360	3002
349	8968	9088	9542	3105	3731	4746
350	12778	12948	13595	3928	4720	6003
351	12778	12948	13595	3317	3986	5070
352	7432	7531	7908	2391	2873	3654
353	7432	7531	7908	2098	2522	3207

354	8105	8212	8623	2443	2936	3734
355	8105	8212	8623	2018	2425	3085
356	6565	7771	9869	3162	3799	4832
357	6565	7771	9869	3427	4118	5238
358	8777	10389	13195	2549	3063	3896
359	8777	10389	13195	2735	3287	4180
360	8001	8107	8512	2808	3375	4292
361	8001	9850	13002	3312	3979	5061
362	8001	9471	12028	1378	1655	2106
363	7812	9247	11744	2493	2995	3809
364	7812	7915	8311	2015	2422	3080
365	11575	11729	12315	5282	6347	8073
366	11575	13702	17401	7140	8580	10912
	1546058	**1742502**	**2089596**	**478524**	**575026**	**731359**

3.2.3: Methodology for ascertaining and projecting number of Tourists in each TAZ, Goa

For estimating average number of daily tourist in each TAZ, a bottom-up approach has been adopted by locating the hotels/paying guest houses in each TAZ and estimating number of daily tourists residing in these hotels/paying guest houses, after applying average occupancy and duration of stay in these hotels. To elaborate, total number of hotels/paying guest houses in Goa as on 31st March, 2018 is 4,399, which house total 51,250 numbers of rooms. Details are provided in Table 3.2.

Table 3.2: Category-wise total number of Hotels/Paying Guest Houses in Goa as on 31st March, 2018

Sl. No.	Category	No. of hotels/Paying Guest Houses	Total rooms	No. of beds	Average Number of Rooms per hotel
(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F=D/C)**
1.	Category-A	113	12,433	21,490	110
2.	Category-B	316	12,316	21,678	39
3.	Category-C	795	12,636	23,477	16
4.	Category-D	3,175	13,865	23,768	4
5.	Total	4,399	51,250	90,413	

Note: Data mentioned in (B), (C), (D) and (E) are as published by the Goa Tourism Department.

Detailed methodology adopted is as under:

a) Ascertaining number of hotels/paying guest house in each TAZ: Category-A, B and C hotels were marked based on the information available on line as well through primary surveys. Category-D hotels constitute almost 72% of all the accommodation facilities and are mostly in the form of Paying Guest Houses (assumed on the basis of only 4 numbers of rooms per these accommodation facility on an average) and geographical distribution of all of these are not known. For this, they have been distributed based on their density over geographical area.

b) Average number of rooms per hotel/paying guest house is taken from Goa Tourism Department.

c) Average number of tourists per room is assumed as two (2) for Category-A hotels, whereas for Category-B, C and D hotels/paying guest house, it is assumed as three (3).

d) From the above, number of tourists are calculated. Further, average occupancy per hotel/paying guest house is assumed as 70% (i.e. they will be occupied for 70% of the time of year) and average duration of stay per tourist is taken as 6 days, as per data published by Goa Tourism Department.

Table 3.3 below provides the detailed calculation on how the total numbers of tourists in all TAZs have been ascertained.

Table 3.3: Total Number of Tourists in Goa (aggregate in all TAZs)

Sl. No.	Category	Total rooms (all TAZs)	Average number of tourists per room	Number of tourists assuming 100% occupancy and duration of stay as one (1) day	Number of tourists assuming 70% occupancy and duration of stay as one (1) day	Number of tourists assuming 70% occupancy and duration of stay as six (6) day
(A)	(B)	(C)	(D)	(E=C*D)	(F=E*70%)	(G=F/6)
1.	Category-A	12,433	2	24,866	17,406	3,165
2.	Category-B	12,316	3	36,948	25,864	4,702
3.	Category-C	12,636	3	37,908	26,536	4,825

4.	Category-D	13,865	3	41,595	29,117	5,294
5.	Total	51,250		141,317	98,922	17,986

Note: Source of data of (B), (C) and (D) and average duration of stay: Goa Tourism Department

For cross checking purpose, it may be noted that the above-mentioned total number of tourists is in line with the data published by the Goa Tourism Department. Details are provided in Table 3.4.

Table 3.4: Number of Tourists in Goa

	2017	2016	2015	Average of three years
Tourists (annual)	7,785,693	6,330,744	5,297,902	6,471,446
Monthly	648,808	527,562	441,492	539,287
Daily	21,627	17,585	14,716	17,976

Source: Goa Tourism Department

3.2.4: Land Utilization of Goa

Usually Comprehensive Mobility Plans (CMP) are prepared for cities, but the CMP-Goa is the first of a kind where the mobility plan is prepared for the entire State of Goa where the classification is done at a much larger as well as to a regional scale. The land utilization for Goa of 1977 and 2001 and the land utilization suggested in Draft Regional Plan 2021 for different categories are shown in Table 3.5.

Table 3.5: Land Utilization of Goa

Land Utilisation Type	Area 1977 (In %age)	Area 2001 (In %age)	Area 2021 (In %age)	Total Area in Hectres (2021)
FOREST (Protected/reserved/national park/wild life)	-	-	32.28	123202.90
Mangrove Forest	-	-	0.61	2324.12
Private Forest	-	-	0.93	3542.32
Water Bodies/ nalla/ponds	-	-	5.54	21132.65
Paddy Field/Khanzan Lands	-	-	10.06	38392.36
Orchard	24.2	23.2	14.99	57220.97
Natural Cover	24.3	38.2	12.68	48392.23

Cultiviable	13.7	19.4	2.67	10184.43
Salt Pans	-	-	0.08	320.68
Fish farm / Mud Flats	-	-	0.06	225.94
Settlement	5.5	10.7	16.50	62973.19
Institutional	-	-	0.57	2163.74
Industry	0.2	0.7	1.04	3984.36
Miz	-	-	0.08	311.01
Transportation	-	-	1.91	7281.19
Miscellaneous	8.5	1.8	0.01	38.18
Marshy land	5.4	6	-	-
Waste land	18.2	-	-	-
Grand Total			100	381690.27

Source: Draft Regional Plan Goa 2001, 2021

In absence of different empirical data for Transportation category of Land utilization, the accurate percentage change of land use is not possible. However, The spatial requirements of the land for the proposed population of 18,14,864 in 2041 for the State of Goa area is estimated as per the suggested norms and standards as applicable to the different classes of Cities/Towns as classified by UDPFI Guidelines (Urban Development Plans Formulation and Implementation). Based on the above said criteria, the urbanisable land categorised for various categories is estimated for different classes of Cities/Towns of Goa in 2041. The Land use Structure for Development of Urban Centres of Goa in 2041 is given in Table 3.6.

Table 3.6: The Land use Structure for Development of Urban Centers of Goa in 2038

Sl. No.	Land use Category	Percentage of Developed Area			
		Small	**Medium**	**Large**	**Metropolitan**
1	Residential	45-50	43-48	36-39	36-38
2	Commercial	2-3	4-6	5-6	5-6
3	Industrial	8-10	7-9	7-8	7-8
4	Public & Semi Public	6-8	6-8	10-12	10-12
5	Recreational	12-14	12-14	14-16	14-16
6	Transport & Communication	10-12	10-12	12-14	12-14
7	Agriculture, Water bodies and Special areas	Balance	Balance	Balance	Balance

Total Developed Area	100	100	100	100

Source: Revised URDPFI Guidelines 2015

It should also be noted that, it would be desirable to fix the recommended land use share for essential uses like Residential, Transportation and Recreational while the proportion for other uses may be flexible. Actual land use percentage in a given city case should be calculated based on local conditions and needs.

3.3: Travel Demand Forecast

3.3.1: Development of Transport Model

A scientific transport model to replicate Goa state and urban transportation system (roads, congestion delays, transit system, ferries etc.) has been 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 efficient Transit System (such as Metro, Light Rail, Bus Rapid Transit) with land use modifications 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 Goa transport model has been developed using VISUM (state-of-the-art Travel Demand Modeling software).

3.3.2: Model Structure

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

Trip Generation – calculating the number of origins and destinations for each zone.

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

Model Input

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

Mode Choice – determining the mode for each trip (TW, car, auto, Public transport).

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

Network Development

Transport network developed for the model comprises two components, Highway Network for vehicles and the Transit Network for public transport system i.e. buses, metro and any new public transportation system.

Each of the networks is described in detail below:

1. **Highway Network**

The coded highway network for the study area represents the nodes (intersections) and links between them. Connectivity between the network and zones is provided through centroid connectors. Based on the network inventory, each link has been assigned attributes such as: number of lanes; divided or undivided carriageway; encroachments; availability of footpaths etc. The road network for the base year is shown in Figure 3.2 and Figure 3.3.

Modes: The modes that are modeled under the study include two wheelers, Private Cars, Tourist Taxis, Auto rickshaws, Public Transport i.e. Bus. The non-motorized transport and commercial vehicles are considered as a preload.

Zoning: 366 zones within the state, from 367 to 376 are considered for Airport / Rail Terminal / KTC Bus stands, from 377 to 384 are external zones resulting in a total of 384 zones.

Network: The highway (road) network considered all the Key arterials, Sub arterials and collectors. The transit system considered include the existing public transport system in all its forms i.e. bus with routes, frequency, fare structure etc.: (37645 nodes, 220 bus routes (including mofussil Bus Routes)

Centroid connectors - 3886
Links - number 82256

Planning Period: Year 2018 is considered as the base year and 2038 has been set as the horizon year for the planning of the long term strategy.

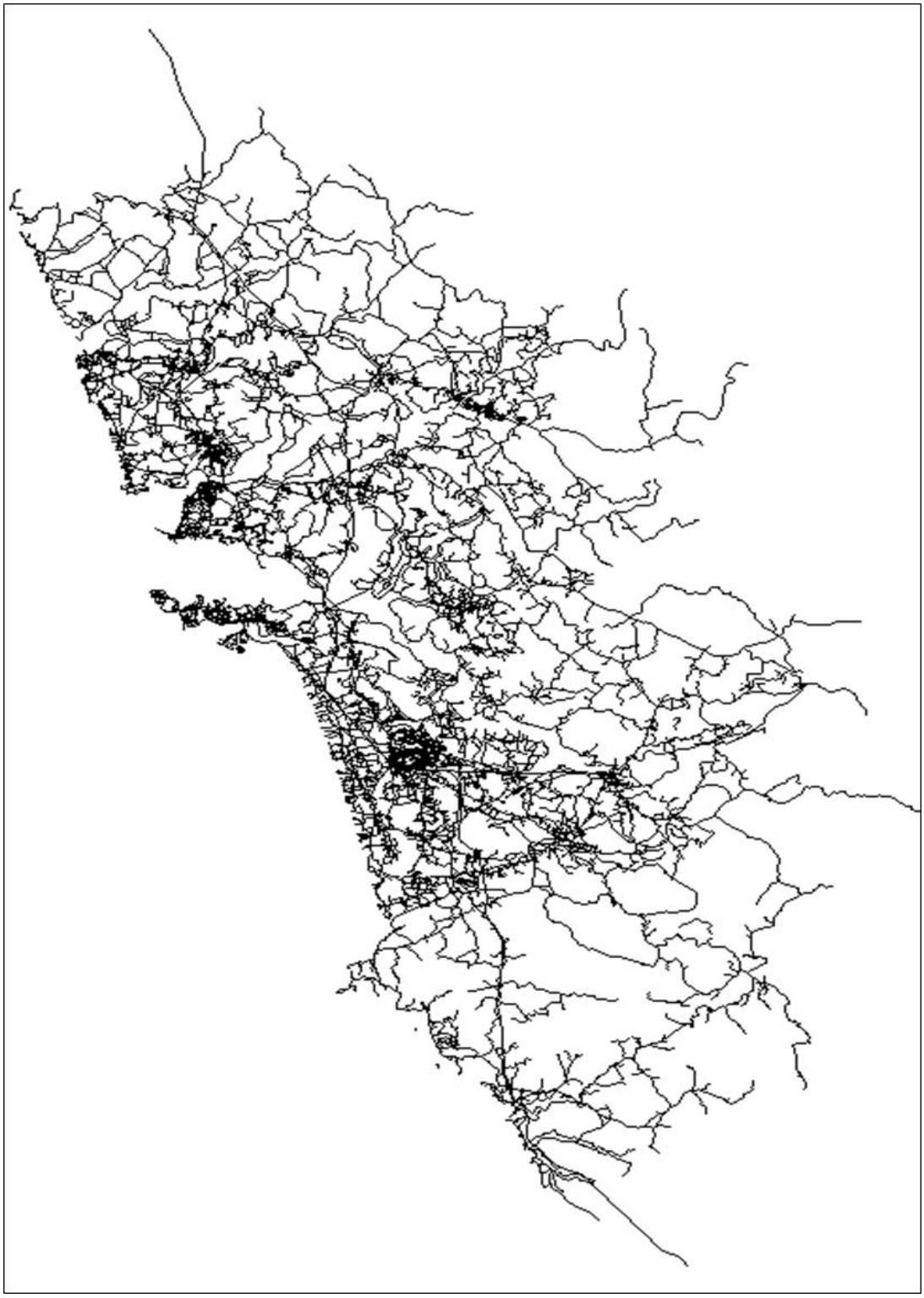


Figure 3.2: Base Year Study Area Road Network-All roads

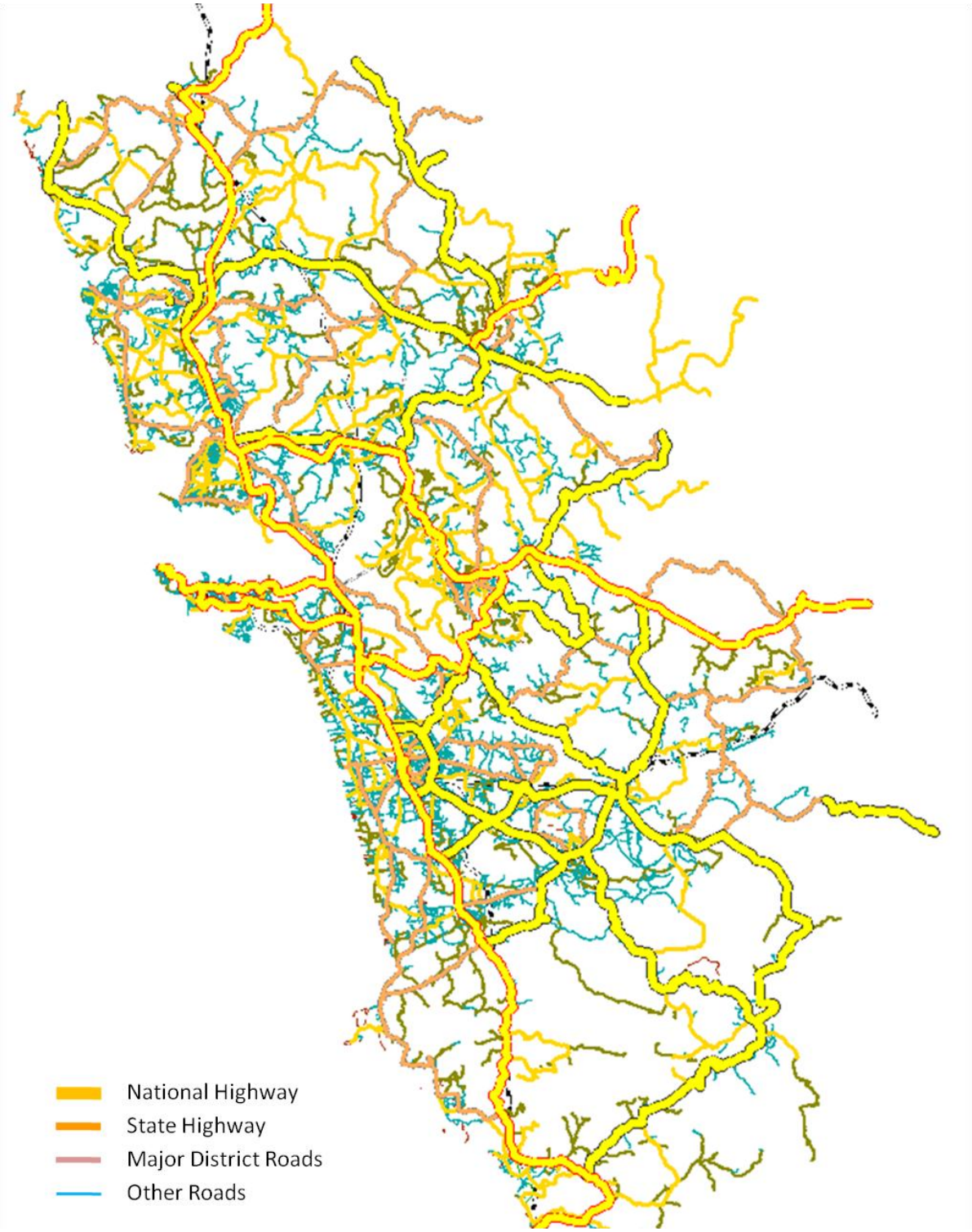


Figure 3.3: Base Year Study Area Road Network – By Category

2. **Transit Network**

The transit network represents the connectivity, headways, speeds and accessibility of transit services. In Goa, majority of buses ply on the main corridors connecting to NH 66 and arterial links within the town. The transit routes are specified as those using the transport links and having stops/stations at determined locations. The access to the stops/stations from zone centroids and other nodes is provided either by existing highway links or by defining exclusive walk links. The distance between the bus stops is generally assumed as 500m in the public transport assignment. In case of Goa, since the development has horizontal spread over large size land parcels, the actual bus stop locations were referred for coding. The transit network for the study area is shown in Figure 3.4.

Currently, about 220 KTC bus routes are operating in Goa. Information on the same was collected and coded in to the system. Fare structure and frequency for each of these services are also included. There are private bus operators running mini-midi buses in side town area. In place limited data available on the private bus operators, consultant has validated the ridership number (Boarding – Alighting numbers) and performed reverse calculations for estimating headways.

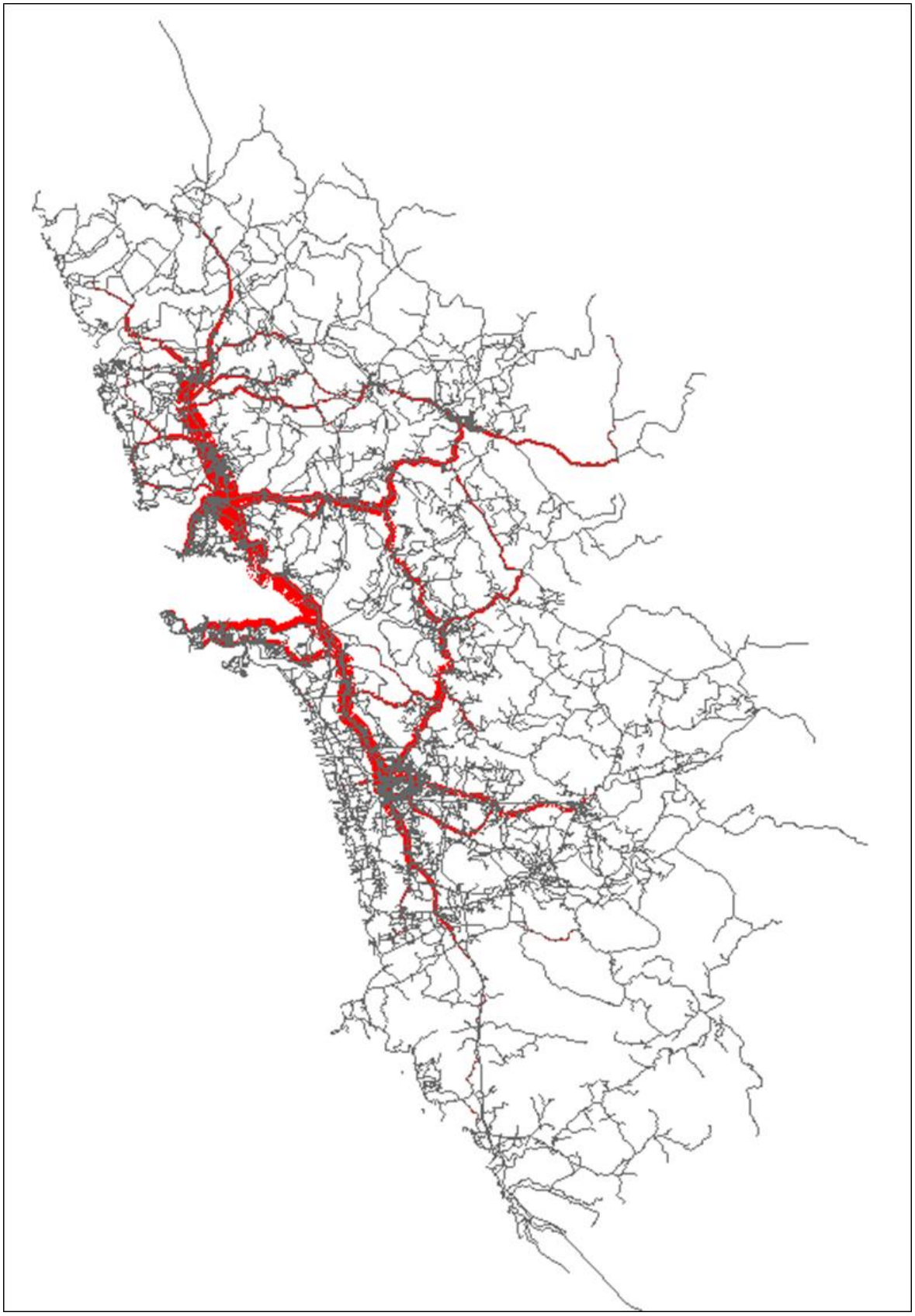


Figure 3.4: Transit Network Maps in the Study Area

3.3.3: Development of Matrices

Household and roadside passenger interview data were used to develop the observed mode-wise trip matrices. The traffic study performed at 8 outer cordon locations and multiple inner cordon and junction count locations. The external trips for the car, two wheeler, auto, public transport and commercial vehicles were constructed based on the O-D survey conducted at the outer cordon.

The mode wise matrices were developed for morning peak hour. From the primary surveys it has been observed that the morning peak is during 9.00 to 10:00. So the model was built for this duration.

Highway Assignment - A user-equilibrium multi-modal assignment procedure based on generalized cost was used for loading matrices in PCU values.

Transit Assignment – The public transport assignment process is a multi-path assignment which enumerates and evaluates the "reasonable" or "attractive" multiple discrete routes between zones, considering number of transfers, non-transit and in vehicle cost, boarding and transfer penalties and fares etc.

3.3.4: Assumptions made for Four Stage Modelling

The reliability of the four stage modelling highly depends on the input parameters given to the model. In other words, the scientific modelling process is based on certain set of inputs arrived either from secondary data or through primary surveys. In case of Goa model, the consultant has identified some data limitations which are described in the Table 3.7.

Table 3.7: Assumptions of Travel Demand Model

Stage	Required Input Parameters	Issues / Data Limitations for Goa Model
Trip Generation	Zone wise Population, income level, vehicle ownership, employment, land use – commercial / industrial zones, tourist trips etc.	The zone wise employment data and information related to tourist accommodation / occupancy was not available. The land use details were available only for limited areas comprising Panaji and Madgaon. The remaining zones excluding these two towns were broadly categorized based on density / settlement but not on the base of land use. In short, the land use details could not be used as a reliable source for modelling task for state.
Trip Distribution	Distance between origin and destination points.	There are selected destination spots for non-home based tourist trips. The detailed information on tourist travel was captured at the inner cordon points. The trip distribution pattern for visitors will be very subjective to their travel plans and changes on daily basis. There is a seasonal impact on tourist trips. Number of trips expected in the month of December and January is higher than June to August.
Mode Choice	Travel cost for public transport modes, income levels to understand value of time, fuel price etc.	The mode selection is based on the utility between various available travel modes. The information on private buses / tourist buses were available with multiple unknown parameters such as routing pattern, fare, ridership details etc.

Considering data limitations and time constraints for completing this assignment, consultant has made assumption (and tried to match with the local travel conditions). The set of assumptions is prescribed in the list below:

- In absence of detailed information on land use, consultant has used land size and location as an additional responsible parameter for trip attraction. This parameter is considered as an independent factor in the regression equation in addition to the employment. The employment details were estimated based on the inputs received from Household Survey.
- From the primary survey information, the base year headway during the peak hour for private bus operators is in the range of 5- 10 min within

urban area. For example, in Panaji, during peak hours, the private operator is plying his buses on the registered route between Panaji bus stand and Miramar with headway of 5 mins.

- There are various ways of handling non home based trips in the traditional modelling process. Since this is a state level model and focused for home based work trips, the consultant has arrived with two options for assignment. The first one have limited tourist trips assigned during non-peak tourist season (June to August) while the other scenario will consider peak season tourist trips (December-January). In both the scenarios, tourist trips will be pre-loaded to the network followed by re-loading of public transport passenger trips and freight vehicle assignment.
- The model is prepared for the state level conditions which is a combination of urban and sub-urban settlement. As a typical example, Goa has very scattered development in the sub-urban part. This will naturally have different travel pattern than the urban settlement. Hence the trip length and mode choice calculations were done separately for urban and sub-urban zones.
- The accuracy of the model is on higher side if we analyze input parameters at mode disaggregate level. For example, if the zone size is smaller, then the information on independent parameter (such as population, land use, employment) will be precisely applicable for that particular zone. This approach can be further refined for cluster level analysis. The zones which have identical or similar functionality (required for trip generation) can be clubbed together to form a cluster. With this as a concept, following 6 types were defined (Table 3.8) and used for trip generation process in this model.

Table 3.8: Zone Categorization for Planning Purpose

Area	Zone Type No / Cluster no	Density Category	Description
Within town / Urban Settlement	1	Urban - High Density	Cluster of zones based on the urban settlement (either residential or commercial or industrial) within town limit / municipal limits.
	2	Urban - Moderate Density	
	3	Urban - Low Density Type	
Outskirts / Next to the town	4	Moderate	These zones are just next to the town limits which have immediate potential for development after saturation of zones inside respective town.
Area between Forest land and Outskirts of town	5	Low	This cluster is a group of zones which have very scattered development and low density. This can include agriculture land and areas away from the town excluding forest zone.
Forest Area	6	Very low	These zones have negligible role both for trip production and attraction. The area is reserved as a forest land.

The information explained in the table above was mapped and presented in the Figure 3.5.

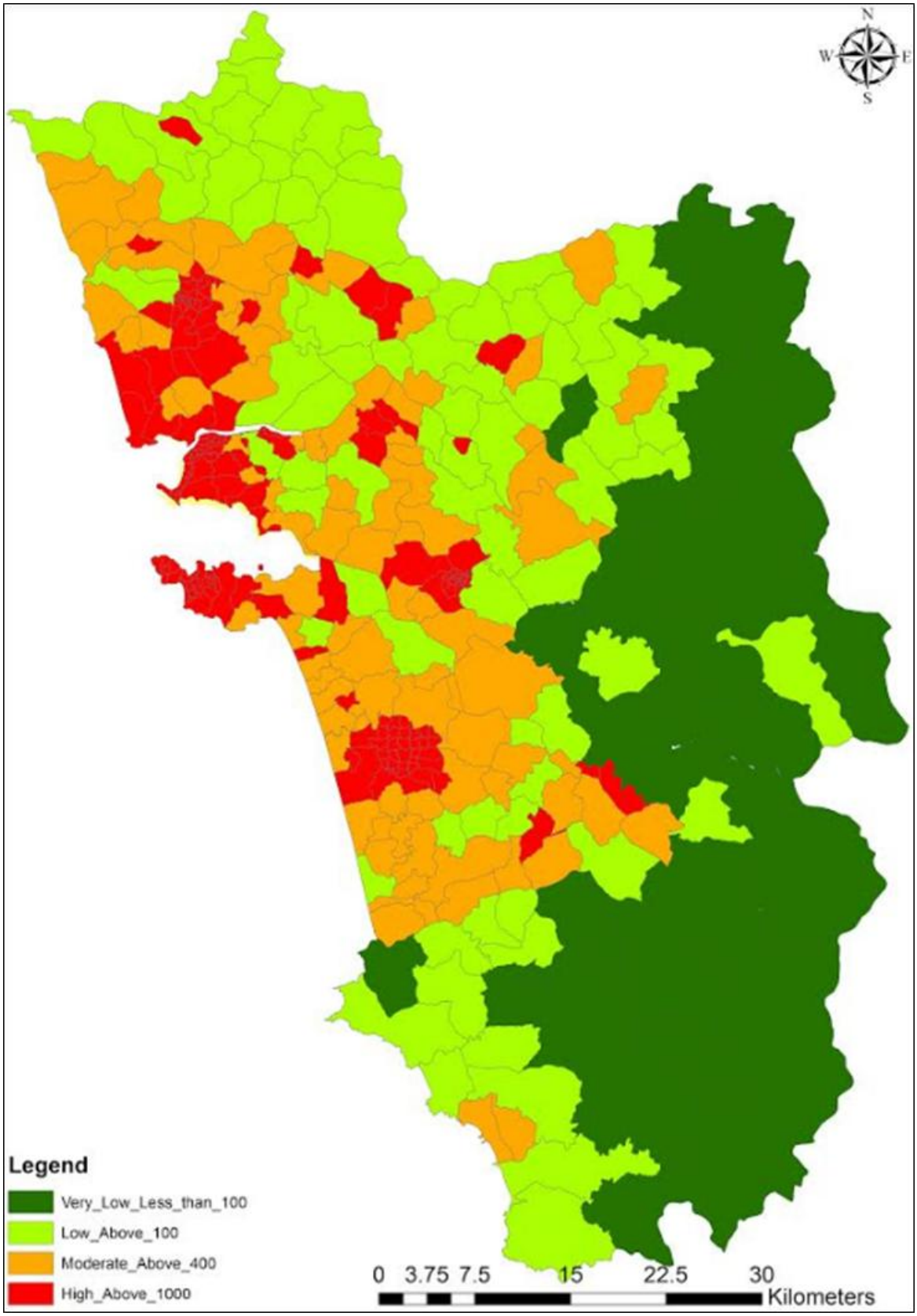


Figure 3.5: Zone Categorization map

3.4: Calibration & Validation of 4 Stage Model

3.4.1: Trip Generation

Journey is an out way movement from a point of origin to a point of destination, whereas the word "trip" denotes an outward and return journey. If either origin or destination of a trip is the home of the trip maker then such trips are called home based trips and the rest of the trips are called non home based trips. Trip production is defined as all the trips of home based or as the origin of the non-home based trips. Trips can be classified by trip purpose, trip time of the day, and by person type. Trip generation models are found to be accurate if separate models are used based on trip purpose/land use density. Trip Generation: Trip end models were calibrated by relating the trip produced from and attracted to the zones with the Land use. The base year population and employment for the study area are presented in Table 3.9.

Table 3.9: Population and Employment – 2018

Sub area	Population	Employment
Goa State	1460000	466000

The calibrated trip end models for the peak hour are presented Table 3.10.

Table 3.10: Trip End Model

Cluster Type	Cluster Number	Production Factor			Attraction Factor			
		Multiplier	constant	R Sq Value	Multiplier 1	Multiplier 1	constant	R Sq Value
Urban - High Density 1	1	0.61	915	0.534	0.000541	-0.006718	1268	0.69
Urban - High Density 2	2	0.61	895	0.62	0.029443	-0.426723	5708	0.62
Urban - Moderate Density	3	4.3	-800	0.65	0.015318	-0.738573	260	0.57
Urban - Low	4	0.6	915	0.54	0.000541	-0.006718	1268	0.69
Moderate	5	0.3605	6	0.84	0.002238	0.114217	47	0.84
Low	6	0.21	170	0.81	0.000	0.009	224	0.6

		02			792	335		
Very low	7	0.29 87	-378	0.95	0.002 138	- 0.015 135	-145	0.98

Comparison of the modelled production-attraction with the observed production-attraction is shown in following tables: It is observed from the figures that the observed and modelled values are close when R Square value is greater than or equal to 0.7. The Other trips produced and attracted for different purposes like Social, Health, Recreational, Shopping etc. It is difficult to model this complexity in travel behaviour.

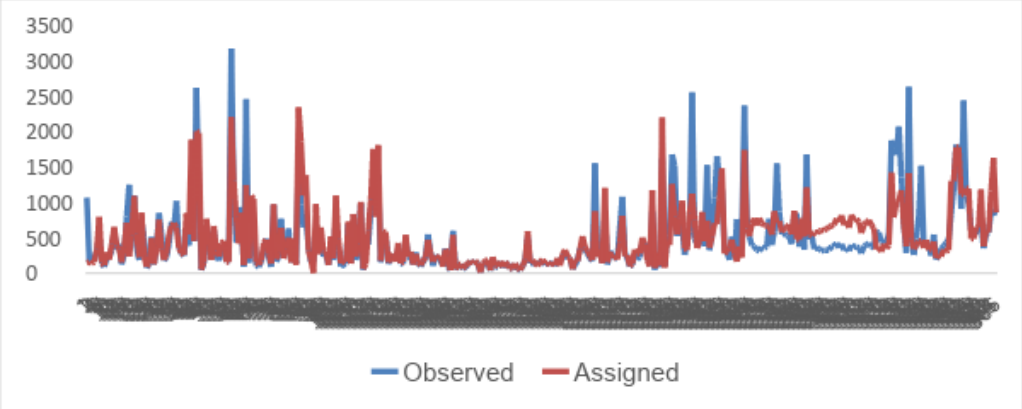


Figure 3.6: Trip Production Comparison

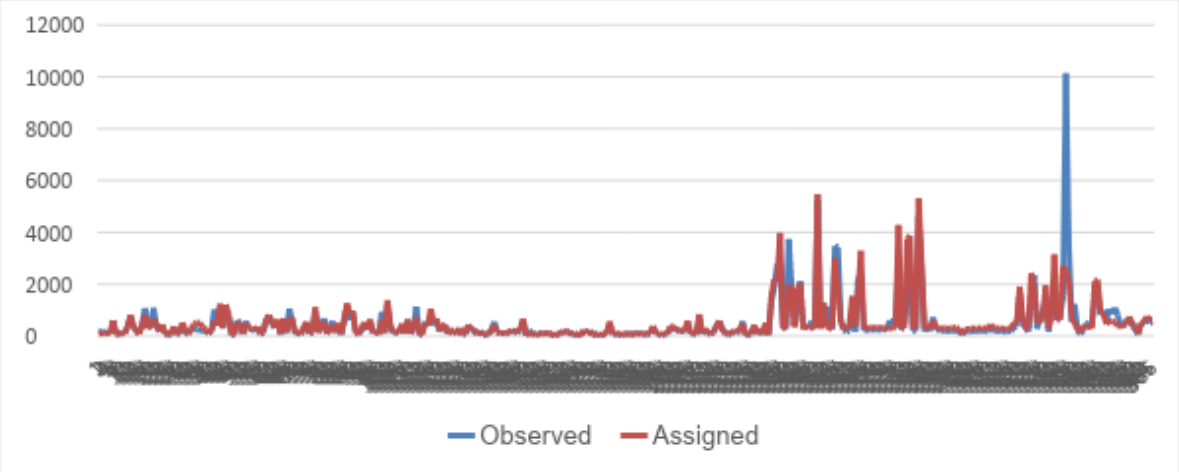


Figure 3.7: Trip Attraction Comparison

3.4.2: Trip Distribution

The decision to travel for a given purpose is called trip generation. These generated trips from each zone are generally distributed to all other zones

based on the choice of destination. This is called trip distribution which forms the second stage of travel demand modelling.

Trip distribution procedures determine where the trips produced in each zone will go and how they will be divided among all other zones in the study area. The output is a set of tables that show the travel flow between each pair of zones.

The decision on where to go is represented by comparing the relative attractiveness and accessibility of all zones in the area -- a person is more likely to travel to a nearby zone with a high level of activity than to a distant zone with a low level of activity. There are several types of trip distribution analyses: the Fratar method, the intervening opportunity model and the gravity model. In this text, we will discuss only the gravity model, because it is the most widely used method.

Gravity model was used to estimate the trip distribution parameters. To arrive at this, different distribution functions like Gamma, Inverse and Exponential functions were tested to fit the data from survey. Gamma function gave the best fit when compared against the observed data. The Gamma function formulation is as below:

f〖(d〗_ij)=a〖*d_ij〗^b 〖*e〗^(c〖(d〗_ij))

Where,
dij: distance in shortest path from zone i to j.
a,b,c : calibrated parameters
The calibrated gravity model parameters for each purpose are shown in the Table 3.11.

Table 3.11: Calibrated Gravity Model Parameters

Parameters	Total Trips
a	2.28509707
b	-1.7361332
c	-0.0337513

The base year (2018) Productions and Attractions obtained from the corrected O-D matrices, skim matrices from network and the calibrated Gamma function parameters were used to generate purpose wise synthetic matrices in VISUM.

The Trip length distributions from Observed/Corrected and Synthetic O-D matrices were calculated and the comparison graph is shown in Figure 3.8. The average trip lengths obtained from the model are presented in the following table.

Table 3.12: Modelled Average Trip Lengths-2018

	Average Trip Lengths in KMs (for Passenger Trips)					
Mode	Regional Level	Panjim	Vasco	Margaon	Ponda	Mapusa
2W	8.86	1.98	1.68	2.07	0.96	1.25
Auto	9.94	2.01	1.76	2.09	0.81	1.39
Car	11.91	2.04	1.72	2.08	0.97	1.47
Bus	14.61	2.66	2.11	2.32	1.01	1.56

3.4.3: Mode Choice

The modal split for person Trips (all purposes for motorized modes) as observed in the base year (2018) is shown in following table. The share of private transport is more than 87%. The relatively high share of private modes is not a desirable mode share from emissions point of view. The absence of organized public transport coupled with consumers' purchasing power, is leading to increase in the number of two-wheeler and car users.

Table 3.13: Observed Mode share

Mode	Observed Mode share
2W	59.09%
3W	6.86%
4W	22.65%
BUS	11.40%
Total	100.00%

1. Utility Theory:

Virtually all mode choice models for predicting individuals' choices are based on a behavioural principle called "utility maximization." This principle and its relation to choice can be stated in words very simply. According to the utility maximization principle, there is a mathematical function U, called a utility function, whose numerical value depends on attributes of the available options and the individual. The utility function has the property that its value for one option exceeds its value for another if and only if the individual prefers the first option to the second. Thus, the ranking of the available options according to the individual's preferences and the ranking according to the values of the utility function are the same. The individual chooses the most preferred option, which is the one with the highest utility-function value.

The utility maximization principle can be stated mathematically as follows:-

• Let C denote the set of options available to an individual (e.g., car, auto and bus in the case of mode choice). C is called the choice set.
• For each option i in C, let Xi denote the attributes of i for the individual in question. For example, if i correspond to car, Xi denotes the travel time, travel cost, and other relevant attributes of car mode for the individual in question.
• Let S denote the attributes of the individual that are relevant to preferences among the options in C (e.g. income, etc.).
Then, according to the utility maximization principle, there is a function U (the utility function) of the attributes of options and individuals that

describes individuals' preferences. U has the property that for any two options i and j in C.

$U(X, S) > U(X, S)$

$i \qquad j$

Utility is an indicator that an individual decision maker will give to an alternative mode. Utility for an alternative mode is generally derived from the attributes of the alternative mode. It is assumed that the decision maker will choose an alternative whose utility value is greater than the utilities of other alternatives.

Utility of an alternative is a function of its attributes. Suppose in a set of alternatives 'C' an individual will only choose the alternative 'i', if and only if Ui is greater than the utilities of all other alternatives 'j'.

$U(Xi) > U(Xj)$, for all $j \varepsilon C$

Where C is as set of 'j' alternatives and Xi , Xj are vectors of attributes describing alternatives i and j respectively.

The utility equation consists of two components: –

• Deterministic portion, which is observable utility portion that can be estimated and;

• The error portion, which is unknown.

This error portion is the sum of the errors from many sources like imperfect information, measurement errors, omission of modal attributes, and errors in the utility function. The final utility equation is represented as follows.

$U(Xi) = V(Xi) + E(Xi)$

Where U (Xi) Total utility of the alternative

V (Xi) Deterministic or observable portion of the utility estimated

E (Xi) Error portion of the utility function unknown to estimate

Based on the utility theory, the decision maker chooses an alternative mode what suits him the best.., i.e. where U of the mode selected is greater than other modes. The following example illustrates the use of the utility maximization principle in mode choice analysis.

2. MNL model for Goa

The Revealed Preference (RP) data (from Household survey) captures observed or reported actual behaviour. On the basis of Household surveys, 14780 choice set data points were collected. The results of calibrated Multi Nomial Logit Model (MNL) are shown in the following table.

Table3.14: MNL results from Goa Households surveys (2018)

MNL Results	
Parameter	Estimate
Log (Generalized Cost- two wheeler)	-40.04%
Constant (two wheeler)	119.26%
Log (Generalized Cost-Auto)	-40.04%
Constant (Auto)	-22.14%

The Generalized cost for each mode is calculated as follows:

Generalized Cost = (Value of Time* Travel time) + Travel Cost

Travel time is the Perceived Journey time experienced by the passenger estimated as follows:

Perceived Journey Time = k1 * In vehicle Travel Time + k2 * Access Time + k3* Wait Time + k4* Transfer wait time + k5*Egress time +10 min*No. of transfers,where

k1= In vehicle travel time factor

k2= Access time factor

k3= Wait time factor

k4= Transfer Wait time factor

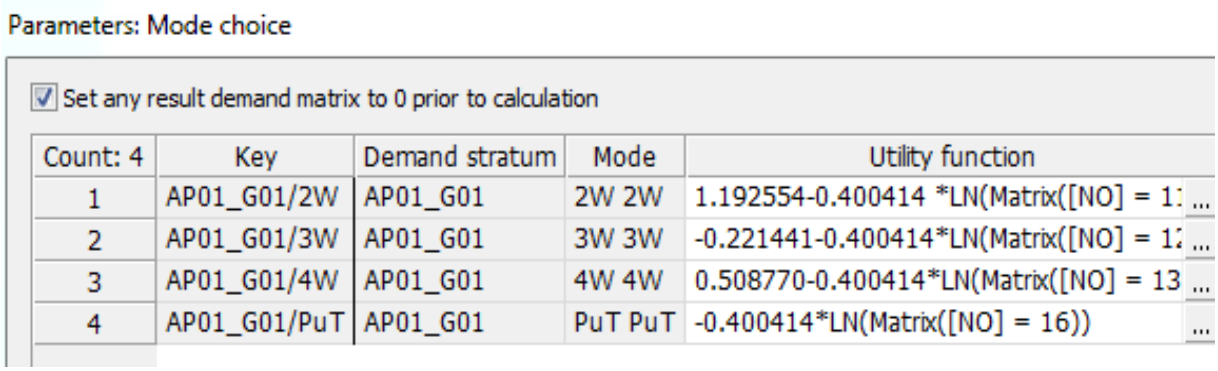
k5= Egress time factor

The following are the assumptions regarding generalized cost calculations for each mode.

Table 3.15: Assumptions for Travel Cost Calculation

Mode	Cost	Remarks	k1	k2	k3	k4	k5
Two Wheeler	Rs 1.5 per KM	Cost of Petrol = RS 60/ltr and Mileage = 40 KMPL	1	0	0	0	0
IPT	As per prevailing fare (20 Rs per km)		1	0	0	0	0
Car	Rs 5 per KM	Cost of Petrol = RS 60/ltr and Mileage = 12 KMPL	1	0	0	0	0
Bus	As per prevailing fare	Based on fare tables provided by govt agencies	1	1	1	1	1

VISUM Model Screenshot for Mode Choice Parameters:



Based on the calibrated MNL models, the aggregate modal shares are estimated and the following table gives the comparison of aggregate observed and modelled modal shares.

Table 3.16: Mode Choice Validation

Mode	Observed Mode share	Modelled Mode share
2W	59.09%	59.62%
3W	6.86%	6.62%
4W	22.65%	21.94%
BUS	11.40%	11.82%
Total	100.00%	100.00%

3.4.4: Trip Assignment

Trip (Traffic) assignment is the process of allocating a given set of trip interchanges to a specific transportation system and is generally used to estimate the volume of travel on various links of the system to simulate present conditions.

The process requires as input a complete description of existing transportation system, and a matrix of inter-zonal trip movements. The output of the process is an estimate of the trips on each link of the transportation system. The model is validated as explained in further sections through GEH statistic.

The purposes of trip assignment are broadly explained as follows:

- To evaluate the effects of limited improvements and extensions to the existing transportation system by assigning estimated future trips to the network.
- To test alternative transportation system proposals by systematic and readily acceptable procedures.
- To provide design hour volumes and turning movements.

The corrected peak hour mode wise demand matrices were assigned on to the supply road network. The volumes to capacity (v/c) ratios close to 0.9 indicate that the operating conditions are close to capacity which is not desirable. V/c ratios between 0.71 and 0.8 indicate that there is less freedom to manoeuvre and high density of traffic volume.

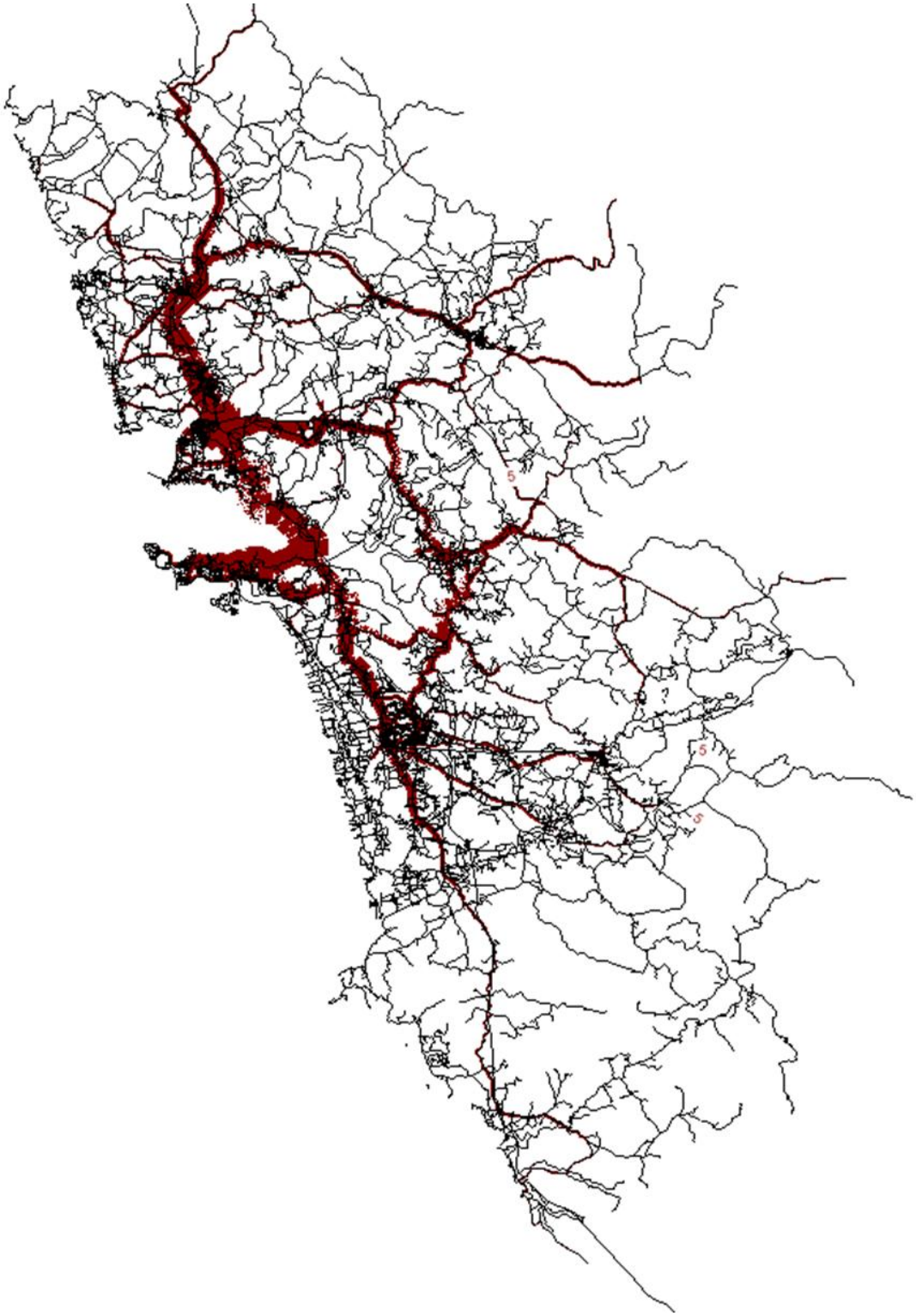


Figure 3.8: Base Year Traffic flow map

3.4.5: Validation (GEH)

The observed highway and public transport matrices were assigned on the network and the assigned traffic volume has been compared with the observed traffic counts on screen lines, inner cordon, outer cordons and at

intersections. The validation is carried both for midblock movements as well as at for the turning volumes. Validation results are given in Table 3.17.

Table 3.17: Base Year Observed OD Validation on Outer Cordon / Inner Cordon and Screen Line

	2W		3W		4W		Bus		Goods	
	Link	Turn	Link	Turn	Link	Turn	Link	Turn	Link	Turn
<5%	63%	67%	63%	90%	72%	74%	67%	73%	74%	78%
>10%	4%	9%	3%	0%	7%	4%	3%	0%	2%	1%

The base year trip matrices have been developed using the data compiled from household surveys, terminal surveys and roadside interview survey. Mode wise peak hour matrices were extracted and expanded from these surveys. The corresponding mode wise matrices are added to get a combined matrix that represents the trip movements for entire Udaipur control area. Each mode wise matrix consists of movements between Internal zones to Internal zones (I-I), Internal to External zones (E-I & I-E) and External movements (E-E). From the household survey, it is observed that, out of the total one-way trips, 20.4% move in the common peak hour (09:00 to 10:00 hrs). These prior matrices thus derived from household, terminal and outer cordon surveys have been calibrated to the counts observed on links and turns using the T-Flow Fuzzy process available in VISUM. This process has been explained below.

- **TFlow Fuzzy Matrix Correction**

TFlow Fuzzy is procedure developed based on Fuzzy logic techniques and made available in VISUM to correct an O-D matrix based on a comparison of counted volumes and assignment volumes. It is possible to run TFlow Fuzzy with any combination of counts on links, turns and O-D traffic for zones. The basic idea behind this procedure is best illustrated with Figure 3.9.

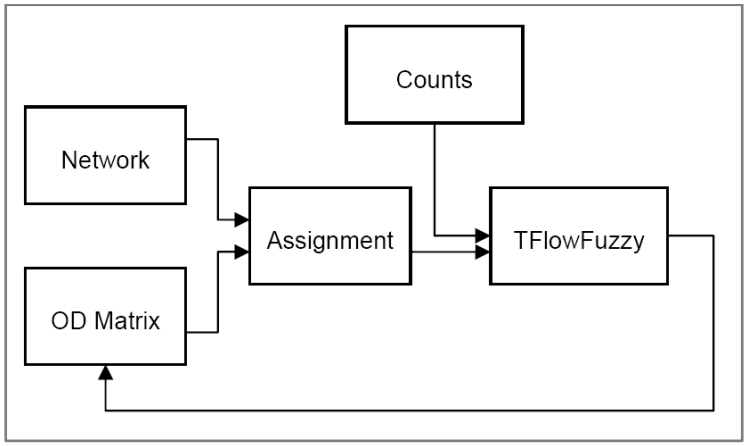


Figure 3.9: TFlow Fuzzy Matrix Correction Methodology Flow Chart

TFlow Fuzzy is an iterative exercise where the corrected matrices in the first iteration is assigned again after relevant network corrections until a satisfactory GEH is achieved, i.e. a calibrated-validated model. Generally, GEH Statistic, an empirically derived statistical relationship, is used to compare two sets of traffic volumes. The formula of GEH Statistic is as follows:

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

Where,

'M' is the hourly traffic volume from the traffic model and

'C' is the real-world hourly traffic count

The peak hour calibrated matrices obtained from TFlow Fuzzy method are assigned on to the road network. The assigned and counted traffic volumes are compared.

The use of GEH as an acceptance criterion is recognized in the UK Highways Agency's Design Manual for Roads & Bridges (DMRB). It is desired that, 85% of the volumes in a traffic model should have a GEH less than 5.0 and 5% of the volumes with GEH greater than 10. Table 3.18 gives the GEH statistic value for different modes in Goa state.

Table 3.18: GEH statistic for Goa

Mode	Comparison	GEH<5%	GEH>10%
2W	Link Volumes	60%	18%
	Turn Volumes	43%	35%
3W	Link Volumes	86%	0%
	Turn Volumes	93%	0%
4W	Link Volumes	70%	13%
	Turn Volumes	57%	20%
Other Buses	Link Volumes	64%	5%
	Turn Volumes	67%	0%
Goods	Link Volumes	69%	3%
	Turn Volumes	74%	1%
Public Transport	Boarding	65%	15%
	Alighting	52%	24%

3.4.6: Base Year Travel Characteristics

Figure 3.10: Desire line –Base year

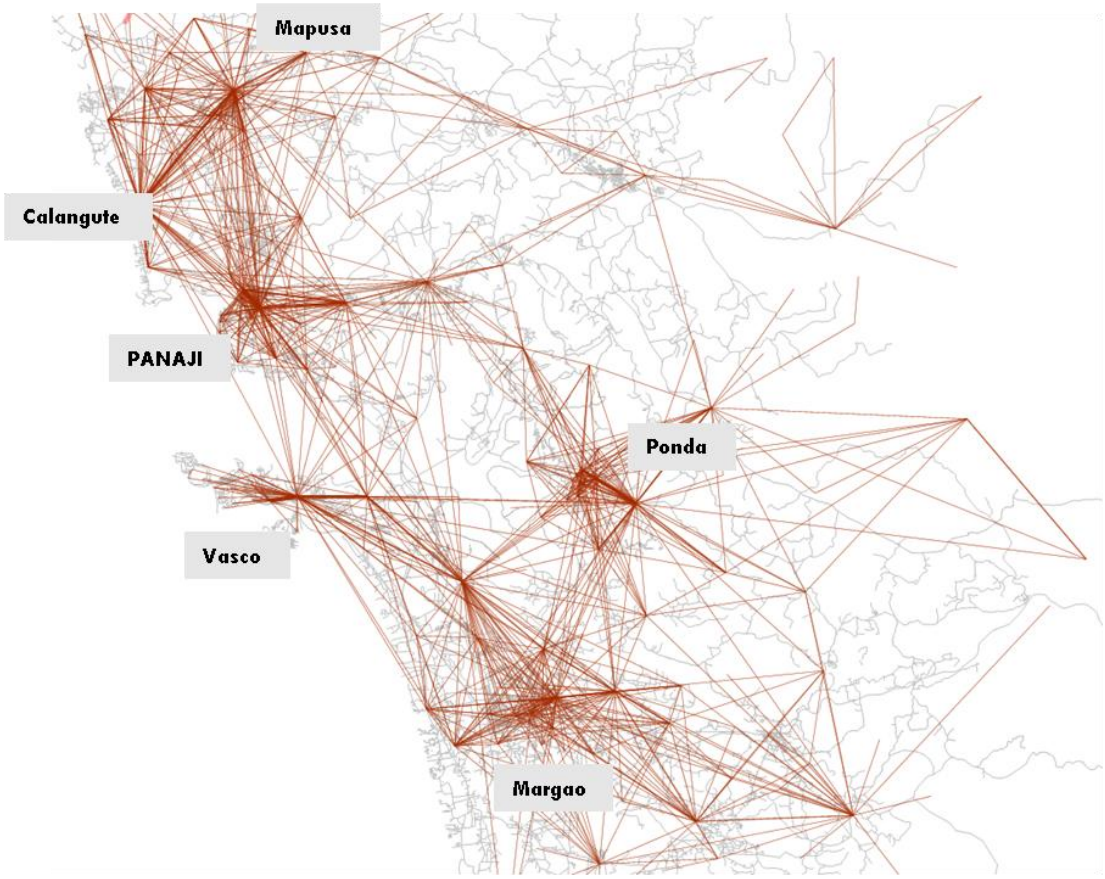


Figure 3.11: Desire line -Base Year for major Towns in Goa State

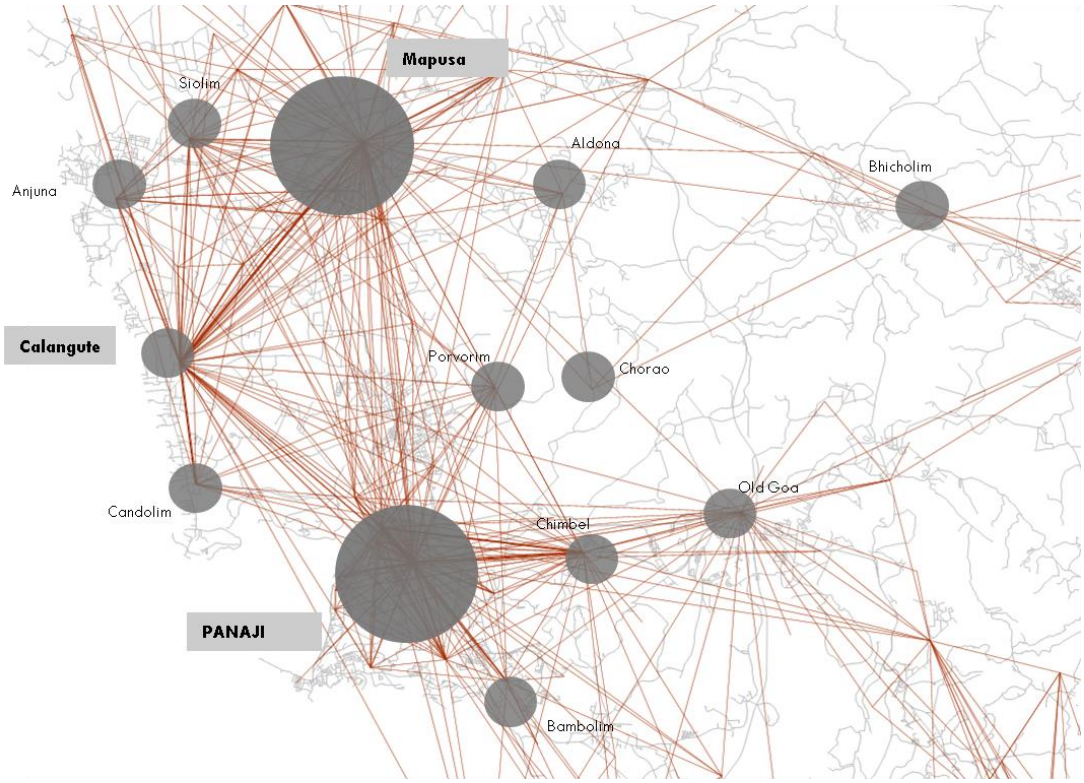


Figure 3.12 : Desire line- Base Year for Major Areas in North Goa

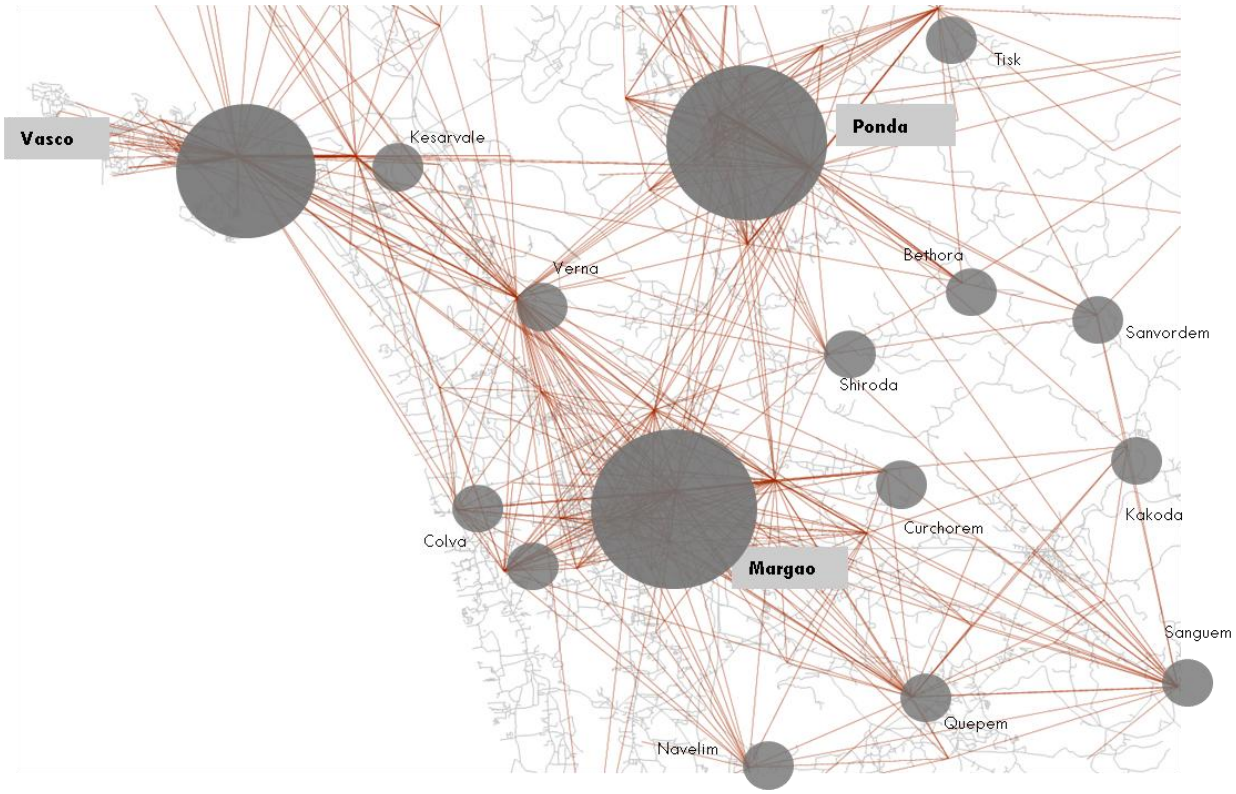


Figure 3.13: Desire Line -Base Year for Major Areas in South Goa

The traffic characteristics of the study area in terms of mode share are given in Table 3.19.

Table 3.19: Base year Travel Characteristics

Passenger Trips	Base Year (2018)	
	Trips (No.)	Percentage
Two Wheeler	109316	59.62%
Auto Rickshaw	12128	6.62%
Car / Taxis	40228	21.94%
Public Transport (Bus and Ferry)	21668	11.82%
Total Trips	183341	100%

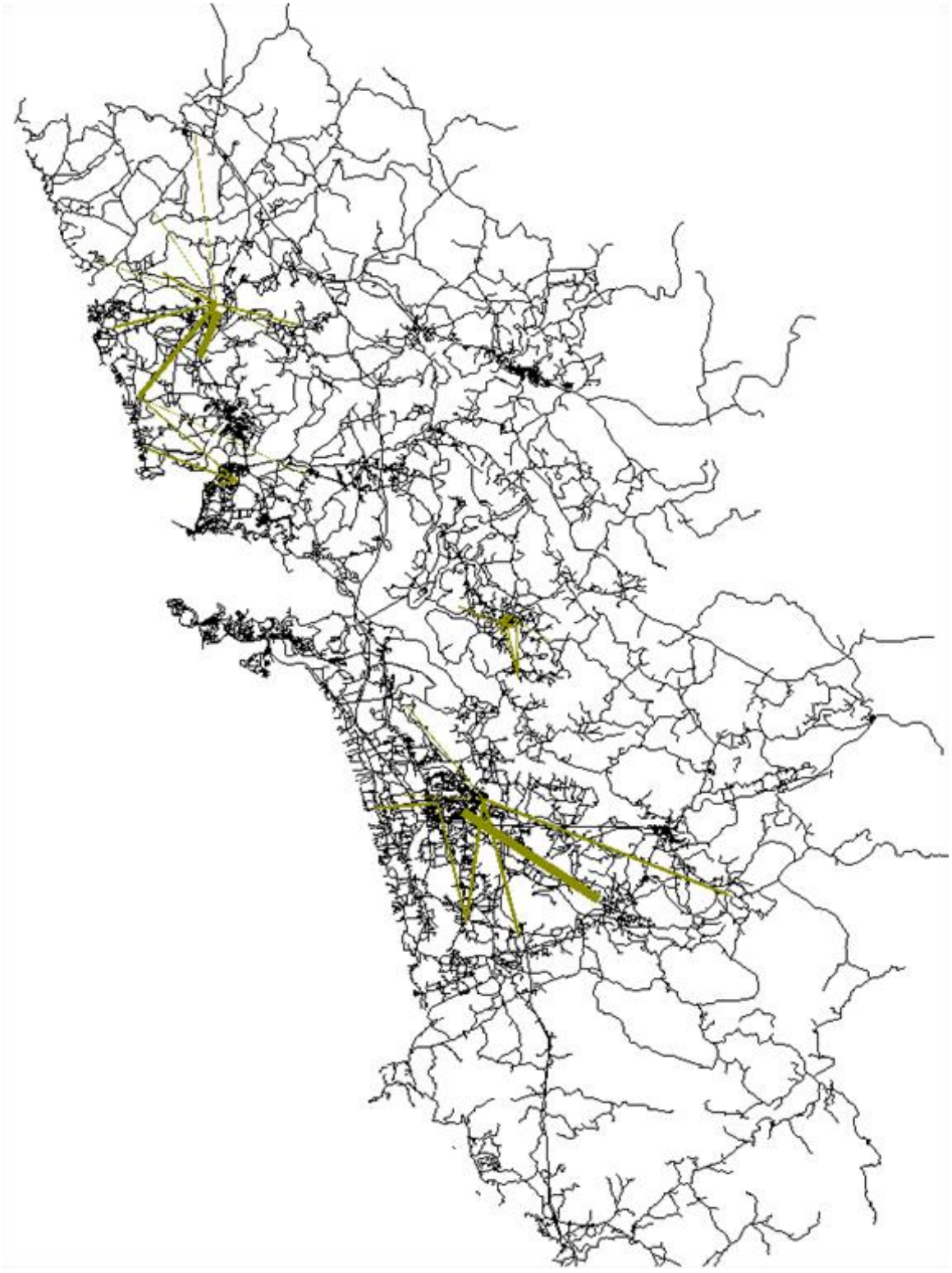


Figure 3.14 : Desire Line -Base Year Trips for Light Commercial Vehicles

The volume to capacity ratios for the major roads, are presented in Table 3.20.

Table 3.20: Base Year (2018) Transport Characteristics on Major roads

Sl no	Name of the Road	V/C Ratio	
		Maximum	Average
1	Vasco Market to NH 66 Road	0.7	0.55
2	Vasco Airport to NH 66 Road	0.6	0.53
3	NH 66 Panjim Bridge	1.4	0.84
4	Panjim Bus Stand to Miramar	1.95	0.8
5	Mapusa Market Road	0.55	0.35
6	Mapusa Municipal Council Road	0.7	0.4
7	Ponda Bus Stand Road	0.9	0.68
8	Ponda Market Road	0.5	0.3
9	Arlem – Margaon Bypass (Outer Road)	0.9	0.55
10	Mapusa Court Road	0.85	0.42

3.4.7: Travel Demand Forecast

The strategic Urban Travel Demand Model developed above has been used to predict travel patterns and modal shares in the horizon year i.e. 2038 under respective land-use and transport network scenarios.

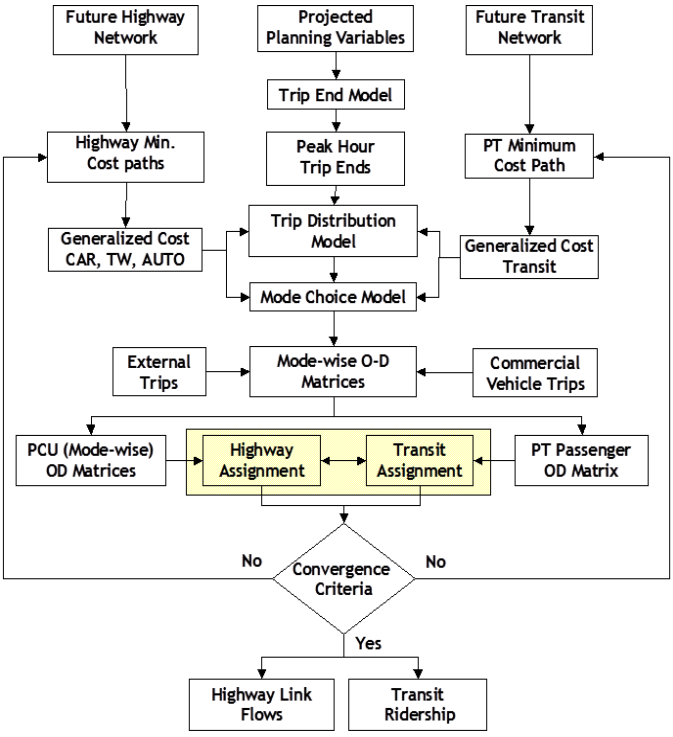


Figure 3.15: Methodology for Travel Demand Forecast

Trip End models have been used to predict the number of trips generated from and attracted to each of the zones in the study area. Projected trip ends along with the network options in the future were provided as inputs to the distribution and modal split models to arrive at future trip matrices for Car, Two Wheeler, Auto Rickshaws and Public Transport. The methodology for travel demand forecast in the study area is presented in the Figure 3.15.

3.4.8: Scenario Development for Horizon Year

As a part of this scientific study, it was essential to analyse impact of traffic growth in absence of any kind of infrastructure development in infrastructure. For example, if we compare any particular road, say NH 66 connecting South and North region in Goa; the base year traffic condition will not remain same after 10 or 20 years horizon period. In absence of any the infrastructure (supply side) improvement of NH 66, the road network performance will degrade. Probably it will create more congestion and bottlenecks at certain locations.

Table 3.21: Comparison of Do-Nothing Scenario for Base and Horizon Years

No of Passenger Trips (Pk Hr)							
	Mode	Regional Level	Panjim	Vasco	Margaon	Ponda	Mapusa
2018	2W	109316	11798	4335	8086	5270	6367
	Auto	12129	1306	461	894	571	697
	Car	40228	4335	1555	2971	1912	2328
	Bus	21669	2054	718	1507	857	1119
	Total	183342	19493	7069	13458	8611	10511
2038	2W	135930	12939	4600	8733	5778	6904
	Auto	13128	1229	406	829	530	658
	Car	51877	4905	1690	3311	2159	2619
	Bus	20272	1710	567	1221	735	965
	Total	221207	20783	7262	14094	9201	11146

Table 3.22: Comparison of V/C Do-Nothing (2018 and 2038) Transport Characteristics on Major roads

Sl no	Name of the Road	V/C Ratio 2018		V/C Ratio 2038	
		Maximum	Average	Maximum	Average
1	Vasco Market to NH 66 Road	0.7	0.55	1.6	0.85
2	Vasco Airport to NH 66 Road	0.6	0.53	1.25	0.81
3	NH 66 Panjim Bridge	1.4	0.84	2.05	1.24
4	Panjim Bus Stand to Miramar	1.95	0.8	2.25	0.98
5	Mapusa Market Road	0.55	0.35	0.9	0.52
6	Mapusa Municipal Council Road	0.7	0.4	1.15	0.6
7	Ponda Bus Stand Road	0.9	0.68	1.45	0.85
8	Ponda Market Road	0.5	0.3	0.95	0.45
9	Arlem – Margaon Bypass (Outer Road)	0.9	0.55	1.2	0.65
10	Mapusa Court Road	0.85	0.42	1.05	0.48

- **Development of Do-Something Scenario for Horizon Years**

As a part of planning procedure, civic or state bodies undertake different projects to improve the supply of physical infrastructure. This includes but not limited to addition of roads, bridges, flyovers, rail over bridges etc. The implementation of such civil projects will add additional capacity.

Amongst the major roadway works undertaken by the PWD, the two prominent works along the National Highways include the roadway networks forming the spine of the State connecting the North –South (NH-17) and East –West (NH-4A, NH-17 A and NH-17 B).

Currently, these corridors cut across major cities like Margao, Ponda, Mapusa, etc. The proposed corridors act as bypass to the through traffic thus reducing the conflicts within the city centres. The roadway segments are currently of two lane width and are proposed to be either 4 lanes or 6 lanes depending upon the type of super structure proposed. These projects are identified and coded in the model to examine their impact on network capacity.

Table 3.23: List of Proposed Road Infrastructure Projects (PWD) in Goa

Location	Length (Kms)	Existing Lanes	Proposed lane details
NH-17: Maharashtra - Pernem - Mapusa - Panaji - Cortalim - Verna - Margao - Cuncolim - Chaudi - Polem - Karnataka	135.96	2	(i) Surface Road: 4 Lanes (45 m) (ii) PUP/ LVUP/VUP/Flyover: 6 Lanes: 45m - 60 m PROW (iii) Elevated Corridor in Urban Area- 4/6 Lanes 30m
NH-4A: Karnataka - Darbandora - Ponda - Bhoma - Banastari - Panaji	69.55	2	(i) Surface Road: 4 Lanes (45 m) (ii) PUP/ LVUP/VUP/Flyover: 6 Lanes: 45m - 60 m PROW (iii) Elevated Corridor in Urban Area- 4/6 Lanes 30m
National Highway 17 A: Cortalim (Kortali) - Sancoale - Chicalim - Murmugao	16.45	2	(i) Surface Road: 4 Lanes (45 m) (ii) PUP/ LVUP/VUP/Flyover: 6 Lanes: 45m - 60 m PROW (iii) Elevated Corridor in Urban Area- 4/6 Lanes 30m
National Highway 17 B: Ponda - Verna - Vasco de Gama	38.45	2	(i) Surface Road: 4 Lanes (45 m) (ii) PUP/ LVUP/VUP/Flyover: 6 Lanes: 45m - 60 m PROW (iii) Elevated Corridor in Urban Area- 4/6 Lanes 30m.

The comparison of Do Something with Do- Nothing Scenario is presented in the Table 3.24 below.

Table 3.24: Comparison of Do-Nothing and Do-something Scenario for Base and Horizon Years

Passenger Trips	2018		2028		2038	
	Do Nothing		Do Something		Do Something	
2W	109608	59.78%	118470	60.43%	136534	61.54%
Auto	12058	6.58%	12722	6.49%	12958	5.90%
Car	40137	21.89%	46716	23.83%	51753	23.43%
Bus	21538	11.75%	18132	9.25%	19960	9.13%
Total Trips	183341	100%	196040	100%	221205	100%

- **Development of Sustainable Mobility for Horizon Years**

The mobility plan has a focus on improving mobility of people rather than vehicles. The aim is to satisfy travel demand in efficient way with minimum

impact on environment. Naturally, the system with higher capacity and lower emission per traveller will be the preference. With the present and proposed settlement pattern, most of the Eastern part of Goa is reserved as a forest land, while the remaining portion is connected by a strong spine – NH 66. The corridor is also identified with higher PPHPD both in base and horizon year. This demands the strengthening of South – North connectivity by augmenting additional fleet in Goa. The connectivity will also strengthen linkage with proposed new airport at Mopa.

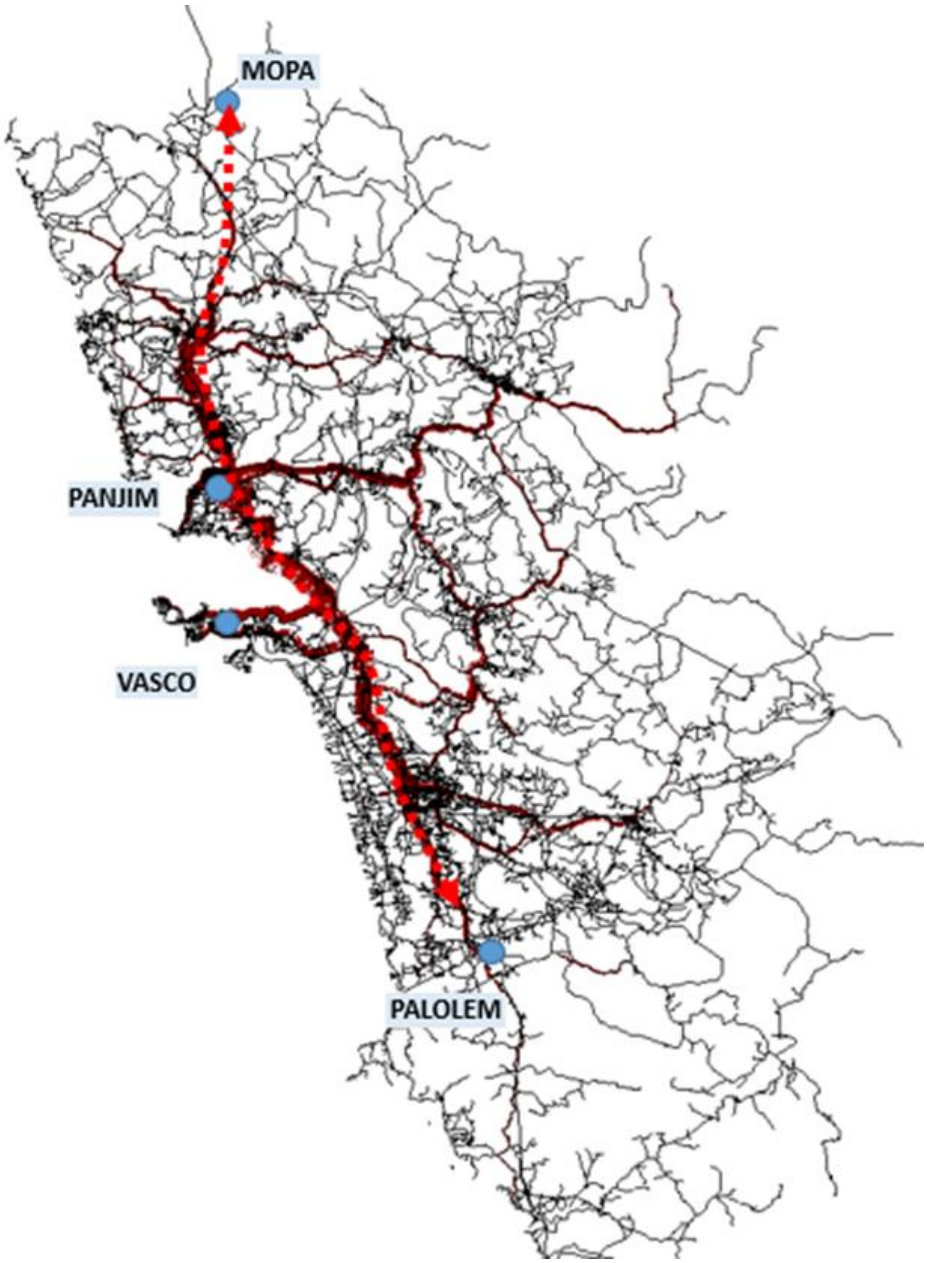


Figure 3.16: Sustainable Mobility for Goa

Table 3.25: Fleet Augmentation Plan -Goa

No	Content	Details
1	Mopa to Palolem Distance (kms)	107
2	Travel time in min at speed of 25 km/hr	214
3	No of fleet required with 2 min headway (electric buses) in 2028	224
4	No of fleet required with 1 min headway (electric buses) in 2038	448

The comparison of Sustainable Scenario with Do- Nothing Scenario is presented in the Table 3.26 below:

Table 3.26: Comparison of Do-Nothing and Sustainable Scenario for Base and Horizon Years

No of Passenger Trips (Pk Hr)							
	Mode	Regional Level	Panjim	Vasco	Margaon	Ponda	Mapusa
2018 (Do Nothing)	2W	109316	11798	4335	8086	5270	6367
	Auto	12129	1306	461	894	571	697
	Car	40228	4335	1555	2971	1912	2328
	Bus	21669	2054	718	1507	857	1119
	Total	183342	19493	7069	13458	8611	10511
2038 (Do Nothing)	2W	135930	12939	4600	8733	5778	6904
	Auto	13128	1229	406	829	530	658
	Car	51877	4905	1690	3311	2159	2619
	Bus	20272	1710	567	1221	735	965
	Total	221207	20783	7262	14094	9201	11146
2038 (Sustainable)	2W	129628	12474	4442	8435	5594	6702
	Auto	12383	1181	391	801	513	634
	Car	49284	4723	1631	3199	2089	2536
	Bus	29912	2400	793	1691	994	1324
	Total	221207	20778	7256	14126	9189	11196

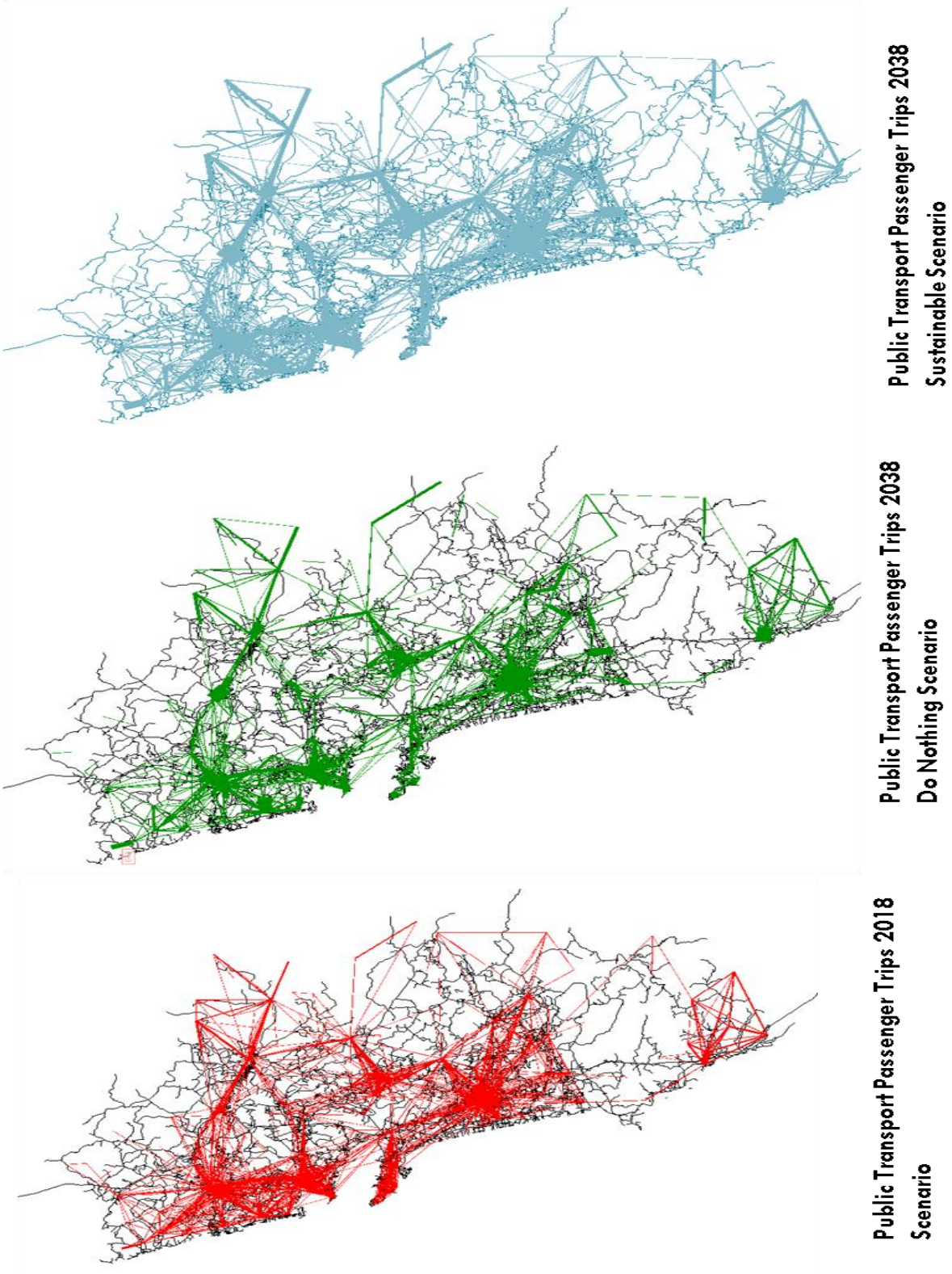


Figure 3.17: Comparison of Public Transport Passenger Trips Scenarios of Base Year, Do Nothing 2038 and Sustainable Scenario 2038

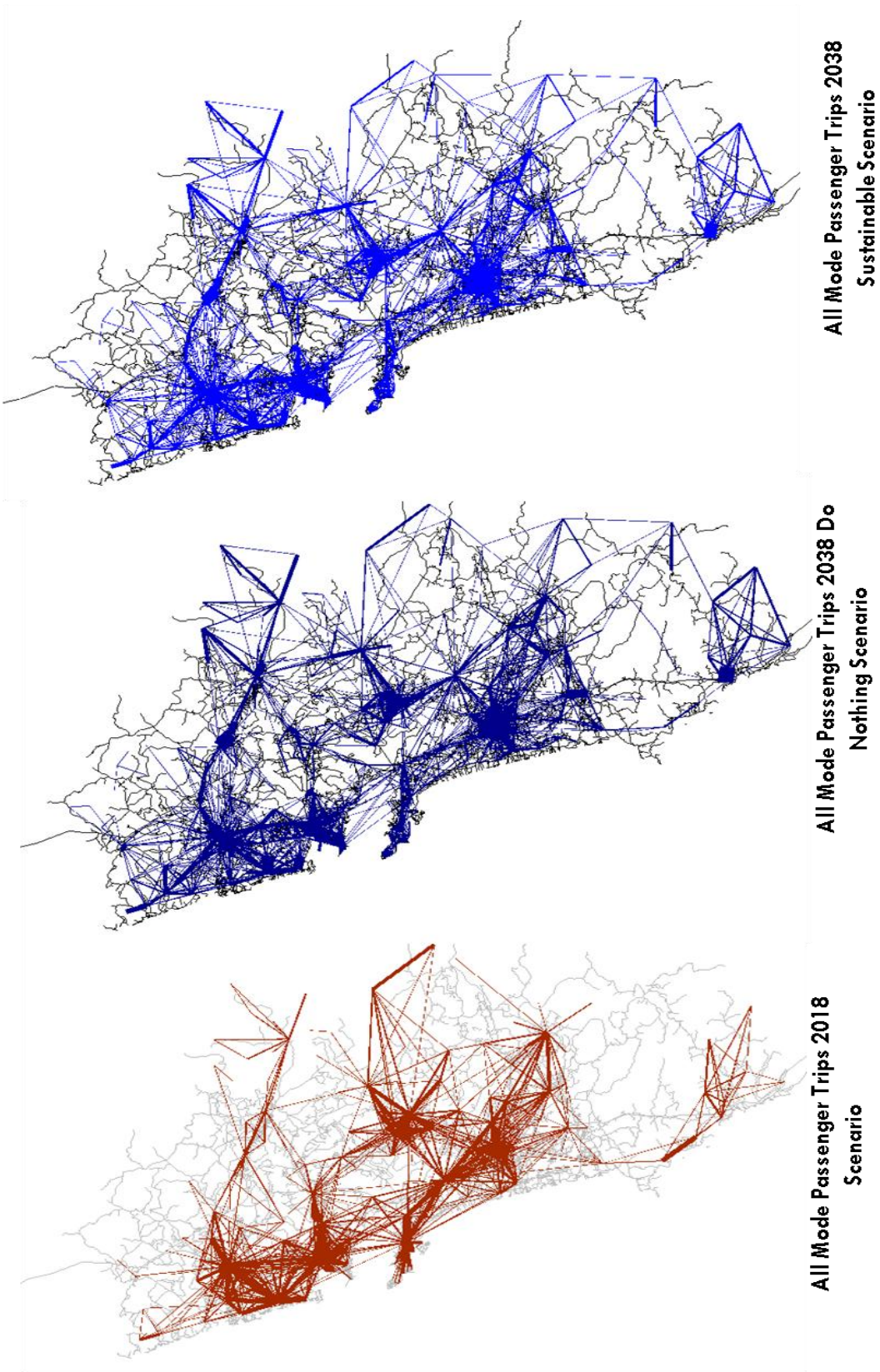


Figure 3.16: Comparison of All Modes Passenger Trip Scenarios of Base Year, Do Nothing 2038 and Sustainable scenario 2038

The sustainable development scenario will also incorporate an impact improved network for access and egress trips. The short length access and egress trips, which potentially depend on the non-motorized transport, will improve with improvement in footpath and cycle tracks. The percentage of public transport mode share could further improve by strengthening long distance access and egress trips which potentially taken place by motorized transport. The yellow lines in following map shows the access and egress trip corridors to be strengthened to support trunk route ridership.

A detailed route rationalization study integrating with all public modes will be presented separately in Public Transport Master Plan.

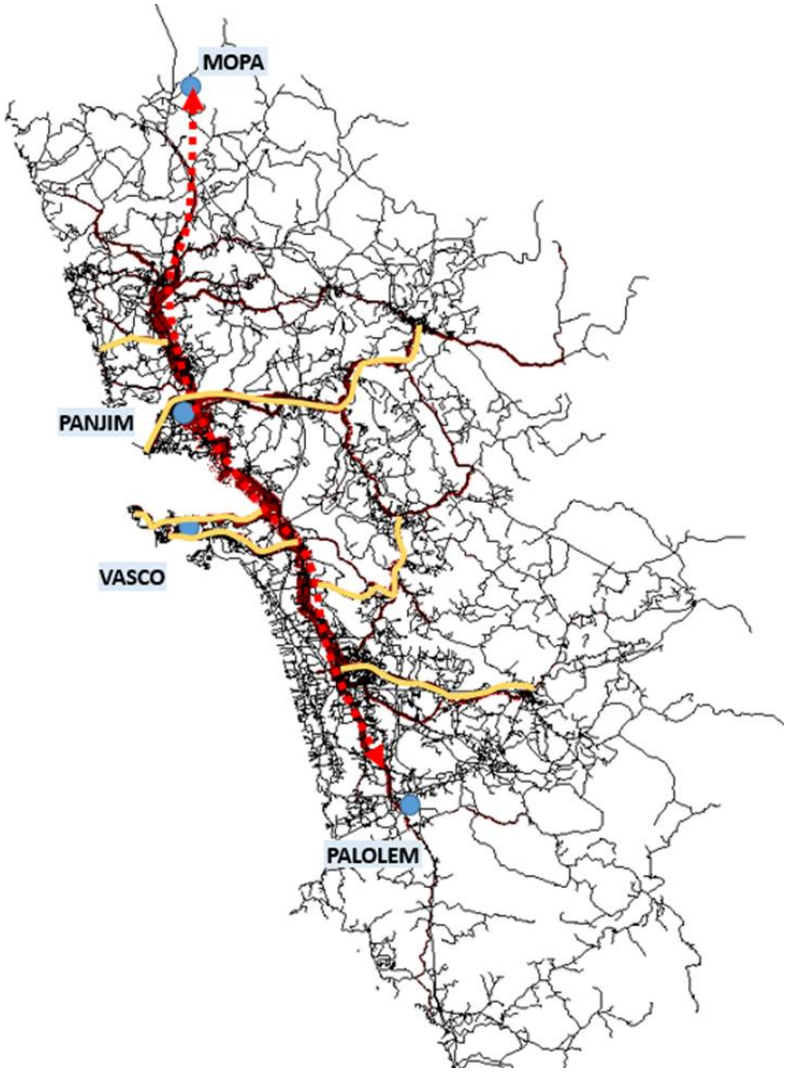


Figure 3.17: Sustainable Development Scenario

3.5 Environmental Impact

Environmental impact from the proposed transport projects is analysed at a broader perspective in terms of vehicular emissions. Total vehicular emissions are categorised into Local land GHG emissions. The local emissions comprise pollutants namely PM2.5, NOx, CO and VOC whereas Green House Gas (GHG) emissions include CO_2 pollutant.

In general, local emissions are secondary pollutants. CO_2 emissions are considered to be harmful for the environmental as it increases the global temperature. The emissions from the transport sector by the use of fossil fuels are considered one of the main reasons for the environmental degradation. Cities across the world are planning for reducing the usage of fossil fuels to control the CO_2 emissions. Accordingly, Comprehensive Mobility Plan has proposed for electrification of public transport fleet in Sustainable Urban Transport Scenario. These emissions are quantified and are presented in Table 3.27.

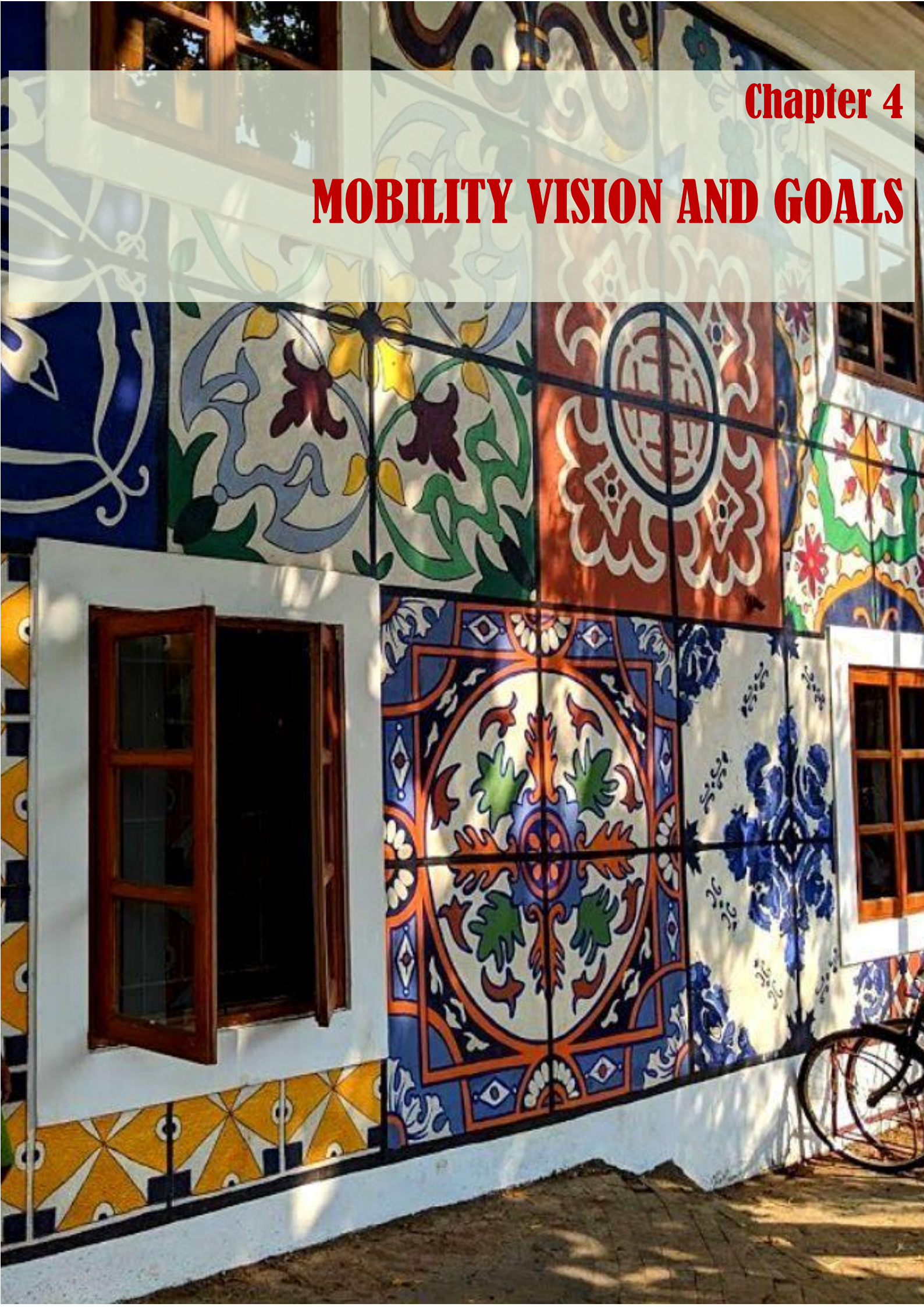
Table 3.27: Vehicular Emissions for various scenarios for Goa State

Name of the Impact	Base Year (2018)	Do Nothing (2038)	Do Something (2038)	Sustainable Scenario (2038)
Local Emissions (Tonnes/day)	27.2	44.0	43.6	13.8
GHG Emissions (Tonnes/day)	954.8	2765.5	3103.3	639.1

Inferences:

- It is observed that the Local emissions from all the modes were estimated to be 27.2 tonnes/day in base year (i.e. 2018). As per Household Survey, about 79% of the personalised vehicles (i.e. Two Wheeler and Car) are having make year less than 5 years resulting in lower emissions. These emissions increase by 1.62 times in Do nothing scenario for horizon year 2038 whereas 1.60 times in Do something scenario for horizon year 2038. However, in Sustainable Urban transport scenario (SUT), the local emissions are observed to decrease by 49 % from 27.2 tonnes/day in 2018 to 13.8 tonnes/day in 2038.

- It is observed that the GHG emissions from all the modes were estimated to be 954.8 tonnes/day in base year (i.e. 2018). These emissions increase by 2.9 times in Do nothing scenario for horizon year 2038 whereas 3.3 times in Do something scenario for horizon year 2038. However, in Sustainable Urban transport scenario (SUT), the GHG emissions are observed to decrease by 33 % from 954.8 tonnes/day in 2018 to 639.1 tonnes/day in 2038.



Chapter 4

MOBILITY VISION AND GOALS

CHAPTER 4: MOBILITY VISION AND GOALS

4.1: Introduction

The Comprehensive Mobility Plan (CMP) of any city presents a strategy for short, medium, and long-term investments to improve accessibility and mobility for its residents. It focuses on the mobility of people to address urban transport problems and promote better use of existing infrastructure, which leads to the integration of land-use and transport and is essential to build smart cities.

The CMP will be a key document to justify and support transport proposals of the city, to the Central Government and multilateral funding agencies.

The focus of CMP is:

- To optimize the "mobility pattern of people and goods" rather than of vehicles.
- To focus on the improvement and promotion of public transport, NMVs and pedestrians as important modes.

4.2: Vision

Considering the rapid rate of vehicular growth in the State as well as the decline in public transit ridership, the Comprehensive Mobility Plan of Goa envisions a long term vision at creating:

"Smart Modal Shift- Personal to Public: Provide accessible transit by creating safe, reliable, universal and sustainable mobility by strategic planning"

4.3: Goals

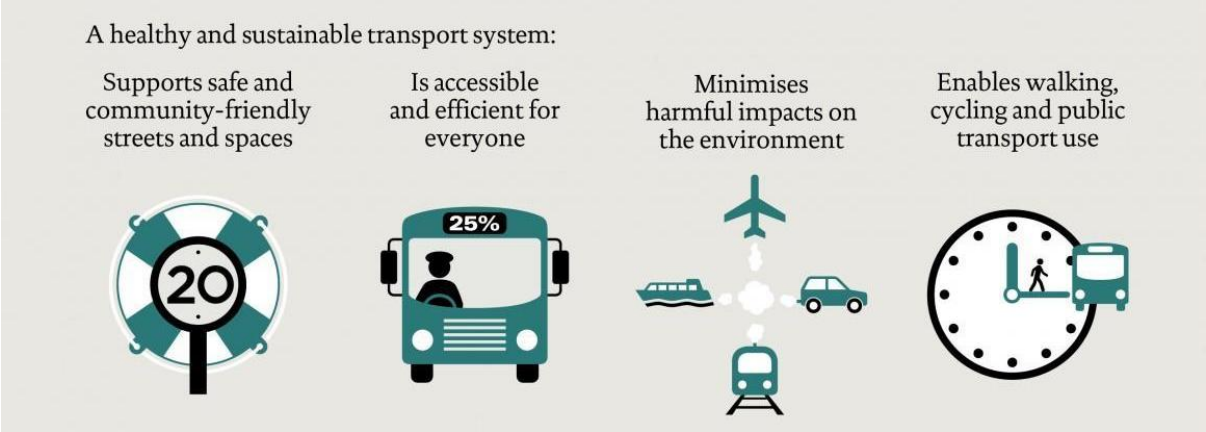
The main goal is to prepare a Comprehensive Plan for the State that ensures the sustainable integration of transport and land use for the State of Goa. The following goals have been formulated:

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, liveable 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.



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

Objectives:-

i. Provide good quality public transport system that is accessible, efficient and effective.
ii. Develop strategy to integrate public transport system with existing IPT System.
iii. Develop strategies to encourage people to use public transport system and discourage use of private vehicles.
iv. Develop policies that encourage concentrated mixed land use development along the public transport corridors.

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

Objectives:-

i. To improve pedestrian facilities in areas of pedestrian concentration.
ii. To provide facilities to pedestrians and ensure safety by segregating their movement from vehicles along major corridors.
iii. To encourage pedestrian movement in heavy pedestrian movement areas and restrict use of private vehicles.
iv. To provide safe pedestrian facilities along major public transport nodes and transfer points.
v. 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:-

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

ii. 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.

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:-

i. Restrict On-Street Parking at critical locations in the city.

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

iii. 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 can be achieved by formulating a series of strategies as per NUTP guidelines. Each of the strategies will be evaluated to see its suitability and applicability for the State of Goa.

Besides the above mentioned Goals, some principles of **National Mission on Sustainable Habitat (NMSH)** need to be considered in this study before formulating the strategies. Accordingly, a brief introduction to NMSH is presented in the following sections:

4.4: National Mission on Sustainable Habitat (NMSH)

Under the National Action Plan for Climate Change, the National Mission on Sustainable Habitat has been launched to cover various aspects which inter alia include better urban planning and modal shift to public transport. The main objective of the mission is to address the following:

- Development of Norms integrating measures related to taxation, parking and congestion charges, public carriage specifications and service.
- Norms to encourage public transportation.
- Development of Norms for Pedestrianisation and cycling.
- Modal regulations for integrating Transport Planning (CMP).

The habitat parameters also take note of the ongoing reform based AMRUT program that has been designed to achieve NUTP principles in the urban transport sector. Accordingly, to ensure sustainability in urban transport planning, the following eight-principles have been proposed.

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

4.4.1: Make Walkable Cities and Towns

A great walking environment must protect pedestrians from motor vehicles. Vehicle speeds need to be radically slowed by Traffic Calming Measures (TCM). 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 - 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 - footpaths for a LOS 2.
- At-grade pedestrian crossings at maximum intervals of 70-250 m.

Goa does not meet these standards. A separate strategy for non motorized transport improvements need to be included.

4.4.2: Create better 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 high 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 make urban transport sustainable.

The following indicators have been recommended for pedestrian facilities:

- NMT network should be 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.

- At present in Goa, 12% of the total daily trips are on cycles and the facilities for cyclists are absent. This invites attention to provide a strong bi-cycle network for the state.

4.4.3: Connect the Blocks

Cities that are pleasant to walk and bicycle typically have large number of short streets and many intersections per unit 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 kilometre be 50.

4.4.4: Build dense-people and Transit Oriented Cities; mix people and activities

The first step to accommodate 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 part 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.

4.4.5: 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 bus transit systems are proving that they are 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 500 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 existing public transport system in Goa requires detail route rationalization with well defined integration of main haul services.

4.4.6: 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 on street 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.

4.4.7: 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.

4.4.8: Impact Assessment

New developments and projects will draw increasingly more attention in the future as these induce and attract additional traffic in the neighbourhood. It is suggested an Impact Assessment needs to be done to estimate the additional traffic and the infrastructure needs of the neighbourhood.

Chapter 5

Sustainable Transport Strategies

CHAPTER 5: SUSTAINABLE TRANSPORT STRATEGIES

5.1: Introduction

The mobility goals for Goa 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 the State of Goa.

- Non-Motorized Transport Strategy
- Public Transit Improvement Strategy
- Freight Management Strategy
- Traffic Engineering Measures
- Demand Management Strategy
- Technological 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 fulfil the goals and objectives of the CMP. The section below discusses these strategies.

*"The **complex transport situation** needs a **multi-pronged approach**"*

5.2: Non-Motorised Transport Strategy

Non-motorized transport strategy considers improvement in NMT user experience by enhancing footpaths and bicycle lanes. It also addresses improvement in safety and accessibility for pedestrians and bicycles at intersections. Reducing barriers and impediments on roads to improve bicycle safety is another aspect considered under this strategy. The non-motorised transport strategy aims at protecting pedestrians from motorized vehicles. The NMT network should foster the most direct access to all local destinations like schools, work stations, bus/metro stations etc. The various action plans framed for improving non-motorized transport infrastructure include:

- Develop "pedestrian only" plazas and streets.
- Provide clean, comfortable and complete footpath wherever possible.
- Introduce cycle tracks for safe cyclist movement.
- Design the intersections to address the accessibility for pedestrians and bicycles.
- Introduce public bike sharing systems.
- Provide safe accessibility to public transport.

5.3: Public Transport Strategy

Public transport is a shared passenger transport service which is available for use by the general public, as distinct from modes such as taxicab, carpooling or hired buses which are not shared by strangers without private arrangement. Improving public transport includes NMT also as any public transport trip includes a component of access and egress which is already covered under NMT Strategy. Improving public transport includes improvements in bus service and mass rapid transit with compatible pedestrian and bicycle infrastructure. Mass Transit is a form of public transport that can transport a greater volume of passengers and provide a higher quality of services than conventional services through a systematic combination of infrastructure, equipment and information technologies. Mass transit options could include Bus Rapid Transit (BRT), Light Rail Transit (LRT), Metro Rail System, Mono Rail System, and Commuter/sub urban Rail Services. Public transport strategy includes following action plans:

- Proposal for mass transit corridors with NMT access facilities.
- Augmentation of bus services in the city.
- Route Rationalization of buses.
- Provide feeder bus services so as to improve the coverage.
- Integrate the multiple modes of transport to provide single journey experience.

5.4: Freight Management Strategy

Freight movement in a city is an inevitable process of trade and economy. The entry of heavy commercial vehicles into the city will interfere with the easy traffic flow. Hence the action plans are prepared such that the freight movement will not interfere in the traffic movement. The action plans for improving freight movement are:

- Frame policies to restrict the heavy vehicle flow in the city.
- Identify freight corridors with the city.
- Permit heavy vehicles into the city only during specific hours.
- Identify truck parking locations (freight terminals).

5.5: Road Network Strategy

Road network is a system of interconnected paved carriageways which are designed to carry buses, cars, goods vehicles or any other travel mode. The road network generally forms the most basic level of transport infrastructure with urban areas. In order to provide mobility solutions for Goa, it is vital that there is effective integration between land use and transport in the entire region. The State of Goa is already having a development pattern similar to the multi-nodal network with many urban centres dispersed from the city centre. The Road network strategy includes:

- Develop Mobility Corridors.
- Develop ring-radial network pattern.
- Propose flyovers, underpasses, ROBs, RUBs wherever necessary.

5.6: Demand Management Strategy

Travel demand management (TDM) 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 to reduce travel demand or redistribute this demand in space or in time. Detailed Strategies are explained in following chapter.

5.7: Traffic Engineering Strategy

In CMP, an equal emphasis is given on the traffic movement in the city which should be safe and accessible for all transport users. Traffic movement in the city should enhance the use of sustainable travel choices. The policies should be framed to increase the generalized cost of travel of motorized modes as compared to NMT and PT mode. The various action plans under traffic engineering strategy are:

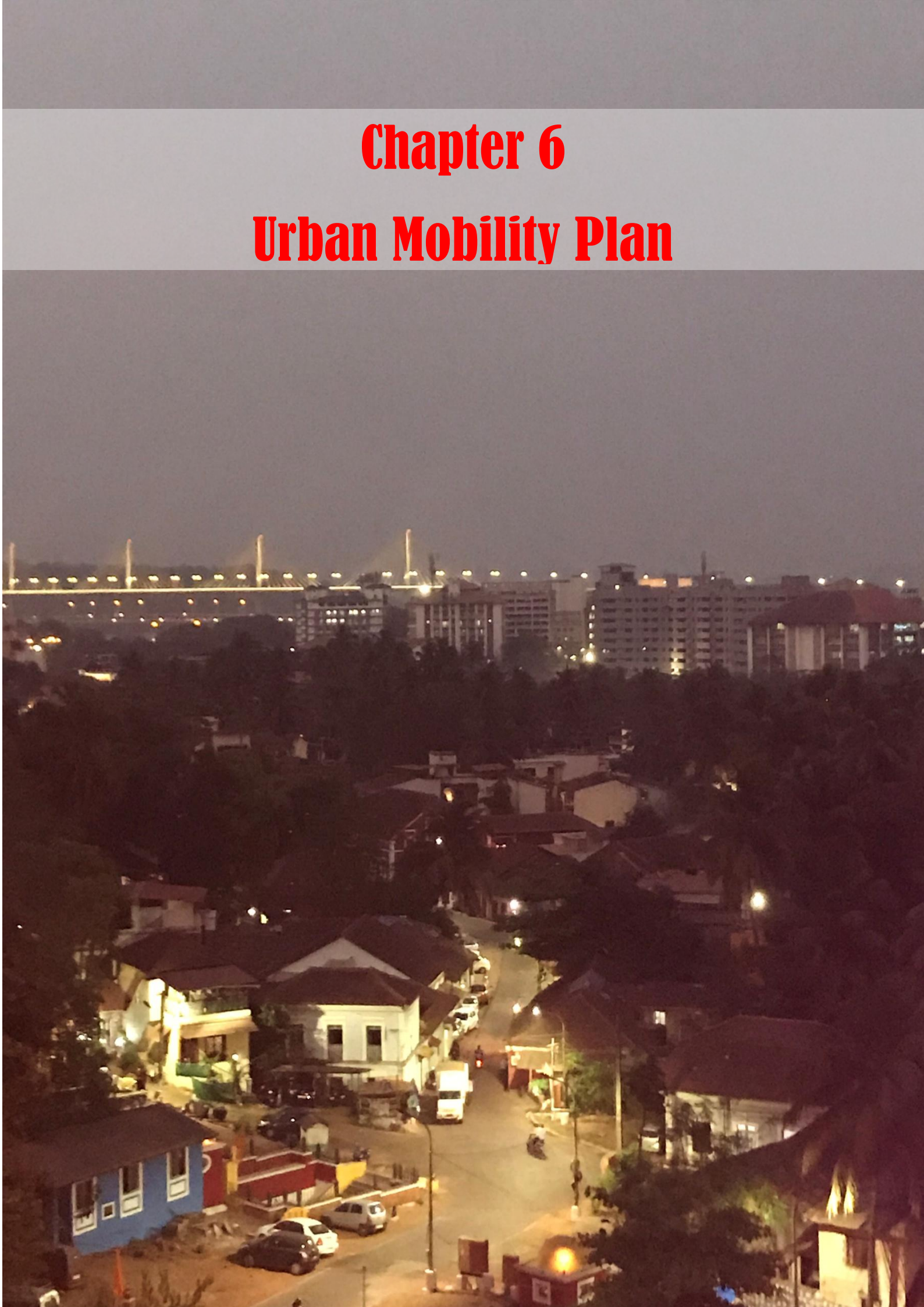
- Junction Improvements.
- Parking Management and off street parking locations.
- One way plans.
- Road markings and signage improvements.

5.8: Technological Strategy

Last but not the least, technological improvements are important for the city to be smart. Technological improvements can encompass changes in vehicle design, fuel use, energy use and reduction in CO2 emissions related to the electrically driven vehicles. Various actions framed for the same are:

- Smart signalling at intersections.
- Real time information systems for public transport.
- Integrated ticketing system.
- Smart parking technologies.

Chapter 6
Urban Mobility Plan



CHAPTER 6: URBAN MOBILITY PLAN

6.1: Introduction

This chapter deals with mobility plans like Public Transport Improvement plan, Inland Waterways Improvement Plan, Freight Management, Non-Motorized Improvement Plan, Intermediate Public Transport Improvement Plan, Parking Management Measures and Traffic Management Measures.

6.2: Public Transport Improvement Plan

Public transport is one of the most environmentally sustainable forms of transport. Public transport provides people with mobility and access to employments, community resources, medical care and recreational opportunities. The incorporation of public transportation options and considerations into broader economic and land use planning will help the communities expand business opportunities, reduce sprawl and create a sense of community. By creating a space for public activities, such development contributes to a sense of community and can enhance neighbourhood safety and security. For these reasons, areas with good public transit systems are economically thriving and offer location advantages to businesses and individuals choosing to work or live in them. Public transportation also helps to reduce road congestion and travel times, air pollution and energy and oil consumption, all of which benefit both riders and non-riders alike. The Comprehensive Mobility Plan for Goa divides public transportation improvement plans into number of sections, including service improvements for buses, inland waterways and para-transit, appropriate Mass Rapid Transit (MRT) options and infrastructure development plans and intermodal integration plans.

The public transport system for Goa should be convenient, efficient, affordable, reliable and integrated. Improving the existing public transport involves infrastructure improvements like reserving lanes and tracks and operational improvement like optimizing routes and schedules. The improvement in public transport is likely to not only involve maintaining the

existing modal share of public transport, but also to create a shift from other modes to public transport.

The provision of public transport is a complex mechanism and in order to evolve an effective and efficient service, it is necessary to understand this complexity. The complexity exists both within the organization of a service provider and the environment in which the service provider operates. As the external environment impacts the transport system to a large extent, it is necessary for the external environment to be examined properly. Public transport system planning will not only consider where terminal, routes and stops are placed but also whether they are accessible to all potential users. The plans for the system should take into account the accessibility issues for pedestrians and cyclists, the differently abled and elderly people as well as private vehicle users after they have parked their vehicles.

At present, the public transport in Goa includes Bus Transport, Ferry Transport and Intermediate Public Transport;

- **Bus Transport:** The bus transport in Goa is operated by State run Kadamba Transport Corporation (KTC) and private bus operators. KTC serves both interstate and intercity services with 565 buses on 220 routes.

- **Ferry Transport**: The River Navigation Department, Government of Goa is instrumental in providing transport services to the commuters across the rivers especially for the islanders in the State of Goa where there are no road accesses. An approximate length of 371 Km of navigable length is being catered by inland water transport. The river navigation dept. provides ferry services to the commuters in its 18 ferry routes with 39 ferries spread all over Goa, catering to approximately 31,000 passengers per day.

It has been observed that the public transportation in Goa is inefficient and lacks proper structure and integration with other modes even though it is affordable. The public transport system for Goa should be convenient, efficient, affordable, reliable and integrated. Improving the existing public transport involves infrastructure improvements like reserving lanes and

tracks and operational improvements like optimizing routes and schedules. The improvement in public transport is likely to not only involve maintaining the existing modal share of public transport, but also to create a shift from other modes to public transport.

The proposals under public transport improvement plan are:

a. Rationalization of existing city bus services for efficient public transport systems.
b. Development of Mass Rapid Transit Systems.
c. Restructuring and Reviving of the Water Transport (Ferry Services for public transportation).
d. Ensuring Multi Modal Integration in public transport.
e. Providing adequate infrastructure facilities for public transport in terms of intermodal mobility hubs, bus stops.
f. Implementation of ITS to improve the reliability of public transport systems.
g. Promoting public participation and mass awareness programs.

6.2.1: Route Rationalization and Fleet Augmentation Of Bus Services

6.2.1.1 Need for Route Rationalization

The existing bus routes need modification as there are multiple overlapping bus routes running across the state. But the services of the Kadamba Transport Corporation are well appreciated in a few regions of the state, while they are neglected or lack reliability in others. This might be because the KTC and private operators are unable to cater to the major production and attractions in the area because of the poor fleet size. Currently, the services are constrained to Inter City Commute with few inter connected towns and villages, which is represented in the Figure 6.1. The present structure of the bus routes in Goa has led to higher frequencies, bunching of services, over speeding and lower patronization for public transport.

The Comprehensive Mobility Plan has identified the need to update the route and schedule which in technical terms is called as route rationalization plan.

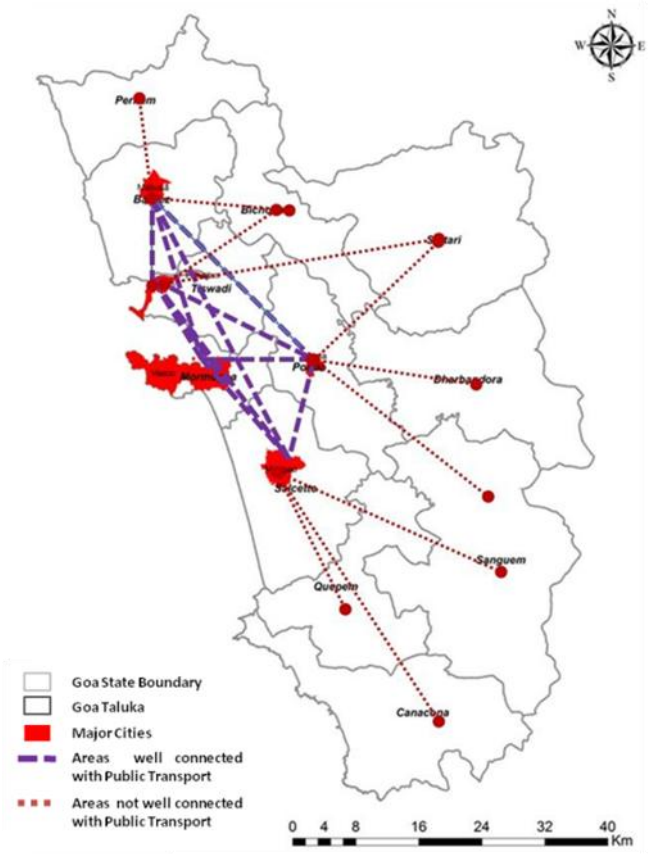


Figure 6.1: Bus Service Operations-Goa

6.2.1.2 Routes to be rationalized

As discussed earlier, KTC operates 565 buses on 220 routes. Distribution of the bus routes over frequency of bus trips per route has been analysed and is presented in the Table 6.1. It could be observed from the table below that of the 101 routes, 75% of the routes have frequency more than 30 minutes, which also means that 75% of the routes undertake only 1 to 2 trips. The route rationalization plan for Goa has been undertaken based on the trunk and feeder network concept. Figure 6.2 represents the trunk corridors.

Table 6.1: Distribution of the bus routes based on the Frequency of Bus Services

Frequency	No. of Routes	Percentage
0 to 5 Mins	0	0.0%
5 to 10 Mins	3	3.0%
10 to 15 Mins	7	6.9%
15 to 20 Mins	9	8.9%
20 to 30 Mins	7	6.9%
30 to 60 Mins	23	22.8%
60 Mins and above	52	51.5%
Total	101	100.0%

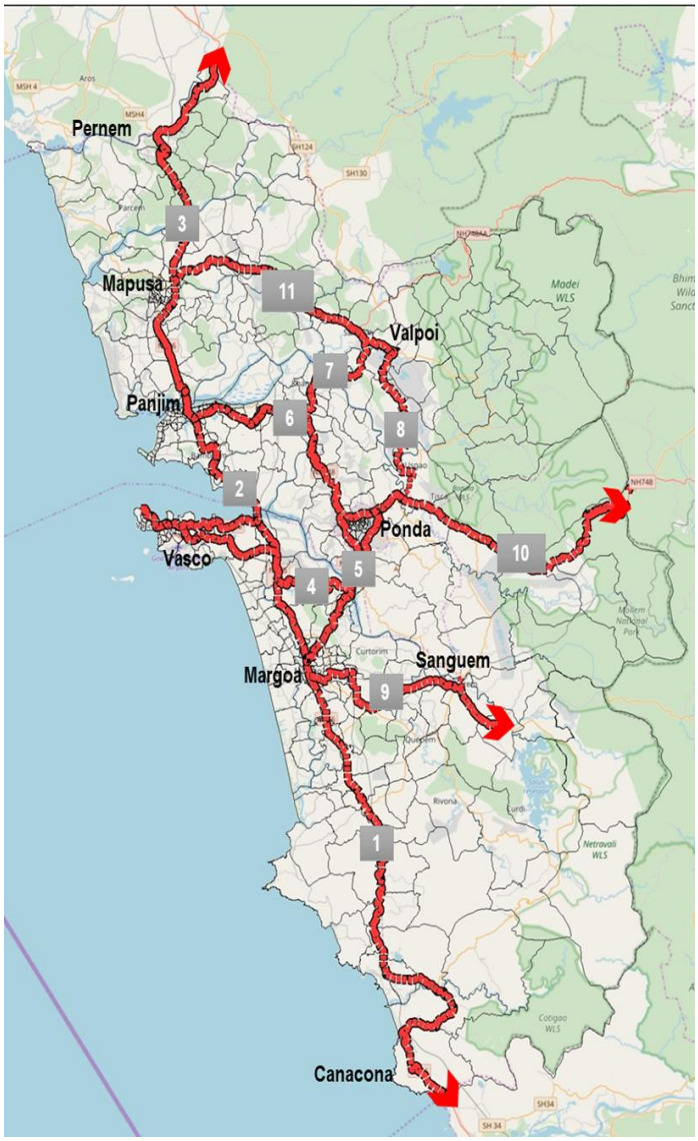


Figure 6.2: Major PT Trunk Corridors

Trunk routes are provided on the corridors with high PPHPD. These routes will have comparatively low frequency and will have high capacity buses or mass rapid transit systems running. Since the mass transit proposals put forward in the earlier sub-section is a long term strategy, the route rationalization plan has to be implemented in the short term with the trunk line as buses. The trunk routes developed according to the route rationalization are described.

Table 6.2: Major PT Trunk Routes Description

Route No	Origin	Destination	Via	Route Length (Kms)
Trunk Corridor 1	Canacona	Margoa		32.9
Trunk Corridor 2	Margoa	Panjim		35.4
Trunk Corridor 3	Panjim	Pernem		31.6
Trunk Corridor 4	Vasco	Ponda		31
Trunk Corridor 5	Margoa	Ponda		18
Trunk Corridor 6	Panjim	Ponda		31.5
Trunk Corridor 7	Panjim	Valpoi	Via Candola	43.5
Trunk Corridor 8	Ponda	Valpoi		27.1
Trunk Corridor 9	Margoa	Sanguem		21.8
Trunk Corridor 10	Ponda	Mollem		30.8
Trunk Corridor 11	Mapusa	Valpoi	Via Bicholim	44.4

The route rationalization plan has identified the routes that need modifications like routes that are to be terminated and retained. The details are given in the Table 6.3.

Table 6.3: Route Rationalization Proposals

Parameters	Inter City	Intra City				
		Margaon	Panjim	Vasco	Mapusa	Total
Total No. of Routes	84	7	4	2	5	102
Total No. of Routes for Curtailment	65	7	4	2	5	83
Total No. of Routes for Retaining	19	0	0	0	0	19
Total No. of New Routes	1	0	0	0	0	1

6.2.1.3 Fleet Augmentation

Frequency of Services

As mentioned in the previous chapter, the existing average headway on all the routes put together is approximately 50 mins, which is higher than the average travel time in the State. This is a deterring factor for any user who is willing to choose public transportation. There arises the need for suitably adjusting the headways of the recommended routes in Goa.

The total estimated ridership on the proposed bus services network is the potential demand which can be captured once the complete modified routes are in place. The expected route frequency is calculated based on the possible peak hour ridership (supply) against the demand (PHPDT). Considering the mentioned parameters and depending on the route type (Trunk/Feeder Routes) and distance of the routes, the average headway derived during the peak and off-peak hours are represented in the following tables.

Table 6.4: Recommended Average Peak Hour Headway on rationalized Bus Routes

Route Length (M)		Peak Hour Headway (2018) (Mins)	Recommended Peak Hour Headway (2038) (Mins)
0	5	12.33	6.17
5	10	31.50	15.75
10	15	87.78	43.89
15	20	102.83	51.42
20	25	114.00	57.00
25	30	104.25	52.13
	>30	106.52	53.26
		81.72	40.86

Table 6.5: Distribution of Headway (mins) on Modified Bus Routes

Headways (Mins)	No. of Routes	% age
0 to 5 Mins	15	29%
5 to 10 Mins	11	20%
10 to 30 Mins	5	7%
30 to 60 Mins	33	30%
> 60 Mins	15	14%
Total	79	100%

To start with, the overall average peak hour headway shall be decreased from 82 mins to 41 mins in 2038 for overall operations of 76 routes. The

frequency of bus routes can be further optimized, once the modified routes are implemented and route loadings are closely monitored to check the build of demand.

Fleet Estimation – Kadamba Transport Corporation

Estimation of Fleet size is quite essential for any public transport system. Surplus no. of fleet often leads to underutilization and eventually increase the capital and operation costs On the other hand insufficient fleet drives the users to adopt a different mode leading to the reduction in the ridership values. So, it is important that an optimal fleet size is determined and such a system needs to be developed which ensures enough fleet size to meet the ridership demand at the same time being self-sustainable.

To estimate the fleet size for the modified bus services for Goa city, various parameters have been considered which were derived from field surveys and model outputs. The fleet estimation assumptions are as follows;

- Hours of Operations – 17 hours
- Average Running Speed – 19.25 kmph
- Distance between bus stops – 1.5 Kms
- Dwell Time at the Bus stops – 1.30 sec per stop
- Average Layover time – 20% of the total one way running time
- Total one way Journey Time – Total Run Time+ Dwell Time at the Bus Stops + Layover Time
- Headway (mins) = (Passenger Capacity of the vehicle * Peak Hour Load Factor * 60) / Peak Hour Demand
- Fleet Required – Total Journey Time (mins) / Headway (mins)
- Spare vehicles – 10% of the Total fleet.

Based on the above parameters, the fleet size has been estimated. The details of the modified routes along with the route length, proposed headway and fleet size are presented in the Table 6.6.

Table 6.6: Route Wise Headway and Fleet Estimation – Trunk Bus Routes

Sl. No.	Row Labels	Origin	Destination	Type of Route	Route Length (Kms)	Headway (mins)_ 2028	Headway (mins)_ 2038	Type of Bus	2018	2028	2038
1	CBS-003-T	Panjim	Pernem, Cargoan	Trunk	30.46	60	60	Midi	6	9	9
2	CBS-007-T	Panjim	Ponda	Trunk	31.50	70	60	Midi	4	9	9
3	CBS-008-T	Panjim	Margoa	Trunk	31.70	5	5	Standard	13	13	13
4	CBS-011-T	Vasco KTC	Mapusa	Trunk	37.90	60	60	Standard	13	10	10
5	CBS-012-T	Vasco Ktc To	Pernem, Cargoan	Trunk	62.77	110	60	Midi	4	4	8
6	CBS-013-T	Vasco	Panjim	Trunk	35.10	55	35	Midi	5	6	10
7	CBS-014-T	Panjim KTC	Margaon KTC	Trunk	32.20	120	120	Midi	2	2	2
8	CBS-015-T	Vasco KTC	Ponda	Trunk	35.81	55	35	Midi	6	10	10
9	CBS-017-T	Ponda	Surla	Trunk	34.39	60	60	Midi	2	2	2
10	CBS-018-T	Panjim	Mala	Trunk	29.14	45	5	Midi	4	5	5
11	CBS-020-T	Panjim	Saquelim	Trunk	28.69	60	37	Midi	5	8	8
12	CBS-024-T	Margaon	Canacona	Trunk	29.40	60	60	Standard	4	16	16
13	CBS-028-T	Margaon KTC	Bicholim	Trunk	49.90	85	65	Midi	4	4	6
14	CBS-035-T	Margaon KTC	Bonda	Trunk	65.65	120	120	Midi	4	4	4
15	CBS-036-T	Margaon KTC	Ponda	Trunk	18.00	55	35	Standard	3	15	15
16	CBS-080-F	Ponda	gaunem	Trunk	5.60	20	20	Midi	1	1	1
17	CBS-082-F	Ponda	Agapur	Trunk	7.38	25	10	Midi	4	4	5
18	CBS-095-F	St Francis Chruch	Kesarvale	Trunk	19.28	15	2	Standard	11	16	16
19	CBS-102-T	Calangute	Mopa Airport	Trunk	37.70	30	15	Standard	19	14	11
20	CBS-103-T	Panjim	Mopa Airport	Trunk	41.60	30	15	Standard	21	15	12
21	CBS-104-T	Margoa	Mopa Airport	Trunk	73.40	30	15	Standard	21	17	15
22	CBS-008-T	Mapusa	Majorda	Trunk	31.70	60	60	Midi	8	7	7
23	CBS-009-T	Vasco KTC	Canacona	Trunk	62.93	60	60	Standard	10	16	16
24	CBS-010-T	Margaon KTC	Cansulim	Trunk	11.83	30	30	Midi	1	2	2
25	CBS-014-T	Panjim	Margaon KTC	Trunk	32.20	55	30	Midi	8	8	9
26	CBS-045-F	Sankhali	Satorim	Trunk	31.00	65	20	Standard	3	23	45
27	CBS-060-T	Bicholim	Sankhali	Trunk	9.10	90	90	Midi	1	1	1
28	CBS-062-F	Mapusa	Bedem	Trunk	7.77	15	15	Midi	2	2	2
29	CBS-067-F	Airport	Kalangut	Trunk	42.60	60	60	Standard	22	67	67
30	CBS-081-T	Ponda	Bicholim	Trunk	33.83	60	60	Standard	11	11	14

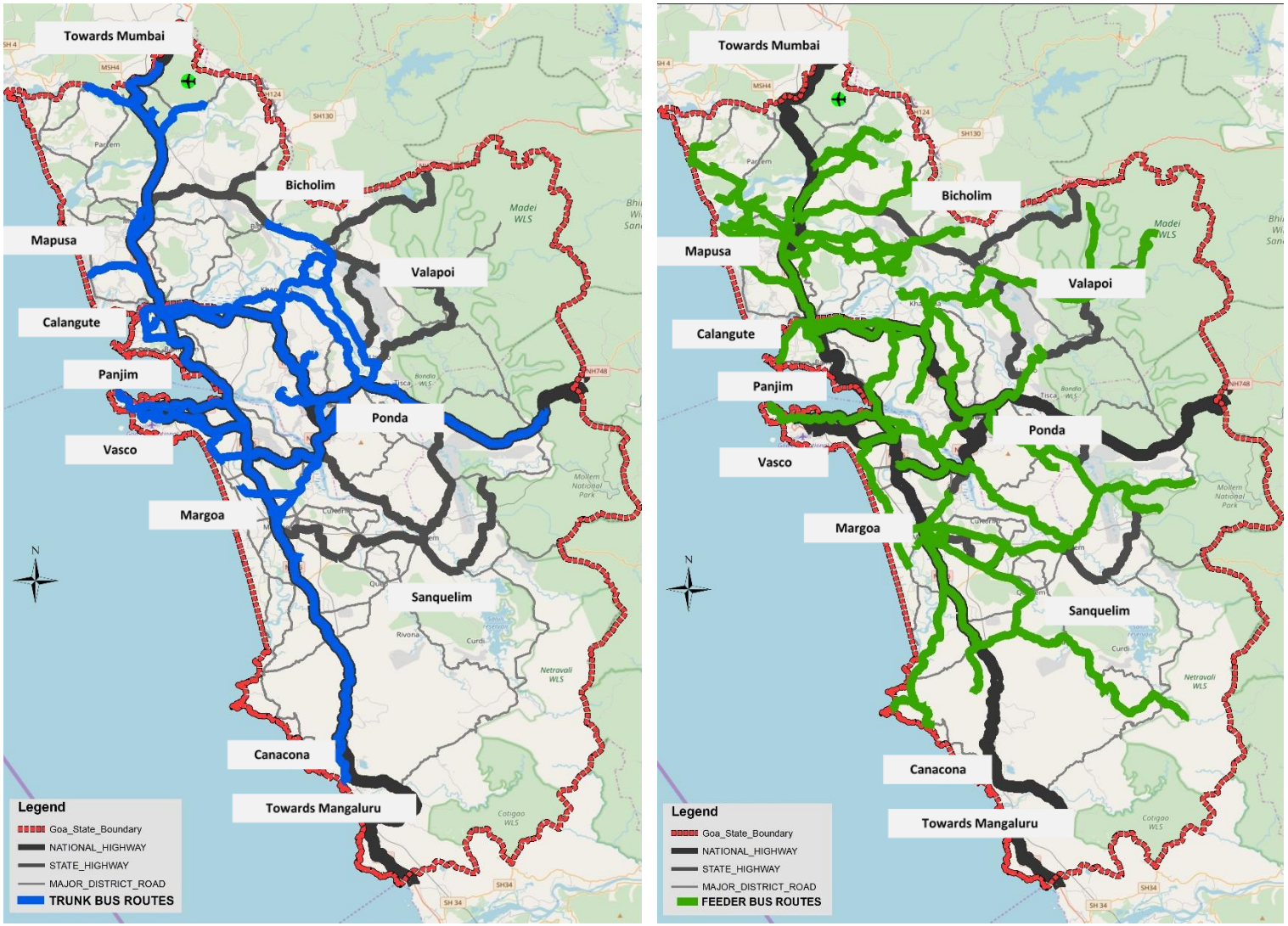
Sl. No.	Row Labels	Origin	Destination	Type of Route	Route Length (Kms)	Headway (mins)_ 2028	Headway (mins)_ 2038	Type of Bus	2018	2028	2038
31	CBS-084-F	Kolva Circle	Raicho Ambo Circle	Trunk	5.62	20	10	Midi	2	2	2
32	CBS-101-T	Pernem	Canacona	Trunk	100.23	15	5	Standard	125	125	115
33	CBS-043-T	Panjim	Surla	Trunk	62.30	50	10	Standard	8	46	93
									357	**494**	**560**

Table 6.7: Route Wise Headway and Fleet Estimation – Feeder Bus Routes

Sl. No.	Row Labels	Origin	Destination	Type of Route	Route Length (Kms)	Headway (mins) 2028	Headway (mins) 2038	Type of Bus	2018	2028	2038
1	CBS-001-F	Bicholim	Varpal	Feeder	6.61	60	30	Midi	3	3	5
2	CBS-002-F	Mapusa	Calvim	Feeder	11.01	60	30	Midi	3	3	3
3	CBS-003-F	Dhargalim	Ibrampur	Feeder	15.00	170	90	Midi	1	1	1
4	CBS-006-F	Mapusa	Maem	Feeder	16.90	35	20	Midi	12	12	12
5	CBS-007-F	Ponda	Dongarwadi-Gululem	Feeder	41.10	170	90	Midi	2	2	3
6	CBS-011-F	Mapusa	Morjim	Feeder	12.60	95	50	Midi	6	6	9
7	CBS-013-F	Vasco	Sankhali	Feeder	40.40	140	75	Midi	2	2	4
8	CBS-014-F	Verna IA	Borim	Feeder	18.40	225	120	Midi	1	1	1
9	CBS-014-F	Verna IA	Shiroda	Feeder	18.40	110	60	Midi	5	5	6
10	CBS-016-F	Margaon	Collem	Feeder	38.79	60	45	Midi	6	8	8
11	CBS-023-F	Margaon	Neturlim	Feeder	50.50	55	30	Standard	6	24	24
12	CBS-024-F	Balli	Pirla	Feeder	25.60	140	75	Midi	4	4	5
13	CBS-025-F	Chinchinin	Canaguinim	Feeder	18.82	110	60	Midi	2	3	3
14	CBS-026-F	Borim	Sanvodem	Feeder	23.70	120	65	Standard	2	38	19
15	CBS-027-F	Ponda	Dabal	Feeder	14.00	120	65	Midi	6	6	8
16	CBS-033-F	Vasco	Canasaulim	Feeder	12.60	40	10	Midi	8	8	8
17	CBS-039-F	Mapusa	Bicholim	Feeder	20.80	55	60	Standard	3	31	31
18	CBS-047-F	Mapusa	Usap,Latambarcen	Feeder	19.00	140	75	Standard	14	14	14
19	CBS-048-F	Mapusa	District Hospital	Feeder	1.08	10	5	Midi	4	4	7
20	CBS-056-F	Panjim	Arambol	Feeder	33.47	110	60	Standard	5	27	54
21	CBS-059-F	Ponda	Khandola	Feeder	19.20	50	50	Midi	6	6	8
22	CBS-060-F	Sankhali	Hiverem	Feeder	27.10	170	90	Midi	1	1	2
23	CBS-063-F	Cortalim	Sal	Feeder	10.30	50	10	Midi	4	3	4
24	CBS-064A-F	Panjim	Madrem	Feeder	10.50	80	80	Midi	3	4	4
25	CBS-064-F	Banastarim	Madkai	Feeder	10.50	60	60	Midi	3	2	3

Sl. No.	Row Labels	Origin	Destination	Type of Route	Route Length (Kms)	Headway (mins) 2028	Headway (mins) 2038	Type of Bus	2018	2028	2038
26	CBS-066-F	Sankhalem	Velguem	Feeder	12.00	110	60	Midi	1	2	2
27	CBS-068-F	Ponda	Vantem	Feeder	18.20	20	10	Standard	14	28	28
28	CBS-069-F	Sankhali	Compordem	Feeder	19.30	90	90	Midi	2	2	2
29	CBS-071-F	Margaon	Morpila	Feeder	24.90	110	60	Midi	6	6	7
30	CBS-075-F	Mapusa	Amthane	Feeder	25.60	55	30	Midi	7	7	8
31	CBS-077-F	Panjim	Alkhada, Golwada	Feeder	21.30	110	60	Standard	7	7	9
32	CBS-078-F	Panjim	Matne	Feeder	25.60	110	60	Standard	10	10	10
33	CBS-079-T	Panjim	Khandola	Feeder	20.90	75	40	Midi	2	2	2
34	CBS-083-F	KTC Bus Stand	Circular Route	Feeder	8.21	10	10	Standard	19	19	19
35	CBS-085-F	Pandava Chapel	Old College	Feeder	1.88	15	7	Midi	2	3	4
36	CBS-086-F	Kamat Bus Stop	Navelim Chruch	Feeder	2.60	10	5	Midi	1	1	2
37	CBS-087-F	Malkarnerkar	Power House	Feeder	4.70	10	5	Midi	7	7	7
38	CBS-088-F	Station	Colva Circle	Feeder	1.95	10	5	Midi	3	3	4
39	CBS-090-F	Bus Stand	Durgawadi	Feeder	5.70	10	5	Standard	7	7	15
40	CBS-091-F	Bus Stand	Dona Paula	Feeder	8.10	5	2	Standard	6	9	19
41	CBS-092-F	Bus Stand	Old Goa	Feeder	9.90	10	5	Standard	9	9	9
42	CBS-093-F	Bus Stand	Santa Cruz	Feeder	5.54	15	10	Midi	4	5	5
43	CBS-094-T	St Francis Chruch	Cortalim	Feeder	16.78	15	5	Standard	30	30	30
44	CBS-096-F	Bus Stand	Ambedkar School	Feeder	7.92	15	5	Midi	3	3	3
45	CBS-097-F	Bus Stand	Sabnis Valley	Feeder	7.12	25	5	Midi	4	4	4
46	CBS-098-F	Bus Stand	Moira	Feeder	5.62	15	5	Midi	7	7	7
47	CBS-099-F	Bus Stand	To Chikhli	Feeder	5.53	20	20	Midi	3	3	3
48	CBS-100-F	Bus Stand	Chapora	Feeder	9.05	25	10	Standard	8	8	8
49	CBS-073-F	Margaon	Colva	Feeder	4.27	10	10	Midi	11	11	11
									285	**411**	**464**

Figure 6.3: Trunk Bus Routes (Left) and Feeder Bus Routes (Right)



With the modification of the routes for the bus services in Goa,

- Trunk Bus Routes (A) – 33 Routes
- Feeder Bus Routes (B) – 49 Routes
- Total No. of Bus Routes (A+B) - 82 Routes

The total no. of buses required on 82 routes is 642 i.e 8 buses per route. In 2028 and 2038 on the same routes need 905 buses and 1024 buses. Table 6.8 represents the consolidated breakup of Fleet by Type of Buses for KTC.

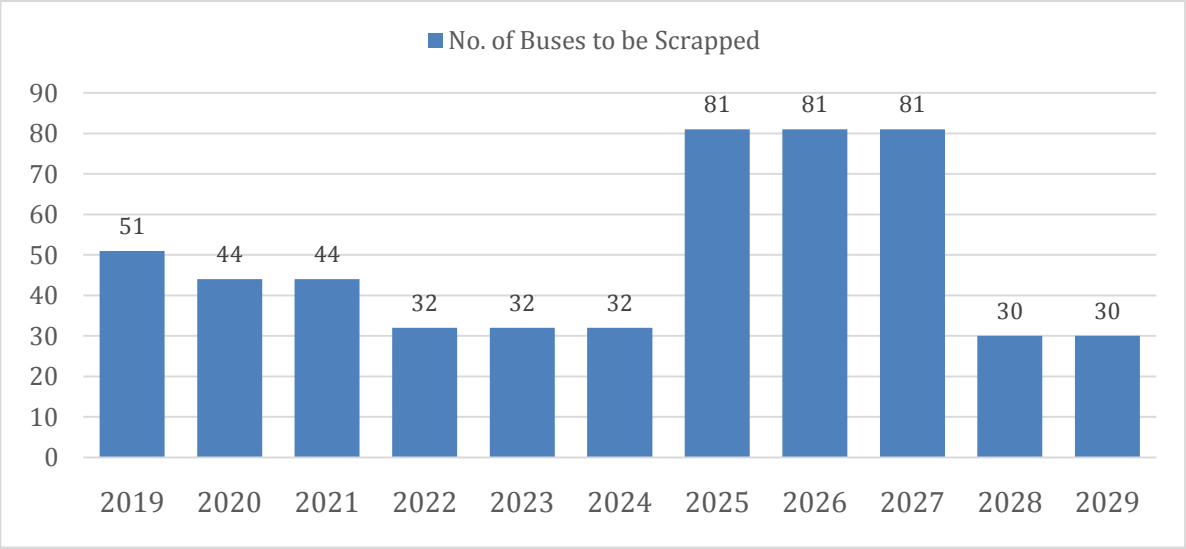
Table 6.8: Consolidated Phase Wise Fleet Requirement by Type of Bus for KTC

	Fleet_2019	Fleet_2028	Fleet_2038
TRUNK (A)			
No. of Routes	33	33	33
Midi Buses (A1)	73	90	102
Standard Buses (A2)	284	404	458
Total No. of Buses (A1+A2)	**357**	**494**	**560**
FEEDER (B)			
No. of Routes	49	49	49
Midi Buses (B1)	145	150	175
Standard Buses (B2)	140	261	289
Total No. of Buses (B1+B2)	**285**	**411**	**464**
Total No. of Buses (C = A+B)	**642**	**905**	**1024**
Spare No. of Buses D = 10% of C)	**64**	**90**	**102**
Grand Total No. of Buses (E = C+D)	**706**	**995**	**1126**

Table 6.8, represents the total no. of buses to be imbibed into the system in 2019, 2028 and 2038. It could be observed that the total no. of buses required by KTC for operations within Goa are 706, 995 and 1126 buses in 2019, 2028 and 2038 respectively. Goa already has a fleet of 567 buses of

which only 539 buses are in service. It could be observed from the Table 3.4 that 51% of the existing fleet operated by KTC in Goa are within the age group of 0 to 5 years. Based on the further assessment of the fleet it was observed that the average age of the buses is 5.95 years. Considering the age profile of all the existing 539 buses would be required to be replaced and condemned in the following 10 years (i.e between 2019 and 2028). Figure 6.4 represent the year wise scrapping/replacement of the existing buses by KTC.

Figure 6.4: Year Wise Existing Buses to be scrapped/replaced.



It could be observed from the Figure that immediately in 2019, 51 buses above the age of 10 years be scrapped/replaced. Following the replacement of 51 buses above the age of 10 years, 44 buses each in the second year and third year, 32 buses each in fourth, fifth and sixth years, 81 buses each in seventh, eighth, ninth year and 30 buses each in the tenth and eleventh year are recommended for replacement. Considering the replacement of the existing fleet, Table 6.9 represents the Summary of the Fleet including the Replacement of the Fleet.

Table 6.9: Consolidated Phase Wise Replacement of Fleet

	Fleet_ 2019	Fleet_ 2028	Fleet _2038
Total No. of Buses Available (A)	539		
Total No. of Buses Required (Refer Table 5-8) (B)	642	905	1024
Spare No. of Buses (@10%) (C)	64	90	102
Total No. of Buses (D = B+C)	706	995	1126
Additional No. of Buses Required (E=D-A)	167	289	131
No. of Buses to be Replaced/Scrapped between 2019-2028, 2028-2038 and 2038-2048 (F)	539	706	995
TOTAL NO. OF BUSES	706	995	1126

Fleet Estimation – Private Operators

As in case of Goa, based on the previous studies as well as from the current study, it has been observed that the city is witnessing a reduced modal share of public transport over the past decades.

The table below represents the desirable modal split in the Indian cities as defined by the MoUD, GoI

City Population (in millions)	Share of Mass Transport (%)	Share of Bicycle (%)	Other Modes (%)
<5 lakhs	30-40	30-40	25-35
5 – 10 lakhs	40-50	25-35	20-30
10 – 20 lakhs	**50 – 60**	**20 - 30**	**15 – 25**
20 – 50 lakhs	60-70	15 -25	10 – 20
50 lakhs +	70 – 85	15 - 20	10 – 15

As the population of Goa is 14.60 lakhs as of 2019 and estimated to be increased to 16.98 lakhs by 2028 and 18.14 Lakhs by 2038. Ideally, the modal share of public transport system for Goa should be in the range of 50 to 60%, but that is not case in Goa. Based on the Travel Demand Model prepared as part of the current study, the base year share of PT is observed to be only 11.75% and under sustainable scenario also the share is

increasing to only 13.52%. In order to reverse the trend instead of adopting demand based approach, the state needs to adopted supply based approach.

As mentioned in the CMP report, as per the guidelines of the Urban Bus Toolkit, the typical requirements for the buses lie between 0.5 and 1.2 buses per 1000 population. For Goa, 1.2 bus per 1000 population has been considered.

Table 6.10: Consolidated Phase Wise Fleet Requirement by Type of Bus for Private Operators

Parameters	2018	2028	2038
Population (in Lakhs)	14.60	16.98	18.14
Number of Buses per 1000 people	1752	2038	2178
10% Spare Vehicles	175	204	218
Total Number of Buses with 10% Spare Vehicles (A)	1927	2241	2396
Existing No. of Private Buses (B)	1714		
		1927	2241
Additional No. of Buses C = A-B	213	314	154
Distribution of Buses between KTC and Private			
Existing Pattern is 67% (Private) and 33% (Public)			
Private Buses	1291	1502	1605
KTC	636	740	791

However it is to be noted that in the previous sections, based on the demand on the rationalized routes to be operated by KTC, the fleet requirement has been worked out, which is as under;

KTC Fleet Requirement	Fleet_2019	Fleet_2028	Fleet_2038
Grand Total No. of Buses (E = C+D)	**706**	**995**	**1126**

Considering the above, the revised distribution of the fleet between KTC and Private Bus operators is as under;

Distribution of Buses between KTC and Private						
Revised Pattern						
Private Buses	1221	63%	1246	56%	1270	47%
KTC	706	37%	995	44%	1126	53%
Additional No. of Buses						
Private Buses	46		25		23	
KTC	167		289		131	
Total	213		314		154	

The demand based fleet assessment for the Bus Services in Goa has evolved to be 2396 buses (1126 – KTC and 1270 – Private). Of the 1126 buses, 901 buses (around 80%) to be electric, whereas the others to be of Diesel based or CNG based buses (around 20%). Through the route rationalization process for the bus services, some of the routes were proposed to be removed, extended/curtailed to improve the connectivity to the demand areas.

Table 6.11: Fleet Distribution between KTC and Private Bus Operators

Type of Bus	Fleet_2018	Fleet_2028	Fleet_2038
PRIVATE BUSES			
Standard AC/Non AC 650 mm	**1221**	**1246**	**1270**
KTC BUSES			
Standard AC/Non AC 650 mm	**388**	**249**	**113**

Standard Electric	**141**	**498**	**901**
Midi Buses 650 mm	**177**	**249**	**113**
TOTAL			
Standard AC/Non AC 650 mm	**1610**	**1495**	**1382**
Standard Electric	**141**	**498**	**901**
Midi Buses 650 mm	**177**	**249**	**113**
ADDITIONAL NO. OF BUSES REQUIRED			
Standard AC/Non AC 650 mm	**117**	**79**	**15**
Standard Electric	**43**	**157**	**123**
Midi Buses 650 mm	**53**	**79**	**15**

Considering the combination of demand based assessment and supply based assessment for public transport for Goa State. It is recommended that slowly the market share KTC in Goa be increased from 37% currently to 53% by 2038. However, the policy decision on the same is to be taken up by the Goa State Government.

One advantage with the recommended scenario is, the State government would have supervision and monitoring authority over the public transport services offered to the citizens of Goa, while giving KTC the flexibility to modify the routes and regulate the fare system.

6.2.1.4 Headway Restructuring

The bus services in Goa need to augment the frequency of services, as it has been seen that the current bus services are constrained to Inter City commute with few inter connected towns and villages.

In addition to the rationalization and fleet augmentation of the bus routes, headways of the current city bus operations also need to be restructured. The current average headway of the city bus services is 60 mins (including all services) which is much larger than the travel time in the city. This is a deterring factor for any user who is willing to choose public transportation.

Considering the above mentioned observations, parameters and route type, the following headways are proposed during the peak hour (Table 6.11):

Table 6.10: Existing Bus Services headway in Goa

Transit Services	Kadamba Transport Corporation	Private Contract Carriages
Major Cities to Major Cities	2.5 Hours	15-20 min
Major Cities to Towns	4.0 Hours	30 min
Town to Towns	Nil	45 min

Source: KTC – Goa & Prviate Bus Organisation, Goa

Table 6.11: Proposed Peak Hour Headway on Routes

Route Type	Route Length (kms)		Average Existing Headway (Mins)	Average Proposed Headway (Mins)
	Min	Max		
Intercity - KTC	0.71	65.65	56.87	48.19
Intracity - Margao	1.7	8.21	13.57	6.71
Intracity - Panjim	4.91	9.9	9.75	5.50
Intracity - Vasco	16.78	19.27	20.00	3.50
Intracity - Mapusa	5.5	9	24.00	9.00

Table 6.12: Distribution of bus routes by Headway in Goa

Frequency	Existing		Proposed	
	No. of Routes	Percentage	No. of Routes	Percentage
0 to 5 Min	0	0.0%	2	2.0%
5 to 10 Min	3	3.0%	15	14.9%
10 to 15 Min	7	6.9%	13	12.9%
15 to 20 Min	9	8.9%	5	5.0%
20 to 30 Min	7	6.9%	3	3.0%
30 to 60 Min	23	22.8%	21	20.8%
60 Min and above	52	51.5%	42	41.6%
Total	101	100.0%	101	100.0%

6.2.1.5 Airport Bus Services

The State of Goa is known for its tourist attractions and tourists from all over the world visit Goa throughout the year. Majority of the tourists visit Goa through Air. The existing International Airport is located at Dabolim in Vasco da Gama. Table 6.14 represents the peak arrival timings and peak departure timings of the tourists through air.

Table 6.13: Airport Bus Services in Goa

Calungute-Panaji-Dabolim Airport & Back			
SL. No.	**From Calungute**	**From Panaji**	**From Airport**
1	10:30	11:00	08:00
2	11:00	11:30	13:00
3	15:00	15:30	13:30
4	15:30	16:00	14:30
5	17:30	18:00	17:30
6	19:15	19:45	18:00

Source: Kadamba Transport Corporation, Goa

Table 6.14: Tourist Arrivals in Goa

Peak Hour	**Departures**	**Arrivals**	**Total**
0900-1000	1620	3463	5083
Other Peak Hours:	0800-1100	1300-1600	1700-2000
Approximate No. of Passengers (Arrivals + Departures) per day			15527 no's.

Source: Primary Survey, UMTC

The airport buses although widely used need the provision of basic infrastructure such as **dedicated bus bays at the airport, luggage carrying facility within the buses, proper scheduling, increased fleet size, etc.** Considering the large number of tourist inflow to the state, provision of an efficient airport service will enable safe and affordable commute to the airport users. Proper way finding enabled with suitable ITS will enhance the experiences of the airport transfers.

6.2.1.6 Extension of Service Timing

One of the other reasons why the use of Public Transport is not widely popular in Goa is the fact that the services are not reliable. The services in major cities commence at 0600 and terminate at 2300 hours. However, it may be noted that the service in minor cities/ towns are even shorter i.e. 0700 hours to 2000 hours. In Goa, the public transport service starts at 0600 and ends at 2100 hours. Thus, an extension of service catering from 0600 hours to 2200 hours has been proposed. The services planned should be based on a feasibility study to recommend the number of fleet as well as the extension of services.

6.2.1.7 Up gradation of Routes & Services of Private Operators:

Private operators consist of individual owners of buses who operate the buses and there is a stiff competition among them because of which there is over speeding, accidents, bunching etc., The frequency of these buses is also not planned properly because of which there is bunching.

In order to avoid all the above problems the following proposals are suggested.

- An **organization** needs to be formed which monitors the private bus operations in Goa.
- The organization allocates a specific route to each of the private buses and they should operate only on that route. ***Currently, the RTO issues permits to the buses to ply on specified routes. However, these are not regularly monitored***.
- The private bus operators will follow the **scheduled frequency** suggested by the organization.
- Fitness of the buses should be maintained and the buses should be road worthy. ***The buses should not be more than 10 years old and buses older than 10 years should not be allowed to operate.***
- All the buses should be as per **standards**.

- A **fare structure** would be defined by the organization.
- The buses should have **uniform colour** so that it gives an identity as a public transportation bus.

Since KTC has got lot of experience in bus operation it can be the organization which can monitor the operation of private buses and they can charge a specific fee from each of the private bus operators.

In the long term, the KTC with its vast experience may take over the operations of the private transport services by giving a fixed sum for the private bus operators while the rest of the operations may be governed by the KTC.

The merger of operations would reduce conflicts between KTC and Private Operators whilst other benefits of uniform fare structure, non-competitive operations, buses as per the scheduled frequency etc., can be availed.

6.2.2: Higher Order Mass Transit Systems

A Mass Transit System is designed to move large number of people at one time. Mass Rapid Transit system usually runs in special guideways which will lead to lower travel time, and decreased congestion.

WHY USE MASS TRANSIT:

To Counter - Congestion on Roads
To Minimize- Energy Consumption
To Ensure - Healthy Environment
To Improve- Safety to all

A number of technologies are available for public transport and as some of the technologies, especially metro rail, are highly capital intensive, it is necessary to have certain guidelines for choice of different transit modes. However, it is emphasized that buses will continue to be the major mode of public transport in Goa, and hence citywide organized city bus service as per urban

bus specifications is required. The selection of higher order system is based on the Passengers per Hour per Direction (PPHPD) and feasibility of implementation, along with other parameters as mentioned below.

Need For A Mass Transit System:-	**Selection Criteria:-**
From energy efficiency point of view, the use of mass transit is vastly superior when compared to using personalized modes of travel. Available literature shows that, to meet each kilometre of passenger travel demand: A car consumes nearly five times more energy than a 52 seater bus with 82% average load factor A car occupies over 38 times more road space per passenger in comparison to a bus The fuel cost of two wheelers is 6.8 times, three wheelers 7 times and cars 11.8 times when compared to a bus.	• Effectiveness of mode in meeting demand • Cost • Right of way availability • Environmental Impact • Journey Time • Safety • Comfort • Flexibility • Reliability • Fare • Technical Sophistication • Implementation Complexities • Image

Source: UNDP Reference Guide, Vol 2: Public Transport – 2013, MoUD, GoI

The guidelines for selection of mass rapid transit choice for the city is given Table 6.15 as specified by working group on Urban Transport for 12th Five Year Plan of India.

Table 6.15: Selection of Mass Rapid Transit Choice

Mode Choice	Desirable PHPDT	Population (Million)	Average Trip Length (km)
Metro Rail #	>15000 for at least 5 km continuous length	>=2	>7-8
LRT primarily at grade	<=10000	>1	>7-8
Monorail	<=10000	>1	About 5-6
BRT	>=4000 and up to 20000	>1	>5
Organized City Bus Service as per urban bus specifications		>1 lac, 50,000 in case of hilly towns	>2 to 3

The urban transport model developed for Goa has evaluated the PPHPD values on all major corridors of Goa (Urban Mobility Corridors) for base year, 2028 and 2038. The PPHPD values along the urban mobility corridors are shown in Table 6.16.

Table 6.16: PHPDT Values along Mobility Corridors In 2036

Corridor No.	Origin	Destination	Via	Route Length (Kms)	PT PHPDT (2018)	PT PHPDT (2038)
1	Canacona	Margoa		32.9	1307	2045
2	Margoa	Panjim		35.4	2410	3000
3	Panjim	Pernem		31.6	1379	1640
4	Vasco	Ponda		31	1037	1750
5	Margoa	Ponda		18	1211	1155
6	Panjim	Ponda		31.5	794	1055
7	Panjim	Valpoi	Candola	43.5	794	1055
8	Ponda	Valpoi		27.1	550	525
9	Margoa	Sanguem		21.8	693	1095
10	Ponda	Mollem		30.8	265	525
11	Mapusa	Valpoi	Bicholim	44.4	703	870

6.2.2.1 Mass Rapid Transit Proposals

Based on the PHPDT values, suitable mass transit systems are suggested. The CMP Study will not identify the exact system to be implemented on the identified corridors. Further, feasibility studies and Alternative Analysis are needed to come up with the exact mass transit systems on the mobility corridors. However, this Study will indicate the possible system to be implemented on the mobility corridors based on the forecasted PPHPD numbers and right of way considerations. Accordingly, the recommended mass transit systems have been presented in Table 6.12.

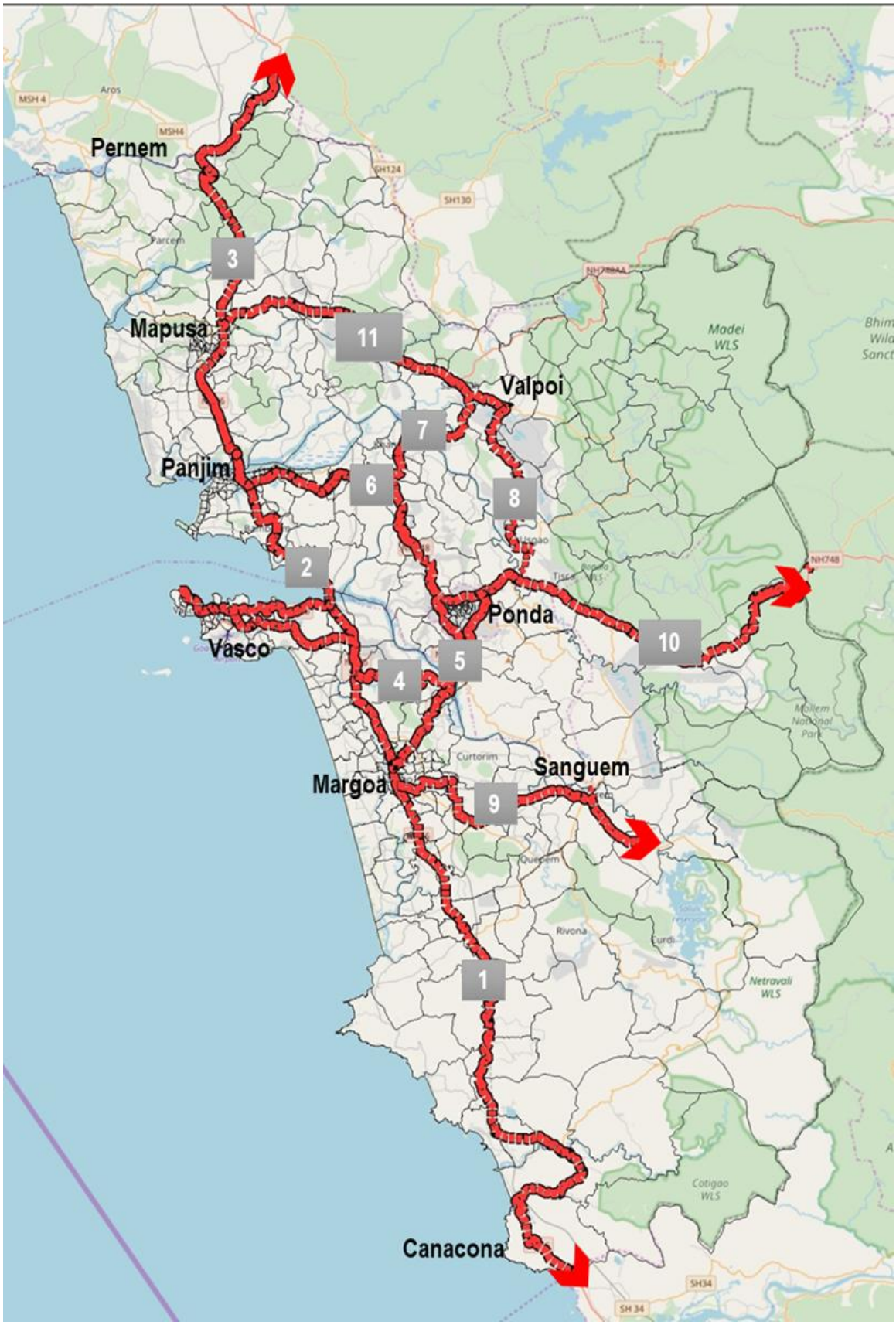


Figure 6.4: Proposed routes for Mass Rapid Transit Systems

Table 6.17: Phase Wise Proposed MRT Systems

Route no	From	To	Route Length (km)	2038	Estimated MRT PHPDT
1	Canacona	Margoa	32.9	High Capacity Bus System with PT Priority Lanes	2045
2	Margoa	Panjim	35.4	High Capacity Bus System with PT Priority Lanes	3000
3	Panjim	Pernem	31.6	High Capacity Bus System with PT Priority Lanes	1640
4	Vasco	Ponda	31	Organized City Bus Services	1750
5	Margoa	Ponda	18	Organized City Bus Services	1155
6	Panjim	Ponda	31.5	Organized City Bus Services	1055
7	Panjim	Valpoi	43.5	Organized City Bus Services	1055
8	Ponda	Valpoi	27.1	Organized City Bus Services	
9	Margoa	Sanguem	21.8	Organized City Bus Services	1095
10	Ponda	Mollem	30.8	Organized City Bus Services	
11	Mapusa	Valpoi	44.4	Organized City Bus Services	870

6.2.3: Water Transport Services

Goa is a coastal city which has grown along the coast. Water transport is the most economical and environmental friendly mode of transport. The water transport system is of two types, inland waterways and oceanic waterways. According to estimates, one litre of fuel can move 24 tonne km of freight by road, 85 by rail and 105 by water transportation.

Goa has got wide network of inland waterways with two main rivers like Zuari and Mandovi and other small rivers like Terekhol, Chapora, Mapusa, Sal which has sufficient draft for navigation. The water network in the State of Goa consists of Six Waterways which have been declared as National Waterways (NWs) under the National Waterways Act 2016. These are;

Mandovi River (NW-68) from bridge at Usgao to the confluence of Mandovi river with Arabian Sea at Reis Magos (41 km).

- Zuari River (NW-111) from Sanvordem bridge to Mormugao Port (50 km).
- Cumbharjua canal (NW-27) from the confluence of Cumbharjua and Zuari River near Cortalim ferry terminal to the confluence of Cumbharjua and Mandovi river near Sao Matias Vidhan Parishad (17 kms).
- Chapora River (NW-25) from bridge at State Highway No. 124 (1 km from Maneri Village) to the confluence of Chapora River with Arabian Sea at Morjim (33 kms).
- Mapusa River (NW-71) from the bridge on National Highway – 17 at Mapusa to the confluence point of Mapusa and Mandovi river at Porvorim (27 kms) and
- Sal River (NW-88 from Orlim Deusa bridge to the confluence with the Arabian Sea at Mobor (14 kms).

Goa has about 555 km of inland waterways out of which only 255 km are navigable through the rivers of Mandovi, Zuari and other tributaries. The better part of the waterway length is used by the mining and export industry for transportation of iron ore to the port of Mormugao and Panaji outer anchorage, from the loading points in the hinterlands.

The State PWD is exploring the possibility of development of the strategic routes of Aldona-Panaji, Cortalim – Durbhat – Panaji, Pilgao – Panaji and Diwar-Chodan-Panaji for movement of both passengers and cargo traffic. The State PWD has also shortlisted nine locations to construct jetties in Goa to promote coastal shipping of cargo and lessen the burden on cargo trucks for shipping goods. This will remove the cargo traffic from the road and will promote coastal/inland shipping. Coastal/inland shipping would be both economical and efficient mode of transportation. The goods transported by waterways in Goa are given in Table 6.18.

Table 6.18: Goods Transported by Inland Waterways

Goa Waterways	Cargo Moved (Lakh Tonnes)		TonneKms (in Lakh)	
	2013-14	2014-15	2013-14	2014-15
	5.99 (1.8)	7.94 (2.2)	270 (1.1)	340 (1.2)

Source: Statistics of Inland Water Transportation 2014-15, Transport Research Wing, Ministry of Road Transport and Highways, Government of India, New Delhi.

It has been observed that with the advancement in the surface transport the state has slowly moved towards motorized surface transport. This led to the step by step depletion of the water based transport system. The passenger boats slowly gave way to the cars. With the construction of new bridges the existing ferries are also vanishing and are only servicing the tourism purposes. The underutilized water network and water based transport system which is cheaper and environment friendly has a very important role to play here. Water transport could cater to the city's growing mobility needs. Water transport could play its role in three areas of mobility:

- Passenger movement
- Freight movement
- Tourism

Cities of Venice, Turkey are good examples of water based passenger movement systems. Venice depends completely on its water for its transportation needs, whereas Istanbul, Turkey is a good example of integration of water and surface transport.

6.2.3.1 Components of Water Transport

A water based transportation system contains the following components in the system namely, Water routes, boats, jetty & its interface, modal integration, ITS etc. Each of the components has its own role to play in the system.

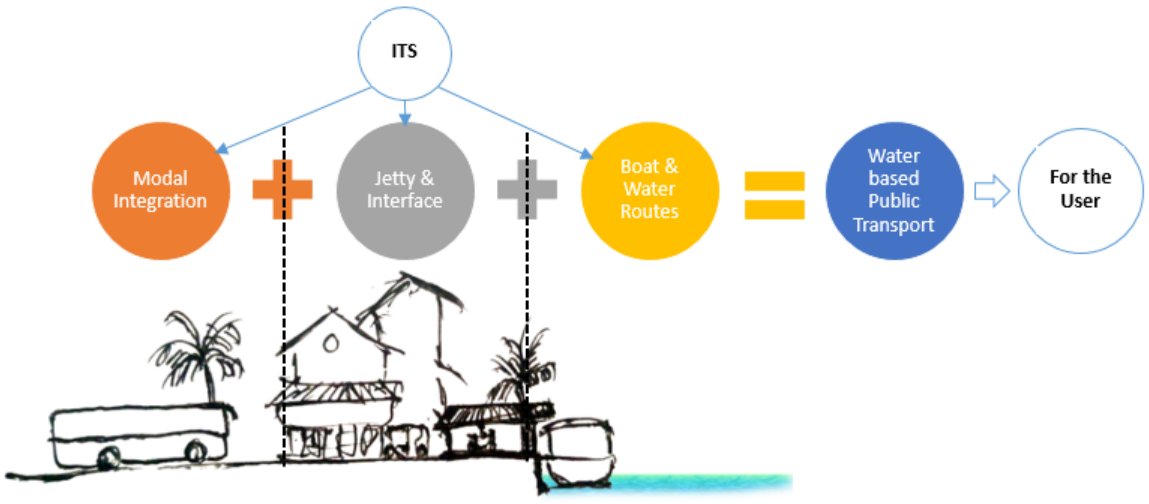


Figure 6.5: Components of Water Transport (Passenger Movement)

It is important to have each of these components addressed in a proper manner to attract passengers back to the water based transport system. Each of these systems is explained in the following sections with reference to Goa.

6.2.3.2 Water Routes

Goa is blessed to have navigable water bodies which are the base of water transport. They include six rivers which cover different parts of the city. However, these channels of water should also have desired depth and width to be truly navigable. Dredging is an important maintenance component which ensures the depth for the passage of the boat. Bridges built on these water bodies should also have enough span and height clearance to endure safe passages of the boats. Many in the main land have low clearance which hinders the passage of boats.

The River Navigation Department, Government of Goa, is instrumental in providing transport service to the commuters across the rivers especially for the islanders in the state of Goa where there are no road access. Goa has good waterway connectivity to various islands and many existing islands are thickly populated. Based on the data collected from the River Navigation Department, it operates 18 Ferry Routes with 39 ferries spread all over Goa. The ferry provides an affordable transport service for passengers, vehicles

and cargo traffic. These services cater to approximately 31,000 passengers per day with daily revenue of around Rs. 80 Lakhs.

Table 6.19 shows the list of the existing ferry routes with ridership. Maximum numbers of passengers transported by ferry is by the route Betim-Panaji with 10,000 passengers per day, next comes the route of Ribander-Charao which transports nearly 7,000 passengers per day. The ferry also transports cars and two wheelers.

Table 6.19: Details of Ferry Services in Goa

Sr. No.	Ferry Routes	No of ferries	Approximate Number of passengers per day
1	Keri – Tiracol	1	500
2	Tuyem – Camurlim	1	200
3	Betim – Panaji	2 * 1	10000
4	Ribandar - Charao	4 * 1	7000
5	St. Pedro – Diwar	2	1500
6	Toltao – Dauji	1	200
7	Vanxin - Amboi	1	200
8	Pomburpa - Charao	1	800
9	Narva – Diwar	1	400
10	Old Goa – Piedade	2	2500
11	Volvoi – Surla	1	200
12	Sarmanas - Tonca	2	800
13	Cumbarjua – Gaundalin	1	200
14	Cortlim – Madkai	2	1200
15	Rai – Shiroda	2	3000
16	Rassaim – Dhurbhat	2	1200
17	Adpai – Rassaim	1	700
18	Volvoi - Maine	1	200
	TOTAL	30	Appr. 31000

Source: River Navigation Department, Goa

As per the stated preference survey conducted for tourist by UMTC, it was found that nearly 20 percent of the tourists preferred ferry as a public transport system in Goa. So there is scope for improvement of ferry services in Goa and the ferry services should be linked with public transportation

like buses so that more number of people use ferry services. Table 6.20 shows the preferred mode of public transport of tourists in Goa.

Table 6.20: Preferred PT System of Tourists in Goa

Sl.No.	Mode of Transport	Percentage
1.	Metro	57%
2.	Rail	6%
3.	Ferry	20%
4.	Bus	9%
5.	E-Ricksaw	7%

In a Detailed Project Report for Development of Coastal Jetties at Goa prepared by AECOM, opportunities have been identified for the proposed jetties in Goa. They have found from the study that two jetties (Ribandar and Old Goa/Divar) have opportunities for both Passenger and Tourism, two jetties (Banastarim and Aldona) have opportunities for only tourism and four jetties (Shiroda, Durbhat, Rassaim and Pilgao) have opportunities only for Passenger.

They have also identified opportunities for proposed ferry route. They have proposed two routes, Shiroda to Nauxim Village and Shiroda to Banastarim for tourism, they have proposed three routes, Panaji/GTDC Proposed Jetties to Old Goa, Panaji to Banastarim and Aldona to Panaji for both passenger and tourism and they have proposed one route, Panaji to Pilgao for Passenger.

6.2.3.3 Boats

Boats are the next major components of the water based transportation system. Custom designed boats can overcome the hindrance factor in water routes such as low height flat base boats can pass through area which has low depths and low height clearances. Safety and speed are other factors that should be looked into for a reliable and safe passage for the passengers. Existing fleet of boats in the city are diesel operated boats with flat bases.

6.2.3.4 Jetties and Interface

Jetties are the areas where the boat docks for passenger boarding and alighting. Based on the observations from the reconnaissance survey, it has been observed that most of the jetties are old and un-safe for both passenger services as well as for the cargo services. As part of the DPR for the development of Coastal Jetties at Goa, 9 locations for new jetties have been identified, which would be enabled with modern arrangement like floating pantaloons which ease the boarding/alights and automatic docking system that ensures smooth docking of the boats. These jetties are located at Cortalim, Caranzalem, Madkai, Quolosium, Rassaim, Durbhat, Raschol, Shiroda and Xelvona. A jetty is a transport node, which witnesses much passenger foot falls that could offer a passenger many other amenities and services other than just boarding/alighting.

The 9 major jetties act as transfer hubs which are also proposed to be developed as an integrated development on the lines of transit station development comprising property development, improved non-motorised transport and feeder access to the boat jetty collectively could be called as interface.

Water based transport system cannot function effectively if operated in isolation. Like any other transport system it also needs integration with the existing infrastructure and last and first mile connectivity. Goa has many areas where this could be easily possible. One of the main factors that help in integration is the proximity of two modes. Goa in that matter is blessed with many spots where integration is easily possible.

6.2.3.5 Issues with the existing Inland Waterways

As mentioned above, at present the Inland waterways are not connected with any other modes of transport. It is recommended that the Public transport (bus) and IPT (Auto) services are connected to all the jetties so that the people can use the public transportation for going to their respective destinations after getting down from the ferry.

- **Up gradation of the Jetties:** Most of the jetties are old and unsafe and it needs to be modernized for better handling of passengers and cargo.
- **Provision of Parking Spaces at the Jetties:** Parking spaces should be provided near the jetties for parking of two wheelers and cars because some of these vehicles are transported by ferries.
- Shelters should be provided near the jetties for passengers who are waiting for longer period of time.
- Proper signs and markings should be provided for safe movement of people and vehicles.
- Navigational aids should be provided for inland waterway routes.

6.2.3.6 Proposals for Water Transport

6.2.3.6.1 Hop-On Hop-Off Ferry Service

Hop-on Hop-off Ferry service can be provided in Goa which can be attraction to the tourist movements. This service can be operated both in the season which starts from October and ends in April and also in the off season between May to September. The Hop-on/Hop-off service can connect some of the tourist locations in and around Goa like Dona Paula, Miramar Beach, Churches in Old Goa, Divar Island, Chorao Sanctuary, Salim Ali Bird Santuary etc., Figure 6.5 shows the proposed route map of Hop-on/Hop-off Ferry Service. There are some existing jetties on the route which may be used by ferries for transportation of tourists/regular commuters. Some of the existing jetties are Dona Paula Jetty, Panaji Jetty, Betim Jetty, Charao Jetty, St. Pedro Jetty, Piedade Jetty, Narva Jetty, Vanxin Jetty, Amboi Jetty, Old Goa Jetty, Ribander Jetty, Divar Island Jetty etc.

Figure 6.6: Proposed Route Map of Hop-on and Hop-off Ferry Service

6.2.4: Intermediate Public Transit (IPT) / Feeder Services

Unreliable last mile connectivity impacts the overall quality and usage of mass transit and results in a mode share shift of public transport. While efforts are being made to enhance mass public transport, last mile connectivity has to be improved and linked into existing services.

An integrated system will aid ease of access for users. Auto-rickshaws not only act as good feeder services to these mass transit options but can also be a mode of choice for occasional short trips. They play a key role in improving sustainability for urban transport. There is a need to introduce new models of regulation and reforms that can be adopted for a more efficient and safer system that enable the rickshaw to have an optimal role in the transport mix.

IPT Passenger service is often poor because:

1. No regulation of fares.
2. Little integration between modes due to lack of co-operation which inconveniences passengers.
3. Lack of safety regulations puts passengers at risk.

4. Concern for safety due to mixed traffic flow driven by growth in private vehicles.

Attempts need to be made to organize IPT,

1. Provide better service to passengers.
2. Transparency of fares and complaints hotline.
3. Driver behaviour and road safety training.
4. Dispatch services or "dial-a-rickshaw".
5. Integrate with mass public transport.
6. Feeder services for first and last mile connectivity
7. Promote sustainability: solar-powered rickshaw or rickshaws on CNG.

6.2.4.1 Key Challenges

6.2.4.1.2 Competition of Auto-Rickshaw services with Public Transport

Current trends in urban transport highlight the usage of IPT modes (i.e. auto-rickshaws and taxis) in cities for daily commute trips, because of the poor quality of public transport. Thus, improving public transport in cities would be a key strategy in ensuring that auto-rickshaw services fulfil their intended role as feeder services instead of competing with public transport for long-distance trips.

6.4.1.2 Challenges in Technology Implementation for dispatch (Dial-A-Rickshaw) Services

Dispatch (dial-a-rickshaw) services in the auto-rickshaw sector would be important in making auto-rickshaw services an attractive door-to-door transport alternative to private motor vehicles for occasional and emergency trips. Fleet operations have been noted to be most effective at implementing the necessary technology for dial-a-rickshaw services (Schaller 2007). However, auto-rickshaw services in the majority of Indian cities are provided by individual owner-operators rather than by fleet companies. The lack of organization poses a barrier for the provision of dial-a-rickshaw services. Regulatory reforms that allow fleet-based operations with dispatch services to enter the auto-rickshaw sector could help address this issue.

6.2.4.2 Proposals for Intermediate Public Transport (IPT)

In Goa, the IPT routes operated overlap with the major trunk PT corridors. Although improving public transport in Goa would be a key strategy, it is also important to ensure that auto-rickshaw services fulfil their intended role as feeder services instead of competing with public transport for long-distance trips. The same is achieved by rationalizing their major routes to feed into the PT corridors, designating the routes, stops and a common mobility card can also be introduced which can be used across the modes by the user.

6.2.4.2.1 Introduction of IPT Routes

About 28 new IPT routes have been identified, which will feed to the City Bus Services. These routes are given in Table 6.21.

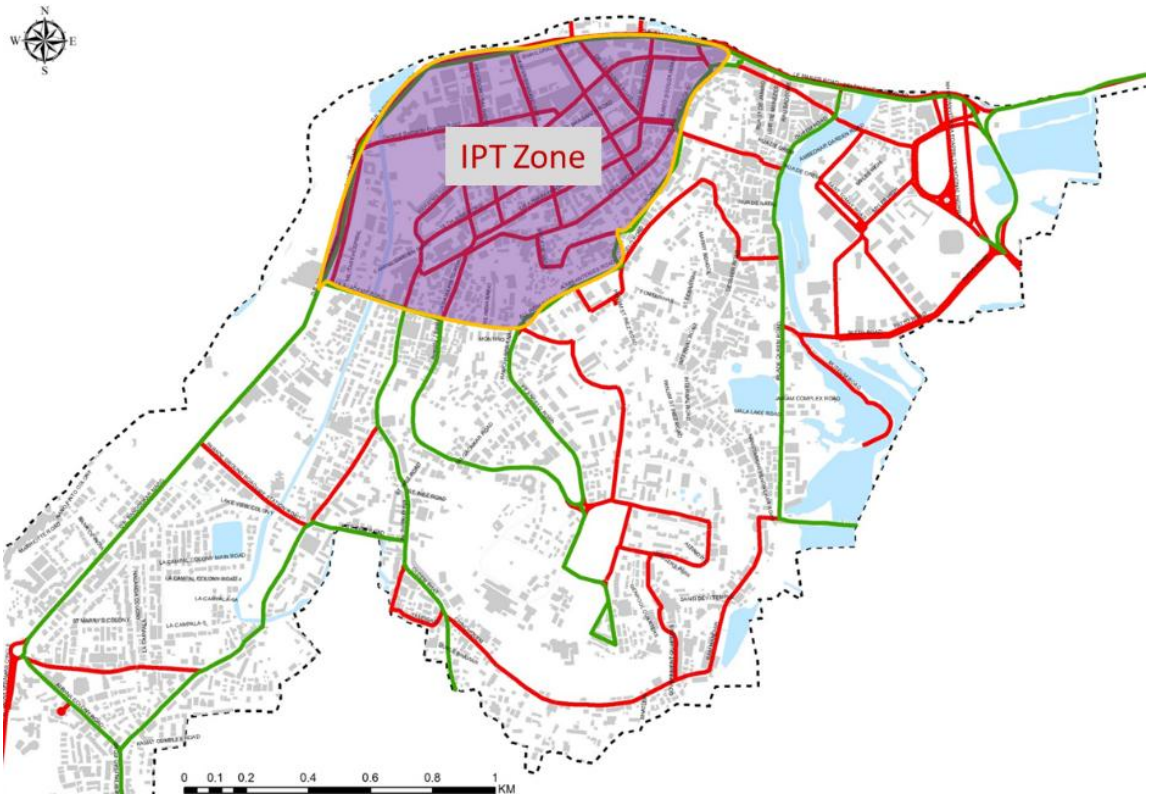
Table 6.21: Feeder Route Details

Route No.	Origin	Destination	Route Length
Route 1	Kolva Circle	Raicho Ambo Circle	5.60km
Route 2	Pandava Chapel	Old College	1.88km
Route 3	Kamat bus stop	Navelim Church	2.26km
Route 4	Madgao Bus Station	Colva Circle	1.70km
Route 5	Bus Stand	Ambedkar School	7.60km
Route 6	Bus stand	Old goa	9.90km
Route 7	Bicholim	Varpal	6.56km
Route 8	Mapusa	Calvim	11.62km
Route 9	Mapusa	Bastora	2.53km
Route 10	Mapusa	District Hospital	0.71km
Route 11	Mapusa	Aldona	9.38km
Route 12	Mapusa	Camrulim	9.33km
Route 13	Mapusa	Maem	17.64km
Route 14	KTC bus stand - Circular route		7.84km
Route 15	Mardoa	Assolda	13.25km
Route 16	Mapusa	Bedem	7.74km
Route 17	Margaon	Colva	4.17km
Route 18	Ponda	gaunem	6.90km
Route 19	Ponda	Agapur	8.55km

Route 20	Pandava Chapel	Old College	1.88km
Route 21	Kamat bus stop	Navelim Church	2.76km
Route 22	Colva	Vanelim	5.34km
Route 23	Bus Stand	Durgawadi	5.34km
Route 24	Bus Stand	Santa Cruz	5.19km
Route 25	Bus Stand	Sabnis Valley	6.63km
Route 26	Bus stand	Moira	5.50km
Route 27	Bus Stand	Chikhli	5.57km
Route 28	Bus Stand	Chapora	8.74km

6.2.4.2.2 IPT: An alternative to PT

Considering the nature in which the cities/towns have emerged in the State of Goa, the streets are narrow with very few roads which are wide enough to accommodate the services of the transit bus services. These narrow road networks are often surrounded by dense developments with high density of population.



The poor services of public transport could be one of the prime reasons to the dependency of personal modes for commute. The constraint can be

overcome by allowing the services to be catered by alternative modes of IPT. IPT although are of less carrying capacity than that of buses, have their advantages in terms of faster turnovers, last and first mile connectivity, energy efficiency, etc. In this regard, IPT can cater as feeders to the main trunk services or as main services in areas of space constraint.

An IPT loop of services can be proposed in the city of Panaji. The city center of Panaji is formed by a network of one way streets, heavily encroached by parking. Creation of an IPT loop connecting to the main trunks on DB road will enable commuters to relay upon PT service. The proposed loop would cover areas such as Campal, Don Bosco School, 18th June Road, MG road, etc.

6.2.4.2.3 IPT: Hop On and Hop Off

Considering the large influence of tourism on the state, there are pockets in the state which can be converted into vehicle free zones or no traffic zones. These zones could be used for better road safety as well as for creating lung spaces in the city. One such zone has been identified at Calangute. The proposed scenario is as demonstrated below, despite having a parking facility about 2 Km away from the beach, most motorist ride up to the beach entrance to drop off the passengers and then ride back to park their vehicles in the parking. This not only creates dead miles but also hinders the safety of the pedestrian and shoppers.

The proposal is to provide IPTs as feeder from the parking. These IPT could be eco-friendly vehicles with a passenger carrying capacity of 7-10 numbers. The restriction of private vehicles and replacement by IPT (preferably electric) would also benefit at providing more walkable space for the pedestrians and shoppers.

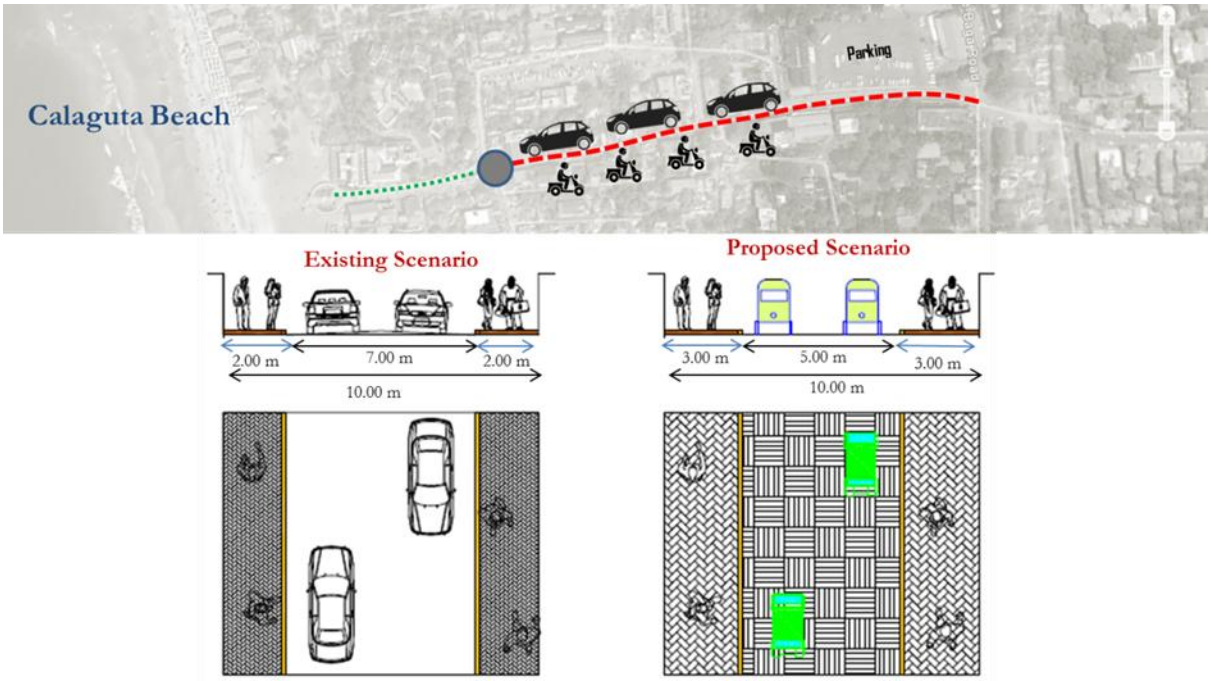


Figure 6.7: Proposed Scenario for Parking in and around Calangute Beach

The following are the proposal for improvement of IPT:

1. **User Guidelines:** The Government or the RTOs must ensure that the vehicle as well as the fitness of the driver is tested and verified for every 2 years. The use of eco-friendly vehicles should be encouraged. The drivers should also be enrolled in road safety awareness campaign and certified accordingly.

2. **Fare Structure:** Auto-rickshaw is not the most preferred mode of the locals in the state as the fare for the system seems to be unreasonably high. Auto-rickshaws are the last preferred options and are used only in case of urgency or emergency. Introduction of a metered system developed and controlled by the Government would enable transparency as well as increase dependency to its users. The fares may be revised by the Government based on the increase or decrease of the fuel prices.

3. **Parking Bays:** Allocation of parking bays for Pilots and Auto rickshaws at crucial nodes such as Bus Terminals, Busy Commercial Areas, Shopping malls, Theatres etc., should be provided with proper signage's and way findings. An average of 3 ECS at a spacing of 600 m is suggested.

4. **Cab Aggregators:** Similar to the autos/pilots, the taxis also have been charging the tourist exorbitantly. In this regard, the introduction of Cab aggregators such as the Uber/Ola may be used for operations in Goa. This would ensure better services, reliability and transparency for both the operator as well as the user.

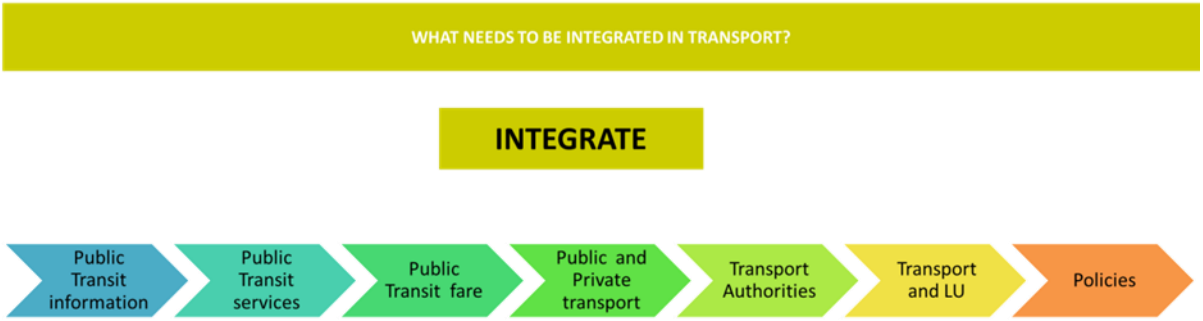
6.2.5: Multi-Modal Integration

Despite having a large range of transport options, the State has seen an increase in the dependency on personal modes. This could be accounted to the lack of intermodal connectivity. Each Mobility/Transit Hub will consist of three main components:

- An integrated terminal facility with adequate facilities and amenities to cater to the requirements of all user groups.
- A mixed-use development with shopping, office spaces and other commercial activity to enable people to fulfill all the needs by using public transport.
- Provision of Park-and-Ride facility to encourage the use of public transport.

The concept of integrated transport planning has emerged as a framework to more closely define the broader term of transport planning. According to the Integrated Transport Planning Framework for Queensland, integrated transport planning is defined as:

"A process to identify current and future access needs – for people, places, goods and services – and inform decision makers on ways to manage the transport system and land-use to best address these needs. It aims to do this in a way that sustains economic growth, conserves the environment and supports the quality of life of current and future generations"

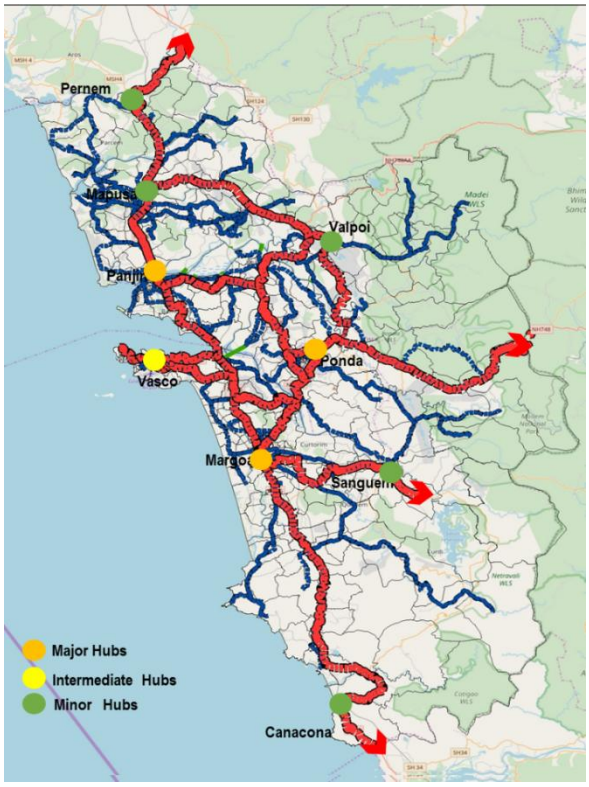


Source: Integration for Seamless Transport, John Preston

6.2.5.1 Inter-Modal Mobility Hubs and Bus Stops

In addition to providing good quality of public transport services, it is important to provide adequate support infrastructure as well. This would account for the provision of bus terminals, jetties, transfer hubs, bus stops etc. The state needs up-gradation of its transit infrastructure in order to improve/increase the public transport patronage.

As mentioned in the previous section, Goa State needs to cater to the infrastructure requirement of 1089 buses by 2041. Typically, 5 acres per 100 buses is considered for estimating the land required for the Depot/Terminal. As in case of Goa, approximately 54.45 acres of area is required for the Bus Terminal/depot. Considering already available land under terminal/depot is 45 acres, an additional area of about 10.50 acres is required for the CBS Services.



The current bus terminals/ Depots in Goa are located in Panaji, Margoa, Vasco, Porvorim, Ponda, Mapusa, Sankhelim. However, other service areas such as Conacona, Pernem, Sanghem, Valpoi are not connected properly. Hence as part of the CMP, it is

recommended to develop Mobility Hubs at the following locations:

1. **Major Transit Hubs**

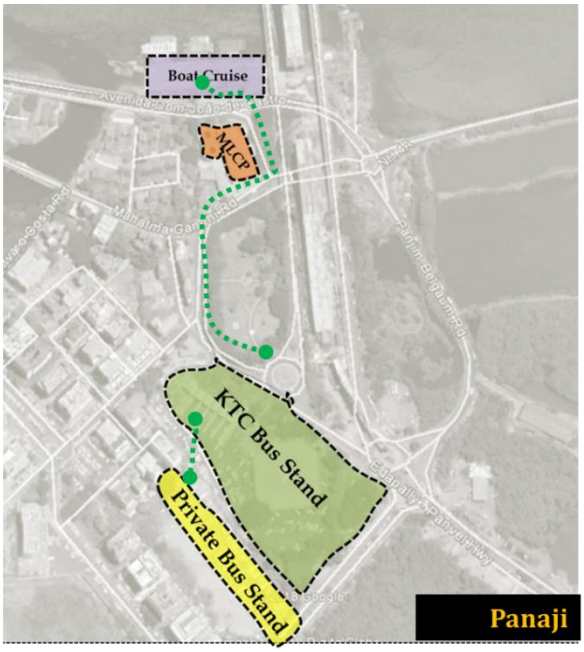
a. Panaji
b. Vasco
c. Madgaon
d. Pernem
e. Mapusa

2. Minor Transit Hubs

a. Canacona
b. Sanguem
c. Valpoi
d. Sanquelim

Based on the Regional Plan, no additional reserved sites for bus terminals/depots with the Goa State have been identified. A feasibility study is needed for checking the viability of the project.

Based on the High volume of commuter traffic Movement, five cities can emerge as major transit hubs, whereas the remaining four can emerge as Minor Transit Hubs. Details of the same are described below:



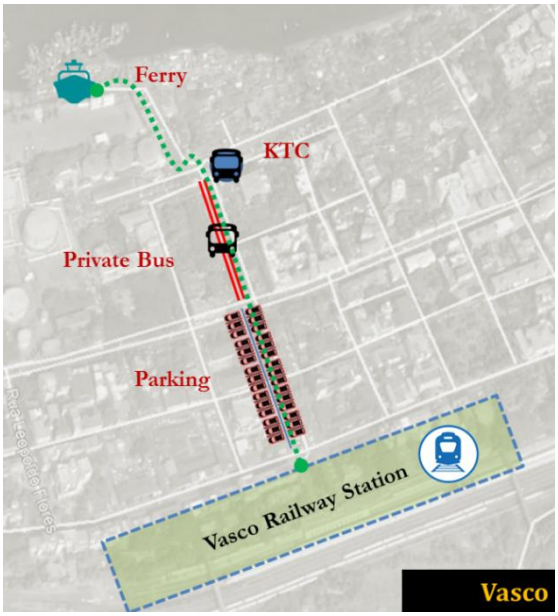
1. **Panaji:** Considered to be one of the busiest terminals in the State, Panaji bus terminal caters to both inter and intra state buses while also accommodating Interstate buses as well. Considering a good ridership on the ferry services of Panaji, the introduction of an intermediate stop at the Santa Monica Jetty may be sought. This connection would provide commuters to either hop on or hop off between the bus and ferry services eliminating the task of

interchanging modes to access. The availability of a Multi Level car park facility within the vicinity of 500-800 m would encourage users to park and ride, thus encouraging public transport usage.

PANJIM BUS TERMINAL

2. **Vasco:** The creation of a multi modal hub at Vasco would enable the connection between 3 modes i.e., Ferry (Water Transportation), KTC (Road Transportation) and Railways. Currently, the Vasco ferry is not operational. The Vasco bus (KTC+ Private) is widely used by the locals due to its proximity to the Fish and Vegetable market as well as for its services catering to the different parts of the State. The Vasco railway station is also widely used both by tourists and the locals. The proximity to the Government offices also makes it a viable location to create an interconnected transit transfer station.

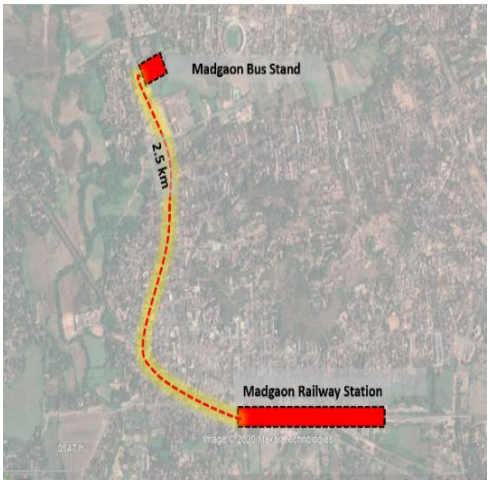
   The connectivity between above mentioned transit hubs require a barrier free pedestrian walkway (3 m wide) with safe crossing (table tops). This could be complimented by co-ordinated scheduled timetables at each transfer node. The creation of a pedestrian plaza may also be sought in the long term.

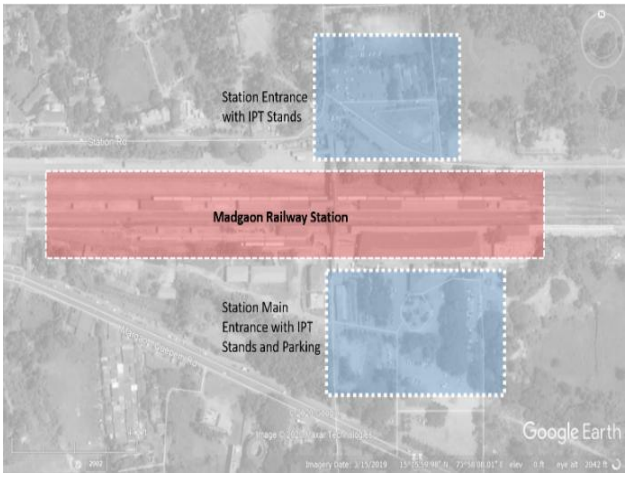


3. **Madgaon:** Madgaon Railway station is a major halting point for most of the trains passing through Goa. The railway station is located 3 km from the Madgaon City centre, 38 km from Panaji, 26 kms from Dabolim International Airport. The Madgaon Junction railway station has 3 platforms, 14 originating, and 54 terminating trains. 92 trains halt here. The madgaon Bus station is located 2.5 km from the railway station and is connected via shuttle service operated by private operators. The travel to Panjim, Mapusa, Pernem, Ponda would require a change over at Margao Bus stand. The railway station has separate Taxi stand.

Shuttle Service Connecting Madgaon Railway Station &

Prepaid Auto Stand outside Madgaon Railway Station





Route showing Madgaon Railway Station to Bus Stand (2.5 Kms) – Left & Madgaon Railway Station Surrounding Area - Right

4. **Pernem:** Pernem City is located towards the north of Goa. The population of Pernem is considerably low compared to other cities in Goa. However, Pernem is set roadmap for development considering the proposed infrastructure facilities like Mopa International airport, Tuem industrial estate development, proposed Logistics Hub development. Pernem city is connected with Pernem Railway station which is the first railway station for inbound trains from Mumbai. Currently, Mondovi Express, Konkan Kanya Express and Goa Sampark Kranti Express halt at Pernem station.

Existing Pernem Railway

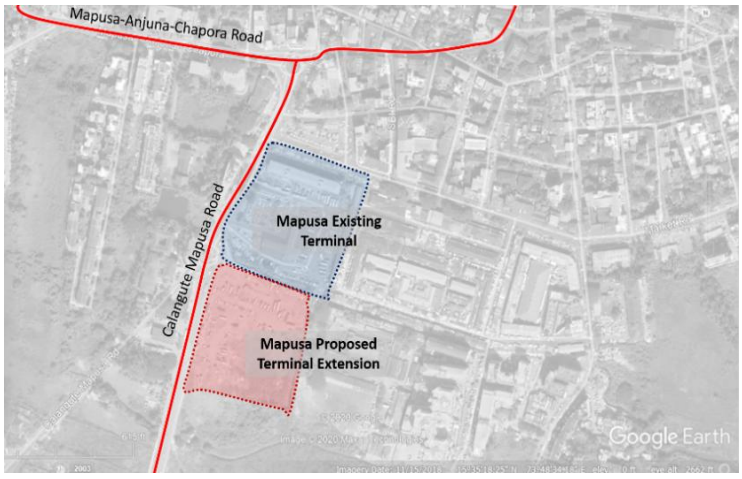
The proposed Mopa Airport located 13km from Pernem railway station is built with the handling capacity of 5 lakh passengers annually during phase I and 13 lakhs passenger annually upon completion.

Access to MOPA AIRPORT from Pernem Railway Station and New Bus Stand

Considering the huge potential for transfers, inter modal connectivity between Pernem New Bus Stand, Pernem Railway Station and Mopa International Airport needs to be strengthened. This could be achieved through operating shuttle service from MOPA airport to Bus Stand and Railway Station or introducing Automated Peoples Mover (APM) connecting the Airport terminal with railway station and bus stand.

5. **Mapusa.** Mapusa, a town in the north Goa is the commercial center. The bus stand in Mapusa acts as entry for the interstate buses from Mumbai, Hyderabad and other major cities to enter Panjim.

The modes of services available for integration includes Intrastate city buses, private buses, Interstate Government buses , tourist buses and private buses, IPT, bicycle and pedestrians. Facilities for all the above modes of transport are to be integrated to facilitate smooth transfer of passengers



Mapusa Bus Terminal

Considering the harsh climate of the State, there is a need for proper bus shelter with good shade, seating arrangement, dustbin, proper information system like route numbers, route map etc., The construction of bus shelters at adequate distance will encourage users. Currently, the bus stops are undesignated and often stops are made when passengers simply show hands. This not only creates confusion amongst the users, but also increases the risk of accidents. Along with the public transit proposals, it is very important to integrate all the services with intelligent transport system. One bus stop needs to be provided for every 0.5 km (500 metres) of road length and hence for 1,200 Km of Primary Network, 2400 bus stops are recommended.

The State depends to a large extent on private mode of transport and doesn't support the patronage of public transit users. Most streets are encroached by parking while leaving no space for the development of public transit infrastructure. The following recommendation to be followed:

a. Bus Stop- ROW=< 7 m
b. Bus Shelter= ROW=10-15 m
c. Bus Bay- ROW>20 m

Bus shelters should be accessible (universally), visible, safe, as well as provide adequate information (Route numbers, Route of Operation, Service Availability, etc.).

6.2.6: Implementation of ITS to improve the reliability of Public Transport Systems

ITS has the ability to provide real time information to public transport passengers through a variety of media such as at-stop displays, SMS

messaging and the internet. As transit service continues to evolve, passenger information systems are quickly becoming a mainstay in today's public transit domain. Integrated systems that keep passengers informed along their journey are increasingly in demand. The application of which would enable reliability and comfort to its users. Amongst the many applications of ITS, the crucial applications that are the need of the hour are mentioned below:

1. ***Passenger Information System (PIS):*** A passenger information system is the key communications link between a transit agency and their riders. Passenger information technology lets a transit agency communicate with its passengers to provide them with real-time bus location and status updates, schedule data and timely announcements. Keeping passengers informed allows them to plan their journey better which also increases passenger comfort and satisfaction. It may include route maps, entertainment, advertisements, bus current position, next station, route number, bus destination, estimated departure time, estimated arrival time, connections, and information about disruptions.

Table 6.22: Contents of a Passenger Information System

On Board	Terminal/ Bus Stops/ Transfer Stations
Next station or stop	The next vehicle to arrive, including its route and destination
Time of arrival	Time of arrival
Estimated Time of Arrival (ETA)	How closely it is running to timetable
	Similar information for the following services
	Other information that may be useful to the passenger in understanding the implications for their travel plans

2. ***Electronic Ticket Machines (ETMs):*** ETMs on any transit buses and trains allow the issue of more specific ticket types, which benefit the passenger. However, they also collect a great deal of management information such as the *measure the speed of a bus along a route, ridership of each stage*, etc which is of use to the operator.

Smartcards retain information about the individual user (e.g. that they have a concessionary permit) as well as facilitating a wider range of fares options than is possible with paper based tickets. They can also be used to reduce ticketing fraud where this is a problem. They can, therefore, have benefits for the passenger as well as for the operator. *Except for the KTC, all private contract carriages don't issue tickets to their commuters*. This affects the commuter's ridership and thus increases pilferages.

6.2.7: Promoting Public Participation and Campaigning for Creating Mass Awareness

For successful implementation of the transit system, it is necessary to promote public awareness and create a sense of public ownership of the project. For this to happen effectively, it is necessary to evolve an outreach and education strategy for promoting the system. The outreach and education goals need to be defined at the planning stage of the system itself to focus on the efforts of the project implementation. The outreach and education goals as listed under UNDP Reference Guide for Public Transport are as follows:

- Introduce the concept of the transit system, its purpose and its benefits to various stakeholders.
- Create profile of the system as a big impact, with incremental city.
- Enhance the understanding that mass transit projects positively impact economic health and environmental stability of the city.
- Introduce the concept of specific systems as an important strategy in making the best use of transportation resources.

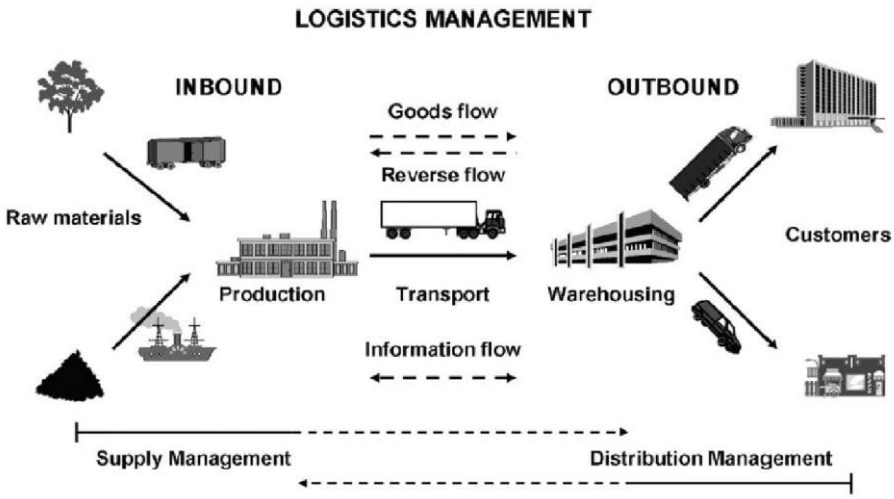
- Establish communication channels for the public to receive information and interact with the implementing agencies.

Following strategies can be adopted for an effective public outreach

1. Create a network of allies and provide platforms for them to actively participate as disseminators of project benefits.
2. Use proactive and creative communication media to promote key messages. Communication media can be print, broadcasts, short films, event marketing etc.
3. Programmes can be conducted in schools and colleges advocating the need for public transport. Events like Car Free Day, Raahgiri can also be promoted.

6.3: Freight Management

Goods are transported from one point to the other and for efficient movement of goods there should be good network of roads, railways, airports and waterways. Various modes of transportation can be used depending upon the cost and travel time. Water transportation can be used for transportation of bulk commodities like iron ore, coal, containerized cargo etc., Air transportation can be used for transporting materials which have a short shelf life. Rail transportation can be used for transportation of bulk commodities for medium to large distance at moderate speeds. Road Transport can be used for relatively small loads over relatively short distance at relatively fast speed. A typical logistics functions includes transport, warehousing, inventory management, information systems, procurement, materials



handling, order management, customer service, packaging and reverse logistics (De Villiers et al). Logistics hub can be constructed for transhipment of goods between various modes of transportation, collection and distribution of goods (Source: de villiers et al).

6.3.1: Goods Transportation Survey

Most of the goods movement happens on NH4A, NH17, NH17A, NH 17B in Goa. An outer cordon roadside interview survey was conducted in order to capture the details of movement of goods and the commodities transported in Goa. It was found from the survey that 34% of the goods transported were fresh produce followed by 25% of petrol and diesel and 22% were food grains. A goods operator's survey revealed the following,

- Average number of trips per month is 34.
- Average distance of travel is 33.5 kms.
- Nearly 60 percent of the truck operators mentioned that they do not have ample parking space and they usually park along the street.
- Bypassing trucks found some convenient intermediate stops at cities like Margoa and Verna.

6.3.2: Criteria for selection of Logistics Hub

There are a number of evaluation criteria for selection of location for logistics hub. The criteria can be classified into main criteria and sub-criteria. The main criteria can be infrastructure facilities, land availability, proximity to market, government and industrial support and labor supply etc., The sub criteria can be adequate multi-modal transfer systems, good telecommunications systems, reasonable port charge, adequate cargo and container handling facilities, capable of handling all types of commodities (including dangerous goods) and available rail and road links with local consumer and industrial areas. Apart from the above main criteria and sub-criteria there are other factors which need to be considered such as vehicle taxes, road density and congestion, road infrastructure, condition of roads and location away from residential zones and so on. Also the decision about location of logistics centre should be made after thorough analysis of the

factors like cost of labor in the given area, cost of warehousing and transport, required level of service i.e., a time from placing an order to the delivery of the product to the customer (for instance 24 hours) and taxes and custom duties. Some selection criteria have been evolved in order to select the location for logistics hub in Goa. The following are some of the selection criteria for selection of logistics hub.

Table 6.23: Criteria for Selection of Logistic Hubs

Sl. No.	Criteria
1	Highway Access
2	Railway Access
3	Port/Inland Waterway Access
4	Airport Access
5	Public Transport Availability
6	Para-transit Availability
7	Industrial Area Access
8	Workforce Availability
9	Basic Service Availability like Water, Electricity, Sanitation etc.,
10	Telecommunication Access
11	Proximity to Market and Market Needs
12	Located away from Residential Area

6.3.3: Location of Multi-Modal Logistics Hub in Goa

Goa Industrial Development Corporation (GIDC) has constructed a truck terminal at Kundaim Industrial Area measuring around 3000 sq.mts with toilet and cloak room facility. South Goa Planning and Development Authority (SGDPA) wanted to construct a truck terminal at Madel in South Goa by acquiring land of 1.37 lakh square meters which was opposed by the local farmers. A multi-modal Logistics Park has been constructed at Balli Station near Madgao and it is located on Konkan Railway Route. The facility is initially spread over 81,300 square meters with scope for expansion with traffic growth in future. Truck terminals provide logistics solution for only one mode of transportation. Instead of providing truck terminals, it is better to provide multi-modal logistics hub so that goods from all modes of

transportation can be efficiently sorted and transported to the respective destinations and one location can solve all the problems of logistics. It is better to provide multi-modal logistics hub in wasteland rather than in the agricultural land.

One multi-modal logistics hub can be provided in the North near Pernem in Goa. This is a potential location and exact location has not been suggested because some more data needs to be collected for evaluation. The logistics hub should be located preferably in wasteland but not on agricultural land.

1. **Pernem:** The multi-modal logistics hub can be setup in the North of Goa near Pernem railway station because there is an existing highway, railway and there is a proposal to set up international airport near Mopa and there is also an industrial area in Tuem.

Table 6.24: Infrastructure available for setting up logistic hub in Pernem

Sl. No.	Criteria	Yes/No
1	Highway Access	Yes
2	Railway Access	Yes
3	Port/Inland Waterway Access	No
4	Airport Access	Yes (Proposed)
5	Public Transport Availability	Yes
6	Para-transit Availability	Yes
7	Industrial Area Access	Yes (Tuem Industrial Area)
8	Workforce Availability	Yes
9	Basic Service Availability like Water, Electricity, Sanitation etc.,	Yes
10	Telecommunication Access	Yes
11	Proximity to Market and Market Needs	No
12	Located away from Residential Area	Yes

6.3.4: Freight Corridors

Freight corridors should be provided for fast and efficient movement of goods. The freight corridor should connect all the industrial estates, existing truck terminals and proposed multi-modal logistics hub. The freight corridors should be wide enough and there should be truck bays at frequent

intervals so that the truck drivers can park their trucks and take rest and also in case of breakdown of trucks, it can be moved to truck bays for temporary repair.

The movement of trucks inside the cities like Panaji, Mapusa, Ponda, Margao, and Vasco should be restricted during daytime from 7.00 a.m. to 10.00 p.m. and it should be allowed only between 10.00 p.m. to 6.00 a.m. Figure 6.8 shows the freight corridor connecting industrial estates, existing truck terminals and proposed multi-modal logistics hub.

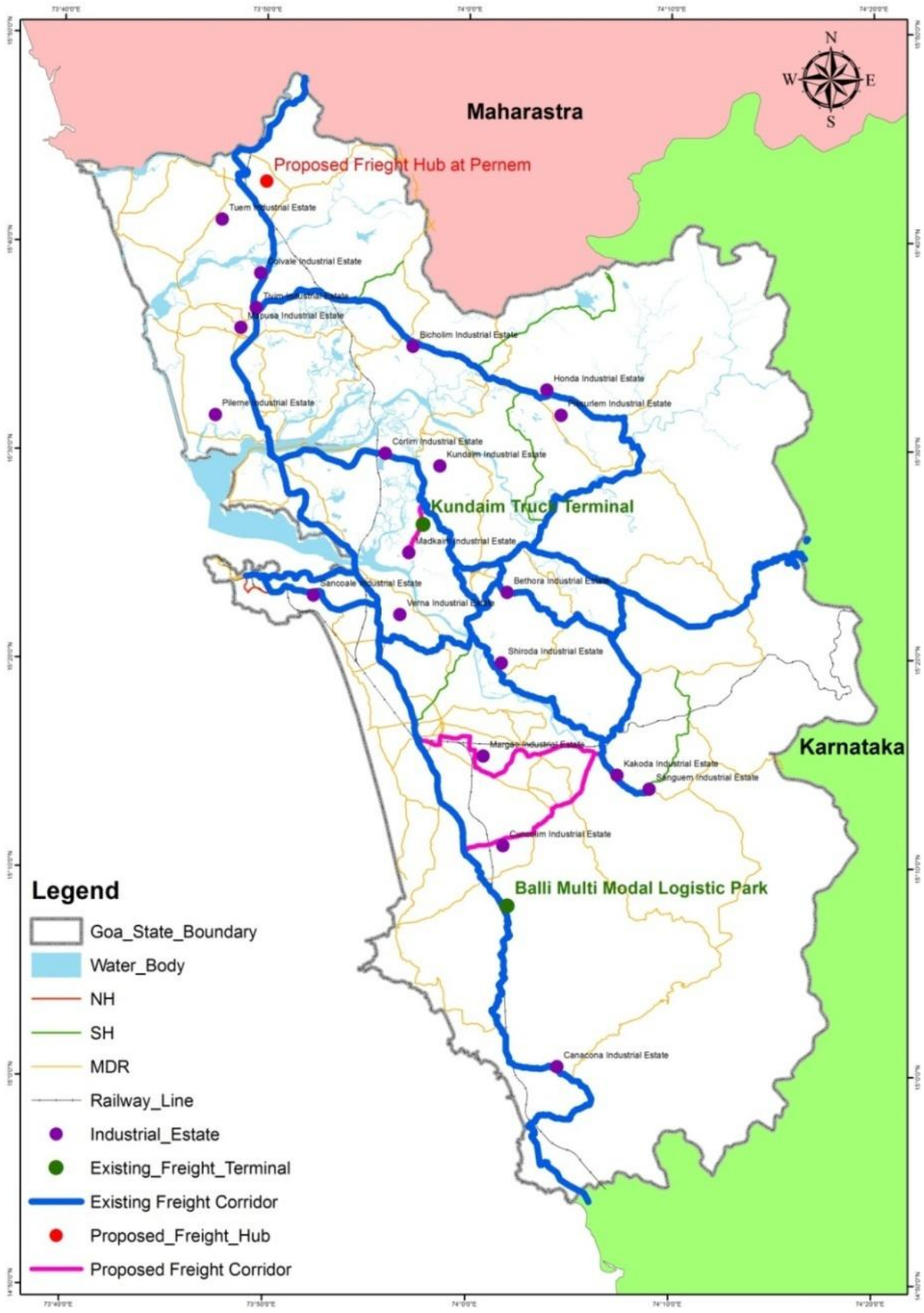


Figure 6.8: Freight Corridor with Proposed Multi Modal Logistics Hub

6.3.5: Freight Policy

Freight has always remained as an unnoticed transportation policy. The word "FREIGHT" should be considered in all the planning and policy documents to give considerable recognition to its management. The freight policy will be aimed at the overarching aim of efficient and reliable handling and distribution of goods and services.

Freight policy principles adopted for the State of Goa are:

- Manage the heavy demands placed on the regional infrastructure, by balancing the needs of freight and passenger traffic.
- Improve the array of transportation options available to regional freight users.
- Restrict the heavy vehicles entering the city during day time. However, International Container Terminal Road can be made available for heavy vehicles. By pass the freight traffic passing through the city.
- Develop truck terminals near cordon points and distribute the goods in LCV/sustainable transport choices.
- It is advisable to develop a Freight Operator Recognition Scheme. A tiered set of membership levels can be given to frequent operators coming to the city.
- Develop a freight information portal i.e a single interface is available for information on the freight movement.

6.4: Non Motorised Transport Improvement Plan

Goa with its highest accident per lakh of population in the country claiming 40% of deaths (unnatural causes) in Road accidents out of which 7% of road accident involve pedestrians and so there is a great need for pedestrian safety.

It may also be noted that despite 36% of average trip lengths being around only 2 km, but only 1% is of those trips are walk trips. In this regard, Goa needs to lay emphasis on improving the NMT share which would directly reduce the dependency on personal modes as well as increase the Public Transport ridership.

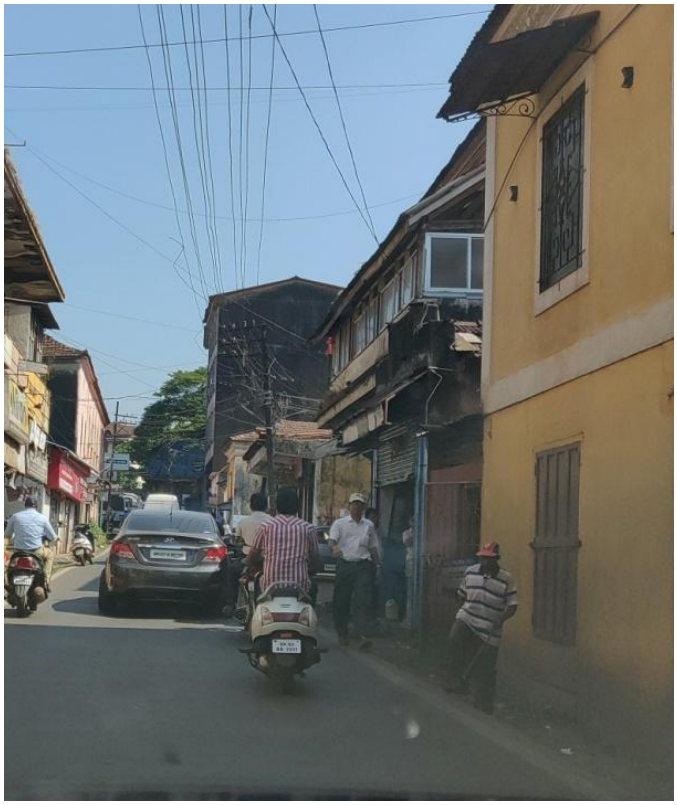
The NMT plans stated below are concentrated to the city centers. The 5 major urban cities that are considered include: Panaji, Vasco, Ponda, Mapusa and Madgaon.

The NMT mainly comprises 2 sectors: Walking and Cycling.

6.4.1: Development of Footpaths

Pedestrian trips are generally short trips and can be observed everywhere in a city. And hence, ideally pedestrian walkways should be provided on all major roads and streets in the city. However, special consideration for pedestrians should be given near junctions (dangerous intersections), major activity nodes (like schools, colleges etc).

Safe Route to Schools program should be conducted and should be encouraged to follow in all the schools in Goa. The streets accessing the schools should be designed for pedestrians.



The Comprehensive Mobility Plan has identified all the major spines of the state for immediate need of footpaths. All the junctions should be designed with due consideration for pedestrians. The footpath design should be uniform across the city.

Some of the design principles adapted are:

- Depending on the volume of pedestrians, nature of land use abutting the road, etc the width of the footpath may vary from a minimum width of 1.5 m to 5 m.
- It is also crucial to maintain a kerb height of 150 mm from the finished road surface as well as ascertain universal accessibility for the differently enabled.
- Traffic Calming measures may be adopted suitably to cater to the safety of the pedestrians.
- Strict enforcement on the removal of encroachment of vendors as well as parking on footpaths should be carried out.
- Pelican Signals or Pedestrian signal phasing at major intersections to enable safe crossing.

Accordingly, CMP has identified 384 km road within the major urban centres of the state where the footpaths need interventions with reference to the dilapidated pavement conditions, insufficient walkway widths, lack of universal accessibility, etc.

Table 6.25: Footpaths widths for various types of road

Carriageway	Arterial	Sub Arterial	Collector	Local
<5.5m	--	--	Shared Space	Shared Space
5.5-10.5m (One/Two lane Traffic)	--	1.5-1.8 m	1.5-1.8 m	---
15 m- 18 m (Two Lane Traffic)	2.0-3.0 m	1.8-2.0 m	--	--
>18 m	2.5-3.0 m	1.5-2.0 m	--	--

Two Lane traffic with carriage way width > 15 m should be provided with a median of 1 m as pedestrian refuge area.

Figure 6.9: Classification of Urban Roads

Table 6.26: Name of roads which need footpath improvement in Panaji

Sl. No.	Name of the Road	Classification of the Road	Footpath Length (Kms)
1	18th June Road	Sub-Arterial	1.13
2	Av. Teofilo Braga Road	Collector	0.7
3	Caetano de Albuquerque Road	Local	0.26
4	Cunha Rivara Road	Collector	0.26
5	Dayanand Bandodhkar Marg	Sub-Arterial	4.15
6	Dhempe College Road	Sub-Arterial	0.43
7	Dr .Dada Vaidya Road	Collector	0.83
8	Dr Alvaro Costa Road	Collector	0.2
9	Dr Alvaro Costa Road	Collector	0.22
10	Dr Atmaram Borkar Road	Collector	0.71
11	Dr Braganza Pereira Road	Collector	0.39
12	Dr Gama Pinto Road	Local	0.27
13	Dr Jack de Sequeira Road	Sub-Arterial	2.96
14	Dr P Shivgaonkar Road	Collector	0.31
15	Dr Pandurang Pissurlekar Road	Collector	0.5
16	Dr RS Road	Local	0.2
17	Dr TB Cunha Road	Collector	0.31
18	Dr. B. Ambedkar Park Roa	Arterial	0.23
19	DR. Wolfgang Silver Road	Local	0.18
20	General Bernardo Guedes Road	Collector	0.65
21	General Costa Alvares Road	Collector	0.55
22	Governador Pestana Road	Collector	0.36
23	Luis de Menezes Road	Local	0.24
24	Mahatma Gandhi Road	Sub-Arterial	2.36
25	Menezes Braganga Road	Local	0.31
26	Municipal Park Road	Local	0.08
27	Parade Ground Road	Collector	0.44
28	Patto Centre	Sub-Arterial	0.12
29	Patto Road	Collector	0.2
30	Ponda - Panaji Road	Sub-Arterial	0.13
31	Praga da Lgreja Road	Sub-Arterial	0.13
32	Rua 31 de Janeiro	Local	0.25
33	Rua de Ourem	Sub-Arterial	1.15

34	Rua Emφdio Garcia Road	Collector	0.38
35	Rua Heliodoro Salgado Road	Collector	0.21
36	Rua Jose Falcao	Local	0.26
37	Rua Sao Tome	Local	0.17
38	Sindhi Gurmandir Road	Local	0.11
39	St. Inez Road	Collector	1.76
40	Swami Vivekanand Road	Collector	0.6
41	Unnamed Road	Local	0.09
TOTAL			24.82

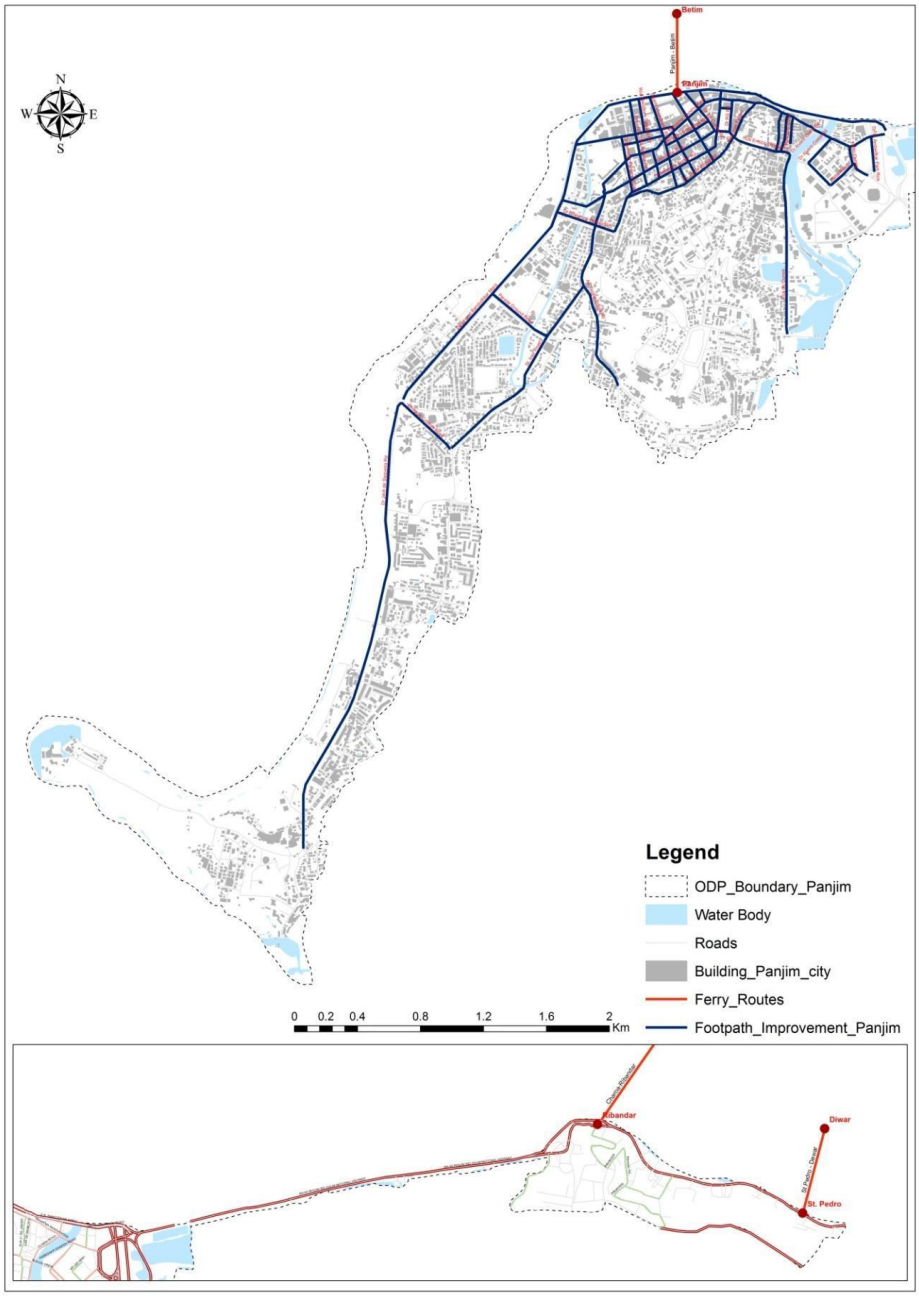


Figure 6.10: Roads which need Footpath Improvement in Panaji

Table 6.27: Name of roads which need footpath improvement in Vasco

Sl. No.	Name of the Road	Classification of the Road	Footpath Length (Kms)
1	Alto Desterro Road	Collector Road	1.89
2	Swatantra Path	Arterial Road	1.5
3	Fl Gomes Road	Collector Road	1.33
4	R. Leopoldo Flores Road	Collector Road	0.16
5	Baina Market Road	Collector Road	1.06
6	Airport Road (NH 566)	Arterial Road	1.62
7	Mangor Airport Road	Arterial Road	1.19
8	Swatantra Path (NH366)	Arterial Road	1.94
9	Unnamed Road 2	Local Road	0.35
10	Unnamed Road 1	Local Road	0.34
11	Fr Jose Vaz Road	Collector Road	1.01
12	Unnamed Road 3	Local Road	0.39
13	Railway Stn. Road	Sub Arterial Road	0.17
14	Vaddem jetty Road	Sub Arterial Road	0.78
15	Fish Market Road	Sub Arterial Road	0.15
TOTAL			13.89

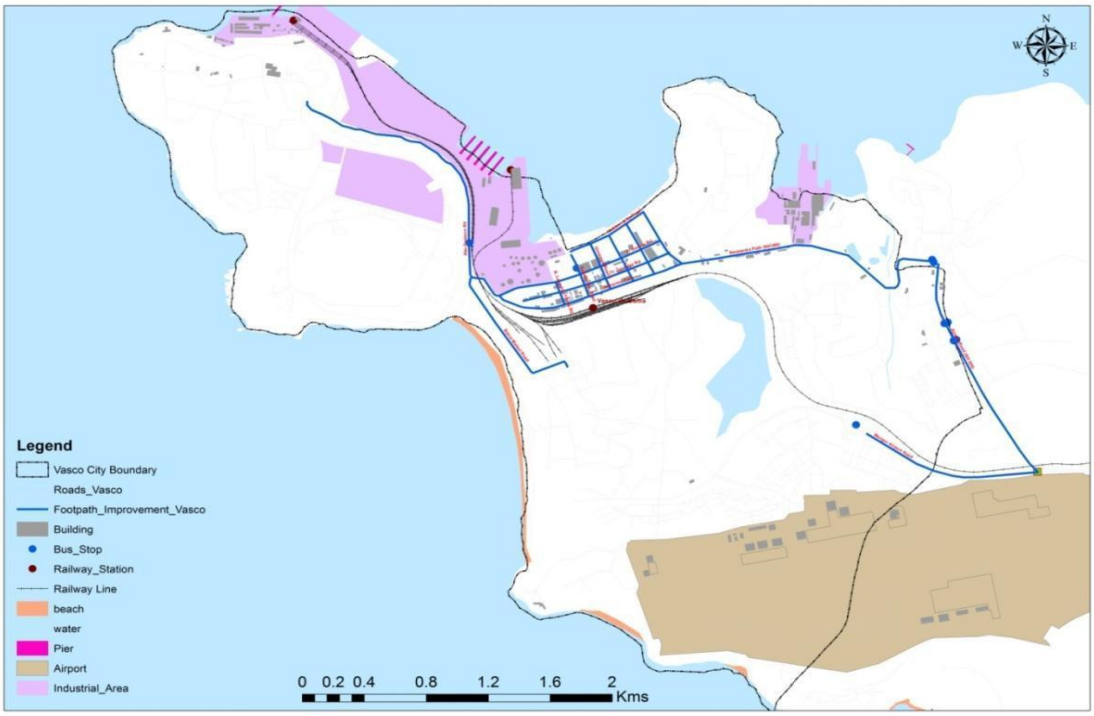


Figure 6.11: Roads which need Footpath Improvement in Vasco

Table 6.28: Name of roads which need footpath improvement in Margao

Sl. No.	Name of the Road	Classification of the Road	Footpath Length (Kms)
1	Margao Bypass (SH-8)	Sub-Arterial	2.02
2	Margao Quepem Road (SH-8)	Sub-Arterial	2.03
3	NH 66 Navelim	Sub-Arterial	0.72
4	Jose Inacio Loyala Road	Sub-Arterial	0.29
5	Abade Faria Road	Sub-Arterial	1.12
6	NH 66 / Old Market Road	Sub-Arterial	0.25
7	Colva Beach Road	Sub-Arterial	1.25
8	National Highway 17, Madel	Arterial	0.94
9	Margao - Ponda Highway	Sub-Arterial	2.49
10	St Sebastian Chapel Church Road	Sub-Arterial	0.32
11	Unnamed Road 1	Sub-Arterial	0.17
12	Old Market Road	Sub-Arterial	0.6
13	St Joaquim Road	Collector	0.72
14	Agostinho Lourenꝺo Road	Collector	0.58
15	Padre Miranda Road	Sub-Arterial	0.99
16	Varde Valaulikar Road	Collector	0.59
17	Isidorio Baptista Road	Collector	0.77
18	Rua ConstΓncio Roque da Costa	Collector	0.73
19	Martires Dias Road	Sub-Arterial	1.25
20	Babu Naik Road	Sub-Arterial	1.49
21	Aquem Alto	Collector	0.81
22	St Joaquim Road	Sub-Arterial	0.52
23	Holy Spirit Road	Sub-Arterial	0.34
24	Old Station Road	Collector	1.3
25	Fire Station Road	Collector	0.37
TOTAL			22.67

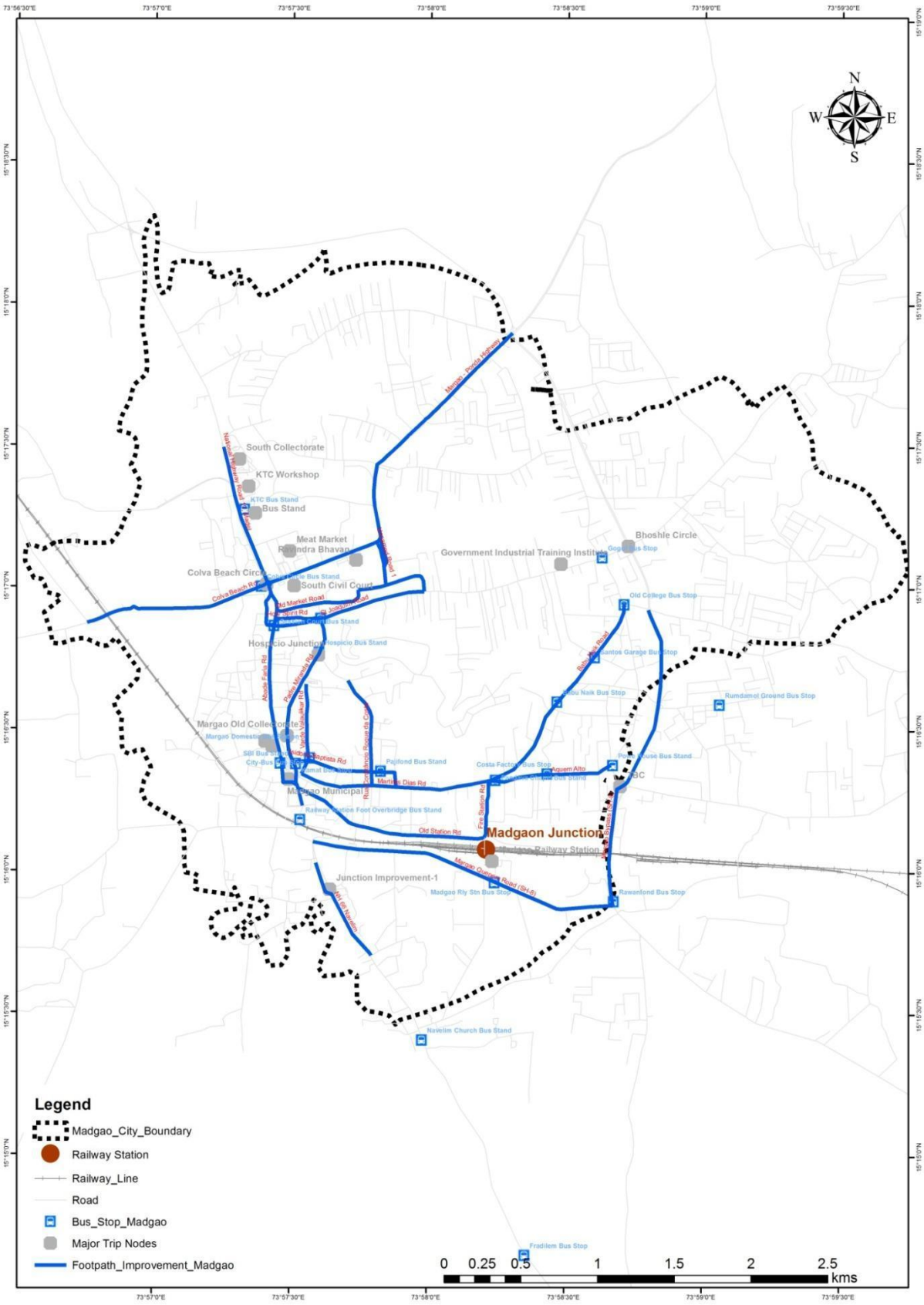


Figure 6.12: Roads which need Footpath Improvement in Margao

Table 6.29: Name of roads which need footpath improvement in Mapusa

Sl. No.	Name of the Road	Classification of the Road	Footpath Length (Kms)
1	Unnamed Road 1	Local	0.26
2	Unnamed Road 2	Local	0.27
3	St. Mary's School Road	Collector	0.34
4	Mapusa û Moira - Aldona - Corjuem Road	Local	0.21
5	Milagres Church	Local	0.04
6	Duler Marna Siolim Road	Sub-Arterial	0.63
7	Duler Ground Road	Arterial Road	1.32
8	Unnamed Road 3 (Catholic Cemetery)	Local	0.73
9	District Hospital Road	Collector	0.51
10	Market Road	Local	1.06
11	Market Road (Morod)	Collector	0.21
12	Market Road (Fish Market)	Collector	0.32
13	Anjuna Mapusa Chapora Road	Sub-Arterial	1.29
14	District Hospital Road / Pedem Road	Sub-Arterial	0.73
15	Market Road (Angod)	Collector	0.1
16	Taxi Stand	Collector	0.07
17	SBI Road	Local	0.15
18	Calungute Mapusa Road	Arterial Road	0.8
19	Gurim Road	Sub-Arterial	0.44
20	New Navtara - Canca Bypass Road	Sub-Arterial	0.78
TOTAL			10.25

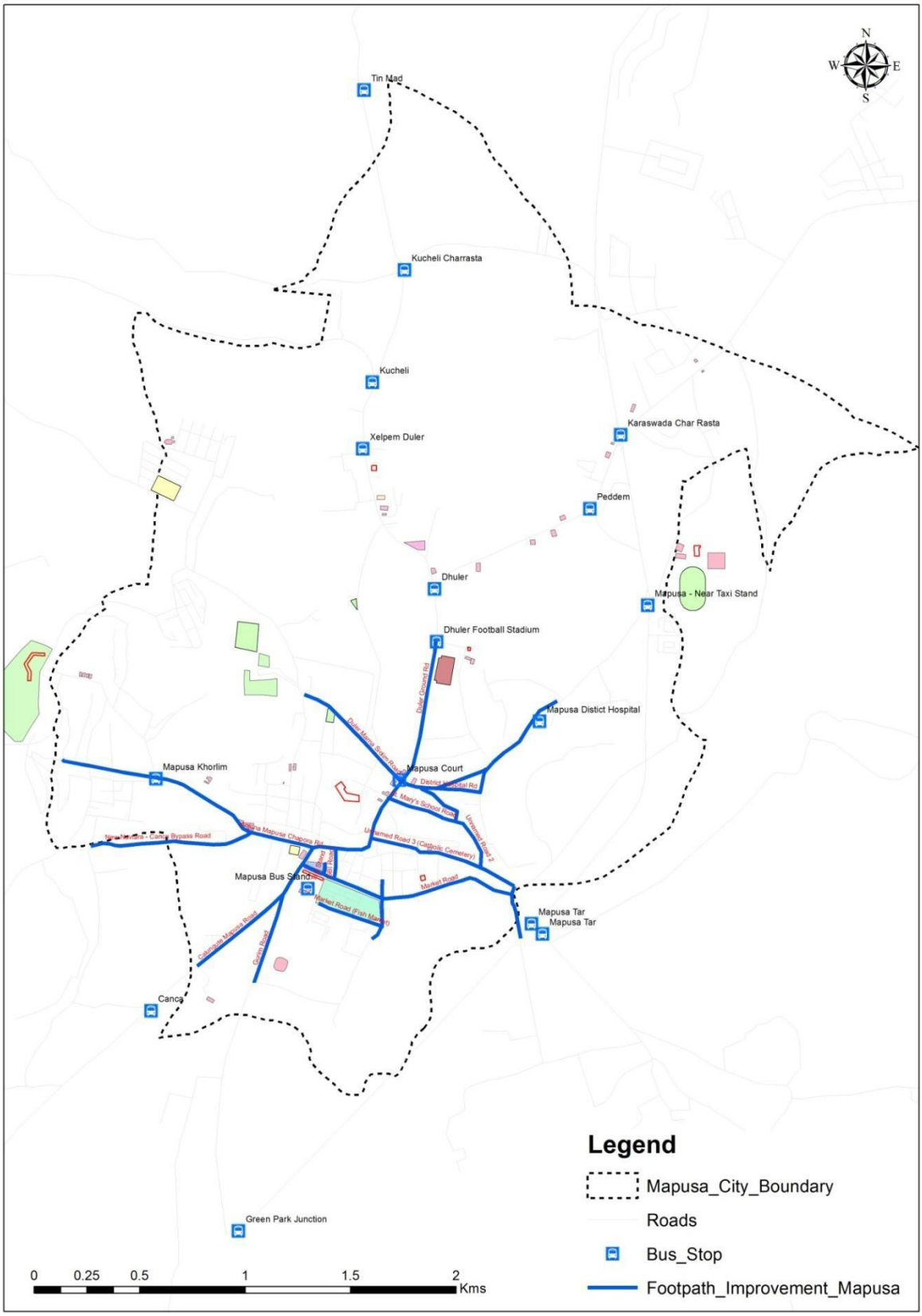


Figure 6.13: Roads which need Footpath Improvement in Mapusa

Table 6.30: Name of Roads which Footpath Improvement in Ponda

Sl. No.	Name of the Road	Classification of the Road	Footpath Length (Kms)
1	Ponda û Curti Road	Sub-Arterial	0.82
2	Ponda_Panaji Road Varkhande	Arterial	0.68
3	Khadpabandh Road	Collector	0.7
4	Ponda - Curti / Market Road	Sub-Arterial	0.66
5	Ponda - Margao Highway	Sub-Arterial	1.96
6	Upper Bazar Road	Sub-Arterial	1.1
7	Shantinagar Road	Collector	1.01
8	Ponda û Curti Road Sadar	Sub-Arterial	0.41
9	Durgabhat	Collector	0.43
TOTAL			7.77

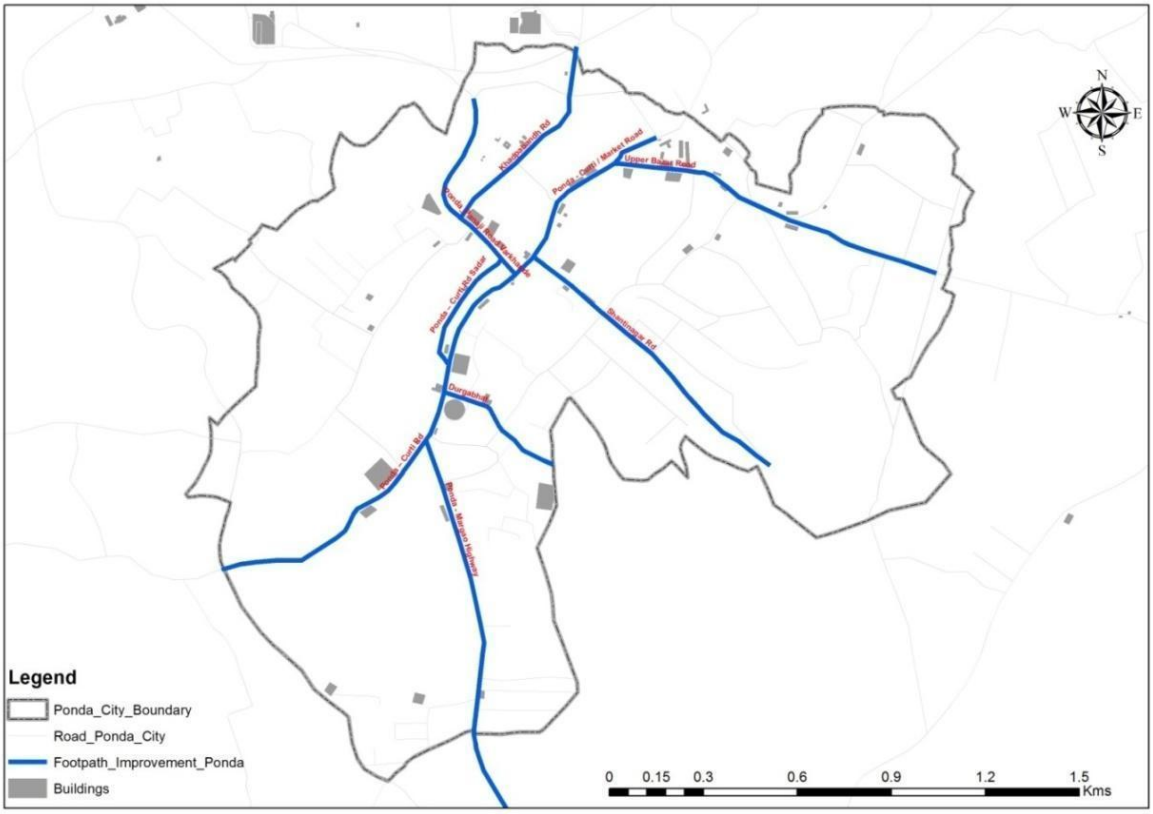


Figure 6.14: Roads which need Footpath Improvement in Ponda

6.4.2: Development of NMT Priority Zones

Cities are searching for more creative ways to activate public spaces to serve the public health of communities, while simultaneously working towards the increased active transportation goals of their city. In order to create awareness as well as increase the PT share, it is crucial to create spaces or pathways where the users feel safe, convenient and comfortable during their time spent in transit. These spaces could be at centres of work, markets, recreations, etc.

Figure 6.15: Redevelopment of Mandovi River Front

In this regard, the following NMT friendly zones have been identified:

- Panaji Market and Bus Stand.
- Panaji Waterfront Development.
- Upper Bazaar Road, Ponda.
- Mapusa Market, Mapusa.
- Vasco Taxi Stand, Vasco.

6.4.2.1 *Panaji Market and Bus Stand (200 Meter)*

Panjim Municipal Market also known as 'Panjim New Market' is located near Inox Multiplex, off the Campal road. It is a well-organized market for all needs. Though the right of way of Market road is around 10 m, the effective ROW gets reduced to 6.3 m due to excessive parking on either side. The Panaji Market Bus stops are 200mts away on Dayanand Bandodkar Marg.

The proposal is to connect both the market bus stops by table top crossings to help aid safe pedestrian crossings to and fro the Market. Figure 6.16 below shows the project area location with the market bus stops and the market location.

Market road shall be converted to a paved street to reduce speeds and make it safer to commute. The market loading and unloading areas shall be clearly demarcated and the market road stretch shall have adequate street lights and bollards.

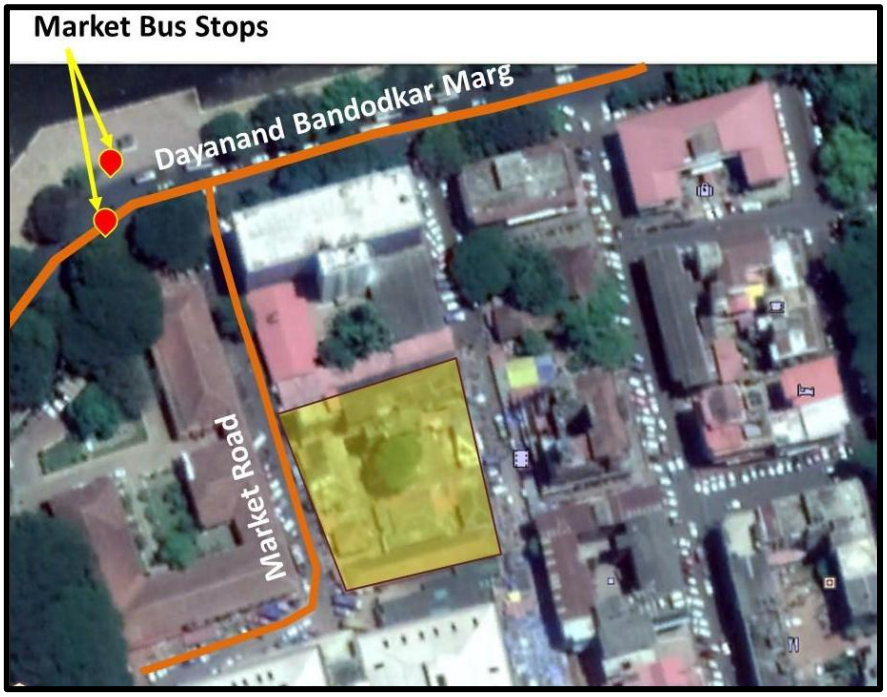


Figure 6.16: Project Area – Panaji Market

Traffic calming measures such as paved streets or cobbled streets are most suited to ensure pedestrian safety in a mixed traffic street. They considerably bring down the vehicular speeds by their factor of design.

A sample of paved street is shown below in Figure 6.16 Church Street in Bangalore was redeveloped into a pedestrian friendly street. The street has

been completely paved, wide footpaths with tac-tile paving have been developed, and also dustbins at regular intervals and bollards have been provided at the street edges. This redevelopment has raised the footfalls considerably in the area.

Figure 6.17: Redeveloped Church Street - Bangalore; Source-Tender Sure

6.4.2.2 Water front development (1.8 Km)

The proposal is to develop the Dayanand Bandodkar Marg stretch of approximately 1.8 km starting from the Multi-level car park to the Air India Office along the lines of water front development project. The project area is as shown in Figure 6.18.

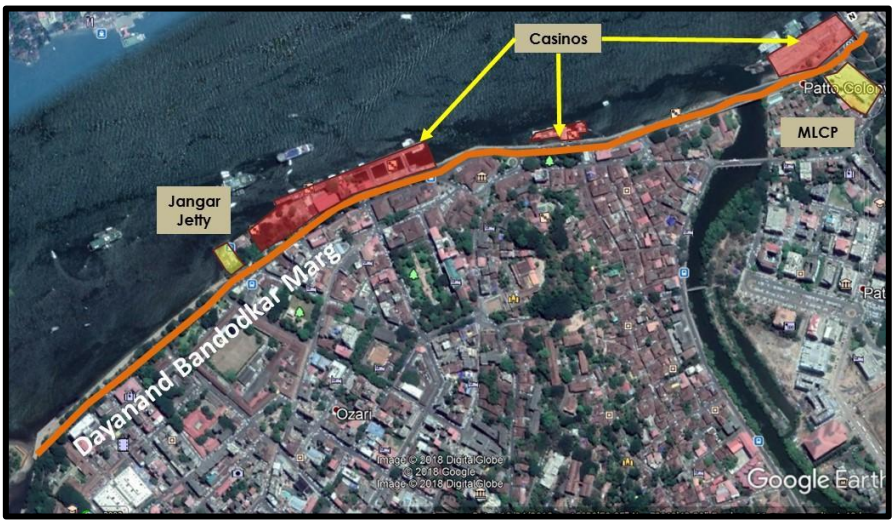


Figure 6.18: Project Area – Water Front

The proposals include redeveloping the existing walkways in a more pedestrian friendly manner, with adequate street lights, signage's and street furniture. The idea is to provide pedestrian connectivity from the MLCP to the casinos so as to reduce the demand of parking as well as to reduce the number of vehicles accessing the casinos. Additional seating places and kids furniture and play areas need to be accommodated in the area for a rounded urban place making.

It is observed that the identified 1.8 Km stretch has right of way varying from 22m to 15 m, it is hence suggested to redistribute the road space so as to achieve a uniform carriage way throughout. This will not only ease the flow of traffic by reducing bottle necks but shall also allocate more space for the proposed urban place making.

It is also proposed to shift the bus bay as the existing location is right at the T-intersection of the Malacca road with Dayanand Bandodkar road. As per the principals of ideal bus stop location it is proposed to be shifted further away from the junction; away from the ferry point. A table top pedestrian crossing should be provided to cross over from behind the bus for increased safety.

Figure 6.19: Project Area – Panaji Ferry

As part of the water front development project both pedestrian and vehicular access to the Panaji ferry point shall be developed. The taxi/car rental

services near the ferry point will have to be re-adjusted so as to not lose out on carriage way and also not allow encroachment of the entry point for the ferry. The Sabarmati Waterfront Development (figure 6.20, *Source-hcp.co.in*) can be considered as a successful example, which may be referred for in case of Panaji.

Figure 6.20: Sabarmati Waterfront Development – Ahmedabad

6.4.2.3 Upper Bazaar Road Development (700 m)

The 700 m stretch starting from Delta City Plaza on the Market Road to the UCO Bank on the Upper Bazaar Road has been identified to be redeveloped as a pedestrian friendly area (Figure 6-21). It is proposed to restrict parking along Upper Bazaar Road, along with:

- Providing adequate pedestrian walkways.
- Paving the Upper Bazaar Road as a traffic calming measure to control vehicle speeds.
- Providing designated parking for Pilots on the upper bazaar road.

The upper bazaar road leads to the Ponda Market and is also lined with retail and commercial stores. The footpaths have been observed to be narrow and encroached by excessive parking.

Figure 6.21: Project Area, Upper Bazaar Road

6.4.2.4 AJDA School Area Improvement

A. J. de Almeida High School is a 106 year old institution which is centrally located near Ponda Bus Stand. Because of its central location the Ponda – Panaji road is heavily congested during the school times so much so that traffic is restricted during the mornings to facilitate the drop off of students. There are no adequate footpaths (Figure 6-22) or drop off facilities to ease the congestion. The narrow footpaths are often encroached by two wheelers of parents waiting to pick-up their wards.

Figure 6.22: No adequate footpath

The school area is also a major safety concern as the Ponda – Panaji road is an arterial road with heavy vehicle movement. It is proposed to install bollards to restrict parking on the footpath and also provide a dedicated walking space for pedestrians especially the school students.

The land opposite to the school is proposed to be developed as a pick-up and drop-off point for the parents. A table top crossing from the parking to the school shall aid as a safe crossing.

The list of other on-going pedestrian priority projects in the state are as listed below:

Table 6.31: List of Ongoing pedestrian priority projects in the state of Goa

Sl No	Name of the Project	Status
1	Universal Walkways, Panaji	DPR
2	Raibandar Wharf	Tender
3	Café Bhoshle, Panaji	DPR
4	Beautification of beach front promenade at MIRAMAR	DPR
5	Dona Paulo, Panaji	DPR

6.4.3: Public Bike Sharing Systems and Docking Stations

Public Bicycle Sharing (PBS) systems are a flexible public transport service that involves the creation of a dense network of cycle stations. Users can check out a cycle from any station and return it to any other station in the system. The station where the cycle is returned need not be the original station from where the cycle was borrowed.

This flexibility is one of the key features which differentiate PBS systems from traditional bicycle rental stores. PBS systems also encourage the use of cycles for short distances by making the use of cycles free for a short period of time (usually 30 mins), after which the cost of borrowing increases exponentially. This progressive fare structure ensures that the cycles are returned to the stations quickly, and are mostly used for last mile connectivity. This is another feature which differentiates it from traditional rental systems where cycles are usually borrowed for a day or more.

Currently, the Government of Goa has initiated the implementation of PBS in the capital city of Panaji under the supervision of the IPSCDL.

In this regard, the following guidelines as suggested in the ITDP may be adopted:

- Station Density: 10–16 stations per km2
- Bikes/Resident: 10–30 bikes for every 1,000 residents (within coverage area)
- Docks per Bike Ratio: 2–2.5 docking spaces for every bike

The density could be higher in the major commercial centers of the city and are placed in high demand generating areas like market areas, business districts and popular cultural and tourist points in the city.

6.5: Parking Management Measures

Parking management is a powerful tool for cities to influence transport. By managing the supply, design and price of parking spaces, cities can exert a high level of control over traffic flow and density. In the past, municipalities merely expanded parking supply in order to attract more and more cars. Contemporary parking policies have a more balanced view, which include social and environmental goals and want to improve the quality of life in cities.

Since private vehicles are in use for an average of only one hour per day, it is easy to understand why stationary traffic needs special attention. The

cities have seen a burgeoning growth in human as well as vehicles. This has led to the task of providing space in the form of on street or off street parking. The smarter approach is to deal with parking in a more efficient way–parking management.

"Public space has a high value and therefore should be paid if used for parking."

There are three important areas of managing parking, namely:

1. **On-Street Parking:** The need of on street parking arises in 2 main areas, namely: the place of ownership as well as the place of visit. Goa has the highest number of vehicular ownership thus resulting/urging for the need for more parking spaces.

"Parking Spaces are Dead Spaces"

The ratio of demand to supply can hardly be met especially in areas such as markets, public spaces, commercial centres, etc. The demand in few areas is extremely high that they even spill over to the carriageway or even the

pedestrian walkways. If this demand is not controlled, the operations of the entire carriageway would be completely chaotic.

The following on street demand management techniques are suggested:

- Provide Footpath of 1.5 m minimum before making provision for on-street parking.
- Parallel parking on major corridors.
- Parking fee should be levied for on-street parking. Dynamic pricing may be adopted.
- Allocate parking spaces for:
    a. Differently abled
    b. Cyclist
    c. IPT
    d. Electric Mobility
    e. Pick up & Drop off Zone (If applicable)
- Use smart technology for: monitoring, fee collection etc.,
- Parking management cell to be set up.
- Strict enforcement on illegal parking.
- The design should be self-enforcing.
- The parking spaces should be designed as per the guidelines mentioned in IRC: SP: 12-2015.

Table 6.32: On street Parking Recommendations

Traffic Movement	Carriageway	Arterial	Sub Arterial	Collector	Local
One way traffic movement	<5.5m	--	--	No Parking	Parking on one side
	5.5-10.5m (One/Two lane Traffic)	--	Parking on one side	Parking on one side	---
	10.5-15 m (One/three lane Traffic)	--	Parking on both sides	Parking on both sides	--
Two way Traffic Movement	10.5-15 m (One/two lane traffic)	Parking along one service lane if available	Parking on one side	Parking on one side	
	15 m- 18 m (Two Lane Traffic)	Parking along both service lanes if available	Parking on both sides	--	--
	>18 m	Parking along both service lanes if available	Parking on both sides	--	--

2. **Off Street Parking:** These spaces are often created to accommodate the surge of excess demand of parking from the streets. The state of Goa has few locations that may be identified as off street parking locations, namely:

Table 6.33: Off-street Parking Recommendations

Location	User Fee	Usage
Panaji MLCP near Santa Monica Jetty	Yes	Average
Calangute Parking Lot	Yes	Good
Candolim Parking Lot	Yes	Good
Baga Parking Lot	Yes	Average
Margao Parking Lot, Opp. to Margao KTC bus stand	No	Very Good
Airport Taxi Parking, Opp. to Dabolim Airport	No	Very Good

Despite the provision of such capital intensive infrastructures, the occupancy is never full. This is mainly due to the availability of free on street parking spaces, lack of visibility, increased fares, etc. In this regard, the

following steps can be taken towards encouraging motorist to use off street parking over on street parking facilities:

- All on-street and off Street parking should be paid parking.
- The parking charges for off-street parking sites shall be less by 10%-20% when compared to on-street parking charges.
- Further, during off-peak hours, the off street parking charges shall be decreased further.
- The parking charges will increase with the duration of parking and short term parkers must be encouraged.
- The parking charges for an off street parking facility shall be clearly displayed.
- During special events, the off street parking spaces may be provided for free against bulk payments.
- These off-street parking spaces should encourage the use of public transit facilities by creation of bus stops or feeder services.
- No parking zones (On street) should be strictly enforced on 500 m buffer of every off street parking.

**Currently, the existing parking lots opposite to Margao bus stand and the vacant plot opposite to Dabolim Airport, Vasco are free parking. It should be converted to pay parking.

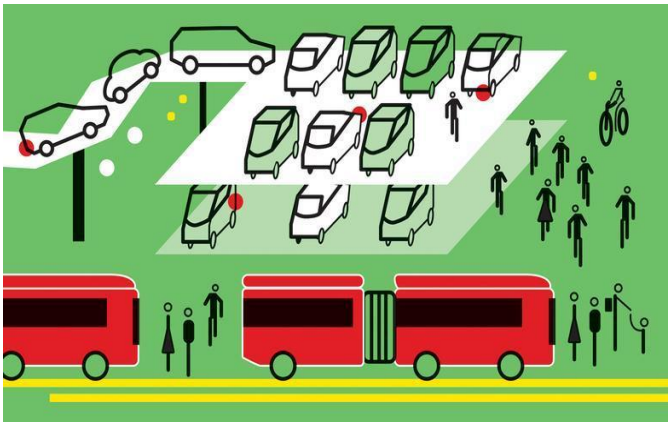
***It is crucial to identify areas of off street parking within the city centres as the increased demand in the city centres are eating away spaces allocated for pedestrians.

3. **Terminal Parking:** These spaces refer to the parking spaces available at the terminal such as bus terminals, railway stations, ferry stations, etc. These spaces are often used by park and ride users and are usually long term parkers (3-8 hours). These spaces are usually priced. Some of the widely used terminal parking facilities in the city includes:

Table 6.34: Terminal Parking Recommendations

Location	User Fee	Usage
Panaji Bus Terminal	Yes	Good
Margao Bus Terminal	Yes	Good
Margao Railway Station	Yes	Good
Vasco Railway Station	Yes	Average
Ponda Bus Terminal	Yes	Good
Mapusa Bus Terminal	Yes	Good

Considering the high dependency of residents on personal modes of transportation, the demand of parking in terminals remains unfulfilled. This is due to the poor services of the public transport services.



In order to encourage commuters to opt for public transport while still depending upon personal modes for first or last mile connectivity, the following interventions may be applied:

- Well established connectivity of the Public Transit facilities to the commuter's trip ends.
- Well established connection for transit between different modes.
- Well designated bays to ensure organized parking arrangement.
- Good quality of parking infrastructure to ensure reliability and safety.
- The off street parking charges shall be subsidized or decreased by 10%-20% when compared to on-street parking charges.
- The parking charges for an off street parking facility shall be clearly displayed.
- No parking zones (On street) should be strictly enforced on 500 m buffer of every off street parking.

The terminals which need immediate up gradation of their parking infrastructure are listed in the following table:

Table 6.35: Bus Terminals which needs immediate upgradation

Sl. No.	Location	Proposed Intervention
1	Ponda Bus Terminal	Up gradation (Design, Accessibility)
2	Bicholim Bus Terminal	Absence/negligible parking space, Lighting, fare collection
3	Panaji Bus Terminal	Increase in capacity, design, intermodal connectivity, etc
4	Margao Railway Station	Underutilized, better accessibility,

Parking Policy: IPSCDL are currently finalizing the parking policy for the city of Panaji, the State capital of Goa. The purpose of this strategic parking policy is to provide the guiding principles and policies for the management and supply of parking in Panaji. This policy enables in approaching all the parking issues in a consistent manner considering the sustainable transport approach. The parking policy for Panaji is prepared based on the understanding that providing more and more parking is certainly not a sustainable solution to parking.

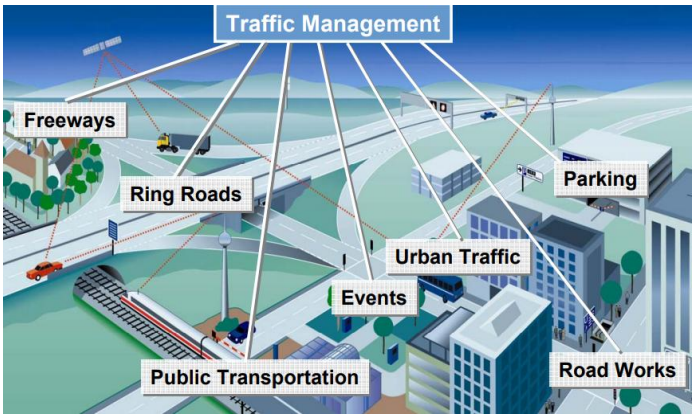
The absence of a comprehensive parking policy in Panaji, has resulted in independent dealing of the parking issues by multiple stakeholders. This lack of a coherent approach has led to plans and projects that are contradictory in nature and often end being infrastructure projects that require high investment and attempt to solve a short-term parking problem. Panaji needs a parking policy that has a holistic vision, with strategic objectives and is in sync with State's overall transport policy and objectives, as well as the statutory Development Plan.

Some of the policies that have been drafted under the Parking Policy of Panaji include:

i. Policy 1: On Street Parking Management
ii. Policy 2: Off Street Parking Management

iii. Policy 3: Parking Permits
iv. Policy 4: Use of Technology
v. Policy 5: Enforcement
vi. Policy 6: Building Regulations
vii. Policy 7: Proof of Parking
viii. Policy 8: New Mobility

6.6: Traffic Management Measures



In cities, where the number of vehicles continuously increases faster than the available traffic infrastructure to support them, congestion is a difficult issue to deal with. This problem affects many aspects of the modern society, including economic development, traffic accidents, increase in greenhouse emissions, time spent, and health damages. In this context, cities rely on traffic management system to minimize traffic congestion and its negative effects. Traffic management systems are composed of a set of application and management tools to improve the overall traffic efficiency and safety of the transportation systems.

These 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 not very capital intensive and give instant results.

6.6.1: Junction Improvement

Most intersections in the State of Goa are Unsignalised intersections. Some intersections have been effectively operating while others over time are being saturated and require immediate interventions. The increase in the vehicular traffic is becoming a severe problem. To effectively control this increasing traffic on road some traffic control measures are used i.e. traffic

rotary, traffic signal, channelization of road etc. but there are some traffic limits for which these measures can help. Conflicts at Intersections are primarily due to the design considerations of intersections, including traffic volume, traffic control, and frequency of access points, the number of arms, the speed limit, the median type and width, the number of traffic lanes, the existing turn lanes and the lighting level. Design principles for the effective operations of the Junction include the following elements:

- Closure of medians at certain intersections.
- Prohibition of free right turns.
- Provision of adequate sight distance.
- Providing adequate corner radii.
- Providing sufficient turning radii.
- Flaring approaches towards intersections.
- Providing channelizers/division islands.
- Providing pedestrian and cyclist crossing facilities.
- Bus stops near junctions to be re-located.
- Providing signs/lane-markings/lighting.

Pedestrians should be given priority at all junctions. If it is difficult to channelize the pedestrian movement, it is advised to install pelican signals. Intersection improvements are recommended to facilitate the movement of vehicles and safe movement and crossing of pedestrians at junctions.

Table 6.36: Locations of Proposed Junction Improvements

City	Junction Improvement
Panaji	Diuvja Circle
	Caculo Circle
	Santa Inez, Near Candolim Urban Cooperative Bank
	Near Immaculate Conception Church
	Dona Paula Circle
	Front of KTC Bus Stand
	Miramar Circle
	Bambolim Junction

Vasco	Zuari Bridge
	In front of railway station
	IOC Junction
	Chicalim Park
	St. Andrews Church Junction
	Vasco Pvt Bus Stand (Fl Gomes Road)
Madgoan	Bhoshle Circle
	Margao Bypass vs Davorlim Road
	Colva Beach Circle
	Sanscar Society
	Margao Old Collectorate
	Hospicio Junction
	Margao - Ponda Hwy, Borda
Ponda	Ponda - Margao Hwy, Friends Colony
	Dada Vaidya Chowk
	Upper Bazar Rd, Shanti Nagar
	Ponda Curti Road
	Varkhande, Khadpabandh, Ponda
Mapusa	Mapusa Municipal Council
	Hutatma Chowk
	Duler Road, Duler
	Karaswada Junction
	Guirim Bypass Junction

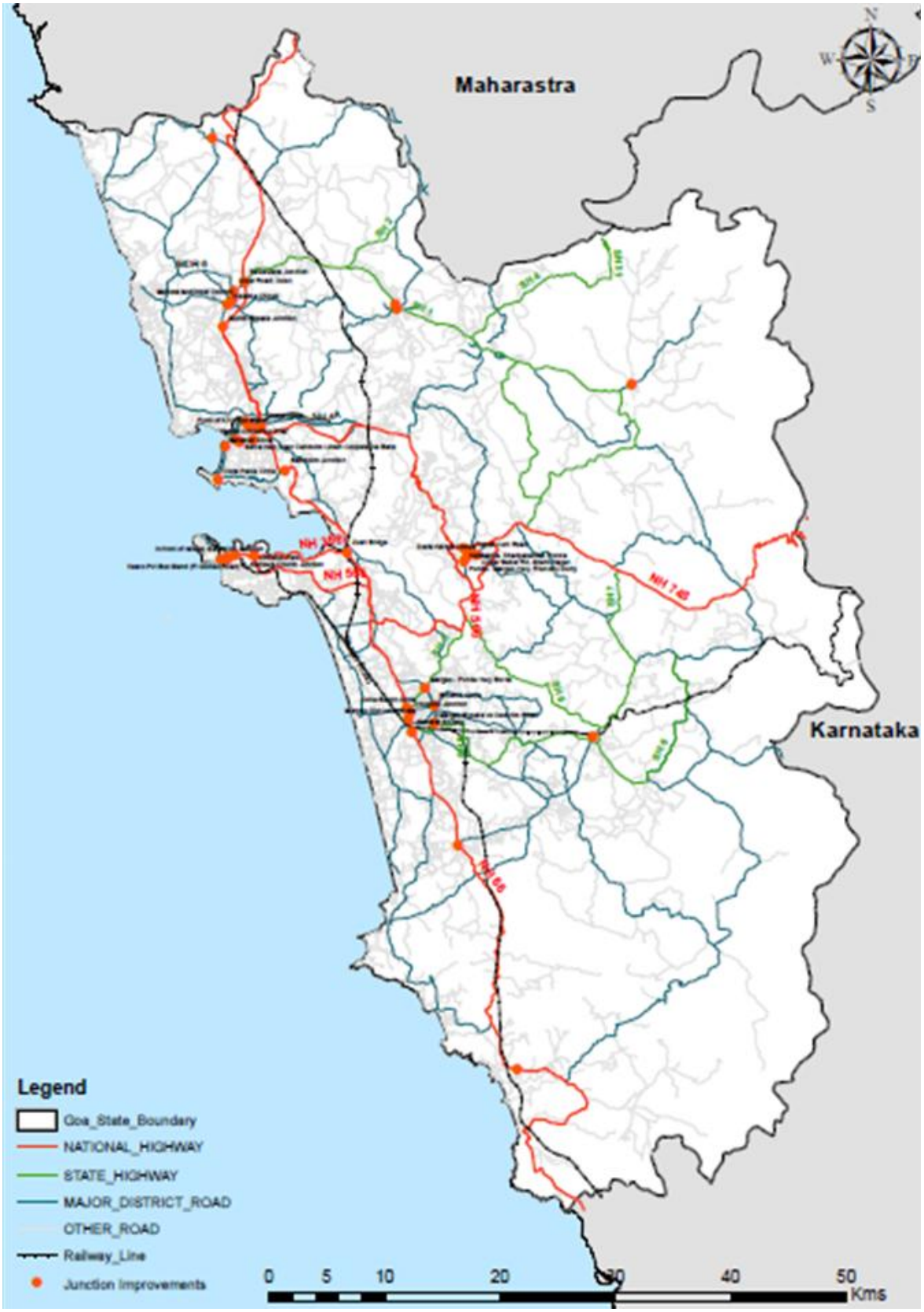


Figure 6.3: Location of Junctions which need improvement

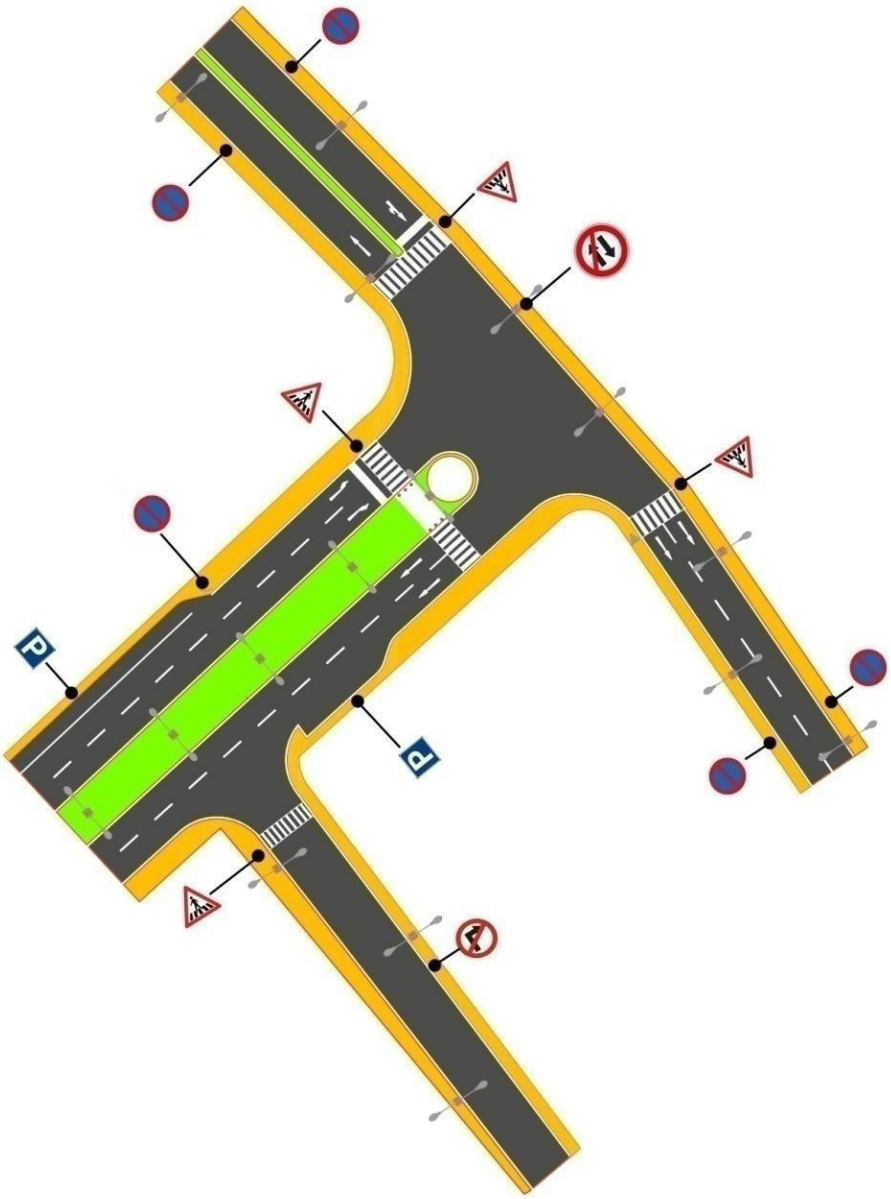


Figure 6.4: Junction Improvement near Old Bus Stand in Ponda

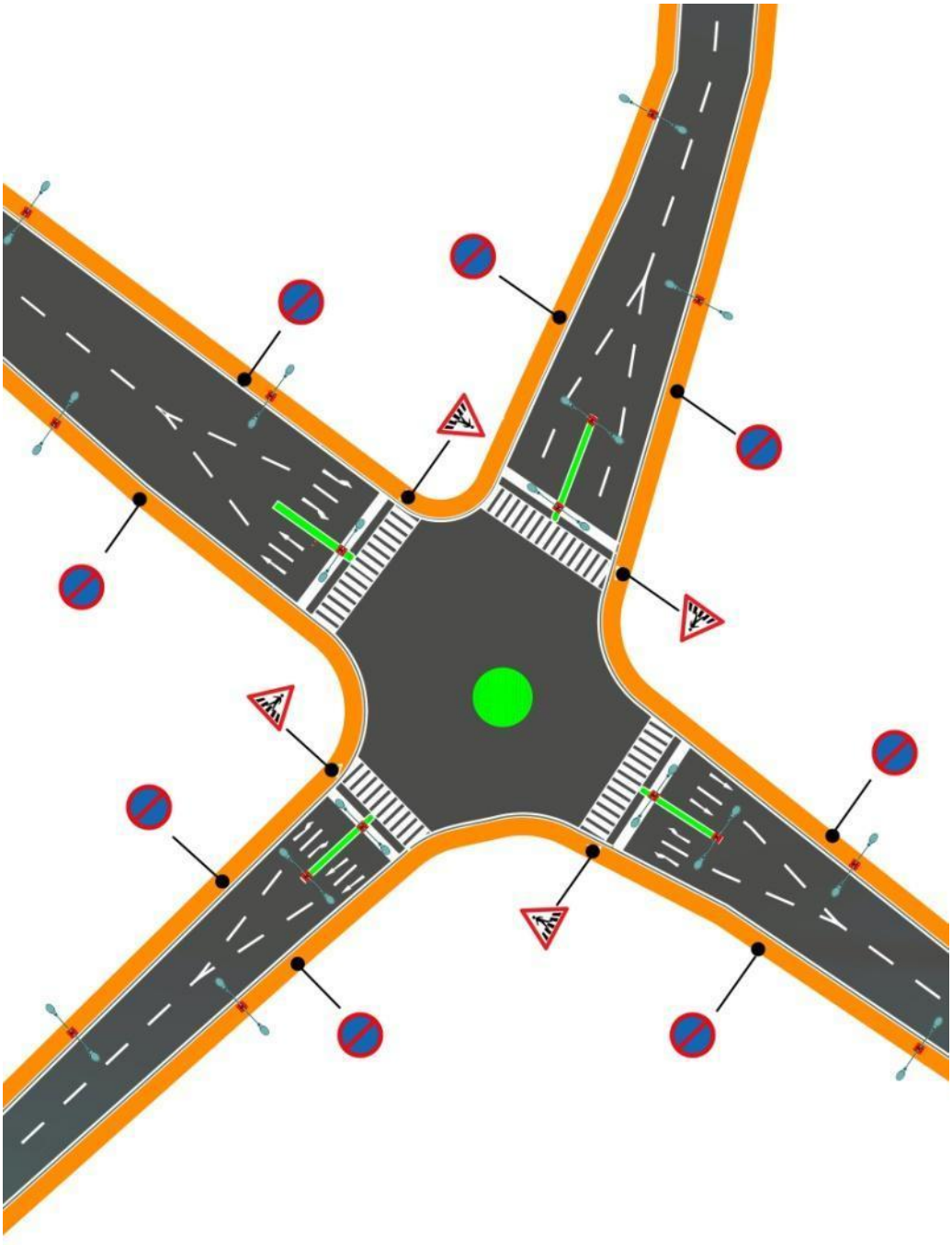


Figure 6.5: Junction Improvement of Court Junction in Mapusa

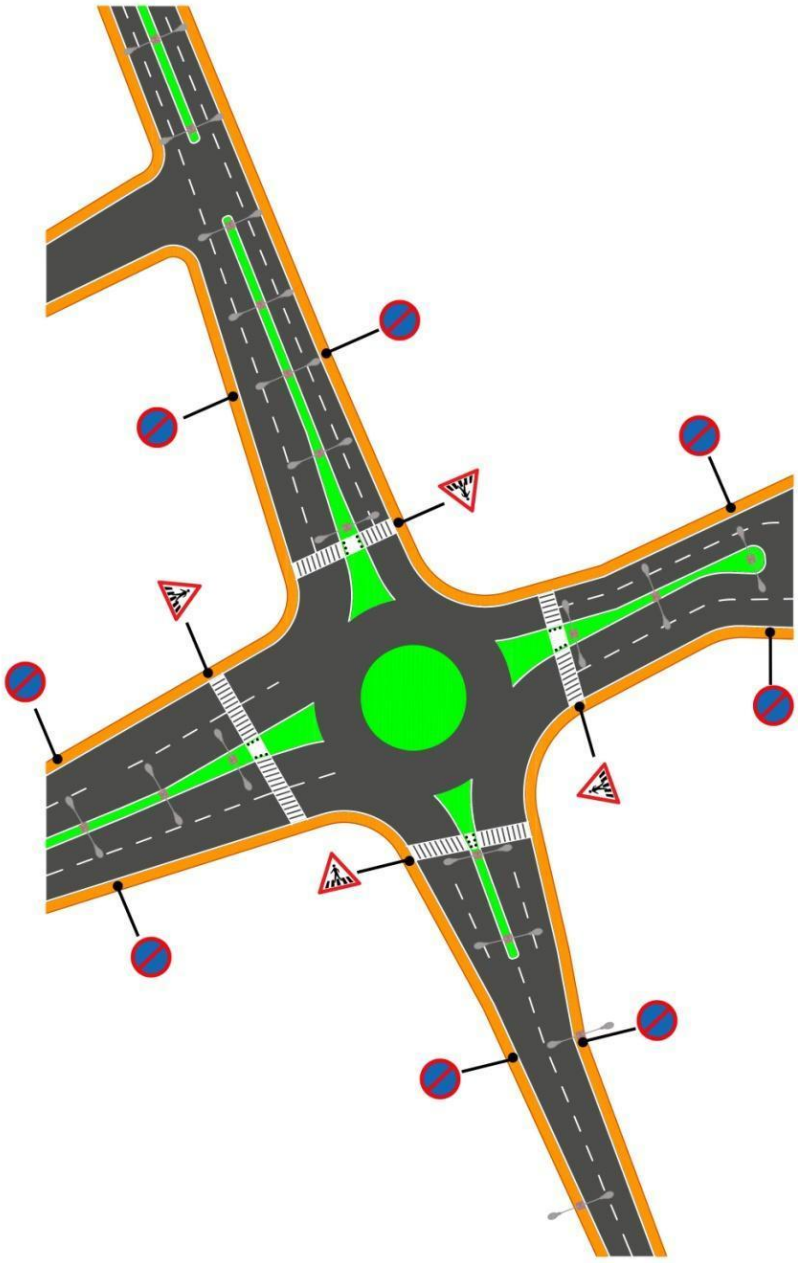


Figure 6.6: Junction Improvement of KTC Junction in Margao

6.6.2: Road Signs and Markings

Road Markings play a vital role at channelizing the traffic movement. The road marking in Goa need attention as they lack visibility and are often non-existent. Good road marking and signage impact the driver behaviour on road and are very effective at managing traffic at minimum cost intervention.

Emphasis on marking of pedestrian walkways and parking bays should be made. Road markings such as: Centre line, Traffic lane lines, Stop lines, Pedestrian crossings, Parking bays, Kerb marking for visibility, Obstruction marking etc must be provided keeping in view all users of the road and especially during the night. All the traffic signs should be facilitated as per the guidelines provided in IRC:67-2001.

6.6.2.1 Road Signages:

Road signs are classified into three categories:

1. **Mandatory/Regulatory Signs:** To inform users about certain rules and regulations that needs to be followed to improve safety and free flow of traffic. These include all signs such as STOP, GIVE WAY, Speed Limits, No entry etc. The violation of these rules and regulations is a legal offence. Figure 6.26 shows the Mandatory Signs.

Figure 6.7: Mandatory Traffic Signs

2. **Cautionary/Warning Signs:** To caution the road users of certain hazardous condition either on or adjacent to the roadway. Some examples are Hairpin bend, Narrow Bridge etc., Figure 6.27 shows the Cautionary Signs.

Figure 6.8: Cautionary Traffic Signs

3. **Informatory Signs:** These signs are used to provide information and to guide road users along routes. The information could include name of places, sites, direction to the destinations etc., Figure 6.28 shows the Informatory Signs.

Figure 6.9: Informatory Traffic Signs

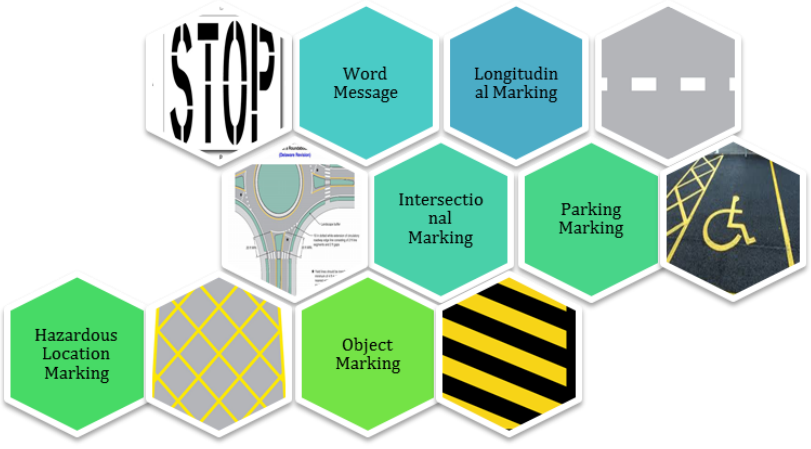
4. **Innovative Signage's:** Way finding is how people get from one location to another, including their information gathering and decision-making processes for orientation and movement through space. People make a series of decisions when way finding. Choice of destination as well as mode choice and the route opted by road users will enhance the usability and easy access of the cities trip ends. The way finding proposed for the State of Goa is as mentioned below:

i. ***City Map:*** Creation of a City wide information map which would include information on major activity centres, places of interest, transit options, etc. The city wide network map may be placed at tourist location, government offices and market centres for users to plan their trip accordingly.

ii. ***Transit Map:*** Transit maps placed at all transit stations to enable commuters to be aware of the mode choice available, choose his mode accordingly as well as plan his entire trip thus reducing his dependency of private modes. The way finding at transit stations will include information on the name of the transit station, other readily available modes surrounding a 500 m walk distance, its connectivity to the nearby trip ends, etc.

6.6.2.2 Road Markings:

Pavement markings are used to convey messages to roadway users. They indicate which part of the road to use. Road markings play a significant role when it comes to promoting safety in traffic. These road markings give important information and instructions to the motorists and drivers about vehicle positioning, road alignment and other vital road information. They also help bring attention to detours, construction work and hazards, such as sharp turns and steep hills.





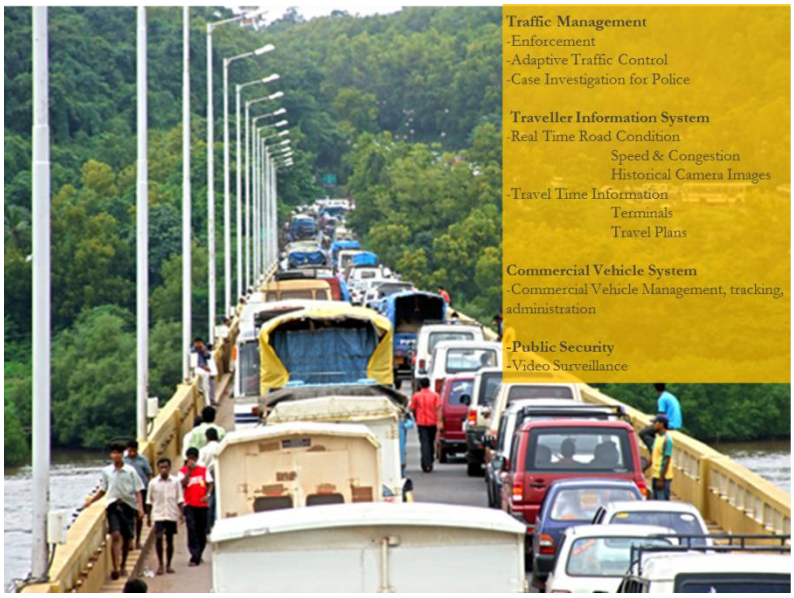
Innovative Markings: Considering Goa has the highest number of inflow and also is culturally rich, adaptation of innovative methods of road makings to create a vibrant environment for its users. Adaptation of innovative and artistic road markings especially at crucial nodes such as junctions, pedestrian zones, accident prone areas, etc., will automatically bring about a change in driver as well as pedestrian behaviour channelizing them towards traffic disciple.

6.7: Technological Measures

The use of technology in any field has made users more receptive towards the usage. The case is similar with transportation as well. The adaptation of technology either in mode, design or monitoring has enabled reliable services to its user.

6.7.1: Intelligent Transportation System (ITS)

An intelligent transportation system (ITS) is an advanced application which, without embodying intelligence as such, aims to provide innovative services relating to different modes of transport and traffic management and

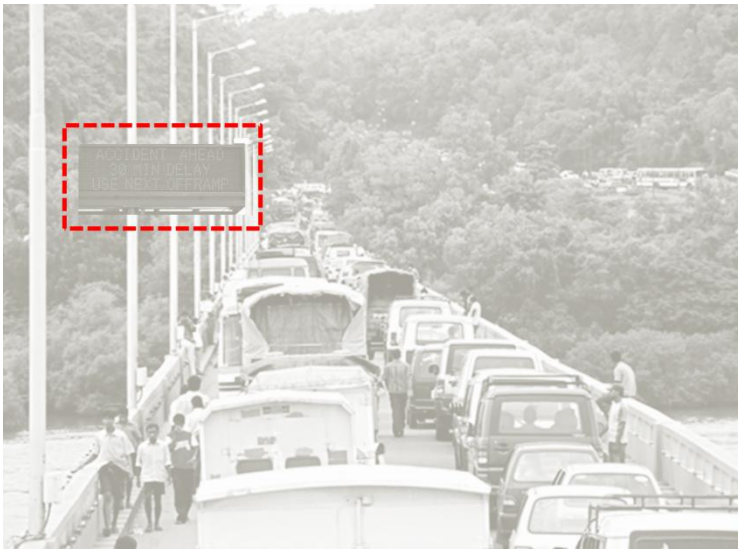


enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

ITS includes a wide range of applications that process and share information to ease congestion, improve traffic management, minimize environmental impact and increase the benefits of transportation to commercial users and the public in general.

The applications include:

1. **Advanced Traffic Management Systems (ATMS):** Advanced Traffic Management System (ATMS) seek to reduce, or at least contain, traffic congestion in urban environments by improving the efficiency of utilization of existing infrastructures. These systems typically seek solutions to congestion problems occurring on urban freeways and surface streets through the deployment of state-of-the-art sensing, communications, and data-processing technologies. Problems considered include both congestion caused by regular traffic patterns (congestion management systems) and traffic problems caused by stalled vehicles or other unpredictable incidents (incident management systems).



   These systems typically attempt to use available traffic information to develop optimal traffic control strategies addressing traffic needs at a single intersection, along an arterial or freeway, along a given corridor, or throughout a given area. Real-time solutions capable of automatically adjusting to changes in traffic conditions are often sought. These systems also frequently rely on variable message signs

or other information dissemination technologies to provide relevant traffic information and travel recommendations to travellers.

2. **Advanced Traveller Information Systems (ATIS):** Advanced traveller information includes static and real-time information on traffic conditions, and schedules, road and weather conditions, special events, and tourist information. An ATIS may operate through information supplied entirely within the vehicle (autonomous system) or it can also use data supplied by the traffic management centres.
3. **Commercial Vehicle Operations (CVO)** is used for constant monitoring of heavy vehicles. It can be in the form of smart cards, weigh bridges etc.
4. **Advanced Public Transportation Systems (APTS)** to enhance efficiency of public transit systems through information systems, signal priorities, GPRS etc.

6.7.2: Smart Parking Technology:

Considering the high demand for parking spaces within the city centres, striking the balance between the supply and demand is the need of the hour. Thus, parking management measures such as paid parking, limiting of parking spaces, etc, may be sought for feasibility. In this regard, management of parking spaces retained is crucial as the demand would be higher or greater than the supply. Some of the smart parking technologies that can be sought for the cities in Goa include:

1. ***Delineation and numbering of Parking Space along with Parking sensors:*** The sensor must be fitted with a magnetic loop to detect the occupancy of the spot by a vehicle and an RFID reader to identify the TAG of who has booked and constantly check the TAG to verify the presence of the car.
2. ***Parking Information via Internet and Phone:*** The parking availability information captured through the sensors must be provided through internet platform as well mobile phone applications. Information on parking locations, costs, space reservation, and regulations can be obtained via the Internet.

3. ***Parking Meters:*** The parking meters shall be fitted on all streets for the users who are not using advanced payment systems.

6.7.3: Electric Mobility:

More than 25 Indian cities are within the list of 100 most polluted cities in the World. The cause of growing air pollution in cities is related to a variety of sources however transport sector makes significant contribution. It is important that the emissions from transport sector are minimized. Electric vehicles have been seen as a promising technology option and several national governments have successfully implemented policies to promote the technology. Indian government is keen to promote electric vehicles as a green mobility options and is also considering it as a viable solution to reduce air pollution in cities. Electric mobility/ e-mobility refers to the concept of electricity driven vehicles (commonly known as electric vehicles) and hybrid vehicles, in order to reduce the dependency on fuel driven automobiles, while also addressing carbon emissions. De-carbonization of public transport is expected to tackle environmental issues such as air-pollution, particularly in densely populated areas. Emission-free electric buses and taxis are finally gaining popularity and it is considered as the epitome of sustainable transportation.

The National Electric Mobility Plan 2020 aiming to achieve National fuel security by promoting hybrid and electric vehicles in the country. Government aims to provide fiscal and monetary incentives to kick start this technology.

Considering the rapid growth of vehicular ownership in the State of Goa, areas of application of Electric mobility would include:

1. ***Intermediate Public Transport:*** The two areas in which IPT could play a major role in the state:

    - An alternative to PT: considering the narrow roadway networks as well as the traffic management system of the major cities in Goa, IPT may be sought as alternate mode connecting

commuters to their closest transit node. The Hop on-Hop off services may also be sought for feasibility.

- Commute at Pedestrian Priority Zones: Certain zones within the tourist towns of the State may be demarcated as Pedestrian priority zones. IPT may be used as modes for commute within these zones.

2. **Buses:** The introduction of Electric mobility technology into the transit system of the State is the need of the hour as the State is currently in process of upgrading their fleet size. Electric buses are energy efficient with lower CO2 emissions and noise pollutions. As a phasing plan, these could be implemented on priority within the major urban cities and later may be used for regional mobility.
3. ***Other Urban Transport Options:*** A rebate targeted at affordable battery electric vehicles (BEVs) combined with early investments in charging infrastructure along roadways where EVs would most need them is likely to increase EV adoption. The availability of tax incentives- especially in promoting sales of plug-in hybrid electric vehicles.

Electric Vehicles can contribute towards reducing greenhouse gas emissions but not energy efficiency/safety and they still need parking spaces.

Following directives have been suggested as per the Parking Policy prepared for the city of Panaji as a part of the Parking Master Plan-Panaji:

- For an initial period, on-street parking charges near on street charging points or other locations will be made free for electric vehicles in CBD. Thereafter, the price of charging a vehicle can be included in the parking charges.

- Designate 10%-30% of the parking permit to the electric vehicles at a lower rate and accordingly reduce the permit for other vehicles.

- To successfully create a shift away from Fossil Fuel, Goa will require a robust ecosystem. Before the mobility revolution begins, however, Goa will need an ecosystem that can sustain Electric Vehicles.

6.8: Travel Demand Management (TDM) Measures

Travel Demand Management, Transportation Demand Management or Traffic Demand Management (all TDM) is an application of strategies and policies to reduce travel demand or to redistribute this demand in space or in time. Some of the TDM measures are,

1. Improving the existing public transportation system.
2. Increasing the ridesharing like carpooling, vanpooling etc.
3. Staggered hours.
4. Telecommuting.
5. Subsidizing transit costs for employees or residents.
6. Flexi-time work schedules with employers to reduce congestion at peak times.
7. Including and improving public transportation infrastructure such as subway entrances, bus stops and routes.
8. Including or improving pedestrian-oriented design elements, such as pedestrian crossings, wide sidewalks and providing trees on the sidewalk.
9. Road space reallocation, aiming to re-balance provision between private cars which often predominate due to high spatial allocations for roadside parking, and for sustainable modes.

6.9: Social impact of proposed projects

The proposed impact of short term, medium term and long term improvements is analyzed in a broader prospective. 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 and reduce travel time. The broad impacts have been compiled in table given below:

Table 6.37: Social Impact of Short, Medium and Long Term Improvement Proposals

Project Term	Project	Right of Way/ Land Acquisition	Requirement of Rehabilitation and Resettlement	Improve Mobility	Reduction in Travel time
Short Term Improvements	Non Motorized Transport				
	Upgradation of Footpath	No	No	Yes	Yes
	Construction of New Footpath	No	No	Yes	Yes
	Traffic Engineering Measures				
	Junction Improvement	No	No	Yes	Yes
	Road Signs and Markings	No	No	Yes	Yes
	Street Names Plates	No	No	No	No
	Inland Water Transport				
	Hopon/Hopoff Ferry Service	No	No	No	No
	Public Transport Improvement				
	Procurement of Fleet	No	No	Yes	Yes
	Bus Shelters	No	No	Yes	Yes
	Depot Development/Upgradation	No	No	No	No
	Bus Terminal Upgradation	Yes	No	Yes	Yes
	ITS Infrastructure	No	No	No	No
	Charging Infrastructure for Electric Buses	No	No	No	No
Medium Term Improvements	Public Transport Improvement				
	Bus Fleet Augmentation	No	No	Yes	Yes
	Charging Infrastructure	No	No	No	No
	Parking				
	Off-Street Parking Development	Yes	No	Yes	Yes
	Transit Hub				
	Multi Modal Transit Hubs	Yes	No	Yes	Yes
	ITS				

	ITS	No	No	Yes	Yes
Long Term Proposals	Public Transport Improvement				
	Bus Fleet Augmentation	No	No	Yes	Yes
	Charging Infrastructure	No	No	No	No
	Logistics Hub				
	Multi-Modal Logistics Hub	Yes	Yes	Yes	NA

6.10: Road Safety

Goa ranks 14th among the top 19 states and union territories in the country that has high rate of death by accidents according to the "Accidental Deaths and Suicides in India 2014" published by National Crime Records Bureau(NCRB). As compared to an all India average of 36.3 deaths per one lakh of population, Goa recorded a rate of 44.6 deaths per lakh of population which was the 14th highest rate of death by accidents in the country (Source: TOI, Goa). Table 6.38 shows the road traffic accidents during the year 2015-16 in Goa.

Table 6.38: Road Traffic Accidents during the Year 2015-16

Sl. No.	Description	Goa	North Goa	South Goa
1	No. of motor accident cases reported	4358	2024	2334
2	No. of persons killed in motor accidents	316	139	177
3	No. of persons injured in motor accidents	2076	754	1322
4	No of vehicles involved in road traffic accidents	7213	3450	3763

Source: Goa Police Department.

In the month of June 2018, there were 306 accidents in Goa, out of which 14 were fatal, 15 were serious injuries, 57 were minor injuries and 220 were non-injury accidents (Source: www.heraldgoa.in).

The Government of Goa is planning to reduce the road accidents in Goa by 50 percent by 2020. The transport department is in the process of floating a tender for procurement of road safety devices like interceptors, speed guns and alcometers which will act as deterrent for rash drivers. The road safety

committee has also decided to introduce a curriculum on road safety in schools (Source: TOI, Goa).

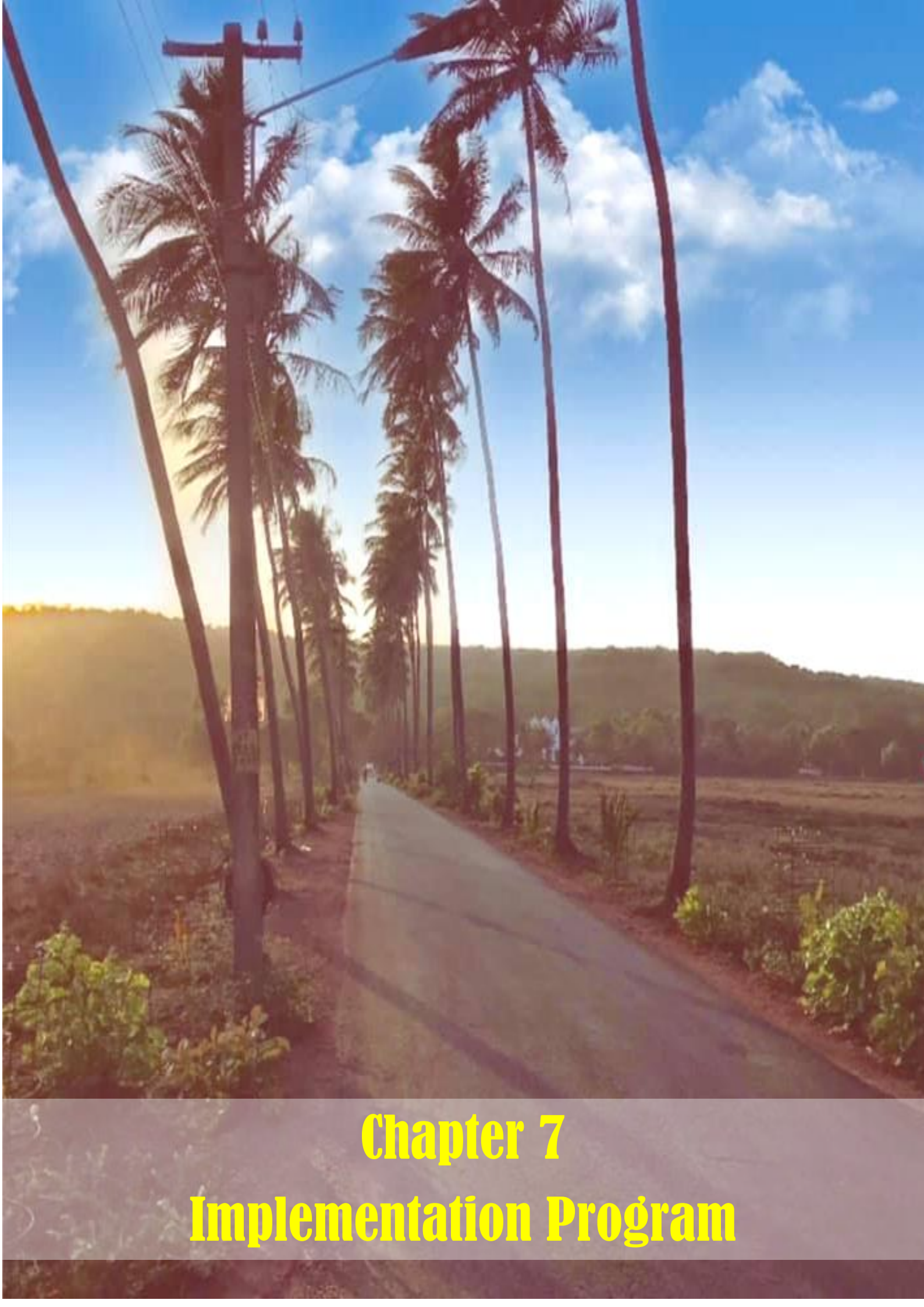
The Government of Goa should go in for four E's, Engineering, Enforcement Education and Emergency Care in order to reduce road accidents and improve road safety in Goa. Road Safety Audit (RSA) should be done for all major roads in Goa in order to reduce accidents.

Government of India has made several efforts to enhance road safety in India. A major one was the appointment of the Committee on Road Transport and Traffic Management (Sundar Committee, 2007). Following are the important steps taken in recent years to enhance road safety in the country.

1. A Multi-Pronged Strategy has been adopted by the Ministry of Road Transport and Highways, based on the Four Es – Engineering, Enforcement, Education and Emergency Care for ensuring road safety.
2. Making engineering level innovations to improve road safety: The MORTH has established a Road Safety Cell in 2015 to exclusively work on Road Safety Engineering. The ministry is making concerted efforts in road safety engineering by way of:
    a. Identification and rectification of road accident black spots.
    b. Road safety improvement works at identified accident prone locations on NHs under Road Safety Annual Plans.
    c. Road Safety Audits (RSA).
    d. Improving road accident data collection and data base management.
    e. Training of Highway Engineers and Professionals in Road Safety Engineering.
    f. Improving Vehicular Safety Standards.
    g. Training of Drivers.
    h. Effective Trauma Care.
    i. Pilot Projects for Cashless Treatment of Road Accident Victims.

j. Good Samaritan Guidelines.
k. Highway Advisory System (HAS).
l. Quick Response Ambulances.

3. Road Safety Bill: The MoRTH introduced the Motor Vehicle (Amendment) Bill 2016 in Parliament (Lok Sabha) in August 2016. The bill addresses several road safety issues by providing for stiffer penalties, permitting electronic enforcement, improving fitness certification and licensing regime, statutory provisions for protection of good Samaritans and recognition of IT enabled enforcement systems etc., (Source:www.indianeconomy.net).



Chapter 7
Implementation Program

CHAPTER 7: IMPLEMENTATION PROGRAM

7.1: Introduction

The chapter on strategies and proposals discussed the way forward for improving urban transport in Goa from which we have established a large number of options that are short term, medium term and long term in nature. This chapter details out the costs associated with each of the proposed improvements, along with the phasing of the projects. The implementation plan also provides various financial options to be looked at towards implementing the proposed projects. A proper Institutional Framework is of utmost importance for the successful implementation and monitoring of all the schemes. In this regard, an institutional setup is also recommended.

7.2: Prioritization of Projects

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

Long Term Improvements: the usefulness of 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 project proposals for Goa are shown in Table 7.1, Table 7.2 and Table 7.3.

Table 7.1: Short Term Projects

Sl. No.	Projects	Unit	Quantity	Unit Cost (Crores)	Total Cost (Crores)
1	Up gradation of Footpath	Km	250	0.1	25
2	Construction of New Footpath	Km	384	0.2	76.8
3	Road Signs and Markings	Km	240	0.05	12

4	Junction Improvement	Nos.	41	0.2	8.20
5	Street Name Plates	Per City	6 cities	5	30.00
6	Hop on/Hop off Ferry Service Boats	Nos.	4	2	8.00
7	Public Transport Improvement				801.81
	a) Procurement of Fleet	Nos.	213		135.90
	Standard AC/Non AC 650 mm	Nos.	138	0.60	82.80
	Standard Electric	Nos.	33	1.10	36.30
	Midi Buses 650 mm	Nos.	42	0.40	16.80
	b) Bus Shelters	Nos.	763	0.638	48.67
	c) Depot Development/ Upgradation				84.83
	d) Bus Terminal Upgradation				520.00
	e) ITS Infrastructure				6.38
	f) Charging Infrastructure for Electric Buses				6.03
Total Cost					**961.81**

Table 7.2: Medium Term Projects

Sl. No.	Projects	Unit	Quantity	Unit Cost (Crores)	Total Cost (Crores)
1	**Public Transport Improvement**				
	Bus Fleet Augmentation				
	Additional Fleet	Nos.	315		**247.10**
a	Standard AC/Non AC 650 mm	Nos.	98	0.60	58.80
b	Standard Electric	Nos.	145	1.10	159.50
c	Midi Buses 650 mm	Nos.	72	0.40	28.80
	Bus Augmentation and Replacement of Fleet	Nos.	5301		**3363.80**
a	Standard AC/Non AC 650 mm	Nos.	4292	0.60	2575.20
b	Standard Electric	Nos.	550	1.10	605.00
c	Midi Buses 650 mm	Nos.	459	0.40	183.60
	Charging Infrastructure				
	For Additional Fleet		145		**26.95**

	Slow Chargers	Nos.	290	0.08	23.20
	Fast Chargers	Nos.	15	0.25	3.75
	For Replacement Fleet		550		**101.75**
	Slow Chargers	Nos.	1100	0.08	88
	Fast Chargers	Nos.	55	0.25	13.75
2	**Off-Street Parking Development**	Nos.	6	25	**150**
3	**Multi Modal Transit Hub**	Nos.	5	100	**500**
4	**ITS**	Nos.	6	20	**120**
Total Cost					**4509.60**

Table 7.3: Long Term Projects

Sl. No.	Projects	Unit	Quantity	Unit Cost (Crores)	Total Cost (Crores)
1.	Public Transport Improvement				
	Bus Fleet Augmentation	Nos.			
	Additional Fleet		**154**		**142.30**
a	Standard AC/Non AC 650 mm	Nos.	36	0.60	21.60
b	Standard Electric	Nos.	105	1.10	115.50
c	Midi Buses 650 mm	Nos.	13	0.40	5.20
	Bus Augmentation and Replacement of Fleet		**2319**		**1794.20**
a	Standard AC/Non AC 650 mm	Nos.	1365	0.60	819
b	Standard Electric	Nos.	848	1.10	932.80
c	Midi Buses 650 mm	Nos.	106	0.40	42.40
	Charging Infrastructure				
	For Additional Fleet		105		**19.55**
	Slow Chargers	Nos.	210	0.08	16.80
	Fast Chargers	Nos.	11	0.25	2.75
	For Replacement Fleet		848		**157.01**
	Slow Chargers	Nos.	1697	0.08	135.76
	Fast Chargers	Nos.	85	0.25	21.25
2	**Multi-Modal Logistics Hub**	Nos.	1	50	**50.00**
Total Cost					**2163.06**

Table 7.4: Project Priority

Sl.No.	Project Priority	Cost (in Crores)
1	Short Term Projects	961.81
2	Medium Term Projects	4509.60
3	Long Term Projects	2163.06
Total Cost		**7634.47**

7.3: Phasing Plan and PPP Potential

The projects identified in the earlier section are divided into three categories of short, medium and long term projects based on the urgency and duration of implementation. Some of the long term projects have the potential to be implemented under PPP, however case to case project reports are required for validating the feasibility of each project. The cost of all the recommended projects is around **Rs. 7634.47 crores**. It is important to highlight that the CMP serves only to identify schemes and the costs presented are only approximate estimates for decision makers. Detailed cost estimates need to be worked out at further stage.

Table 7.5: Project Phasing and PPP Potential

Sl. No.	Projects	Unit	Quantity	Rates (in Crores)	Total Cost (in Crores)	Project Phasing (Amount)			PPP Potential
						Phase 1	Phase 2	Phase 3	
Short Term Projects									
1	Up gradation of Footpath	Km	250	0.1	25.00	**25.00**			No
2	Construction of New Footpath	Km	384	0.2	76.80	**76.80**			No
3	Road Signs and Markings	Km	240	0.05	12.00	**12.00**			No
4	Junction Improvement	Nos.	41	0.2	8.20	**8.20**			No
5	Street Name Plates	Per City	6 cities	5	30.00	**30.00**			No
6	Hop on/Hop off Ferry Service Boats	Nos.	4	2	8.00	**8.00**			No
7	Public Transport Improvement								No

	Procurement of Fleet	Nos.	213		**135.90**	**135.90**			
	Standard AC/Non AC 650 mm	Nos.	138	0.60	82.80				
	Standard Electric	Nos.	33	1.10	36.30				
	Midi Buses 650 mm	Nos.	42	0.40	16.80				
	Bus Shelters	Nos.	763	0.638	**48.67**	**48.67**			
	Depot Development/Upgradation				**84.83**	**84.83**			
	Bus Terminal Upgradation				**520.00**	**520.00**			
	ITS Infrastructure				**6.38**	**6.38**			
	Charging Infrastructure for Electric Buses				**6.03**	**6.03**			
Total Short Term Project Cost/Phase Wise Cost					**961.81**	**961.81**			
Medium Term Projects									
1	Public Transport Improvement								No
	Bus Fleet Augmentation								
	Additional Fleet		315		**247.10**		**247.10**		
	Standard AC/Non AC 650 mm	Nos.	98	0.60	58.80		58.80		
	Standard Electric	Nos.	145	1.10	159.50		159.50		
	Midi Buses 650 mm	Nos.	72	0.40	28.80		28.80		
	Bus Augmentation and Replacement of Fleet		5301		**3363.80**		**3363.80**		
	Standard AC/Non AC 650 mm	Nos.	4292	0.60	2575.20		2575.20		

	Standard Electric	Nos.	550	1.10	605.00		605.00		
	Midi Buses 650 mm	Nos.	459	0.40	183.60		183.60		
	Charging Infrastructure								
	Additional Fleet		145		**26.95**		**26.95**		
	Slow Chargers	Nos.	290	0.08	23.20		23.20		
	Fast Chargers	Nos.	15	0.25	3.75		3.75		
	For Replacement Fleet		550		**101.75**		**101.75**		
	Slow Chargers	Nos.	1100	0.08	88		88		
	Fast Chargers	Nos.	55	0.25	13.75		13.75		
2	Off-Street Parking Development	Nos.	6	25	150	50	**50**	50	Yes
3	Multi Modal Transit Hub	Nos.	5	100	500	0	**500**	0	Yes
4	ITS	Nos.	6	20	120	40	**40**	40	No
Total Medium Term Project Cost/Phase Wise Cost					**4509.60**	**90**	**4329.60**	**90**	
Long Term Projects									
1	Public Transport Improvement								No
	Bus Fleet Augmentation		Nos.						
	Additional Fleet			**154**				**142.30**	
	Standard AC/Non AC 650 mm	Nos.	Nos.	36	0.60			21.60	
	Standard Electric	Nos.	Nos.	105	1.10			115.50	
	Midi Buses 650 mm	Nos.	Nos.	13	0.40			5.20	
	Bus Augmentation and Replacement of Fleet			**2319**				**1794.20**	
	Standard	Nos.	Nos.	1365	0.60			819	

	AC/Non AC 650 mm								
	Standard Electric	Nos.	Nos.	848	1.10			932.80	
	Midi Buses 650 mm	Nos.	Nos.	106	0.40			42.40	
	Charging Infrastructure								
	Additional Fleet			105				**19.55**	
	Slow Chargers	Nos.	Nos.	210	0.08			16.80	
	Fast Chargers	Nos.	Nos.	11	0.25			2.75	
	For Replacement Fleet			848				**157.01**	
	Slow Chargers	Nos.	Nos.	1697	0.08			135.76	
	Fast Chargers	Nos.	Nos.	85	0.25			21.25	
2	Multi-Modal Logistics Hub	Nos.	1	50	50		50		Yes
Total Long Term Project Cost/Phase Wise Cost					**2163.06**		**50**	**2113.06**	

7.4: Financing Options

The financing of urban transport projects in the country is largely confined to Gross Budgetary Support (GBS) 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 government. The other funding sources apart from GBS and fare box can be rent from the offices, shops, hotels in the terminal building, advertisement on buses and terminals and bus stops etc., The government should also not charge heavy taxes for purchasing of buses for public transport. There is a need for long-term sustainable dedicated

financing mechanism to address fast worsening scenario in the field of urban transport.

7.4.1: Public Private Partnership (PPP)

Public Private Partnership (PPP) is co-operation between Public Authority and Private Company which is created to carry out a specific project. In PPP, the public authority creates a secure environment for the private sector to carry out the project and the private company offers its industry know-how, provides funding and shares in projects risk. There are many types of PPP like BOT (Build, Operate and Transfer), BOOT (Build, Own, Operate and Transfer), DBFOT (Design, Build, Finance, Operate and Transfer) etc.,

Certain long term and medium term projects can be done by Public Private Partnership (PPP). Some of the long term and medium term projects which can be done under PPP are Off-street Parking Development, Multi-modal Logistics Hub and Multi-modal Transit Hub.

7.4.2: Government sources of Funding

The Government Sources of Funding for urban transport are,

a) AMRUT.
b) SMART City Funding.
c) Fare Collection.
d) Dedicated Urban Transport Fund at City Level.
e) Viability Gap Funding (VGF).

7.4.2.1 AMRUT (Atal Mission for Rejuvenation and Urban Transformation)

The mission is to provide basic services (e.g., water supply, sewerage, urban transport) to households and build amenities in the city which will improve the quality of life for all, especially the poor and the disadvantaged. The thrust areas are,

- Water Supply.
- Sewerage Facilities and Septic Management.
- Storm Water Drains to Reduce Flooding.

- Pedestrian, non-motorized and public transport facilities, parking spaces and
- Enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centres especially for children.

Five hundred cities will be covered under AMRUT. The category of cities that will be covered in AMRUT is given below,

- All Cities and Towns with a population of over one lakh with notified Municipalities, including Cantonment Boards (Civilian areas),
- All Capital Cities/Towns of States/ UTs, not covered in the above,
- All Cities/ Towns classified as Heritage Cities by MoUD under the HRIDAY Scheme,
- Thirteen Cities and Towns on the stem of the main rivers with a population above 75,000 and less than 1 lakh and
- Ten Cities from hill states, islands and tourist destinations (not more than one from each State).

The mission components of the AMRUT consist of capacity building, reform implementation, water supply, sewerage and septage management, storm water drainage, urban transport and development of green spaces and parks. During the process of planning, the Urban Local Bodies (ULBs) will strive to include some smart features in the physical infrastructure components. The details of the Mission components are given below.

1. Water Supply

a. Water supply systems including augmentation of existing water supply, water treatment plants and universal metering.
b. Rehabilitation of old water supply systems, including treatment plants.
c. Rejuvenation of water bodies specifically for drinking water supply and recharging of ground water.

d. Special water supply arrangement for difficult areas, hill and coastal cities, including those having water quality problems (e.g. arsenic, fluoride).

2. Sewerage

a. Decentralised, networked underground sewerage systems, including augmentation of existing sewerage systems and sewage treatment plants.
b. Rehabilitation of old sewerage system and treatment plants.
c. Recycling of water for beneficial purposes and reuse of wastewater.

3. Septage

a. Faecal Sludge Management- cleaning, transportation and treatment in a cost-effective manner.
b. Mechanical and Biological cleaning of sewers and septic tanks and recovery of operational cost in full.

4. Storm Water Drainage

a. Construction and improvement of drains and storm water drains in order to reduce and eliminate flooding.

5. Urban Transport

a. Ferry vessels for inland waterways (excluding port/bay infrastructure) and buses.
b. Footpaths/walkways, sidewalks, foot over-bridges and facilities for non-motorised transport (e.g. bicycles).
c. Multi-level parking.
d. Bus Rapid Transit System (BRTS).

6. Green space and parks

a. Development of green space and parks with special provision for child-friendly components. Reforms management & support.
b. Support structures, activities and funding support for reform implementation.
c. Independent Reform monitoring agencies.

7. Capacity Building

a. This has two components- individual and institutional capacity building.
b. The capacity building will not be limited to the Mission Cities, but will be extended to other ULBs as well.
c. Continuation of the Comprehensive Capacity Building Programme (CCBP) after its realignment towards the new Missions.

8. Indicative (not exhaustive) list of inadmissible components

a. Purchase of land for projects or project related works.
b. Staff salaries of both the States/ULBs.
c. Power.
d. Telecom.
e. Health.
f. Education and
g. Wage employment programme and staff component

7.4.2.2 SMART City Funding

Smart City is an urban area that uses different types of electronic data collection sensors to supply information which is used to manage assets and resources efficiently. This includes data collected from citizens, devices and assets that is processed and analyzed to monitor and manage traffic and transportation systems, power plants, water supply networks, waste management, waste management etc

Some typical smart city features of comprehensive development in Smart Cities are described below.

1. Promoting mixed land use in area based developments–planning for 'unplanned areas' containing a range of compatible activities and land uses close to one another in order to make land use more efficient. The States will enable some flexibility in land use and building bye-laws to adapt to change;
2. Housing and inclusiveness - expand housing opportunities for all;

3. Creating walkable localities –reduce congestion, air pollution and resource depletion, boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance;
4. Preserving and developing open spaces - parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effects in Areas and generally promote eco-balance;
5. Promoting a variety of transport options - Transit Oriented Development (TOD), public transport and last mile para-transport connectivity;
6. Making governance citizen-friendly and cost effective - increasingly rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices. Forming e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites;
7. Giving an identity to the city - based on its main economic activity, such as local cuisine, health, education, arts and craft, culture, sports goods, furniture, hosiery, textile, dairy, etc;
8. Applying Smart Solutions to infrastructure and services in area-based development in order to make them better. For example, making Areas less vulnerable to disasters, using fewer resources, and providing cheaper services (Source: www.smartcities.gov.in)

7.4.2.3 Dedicated Urban Transport Fund at City Level

In order to fund the urban transport projects, there is a need to create a dedicated urban transport fund through sources like land monetization, betterment levy, land value tax, advertisement, employment tax, cess on

sales tax, parking charges, supplement to petrol and diesel, rent from terminal buildings etc.,

7.4.2.4 Viability Gap Funding (VGF)

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. The Government of India has set certain criteria to avail this facility under formal legal guidelines, issued in August 2004, to support infrastructure under PPP framework. Viability Gap Funding (VGF) can take various forms such as capital grants, subordinated loans, O&M support grants and interest subsidies. It will be provided in instalments, preferably in the form of annuities. 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:

1. Roads and Bridges, Railways, Seaports, Airports, Inland Waterways.
2. Power.
3. Urban Transport, Water Supply, Sewerage, Solid Waste Management (SWM) and other physical infrastructure in urban areas.
4. Infrastructure projects in Special Economic Zones.
5. International convention centres and other tourism infrastructure projects.

7.5: Institutional Framework

In order to co-ordinate all urban transport activities, it is recommended that a Unified Metropolitan Transport Authority (UMTA) be set up at the city level so that it acts as a planning and decision making body for all matters related to urban transport.

7.5.1: Functions and powers of authority

The following are the functions and powers of Unified Metropolitan Transport Authority (UMTA),

1. Prepare Comprehensive Mobility Plans and a Transport Master Plans, including but not limited to Public Transportation, and Non-motorized Transportation within the Urban Mobility Area.
2. Prepare Transport Investment Programmes of the Urban Mobility Area to achieve the goals of the approved Comprehensive Mobility Plan and Transport Master Plan and in a manner such that the Transport Investment Programme can give guidance and directions to the various agencies engaged in provision of the Urban Transport and the Urban Transport Ancillary Services to prepare their own investment programmes and projects in alignment with the overall Transport Investment Programme.
3. Plan for financing, construction, and operation of facilities and services related to the Urban Transport and the Urban Transport Ancillary Services in the Urban Mobility Area.
4. Promote or undertake development of integrated facilities and systems for Urban Transport within Urban Mobility Area including developing systems for seamless transport access within an Urban Mobility Area.
5. Develop, construct, repair, reconstruct and operate and manage any integrated or standalone transport facilities and services that aid and enhance the efficiency or service levels of the Urban Transport to the consumers, in the Urban Mobility Area, either suo-moto or through agencies appointed for this purpose.
6. Adopt existing standard and guidelines provided by State and Central Government from time to time and as necessary develop, publish and issue their own standards and guidelines relating to the development and operation of Urban Transport facilities and services within Urban Mobility Area in accordance with the requirements, including those required for physically challenged, elderly, women and children and

take measures that compliance of the same by various relevant public and private transport operators in the Urban Mobility Area is ensured.

7. Develop and disseminate performance indicators for Urban Transport services within its jurisdiction.
8. Regulate and enforce technical and performance standards on all strategic and operational matters that have a direct effect on the levels of service provided to the users of Urban Transport.
9. Regulate and enforce environmental standards for all aspects related and/or incidental to the Urban Transport and the Urban Transport Ancillary Services.
10. Set up and operate an operation control centre, a web based user information system, and a helpline to provide integrated information to the users of Urban Transport in the Urban Mobility Area.
11. Set up and operate a smart card based ticketing system for payment of user charges for Urban Transport and Urban Transport Ancillary Services.
12. Promote technology-based solutions for traffic management, transport planning and design of transport systems and selection of mode of transport.
13. Collate information on urban transportation within Urban Mobility Area and provide the same to the relevant agencies with a view to contributing to the national database on urban transport.
14. Promote consumer awareness in relation to the integrated urban transport, and ensure that information is appropriately publicized and displayed for users of various urban transport services within the Urban Mobility Area.
15. Undertake activities for the purpose of advancing the skills of persons employed by the Authority by provision of training, education and research facilities.
16. Fund and/or facilitate financing of all transport related projects, plans, schemes and proposals included in the Transport Investment Programme.

17. Approve all major Transport Projects proposed for or in the Urban Mobility Area by any State/Central/any other agencies from the perspective of alignment with Transport Master Plan.
18. Issue permits/licenses for public transport services.
19. Monitor and audit compliance with the Transport Master Plan (TMP), the Comprehensive Mobility Plan (CMP), and the Transport Investment Programme. Prescribe fees and charges for roads, public transport, parking and other public transport facilities and services and regulate fares for all Urban Transport Services as may be prescribed from time to time.
20. Monitor use of funding for urban transport activities and ensure Audit of Accounts and loans.

However, the various authorities under UMTA should perform their individual function under the purview of UMTA.

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PROJECT PROFILE SHEETS

PS Express

Project 1: Upgradation of Footpath

Project No: 1	Project Title: Upgradation of Footpath
Project Type: Short Term	Length: 250 kms
Location: Panjim, Margoa, Vasco, Mormugao, Mapusa and Ponda	Approximate Capital Cost: Rs. 250 million or Rs 25 Crores (Rs.10 Lakhs per km)
Detailed Description: Most of the footpaths in the above cities are not maintained properly due to which pedestrians walk on the road thus reducing the capacity of road.	
Implementation Period: Phase I	Potential Benefits: Improves the Safety of Pedestrians and increases the capacity of traffic.

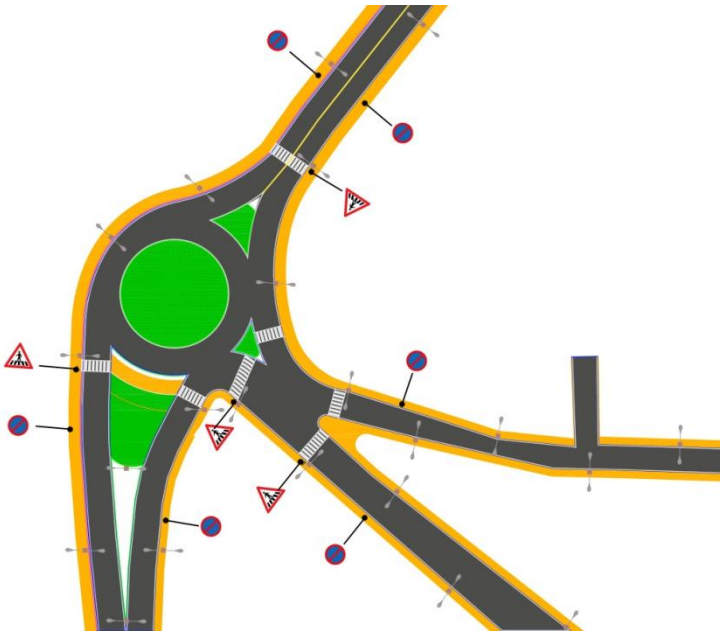
Project 2: Construction of New Footpath

Project No: 2	Project Title: Construction of New Footpath
Project Type: Short Term	Length: 384 kms
Location: Panjim, Margoa, Vasco, Mormugao, Mapusa and Ponda	Approximate Capital Cost: Rs. 768 million or Rs. 76.8 Crores (Rs. 20 Lakhs per km)
Detailed Description: Footpath should be constructed on all major and minor roads of the above six cities.	 *Source: www.google.co.in*
Implementation Period: Phase I	Potential Benefits: Improves the Safety of Pedestrians.

Project 3: Road Signs and Markings

Project No: 3	Project Title: Road Signs and Markings
Project Type: Short Term	Length: 240 kms
Location: Panjim, Margoa, Vasco, Mormugao, Ponda and Mapusa	Approximate Capital Cost: Rs.120 Million or Rs. 12 Crores (Rs. 5 lakhs per Km)
Detailed Description: Road Markings like, 1) Centre Line Markings. 2) Traffic Lane Markings. 3) Stops Lines. 4) Pedestrian Zebra Crossing Markings. 5) Marking for Two Wheeler and Car Parking., 6) Kerb Marking. 7) Hazard Marking. Road Signs like, 1) Speed Limit Sign. 2) No Parking Sign. 3) Parking Sign. 4) Stop and Go Sign. 5) School Zone Sign. 6) No Overtaking Sign. 7) Traffic Calming Hump Sign. 8) No U-Turn Sign. 9) Median Gap Sign.	 *Source: http://www.pixabay.com*
Implementation Period: Phase I	Potential Benefits: Benefits include systematic traffic flow, vehicle safety especially for night time driving and pedestrian safety.

Project 4: Junction Improvement

Project No: 4	Project Title: Junction Improvement
Project Type: Short Term	Numbers: 41
Location: Panjim, Margoa, Ponda, Mapusa and Vasco	Approximate Capital Cost: Rs. 82 million or Rs. 8.2 Crores (Rs. 20 Lakhs per Junction)
Detailed Description: Junction Improvement involves the following elements: 1) Provision of adequate sight distance. 2) Providing adequate corner radii. 3) Providing sufficient turning radii. 4) Flaring approaches towards intersections. 5) Providing channelizers/division islands. 6) Providing pedestrian/cyclist crossing facilities. 7) Bus stops near junctions to be re-located. 8) Providing signs/lane markings/lighting. 9) Prohibiting parking at intersection corners through proper marking of kerbs i.e., yellow markings.	 *Photo: Miramar Junction Conceptual Plan*
Implementation Period: Phase I	Potential Benefits: Systematic movement of traffic, reduce traffic conflicts and delay at junction, ensure smooth traffic maneuvering, enable safe pedestrian movement and crossing with minimal cost.

Project 5: Street Name Plates

Project No: 5	Project Title: Street Name Plates (Information Sign)
Project Type: Short Term	Numbers: 6 Cities
Location: Panjim, Margoa, Vasco, Mormugao, Ponda and Mapusa	Approximate Capital Cost: Rs. 30 Crores (Rs.5 Crores per city)
Detailed Description: Most of streets in Goa do not have street name plates. Street name plates made of steel may rust in Goa, so alternate material like aluminium can be used for street name plates.	 *Source:www.safetysign.com*
Implementation Period: Phase I	Potential Benefits: Street name plates will help the driver to reach their destination easily without moving haphazardly and stopping for direction and thus creating traffic congestion and also accidents.

Project 6: Boats for Ferry Service

Project No: 6	Project Title: Boats for Ferry Service (Hopon/Hopoff Service)
Project Type: Short Term	Numbers: 4
Location: Panjim	Approximate Capital Cost: Rs. 8 Crores (Rs. 2 crores for each ferry boat)
Detailed Description: Hopon/Hopoff ferry service can be provided in the route of Dona Paula, Panjim, Ribandar, Old Goa, Narva, Vanxim, Charo and Betim.	Proposed Hopon/Hopoff Ferry Service Route Map with Location of Jetties 
Implementation Period: Phase I	Potential Benefits: It will increase tourism and also increase income to the Government.

Project 7: Depot Development/Upgradation of Bus Depot

Project No: 7	**Project Title: Development and Upgradation of Bus Depot and Workshop**
Project Type: Short Term	Numbers:
Location:	Approximate Capital Cost: Rs. 84.83 Crores
Detailed Description: 1) Provide separate access for bus, passengers, two wheelers, taxis and cars. 2) Provide well designed bays for buses. 3) Provide space for free movement of passengers. 4) Provide enough chairs for passengers to sit. 5) Provide enough number of toilets for men and women. 6) Provide Passenger Information System (PIS) in the terminals. 7) Drinking water spouts. 8) Provide separate lounge rooms for male and female passengers. 9) Provide proper signboards. 10) Provide shops like medical shops, newspaper joints, coffee shop, hotels, mobile recharging shops (prepaid and post paid), mobile recharging points etc., 11) Provide parking space for two wheelers, cars, taxies etc.,	 Source: www.google.co.in
Implementation Period: Phase I	Potential Benefits: Better maintenance of buses so that it lasts longer.

Project 8: Bus Fleet Augmentation

Project No: 8	Project Title: Bus Fleet Augmentation
Project Type: Short Term, Medium and Long Term.	**Short Term: 213 Buses** 1) Standard AC/Non AC 650 mm – 138 Nos. 2) Standard Electric – 33 Nos. 3) Midi Buses – 42 Nos. **Medium Term: 315 + 5301 Buses** **Additional Fleet** 4) Standard AC/Non AC 650 mm – 98 Nos. 5) Standard Electric – 145 Nos. 6) Midi Buses – 72 Nos. **Bus Augmentation** 7) Standard AC/Non AC 650 mm – 4292 Nos. 8) Standard Electric – 55 Nos. 9) Midi Buses – 459 Nos **Long Term: 154+2319** **Additional Fleet** 1) Standard AC/Non AC 650 mm – 36 Nos. 2) Standard Electric – 105 Nos. 3) Midi Buses – 13 Nos. **Bus Augmentation** 10) Standard AC/Non AC 650 mm – 1365 Nos. 11) Standard Electric – 848 Nos. 12) Midi Buses – 106 Nos
Location: Augmentation of the buses based on population and phasing out of old buses.	Approximate Capital Cost: Rs.5683.30 Crores 1) Short Term – Rs.135.90 Crores 2) Medium Term – Rs. 3610.90 Crores 3) Long Term – Rs.1936.50 Crores
Detailed Description:	 http://www.google.co.in

Implementation Period: Phase I = 213 Buses Phase II = 315+5301 Buses Phase III = 154+2319 Buses	Potential Benefits: If the public transportation is good, people may shift from their private mode of transportation to public transportation mode and thus help in reducing traffic congestion, air pollution and increase in speeds.

Project 9: Off-Street Parking Development

Project No: 9	**Project Title: Off-Street Parking Development**
Project Type: Medium Term	Numbers: 6
Location: Panjim, Margoa, Mapusa, Vasco, Calangute and Ponda	Approximate Capital Cost: Rs. 150 Crores (Rs. 25 Crores per Multi-Storied Off-Street Parking Building)
Detailed Description: Multi-storied off-street parking lots either of concrete structures or steel structures or mechanical parking lots. Multi-storied parking lots are preferred when compared to surface off-street parking lots because multi-storied parking lot accommodates more number of vehicles in less space.	 *Source: www.google.co.in*
Implementation Period: Phase I– 2 – Rs. 50 Crores Phase II – 2 – Rs. 50 Crores Phase III – 2 – Rs. 50 Crores	Potential Benefits: There will be less number of people parking on-street, which will increase the capacity of the road and speed of vehicles.

Project 10: Bus Shelters

Project No: 10	Project Title: Bus Shelters
Project Type: Short Term	Numbers: 763 Bus Shelters
Location: Panjim, Margoa, Vasco, Ponda and Mapusa	Approximate Capital Cost: Rs. 48.67 Crores (0.0638 Crores per bus stop)
Detailed Description: Bus shelter should be provided at every 500 m or 0.5 km.	 *Source: www.google.co.in*
Implementation Period: Phase I – 763 Shelters – Rs. 48.67 Crores	Potential Benefits: The number of bus riders might increase if the bus shelter is provided at every 500 m or 0.5 km because it increases accessibility.

Project 11: Multi-Modal Transit Hub

Project No: 11	Project Title: Multi-Modal Transit Hub
Project Type: Long Term	Numbers: Five
Location: Vasco Railway Station, Margoa Railway Station, Panaji, Pernem and Mapusa	Approximate Capital Cost: Rs. 500 Crores (Rs. 100 Crores per Multi-Modal Transport Hub)

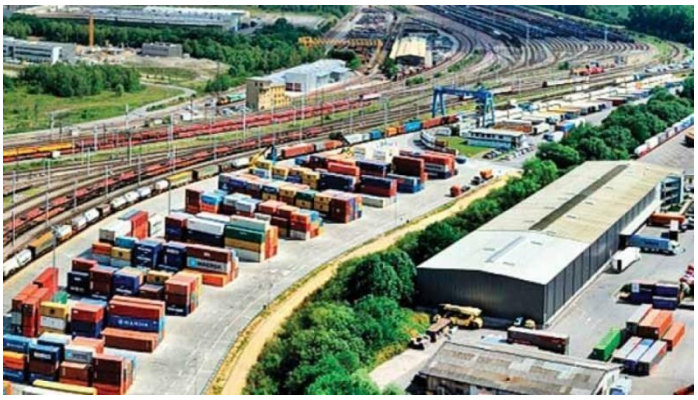
Detailed Description: The multi-modal transport hub should have, Enough space for accommodating different modes of transportation. Proper interlinking of different modes. Sufficient number of ticket counters for each mode of transportation. Parking space for two wheelers, taxis, cars etc., Amenities like hotels, snack shops, medical shops, juice shops, newsstands, phone re-charging facilities, stationary shop, fruits/vegetable shop, convenience/departmental stores etc., Sufficient number of toilets for both male and female passengers. Lounge room/waiting room for male and female passengers. Sufficient space for free movement of passengers. Sufficient number of seating arrangements for passengers. Elevators and escalators for movement of passengers from different floors. Drinking water spouts. Emergency medical facilities.	 *Source:www.google.co.in*
Implementation Period: Phase II – 5 hubs – Rs. 500 Crores	Potential Benefits: Reduce traffic congestion. People need not have to move from one modal hub to another modal hub.

Project 12: Intelligent Transportation System (ITS)

<table>
<tr><th>Project No: 12</th><th>Project Title: Intelligent Transportation System (ITS)</th></tr>
<tr><td>Project Type: Medium Term</td><td>Numbers: 6 cities</td></tr>
<tr><td>Location-Cities: Panjim, Margoa, Mapusa, Vasco, Ponda and Mormugoa.</td><td>Approximate Capital Cost: Rs. 120 Crores
(Rs. 20 Crores per city)</td></tr>
<tr><td>Detailed Description:
ITS Technologies to be Incorporated:
1) Fully Actuated Traffic Signal.
2) Traffic Signal Control System.
3) Enforcement Cameras (Speed Cameras).
4) Surveillance Cameras.
5) CCTV.
6) Parking Guidance and Information System.
7) Variable Message Signs (VMS).
Location-Highways: Variable Message Signs (VMS).</td><td> 

Source: www.google.co.in</td></tr>
<tr><td>Implementation Period:
Phase I – 2 Cities –Rs. 40 Crores
Phase II – 2 Cities – Rs. 40 Crores
Phase III – 2 Cities – Rs. 40 Crores</td><td>Potential Benefits: Efficient movement of traffic.</td></tr>
</table>

Project 13: Multi-Modal Logistics Hub

Project No: 13	**Project Title: Multi-Modal Logistics Hub**
Project Type: Long Term	Numbers: One
Location: Pernem	Approximate Capital Cost: Rs. 50 Crores (Rs. 50 Crores per Multi-Modal Logistics Hub)
Detailed Description: The Multi-Modal Logistics Hub should have, 1) Parking for 150 trucks. 2) Warehouses for storage of goods. 3) Space for transshipment of goods. 4) Space for setting up material handling equipment. 5) Parking for cars and two wheelers. 6) Lodging and Boarding Facilities for Bus Drivers and others. 7) Canteen for Bus Drivers and others. 8) Intelligent Freight Management System (IFMS). 9) Office Space for operators of different modes of transportation. 10) Enough number of toilets for both male and female employees. 11) Emergency medical facilities. 12) Drinking water spouts.	 *Source: www.google.co.in*
Implementation Period: Phase II - One Logistics Hub – Rs. 50 Crores	Potential Benefits: Help in better handling of goods from different modes of transportation.

PROJECT 14: Up gradation of Existing Bus Terminals

<table>
<tr><th>Project No: 15</th><th>Project Title: Up gradation of Existing Bus Terminals</th></tr>
<tr><td>Project Type: Long Term</td><td>Numbers: Four</td></tr>
<tr><td>Location: Vasco Bus Stand, Margoa Bus Stand, Ponda Bus Stand and Panjim KTC Bus Stand.</td><td>Approximate Capital Cost: Rs. 520 Crores</td></tr>
<tr><td>Detailed Description: The terminals should have,
1) Sufficient number of ticket counters.
2) Parking space for two wheelers, taxis, cars etc.,
3) Amenities like hotels, snack shops, medical shops, juice shops, newsstands, phone re-charging facilities, stationary shop, fruits/vegetable shop, convenience/departmental stores etc.,
4) Sufficient number of toilets for both male and female passengers.
5) Lounge room/waiting room for male and female passengers.
6) Sufficient space for free movement of passengers.
7) Sufficient number of seating arrangements for passengers.
8) Elevators and escalators for movement of passengers from different floors.
9) Drinking water spouts.
10) Emergency medical facilities.</td><td>  </td></tr>
<tr><td>Implementation Period:
Phase I: Rs. 520 Crores</td><td>Potential Benefits: It may help in increasing public transit ridership.</td></tr>
</table>