Urban Mass Transit Company Limited

2016

COMPREHENSIVE MOBILITY PLAN - SOLAPUR

Draft Final Report

Solapur Municipal Corporation

Quality Management

Revision	Date	Report Prepared By	Report Reviewed By	Report Approved By	Description
1	18th Oct, 2016	Mahesh Kumar Chenna, Supraja.K & J S Niranjan	R.M.Alagappan	S.Ramakrishna	Draft Final Report

Disclaimer

This document has been prepared for the Comprehensive Mobility Plan, Solapur and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of UMTC being obtained. UMTC accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify UMTC for all loss or damage resulting there from. UMTC accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Background

India's urban population is expected to increase from 377 million in 2011 to 534 million in 2026. The share of urban economy in country's overall economy is increasing over the years. Hence, our country has to improve its urban infrastructure to achieve the objectives of economic development. Urban transport is one of the major problems, affecting the mobility of people and economic growth of the urban areas. These problems are due to prevailing imbalance in modal split; inadequate transport infrastructure and its sub-optimal use, non-integration of land use and transport infrastructure; and lack of improvement or little improvement in city bus services. This has resulted in accelerated growth of personalized modes which is unsustainable and needs to be corrected. This has resulted in the import of oil becoming the biggest component in the imports and increasing current account deficit. This in turn is severely affecting the country's economic growth.

Realizing the need to improve the urban areas, the Government of India approved the National Urban Transport Policy (NUTP) in April 2006 and further revised in March 2014. The Policy primarily focuses on the mobility of people as against the earlier focus on mobility of vehicles. This will require the public transportation system to be more attractive to use. The challenge for improved bus transport is to provide good quality service at an affordable price. It is important to evaluate alternative public transport technologies in the context of city characteristics. Accordingly, the Ministry of Urban Development (MoUD) encourages cities to prepare "Comprehensive Mobility Plans" (CMPs) as part of long-term urban transport strategy providing for sustainable improvement of people's mobility in metropolitan regions.

Solapur Municipal Corporation (SMC) is a designated nodal agency for overseeing city's infrastructure deficiencies. SMC has formed for the purpose of promoting and securing the planned development of Solapur Municipal Corporation. The Solapur Municipal Corporation are desirous of securing a comprehensive mobility plan (CMP) for the urban limits of Solapur.

For this purpose the SMC accomplish the task by engaging a competent consultant for providing the consultancy services for Comprehensive Mobility Plan, which should cover assessment of traffic and transportation needs for the urban limits of the Solapur city.

Accordingly, Solapur Municipal Corporation (SMC) awarded Urban Mass Transit Company (UMTC) for providing requisite consultancy services for Comprehensive Mobility Plan for SMC as per revised CMP toolkit and guidelines issued by MoUD.

The following paragraphs detail out the need for CMP, objectives and the detailed scope of work under this CMP project.

1.2 Need for CMP

The growth of the Solapur and all the economic benefits brought with it an unprecedented stress on SMC's transportation and land use. During the last few years, the urban sprawl has increased and is continuing to spill over into the fringe areas of the Solapur.

What is CMP?

A Comprehensive Urban mobility Plan is a strategic sustainable plan that builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles to satisfy the mobility needs of all people today and tomorrow arising from business growth of the study area, for a better quality of life in cities and their surroundings.

A coordinated implementation strategy for the entire Solapur urban limit is needed. It is wiser to first set goals for the Solapur city and establish strategies to meet these goals and develop the net sum of these projects that would meet required goals. Further the JNNURM under which many of the proposals are seeking funding, requires that a comprehensive mobility plan be prepared. However, CMP should not be confused with feasibility study or DPRs.

CMP FOCUS WILL BE	CMP WILL NOT DO
✓ On providing accessibility for all kinds of people ✓ On emphasizing the importance of pedestrian facilities, NMT measures and Public Transport systems ✓ On increasing the efficiency and cost-effectiveness of the transportation of persons and goods ✓ On integration Land use development and transport systems ✓ On effective and sustainable urban development ✓ On enhancing the attractiveness and quality of the urban environment.	✓ Detail cost estimates ✓ Station location and size ✓ DPR ✓ Detail Traffic Engineering Plans

1.3 Objective of the Study

The objective of current study is to prepare a comprehensive mobility plan for Solapur Municipal Corporation area for the period 2015 - 2035 in line with National Urban Transport Policy, 2014, which focuses on the mobility of people and not vehicles and on the need for promoting safe pedestrian movement, bicycle movement and public transport, integration of land use and transport planning. Sustainable Mobility can only be ensured if the solutions are environmentally, socially, and economically sustainable as presented below.

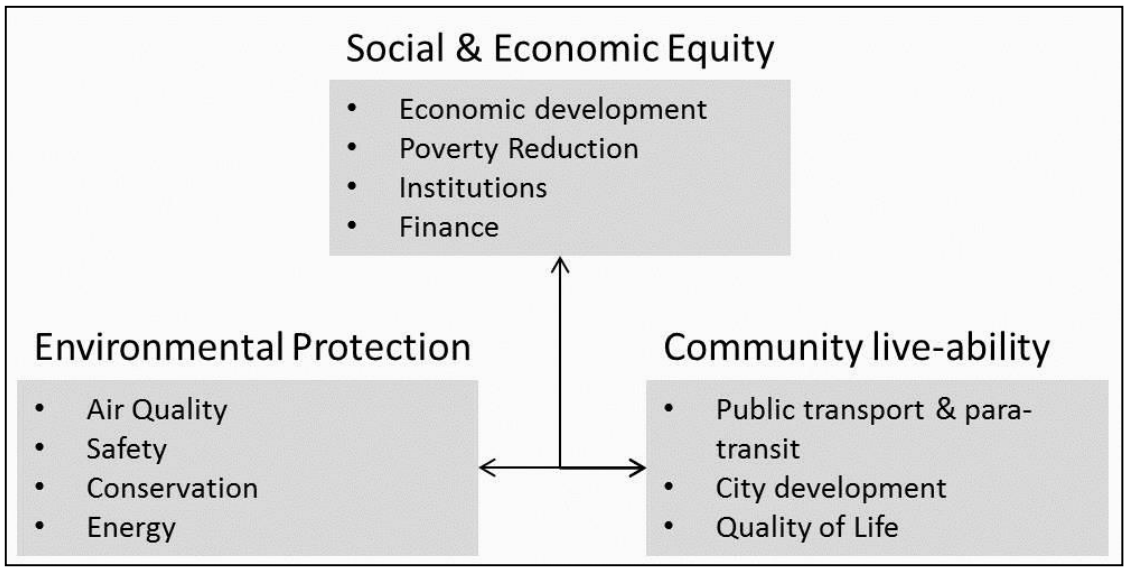


Figure 1-1 Sustainable Mobility Solutions

Thus, CMP to be prepared for Solapur city will be a mobility plan that provides roadmap for infrastructure development options and investment requirement to provide a desirable level of mobility and accessibility while minimizing carbon emissions.

1.4 Scope of the Study

The Scope of work for the study is broadly as per Terms of Reference (ToR) and revised toolkit for Preparing Comprehensive Mobility Plan of MoUD. The detailed scope of work as defined as part of this study is to:

a) Define objectives of the Mobility Plan and delineate Planning Area and Horizon of the Mobility Plan.

b) Assessment of existing problems and issues for mobility of people and goods within the study area.

c) Demand-Supply gap analysis of transportation needs and related infrastructure over the planning horizon.

d) Define Mobility Vision and Goals for the study area and identify strategies and Action Plan for achieving the Vision.

e) Identification of projects and policy measures that the city authorities would need to implement as part of the Mobility Plan.

f) Preparation of a Mobility Plan Implementation Program involving stakeholder's consultation.

g) Estimates of emission of CO^2 from Urban Transport based on travel demand and technological changes

h) Working out the mobility plan which is economically, socially, environmentally and technologically sustainable and climate resilient to achieve the goal of low carbon and inclusive transport incorporating development plans / master plans

Table 1-1 shows the detailed tasks involved in addressing the above scope items.

Table 1-1: Scope of Work for the CMP Solapur

Scope of Work	Detailed tasks involved that address Scope of Work
(i) Define objectives of the Mobility Plan and delineate the Planning Area and Horizon of the Mobility Plan.	*Review of all secondary data collected from cities, and respective agencies/authorities*. Task 1: Delineation of the Planning area and the Planning horizon Task 2: Define Objectives & Vision of the Mobility Plan
(ii) Data Collection and Analysis of the existing Urban Transport Environment.	*Assessment of base year mobility pattern, transport infrastructure and transport demand and supply*. Task 3: Review of the City Profile, Delineation of Traffic Analysis Zones and Review of Landuse Pattern & Population Density Task 4: Review of the Existing Transport Systems Task 5: Data Collection for assessing Demand and Supply Task 6: Study of Existing Travel Behavior Task 7: Review of Energy and Environment Task 8: Analysis and Indicators
(iii) Development of Business As Usual (BAU) Scenario.	*Scenario development and evaluation based on travel and socio-economic characteristics, along with forecasting travel demand based on these scenarios* Task 9: Framework for Scenarios Task 10: Socioeconomic Projections

Scope of Work	Detailed tasks involved that address Scope of Work
	Task 11: Land-use Transitions Task 12: Transport Demand Analysis Task 13: Technology Transitions Task 14: Model Framework Task 15: Analysis and Indicators
(iv) Development of Sustainable Urban Transport Scenarios	Evaluation of different technology and strategy based *solutions to achieve the goals of CMP, based on travel demand and CO_2 emission levels from urban transport for each scenario* Task 16: Framework for Scenarios Task 17: Strategies for Sustainable Urban Transport Scenario Task 18: Transport Demand Analysis of Alternative Strategies for Sustainable Urban Transport Task 19: Technology Transitions under a Low Carbon Scenario Task 20: CO_2 Emissions and Air Quality Task 21: Analysis and Indicators
(v) Development of Urban Mobility Plan	*Impact assessment of all technology and strategies on socio-economic characteristics of the city.* *Proposals for long term, medium term and short term policies, technologies and transport infrastructure projects, based on results from their respective impact assessment* Task 22 : Integrated Landuse and Urban Mobility Plan Task 23 : Formulation of the Public Transport Improvement Plan Task 24: Preparation of Road Network Development Plan & NMT Facility Improvement Plan Task 25: Preparation of Mobility Management Measures Task 26: Preparation of Regulatory and Institutional Measures Task 27: Development of Fiscal Measures

Scope of Work	Detailed tasks involved that address Scope of Work
	Task 28: Mobility Improvement Measures and NUTP Objectives
(vi) Preparation of the Implementation Program	Estimation of costs for the proposals and preparing an investment plan and implementation plan for successful execution Task 29: Preparation of Implementation Programs Task 30: Identification and Prioritization of Projects Task 31: Funding of Projects Task 32: Monitoring of CMP Implementation

Broadly, the study area for CMP preparation has been considered as Solapur Municipal Corporation covering an area of 178.57 Sq. km.

1.5 Vision

The mobility vision for a city is defined by MOUD in CMP guidelines toolkit as below:

"Provide Safe, Efficient and an Environmentally Sustainable Transportation System for the Improved Mobility and Accessibility of People and Goods across Gender and Heterogeneous Socio-Economic Groups"

1.6 Deliverables

The deliverables of this current study as per TOR are as follows:

a) Inception Report & Detailed Work Plan:

b) Interim Report

c) Draft Final Report

d) Final Report

Interim report was submitted in April 2016. This Draft Final report covers data collection and analysis of the existing transportation scenario.

1.7 Stakeholders

Following is the list of stakeholders for consultation regarding the study:

- Solapur Municipal Corporation (SMC)
- Maharashtra State Road Transport Corporation (MSRTC)
- Regional Transport Office, Solapur (RTO)
- Public Works Department, Solapur (PWD)
- Superintendent of Police (Traffic), Solapur
- National Highway Authority of India (NHAI)
- Maharashtra Pollution Control Board (MPCB)

1.8 Structure of the Report

The Interim Report is consists of 11 chapters,

Chapter 1: deals with project details like background/introduction, need for CMP, objectives, scope of work and structure of the report.

Chapter 2: details out the study area characteristics.

Chapter 3: presents the delineation of TAZ, list primary survey carried out and secondary data collection.

Chapter 4: presents the analysis of traffic surveys and house hold surveys.

Chapter 5: Presents the Service Level Benchmark for the City

Chapter 6: Presents the results of Travel Demand Modelling of the city

Chapter 7: Presents the Vision and Goals developed for Solapur City

Chapter 8: Presents the Transport Strategies developed for the City

Chapter 9: Presents the Project Proposals

Chapter 10: Discusses the Implementation Plan for the proposed projects

Chapter 11: Presents the suggestive Institutional Framework for SMC.

2. Study Area Characteristics

2.1 Planning Area

The planning area for the study has been delineated based on the following parameters;

- Existing growth pattern of city.
- Existing urban agglomeration as identified in the master plan/regional plan of Solapur city.
- Areas that forms the part of the urban settlements and fringe area limits.

Based on the afore-mentioned aspects and in consultation with the stakeholders including Solapur Municipal Corporation (SMC), the city plan covers an area of 178.57 Sq. kms. The study area of Solapur is shown in Figure 2-1.

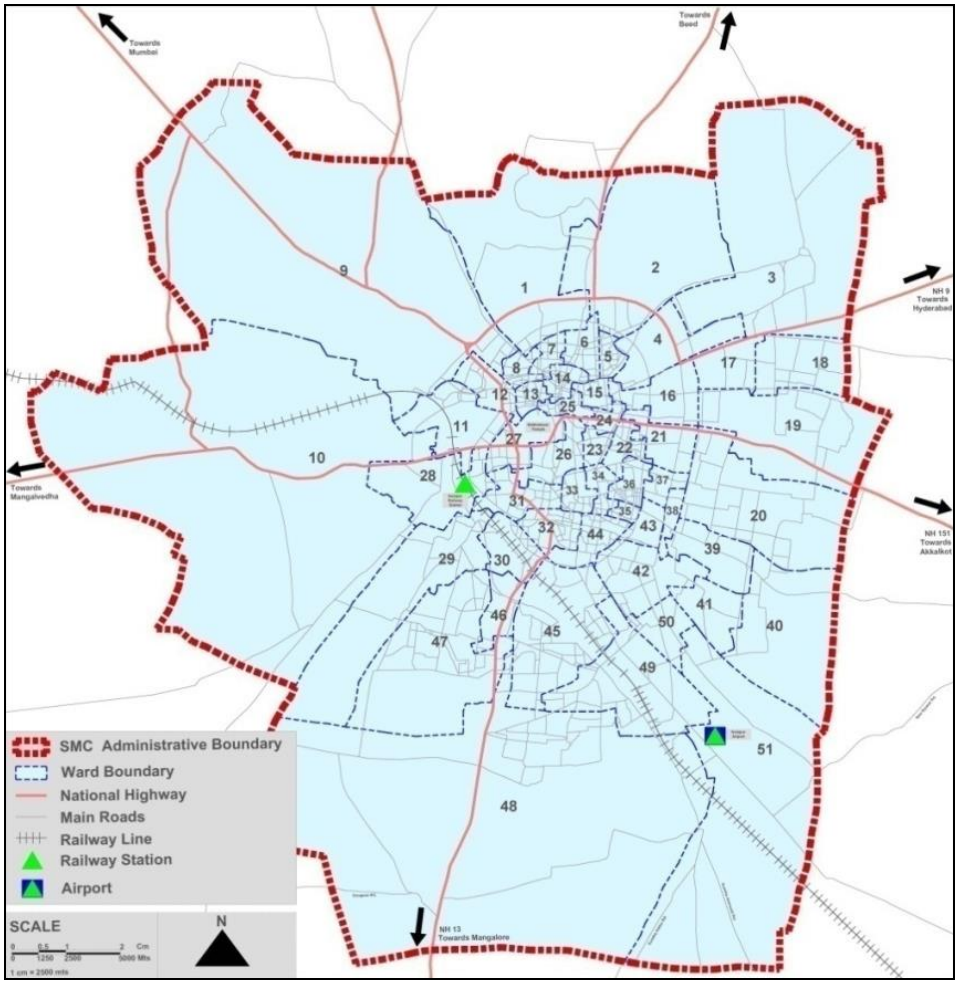


Figure 2-1: Solapur Municipal Corporation Area (Planning Area for CMP)

2.2 Planning Horizon

It has been ascertained that the overall goal of CMP Solapur can be realized over a long term horizon period of 20 years. This timeframe has been divided into three time horizons. The three horizon periods are divided as follows;

1. **Short-term:** The short-term time horizon will last for 0-3 years, starting from 2015-2019. It will focus on short term planning measures that include intersection improvements, signalization of intersections, improvement of non-motorized transport, improvement in pedestrian facilities, traffic circulation plans, parking plans etc. the overall emphasis will remain on improving the safety and accessibility standards.
2. **Medium term:** The time period for this horizon will last for five to ten years, till 2025. The focus will be on medium term planning projects such as NMT corridors, city bus networks and NMT networks. The objective of medium term planning is to arrest the current trend of heavy dependency on private vehicles and set ground for higher PT and NMT usage in the future.
3. **Long term:** This is a 20 year long term period, lasting up to 2035 with a long-term vision of achieving overall Comprehensive Mobility Plan goals.

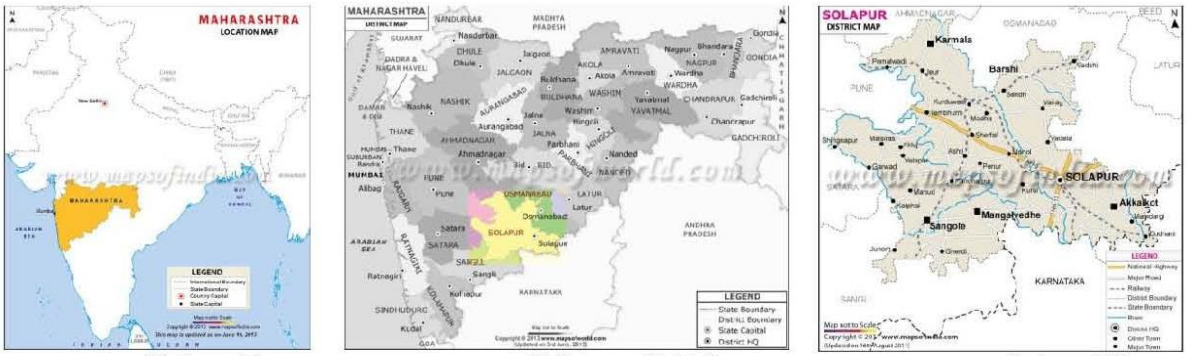
2.3 City Profile

Solapur is the 4th largest district in the western Indian state of Maharashtra in its southern region. Solapur is an important node and plays a critical role in the district as headquarter for district administration. Solapur houses all the administrative offices of the district level administration and has a strong industrial presence. Solapur historically is regarded as an industrial city prominently having the textile units. One of the key events triggering the industrial growth was starting up the railway in Solapur in 1880.

2.4 Location and Regional Setting

Solapur is located in major road and rail routes between Mumbai and Hyderabad, with a branch line to Bijapur and Gadag cities in South Indian state of Karnataka. The city lies centrally in the basin of river Bhima and the watershed of river Adila (a tributary of river Sina). It is located at 17°.10‟ and 18°.32‟ north-latitude and 74°.42‟ and 76°.15‟ east

longitude. It has an average elevation of 457 meters above mean sea level. The location of Solapur city is shown in the Figure 2-2.

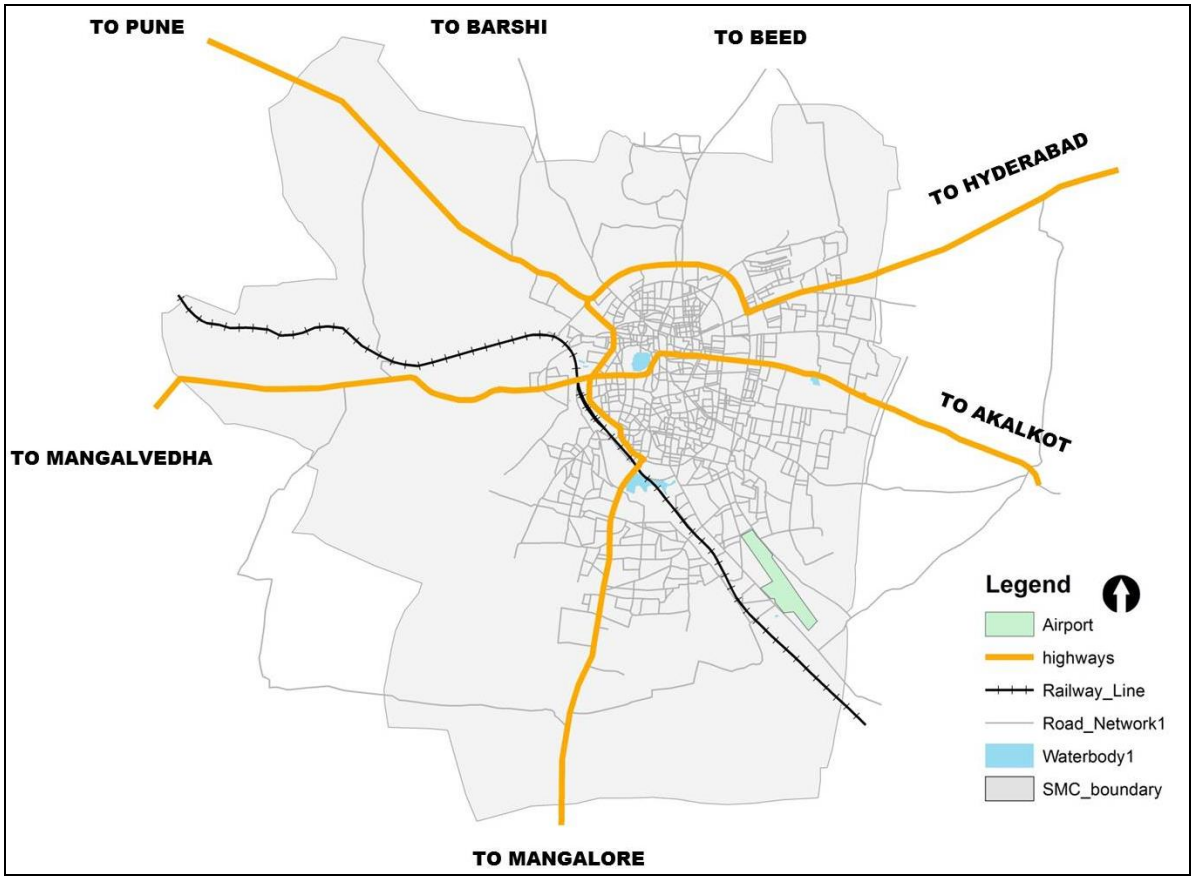


Maharashtra *Solapur – District* *Solapur City*

Figure 2-2: Location of Solapur City

Solapur is well connected by roadways and railways to all major cities in Maharashtra and neighboring states. The city is connected with Karnataka and Maharashtra by four National Highways – NH-52 to Mangalore; NH-65 to Pune and SH- 151 to Mangalvedha. The connectivity of Solapur city to major urban centers is shown in the

Figure **2-3.**



Source: City Development Plan, Solapur

Figure 2-3: Connectivity of Solapur to Major Urban Centers

2.5 Demographics

2.5.1 Population

Solapur grew rapidly as an industrial town in 1970s. This is also reflected in the population growth during the same period. The decadal growth was very high between 1971 and 1991, when the down turn of the textile industry begun.

Table 2-1: Population Trend of Solapur Municipal Corporation (SMC)

Year	Population	Decadal Growth (%)
1971	3,98,361	-
1981	5,14,660	29.24
1991	6,04,215	17.36
2001	8,72,424	44.39
2011	9,51,558	9.07

Source: Census of India 2011

It can be observed from the Table 2-1 above table that the population growth of Solapur was at its peak during 1981-91 owing to the industrialization of the city and opening up of new industries in the textile sector. The population growth during 1991-2001 cannot be considered because the city limits were expanded in 1992 resulting in higher growth rate of population. In the last decade (2001-11) growth of the population has come down to 9.07% from 44.39% in 1991-2001 due to closure of these mills and an overall diminishing industrial growth.

2.6 Population Density

Overall density of the core city has been high over the years until the increase in city limits in 1992. The density pattern varies over the years. In 1971 the density of the city was 17149 persons per km^2 which increased to 20159 persons per km^2in 1981. In 1992, 13 villages adjoining to SMC were merged with the municipal area, increasing the area of SMC jurisdiction from 33.03 km^2 to 178.57 km^2. This increase in the municipal area resulted in decline of the gross population density from 20159 to 4886 person per km2 in 2001 and further it increased to 5329 person per km^2 in 2011. The Table 2-2 presents the change in the gross population density in the city during last four decades.

Table 2-2: Decade Wise Population and Density of Solapur Municipal Corporation (SMC)

Year	Population	Area (Sq. Km)	Gross Density	
			Persons per Sq.km	Persons per hectare
1971	3,98,361	23.23	17,149	171
1981	5,14,660	25.23	20,159	202
1991	6,04,215	33.03	18,293	182
2001	8,72,424	178.57	4,886	49
2011	**9,51,558**	**178.57**	**5,329**	**53**

Source: Census of India & SMC

2.7 Economic Characteristics

2.7.1 Occupational Structure

The composition of the work force infers the way of life of the people and their social and economic activities. The total work force is 3,54,935 in 2011. It is observed that 93% of the working population are main workers whereas marginal workers constitutes 7% .The Table 2-3: Sectorial Distribution of the Workers in Solapur.

Table 2-3: Sectorial Distribution of the Workers in Solapur

Year	Sector	Primary	Secondary	Tertiary	Non Workers
1971	% of total population	0.82	15.02	12.62	71.54
	% of working population	2.88	52.76	44.36	-
1981	% of total population	0.55	2.16	28.35	59.41
	% of working population	1.76	6.95	91.29	-
1991	% of total population	0.75	14.62	15.68	32.72
	% of working population	2.38	47.08	50.54	-
2001	% of total population	1.14	6.03	27.63	65.20
	% of working population	3.26	17.32	79.42	-
2011	% of total population	1.28	4.04	31.98	62.70
	% of working population	3.44	10.83	85.74	-

Source: Census of India 2011 and SMC CDP

From the Table 2-3, it can be inferred that the sectorial distribution of workers shows that the major concentration is in the tertiary sector, owing to gradual shift from the

secondary sector. It can be observed from the data of the last decade that the percentage of secondary workers compared to the total workers has reduced from 17.32% to 10.83%. The reasons behind this can be attributed to the diminishing industrial growth resultant of the poor infrastructure conditions in the industrial area of SMC.

2.8 Work force Participation Rate

The worker population of the SMC has increased by decadal growth rate of 17% during the last decade with an annual increase in the worker population of 1.57%. As compared to this the non-worker population which contributes to 60-65% of the city's population has grown by a decadal growth of 4.88% with an annual increase of 0.48%. According to the provisional Census of 2011, the workforce participation rate (WPR) in SMC has improved marginally from 35% to 37% during the last decade. The Table 2-4 below shows the WPR for Solapur.

Table 2-4: Workforce Participation Rate in Solapur

S. No.	Details	2001	% of total population	2011	% of total population	Growth (%)	CAGR (%)
1	Total workers (main + marginal)	303,590	34.80	354,935	37.30	16.91	1.57
2	Total Non-Workers	568,888	65.20	596,623	62.70	4.88	0.48
Work Force Participation Rate (WFPR)		**34.80**		**37.30**			

Source: Census of India 2011 and CDP, Solapur

2.9 Land Area and Land Use Pattern

As per the Solapur city development plan (1994), 64.4% of the city area was proposed to be developed by 2017. The total undeveloped area constituted about 35.6% of the total land under the jurisdiction of the SMC. Table 2-5 presents the land use break up in Solapur. Since the current land use break up for the SMC area is not available, the prevailing land use presented in the development plan is presented here. The development plan proposed an increase in the residential area from 1160.40 ha to 6513.41 ha an aggregate increase of 461%. However as per the discussions with the department officials, there is no significant development in the extended areas of the city due to lack of infrastructure and basic amenities.

Table 2-5: Existing Land Use in the Development Plan of Solapur

Land Use Type	Past (1994)			Proposed (2017)		
	Area (Ha)	% of Total Area	% of developed Area	Area (Ha)	% of Total Area	% of Developed Area
Residential	1160.4	6.50%	25.44%	6513.41	36.47%	59.59%
Mixed Use	121.1	0.68%	2.66%	1191.97	6.67%	10.36%
Industrial	287.2	1.61%	6.30%	452.76	2.54%	3.93%
Commercial	167.5	0.94%	3.67%	204.96	1.15%	1.78%
Transport and Communication	896.2	5.02%	19.65%	1027.08	5.75%	8.92%
Public and Semi Public	680.84	3.81%	14.93%	652.9	3.66%	5.67%
Public Utilities	40.96	0.23%	0.90%	75.48	0.42%	0.66%
Garden, Play Ground				260.75	1.46%	2.27%
Burial Cremation Ground	76.96	0.43%	1.69%	84.81	0.47%	0.74%
Water Bodies	377.43	2.11%	8.27%	492.04	2.76%	4.28%
Agricultural Land	11926.61	66.79%	-	6348.34	35.55%	55.16%
Vacant Land	1369.2	7.67%	-	-		
SPA-I (MIDC +MHADA)	460	2.58%	10.08%	553	3.10%	4.80%
SPA-II (MHADA)	293	1.64%	6.42%			
Total Area	17857.5	100.00%		17857.5	100.00%	

Land Use Type	Past (1994)			Proposed (2017)		
	Area (Ha)	% of Total Area	% of developed Area	Area (Ha)	% of Total Area	% of Developed Area
Developed Area	4561.69	25.54%		11509.16	64.45%	
Un Developed Area	13295.81	74.46%		6348.34	35.55%	

Source: Development Plan of Solapur (1997-2017) (Landuse Plan in Annexure)

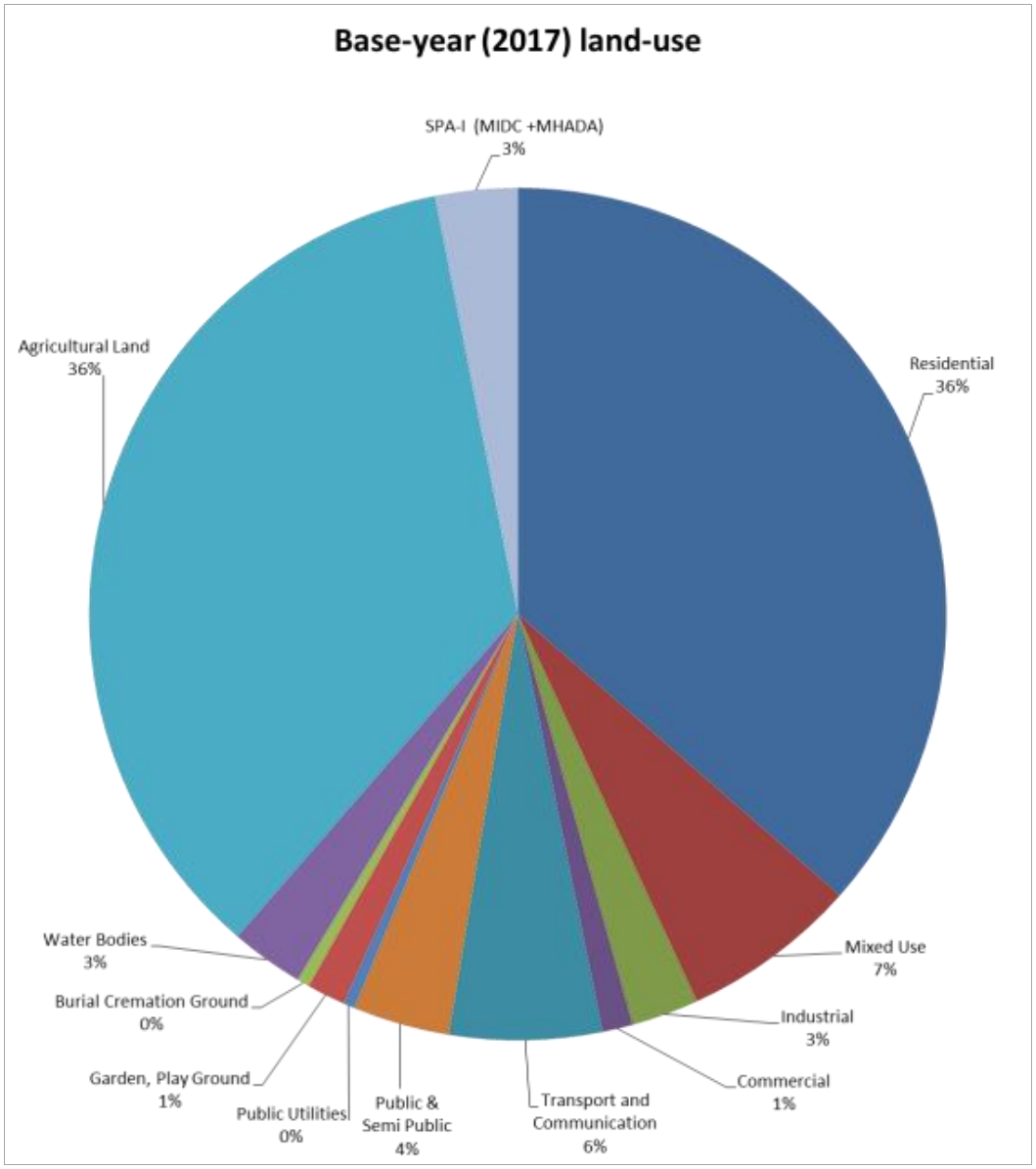


Figure 2-4: Land Use Distribution in Solapur Municipal Corporation

2.10 Growth Pattern

Solapur Municipal Corporation (SMC) was established on 1st May 1964, with 23.23 km^2 jurisdiction area. The Corporation was constituted under the provisions of Bombay Provincial Municipal Corporations Act, 1949, (now Maharashtra Municipal Corporations Act, 2012) and is also governed by the provisions of 74th Constitutional Amendments Act 1992 (CAA)[1]. Municipal jurisdiction of SMC was expanded at various times. As per the Census 2011, the municipal jurisdiction of SMC covers 178.57 km^2 areas which accommodate population of 9.51 lakh. The time-line for original city extension is presented in the Table 2-6 below:

Table 2-6: Chronology of events in expansion of Solapur Municipal Limits

Date	City Limits Details	Extension	Area in Sqkms
29/09/1967	Original City Limits		23.23
01/07/1979	Vijapur and Hotgi Road Area included in SMC	First Extension	2.30
01/04/1989	Salgarwadi, BeediKamgarVasahat and S. No. 23 of Shelgi added in SMC	Second Extension	7.50
05/05/1992	Thirteen surrounding villages included in SMC	Third Extension	145.54
Total	**Area as on 05/05/1992**		**178.57**

Source: Solapur Development Plan, 1997-2017

Based on the discussions with the town planning department of the SMC, it can be mentioned that the city is growing in the direction along the roads connecting to Hyderabad and Akkalkot as shown in Figure 2-5. The main reason attributable to the growth direction may be the proximity to the MIDC located between the Akkalkot road and Hyderabad road and major work force working in this industrial estate comes from Andhra Pradesh and Karnataka. Also it should be noted that the growth of the city is happening at a very slow pace, as only 20% of the area has been developed when compared to the development plan prepared in 1997 which was approved by the State Government in 2004.

[1] City Development Plan for Solapur - 2041

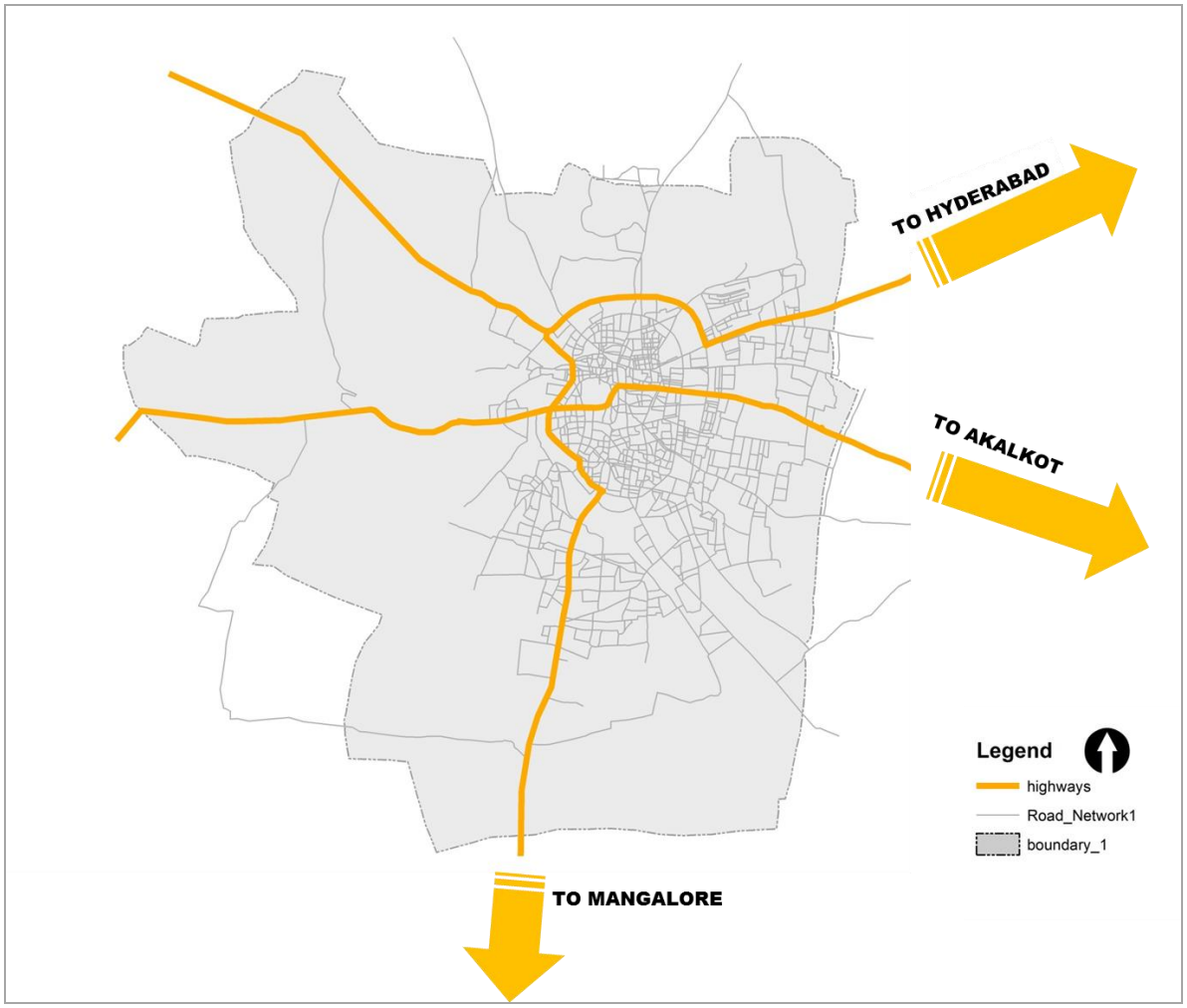


Figure 2-5: Growth Directions of Solapur City

2.11 Population Projection Methods

2.11.1 Arithmetic Increase method

This method is based on the assumption that the population is increasing at a constant rate, i.e. the rate of change of population with time is constant. From the population data for the last 4 to 5 decades, the average increase per decade is calculated which is then used as the design rate of increase for calculating the design population. This method is of limited value and may be useful for smaller design periods for old and very large cities with no industries and which have practically reached their maximum development. For developing areas, which develop faster than the past, this method is likely to give low results.

2.11.2 Geometric Increase Method

In this method, it is assumed that the percentage increase in population from decade remains constant. Therefore, the average value of the percentage increase is calculated and the future populations are calculated at this rate. For a young city, which at present is expanding at a faster rate, this method may give very high results and is useful for old developed cities.

2.11.3 Incremental Increase Method

In this method the average increase per decade is found out. The average incremental increase for each decade is also found out. The future population is calculated from the average increase and average incremental increase of population. This method is a combination of the above two methods and therefore gives the advantages of both and hence gives satisfactory results.

2.11.4 Component Method

The component method uses the components of demographic change to project population growth. In this method, it is assumed that the percentage increase in population from decade is found out and growth of population age groups, sex, ethnicity, fertility, mortality and migration are also found. The same is used and the future populations are calculated at this rate. This is a universally accepted method of making population projections because of the fact that the growth of population is determined by fertility, mortality and migration rates. Hence this method gives satisfactory results.

2.12 Population Forecast for Solapur

Historical or Time series data of Population of Solapur is available and the same is presented in below Table. According census the population from 1971 to 2011 is almost increased 3 times in Solapur. This shows that there is a low in growth of population in city, but considering the stature of city, magnitude of floating population and educational centres etc., this low trend may misguide in estimating the future years population. Considering the optimistic scenario and also the different population projection methods, Population for the horizon year (2035) is calculated. Historical data of population for Solapur City is presented in

Table 2-7 and projected population is presented in the Table 2-8.

Table 2-7: Historical Data of Population for Solapur City

Year	Population
1971	398361
1981	514660
1991	604215
2001	872424
2011	951558

Source: Census of India

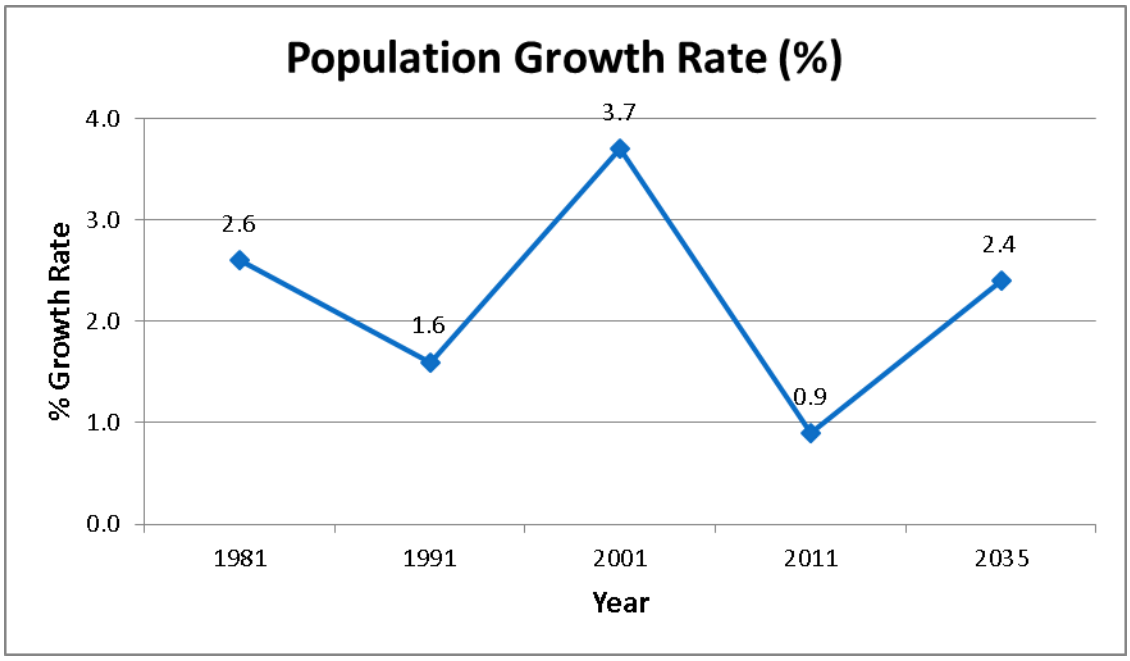


Figure 2-6: Population Growth Rate for Solapur City

Table 2-8: Population Projections for Solapur City

Year	Population			
	Arithmetic Method	Geometric Method	Incremental Increase	Component Method
2016	1020708	1095854	1107994	1065973
2021	1089857	1240149	1309094	1194145
2026	1159007	1428207	1554857	1337729
2031	1228157	1616265	1845284	1498577

Year	Population			
	Arithmetic Method	Geometric Method	Incremental Increase	Component Method
2036	1297306	1861358	2180374	1678765
2041	1366456	2106451	2560128	1880619

Source: Census of India and UMTC Estimates

Considering the growth drivers and in order to arrive at future population for Solapur, population projection was done for major urban core areas using various methods. The past growth trend was considered to arrive at a method for projection of population in all the areas. Summary of historical population trends and projected population is presented in above Table.

Table 2-9 represents the CAGR consider for Population Projections of Solapur City. In the calculations part the CAGR considered for the Solapur for the years 2011-35 was 2.7%.

Table 2-9: CAGR of Solapur City

Year	CAGR
1971-1981	2.6
1981-1991	1.6
1991-2001	3.7
2001-2011	0.9
2011-2035	2.7

Source: Census of India and UMTC Estimates

2.13 Traffic and Transportation System Characteristics

2.13.1 Transport Connectivity

2.13.1.1 Road Connectivity

Solapur is well-connected by road with major cities of Maharashtra as well as the adjoining State Capitals of Andhra Pradesh & Karnataka and important cities in Andhra Pradesh & Karnataka by National Highways namely;

- NH 9 highway connecting Pune with Vijayawada via Hyderabad,

- NH-13 connecting Solapur to Mangalore, Karnataka
- NH-211 connecting Solapur to Dhule and;
- NH 204 connecting Ratnagiri-Solapur passes through city.

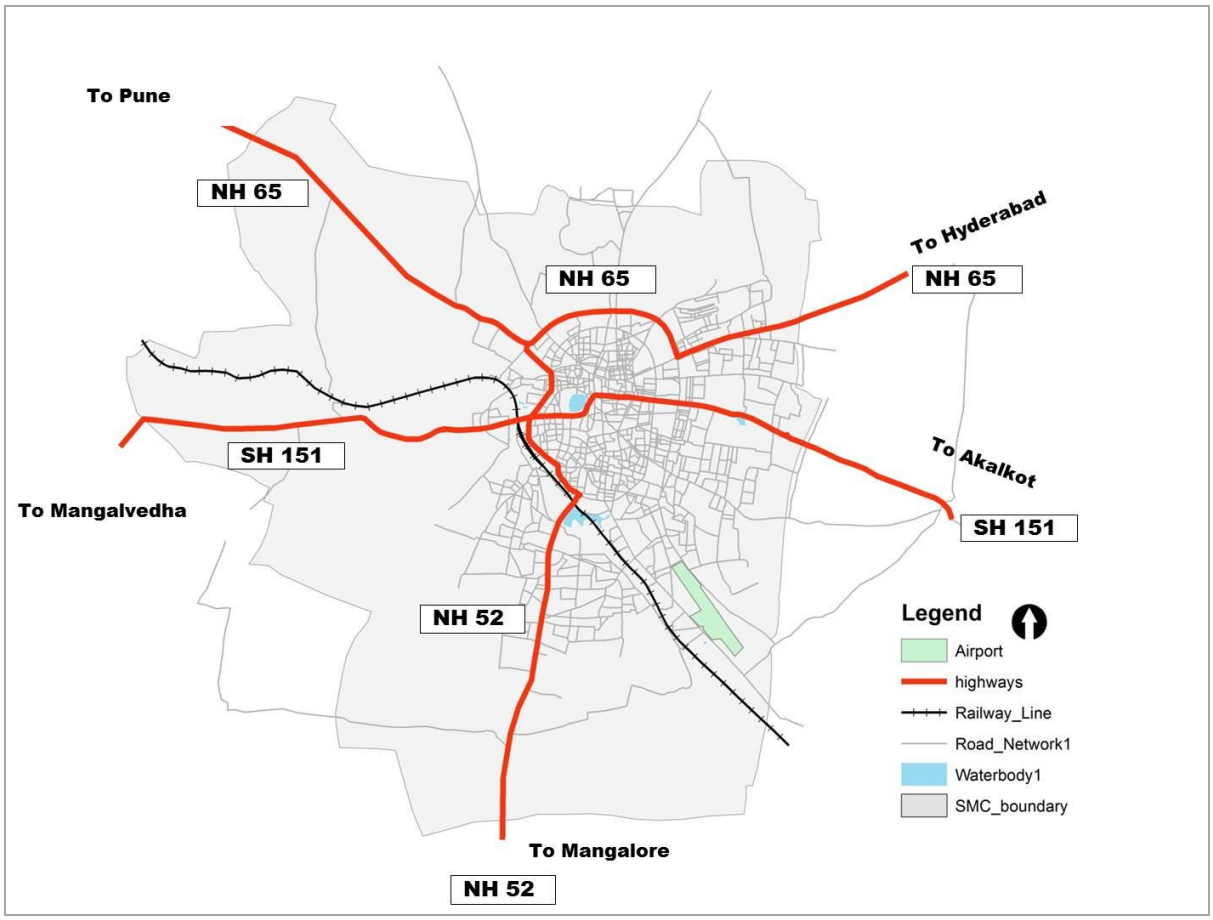


Figure 2-7: Road Connectivity in Solapur

Recently, sanctioned National Highways are Solapur-Gulbarga and Ratnagiri-Solapur (Refer to

Figure **2-3***).*

2.13.1.2 Rail Connectivity

Solapur Railway Station is the main hub within the city. The Solapur Railway Division is an important division connecting South India to Western and North West India. Trains from Ahmedabad, Jaipur, New Delhi, Mumbai, Pune, etc, ply to Southern states (Telangana, Karnataka, Tamil Nadu & Kerala) via Solapur.

It is served daily by Solapur Bangalore express, Solapur Solapur, Solapur Pune Hutatma Express, Solapur Mumbai, Solapur Jaipur Superfast express and Solapur Goa Express.

2.13.1.3 Air Connectivity

Solapur Airport is located to the South of the Solapur city. At present it is not covered by any airline operator.

2.13.2 Road Network

In SMC the city engineer department is responsible for the development if roads in the city. Solapur being a city of industrial importance has a comprehensive road network in the city. Also the city is well connected to the nearby regional centers like Pune, Aurangabad, Beed, etc. Also there are certain sections of the important national highways and state highways pass through Solapur. The total road length in the city is 1903 km of which 42% roads are under the classification of other roads, 52% roads fall under the classification of collector roads and remaining 6% roads fall under sub arterial and arterial roads.

Some of the major junctions in Solapur are as follows:

1. Railway Station Area;
2. Panjrapol (Bus Stand Area)
3. Sat Rasta
4. Lucky Chowk
5. Rangbhavan
6. Park Chowk
7. Kontam Chowk
8. Ashok Chowk
9. Shivaji Chowk
10. ChatrapatiSambhaji Chowk

2.14 Registered Vehicles

Major mode of transportation used by the citizen of the city is two wheelers. The motor vehicle statistics of the Solapur reveals that of the total 5,54,731 vehicle registered in the city till 31st March 2013, of which 4,09,021 are two wheelers which constitute approximately 75% of the total vehicles in the city. The

Figure **2-8** & Table 2-11 represents the composition of the registered vehicles in the city of Solapur.

Table 2-10: Composition of Registered Vehicles in the City Of Solapur

Year	No. of Vehicles Registered	Growth Rate (%)
2006	314,376	
2007	337,182	6.76%
2008	358,417	5.92%
2009	382,663	6.34%
2010	417,013	8.24%
2011	455,944	8.54%
2012	507,298	10.12%
2013	554,731	8.55%

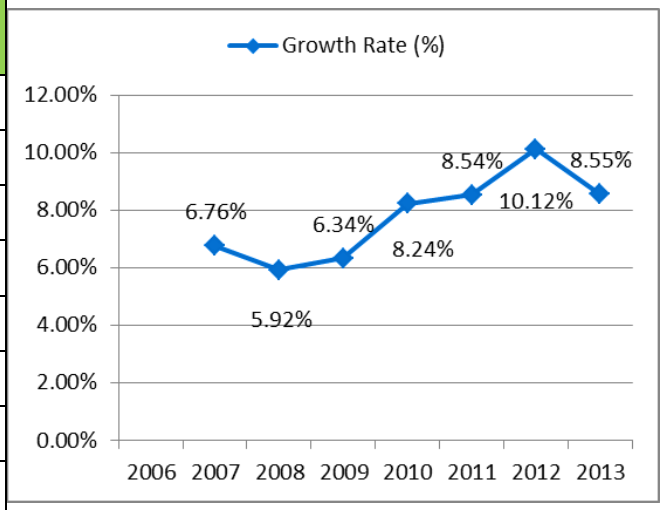


Figure 2-8: Growth of Vehicles in Solapur City

Source: Motor Transport Statistics of Maharashtra 2010 – 2011, 2011-12 and 2012-13

Table 2-11: Mode wise distribution of vehicles registered in Solapur City

Vehicle Wise	No. of Registered Vehicles 2011	% Share of Vehicles 2011	No. of Registered Vehicles 2012	% Share of Vehicles 2012	No. of Registered Vehicles 2013	% Share of Vehicles 2013
Two Wheeler	364,806	80.03%	407,562	80.31%	409,021	73.73%
Four Wheeler	31,032	6.81%	34,448	6.79%	85,905	15.49%
Goods Vehicle	23,970	5.26%	25,279	4.98%	27,471	4.95%
Tractors	13,151	2.89%	16,612	3.27%	11,820	2.13%
Trailer	12,559	2.76%	12,962	2.55%	3,473	0.63%
Auto Rickshaws	8,614	1.89%	8,569	1.69%	8,538	1.54%
Taxis	984	0.22%	1,150	0.23%	4,610	0.83%
Buses	447	0.10%	404	0.08%	2,396	0.43%
Other Vehicles	247	0.05%	474	0.09%	1,497	0.27%
Total	**455,810**	**100.00%**	**507,460**	**100.00%**	**554,731**	**100.00%**

Source: Motor Transport Statistics of Maharashtra 2010 – 2011, 2011-12 and 2012-13

2.15 Road Accidents

The trend of motor vehicle accidents in Solapur from 2005 onwards is shown in the Table 2-12.

Table 2-12: Motor vehicle accidents in Solapur city

Year	No. of Accidents	No. of Persons Killed	No. of Persons Injured
2005	492	84	408
2006	545	87	458
2007	590	78	512
2008	591	85	506
2009	496	99	397
2010	560	111	449
2011	465	87	378
2012	355	76	279
2013	292	85	207

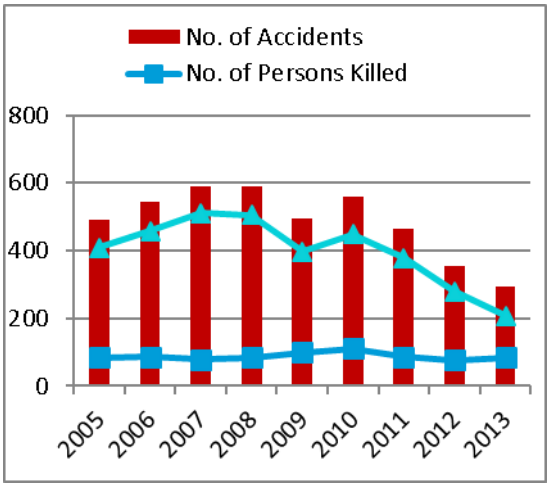


Figure 2-9: Accidents Trend

Source: Motor Transport Statistics of Maharashtra 2010 – 2011, 2011-12 and 2012-13

The mixed nature of roads, improper junction geometric and un-signalized junctions lead to major accidents in Solapur. It has been observed that nearly 98% of the accidents occurred due to the rash driving of motor vehicles. It can be observed from the above figure that the number of accidents in the Solapur has decreased from 449 in 2010 to 207 in 2013. This shows that improvement measures with respect to the road conditions and traffic management in the city are taken by the traffic police department.

2.16 Pedestrian and NMT Facilities

The city has inadequate pedestrian infrastructure. There is no foot over bridges, sub-ways, pedestrian-only traffic signals. In fact the city lacks in provisions for dedicated NMT lanes and dedicated parking facilities for cycle rickshaws.

2.17 Parking Characteristics

Most of the internal road network specifically the network in the core city area faces major difficulty of congestion and unavailability of the full right of way (RoW) due to encroachment by haphazard on-street parking. The city lacks in provision of sufficient and dedicated off street parking facilities. Also the on-street parking is not managed and maintained in structured manner. This is effectively reducing the network capacity and further adding to the congestion level. Vijapur Road, Karkhana Road, Akkalkot Road, Park

Chowk, ZhilaParisad Road, SarafKatta, Kontam Chowk Area, Station Road, NaviPeth are the main areas crowded with unauthorized on-street parking.

2.18 Public Transport Characteristics

Before independence, the facilities for public transportation in Solapur were provided by private companies. The Solapur Municipality had implemented the Bombay Municipal Burrows Act (1925) and started local bus services in Solapur from 10-01-1949. In 1978 the services of bus transportation were extended to Holgi Road, Industrial Places, Sugar Factories, Airport, MIDC, Bijapur Road and nearby villages, while developing the city.

Currently the urban public transportation in Solapur is managed by the Solapur Municipal Transport (SMT). SMT was established in April, 1965 based on the B.P.M.C Act 1949. Currently, SMT operates 106 own buses and 40 additional buses on hire basis. The ownership of the hired buses remains with the private operator, however the manpower for running the operations is supplied by SMT. Based on the daily ridership data collected from the SMT, it was observed that in the year 2012-13; 50,724 passengers used public transport, which essentially means that 5% of the city population use public transportation facility. SMT operates city bus services on 39 routes. The age wise distribution of 106 buses, around 70% of the fleet is at least 15 years old and face high operation cost, breakdowns and high pollution levels.[2]

Solapur Municipal Transport (SMT) had submitted a detailed project report, to avail the funds under the extended JnNURM Scheme, which has been duly approved by the Central Sanctioning and Monitoring Committee (CSMC) meeting. This would imbibe 200 buses on the streets of Solapur.

2.19 Public Transportation Ridership

Based on the data shown in Table 2-13**,** we can observe that there has been no substantial increase in the public transport ridership in SMC from 2007-08 to 2012-23 owing to the condition of the buses available with the SMT. Also, the available fleet of the buses is not

[2]Detailed Project Report for procurement of Buses under the extended JnNURM Scheme for Solapur

entirely owned by the SMT and is rented from the private agencies which puts the additional financial burden on SMT. The total available fleet with the SMT (combined fleet from the private operators as well as from the private suppliers) is 146 buses. As against this, the average daily fleet available for the operations remains in the range of 65-80 buses i.e, 45% to 55% of the total available fleet.

Table 2-13: Passenger and Fleet Details of Solapur Municipal Transport (SMT)

Year	Total Fleet	Average Daily Fleet	Average Passenger per day
2007-08	127	78	46148
2008-09	134	84	56356
2009-10	91	80	50230
2010-11	92	65	44326
2011-12	102	69	48900
2012-13	146	73	50724

Source: Detailed Project Report for Solapur Municipal Transport (SMT)

2.20 Traffic and Transportation Issues in the City

Based on the reconnaissance survey, the following observations were made with respect to the city's traffic and transportation.

Land use

- Road network constitutes 5.02% of the total Solapur city area. As per the URDPFI Guidelines, the city should have an area under transportation between 12-14%.

Road Network

- Major portion of the roads in the city are unpaved, i.e. 37% of the total roads in the city are un-paved roads. Movement of vehicles on the un-paved roads leads to increase in soil particles to rise and lead to increased air pollution in the city. Also the time taken for travel on the un-paved roads is more compared to the paved roads.
- Other road elements such as street lighting, footpaths, and faulty junction designs have been missing.
- In Solapur, 13 intersections are having the automated signal indicators. Considering the road length of the city, additional 20 junctions / intersections in the city are to be provided with automated signals.

- There is no provision of street infrastructure for the differently abled people, who have been completely neglected.

Public Transportation

- Condition of public transportation in the city needs up-gradation, Of the total estimated population of the city in 2013, only five percent of the population use public transport.
- The SMC has a bus fleet of 146 buses for the public transportation in the city. As mentioned in the section 70% of the buses are more than 15 years old. Of the total bus fleet in the city, only 50% is available for daily bus operations.

Parking

- In absence of the dedicated parking spaces in the core city, and commercial activities in the core city lead to use of the available row for on street parking reducing the available right of way for traffic movement.

Non-Motorized Transport

- Based on the reconnaissance survey, it was observed that majority of the people use cycles and cycle rickshaws for their daily travel requirement, yet there is no provision of dedicated NMV lanes within the city.

3. Primary Surveys – Data Collection

3.1 Introduction

While previous section highlights the study area characteristics through analysis of the secondary data, this chapter describes the primary data collection and its preliminary analysis that will form the basis for the detailed analysis and transport modeling. Primary surveys are required to understand the existing traffic and transport situation in Solapur. An enormous data has been collected through various surveys such as Household survey, Outer Cordon Survey, Screen line counts, etc. covering the city. This data is also required for developing a four stage travel demand model. In order to plan for exact survey locations and sample, the zoning is required.

3.2 Zoning of the Study Area

The first step in analysis of the study area is to demarcate the study area itself. The study area should embrace all the existing and potential area to which the development will happen during the study period and will have impact on the transportation system. Majority of the trips originating and destining should be inside the cordoned study area.

The imaginary boundary near fringe of the study area is termed as “external cordon”. Origin-Destination data is collected from road side interview survey thus helping to complete the information coming from Home Interview Survey information of External to External, External to Internal and Internal to external captured in the surveys organized at Cordon points.

3.3 Traffic Analysis Zones (TAZ)

Traffic Analysis Zones are used to aggregate the individual households and premises into manageable localities for modeling purposes. The two main things that need to be decided are the number of zones, and their size. The greater the number of zones, the smaller they can cover the study area and the better they capture traffic management schemes.

It is to be noted that for modeling purpose, all the properties and attributes of each zone are concentrated in a single point called the zone centroid. These centroids are attached to the network through centroid connectors, called as Dummy Links.

Generally the following criteria are adopted for fixing zoning scheme.

- The zoning is to be compatible with other administrative divisions, such as census, electoral and other municipal boundaries.
- They are to be as homogenous as possible in respect of land use or population composition and trip generation characteristics.
- The shape to represent natural catchment of area of the network.
- They could be of similar dimensions in respect of population, travel time units, and therefore will generate smaller zones in congested area, than in open areas.
- Approximate number of households can be around 2000, or population to hold between 8,000 and 10,000. However in sparsely populated fringe areas, in order to restrict the zone sizes, lesser population can be considered.

Census and Electoral and other Administrative boundaries of municipal wards are considered appropriate in order to fix up the internal zoning scheme. Table 3-1 represents the Traffic Analysis Zones for the current study.

Table 3-1: Traffic Analysis Zones

S. No.	Zones	Details
Internal Zones		
1	1 - 51	Solapur Municipal Corporation Wards
External Zones (Outer Cordons)		
2	52	Solapur-Hyderabad Road (NH-9)
3	53	Solapur-Akkalkot Road (SH-151)
4	54	Solapur-Mangalore Road (NH-13)
5	55	Solapur-Mangalwedha Road
6	56	Solapur-Pune Road (NH-9)
7	57	Solapur-Barshi Road (To SH-151)
8	58	Solapur-Tuljapur Road (NH-204)

Source: UMTC (Consultant) analysis

The below Figure 3-1: Zoning of the Study Area

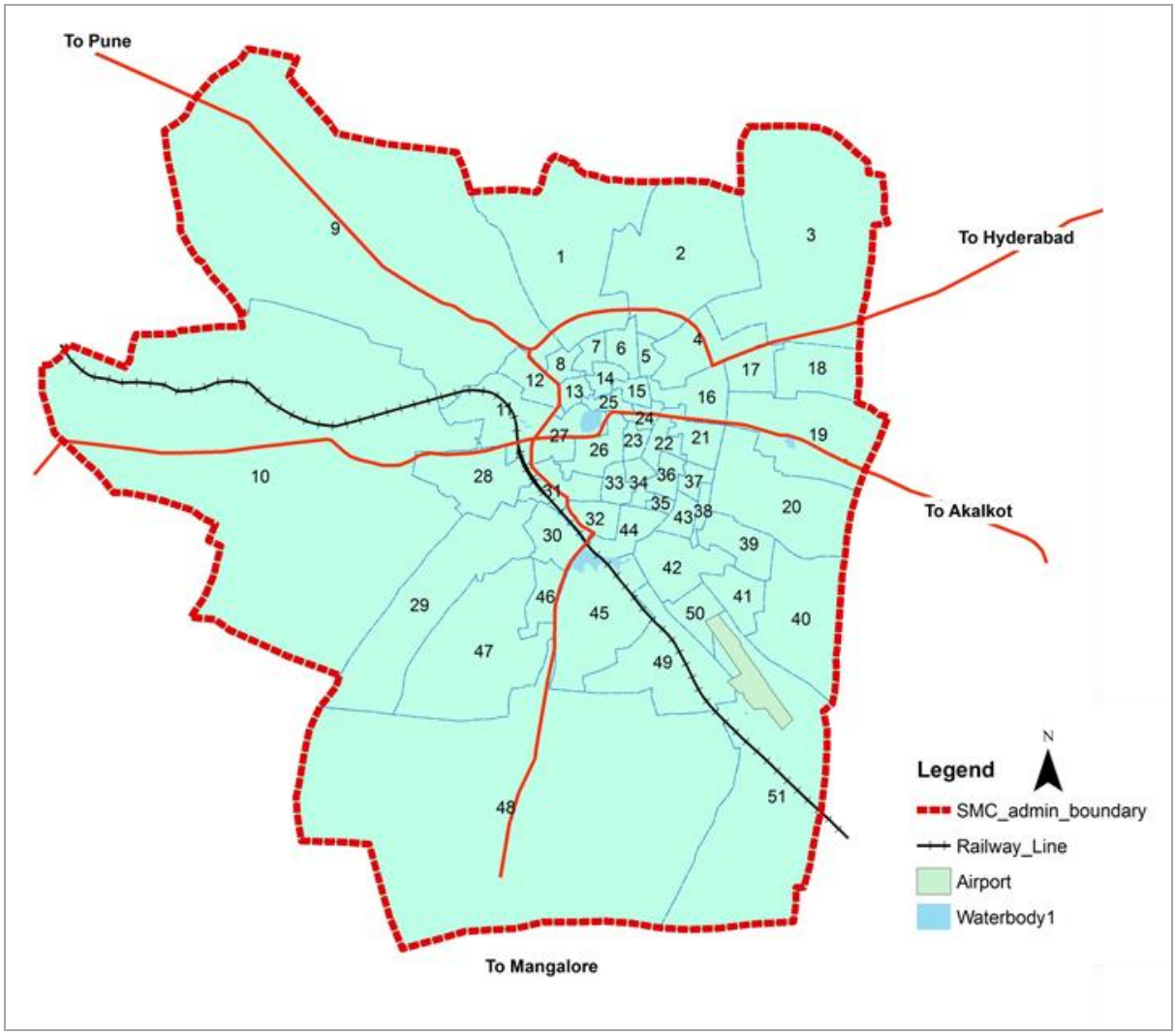


Figure 3-1: Zoning of the Study Area

3.4 Zone-wise Population and Socio-Economic data

The Average household size at city level is observed to be 5.1, and house hold size ranges between 4.5 and 6.5. Zone wise Population and Socio Economic data is given in Table 3-2.

Table 3-2: Zone Wise Population and Socio Economic Data (2015)

TAZ No	Population	House Holds	Employment	TAZ No	Population	House Holds	Employment
1	7818	1613	2916	27	17120	3391	6386
2	23153	4627	8636	28	19694	3835	7346
3	28677	5707	10697	29	11721	2364	4372
4	9051	1633	3376	30	19304	3883	7201
5	17185	3363	6410	31	16960	3489	6326
6	28935	5716	10793	32	19488	3936	7269

TAZ No	Population	House Holds	Employment	TAZ No	Population	House Holds	Employment
7	17960	3462	6699	33	20063	3460	7484
8	27456	5362	10241	34	29232	5416	10904
9	30385	5940	11334	35	9617	1909	3587
10	19653	3646	7330	36	19184	3604	7156
11	44042	9084	16428	37	15789	3124	5890
12	19860	4242	7408	38	17096	3523	6377
13	9041	1851	3372	39	25456	5140	9495
14	16197	3060	6041	40	29709	6039	11081
15	19404	3419	7238	41	18221	3403	6797
16	17818	3467	6646	42	33814	6961	12613
17	12575	2425	4691	43	20397	4152	7608
18	29526	5965	11013	44	8387	1671	3128
19	42964	8749	16026	45	30689	6812	11447
20	26426	5438	9857	46	18008	3720	6717
21	2634	514	983	47	29774	6389	11106
22	19208	3810	7165	48	24463	4855	9125
23	17528	3104	6538	49	20842	4517	7774
24	9719	1683	3625	50	26756	4935	9980
25	8175	1262	3049	51	35956	7319	13412
26	18733	3367	6987				

Source: UMTC Estimates

3.5 Traffic Surveys

Traffic Surveys and studies are integral components in the preparation of Comprehensive Mobility Plan. Appreciation of existing traffic and travel characteristics is extremely important for developing a mobility plan. For any assignment of this kind, establishing baseline data plays a pivot role in building up a model that resembles the realistic conditions of the city. Apart from helping in understanding the existing traffic and transportation situation, challenges and the strengths, this data would help in development, calibration and validation of the travel demand models.

A number of traffic & transportation surveys were conducted as a part of the study in order to assess the passenger and goods movement pattern, travel characteristics, pedestrian & parking characteristics and the available infrastructure facilities with the study area. The details are:

- Classified Traffic Volume Counts (CTVs)
  - Outer cordons
  - Screen line points
  - Intersections
- Parking Surveys
- Origin Destination Surveys (OD Surveys)
- Speed and Delay Survey
- Boarding and Alighting Surveys (Bus & Auto)
- Terminal Commuter surveys
- Household Surveys
- Truck Operator Survey
- Pedestrian Counts
- Road Inventory Survey
- Light Intensity Survey

3.6 Survey Methodology

Traffic Survey has been carried out during the five normal working days on a typical weekday i.e. Monday through Friday. Surveys on days of public holiday were not considered. Further, survey on a rainy day was also avoided. At the cordon interview stations a sample of 10% is achieved.

3.7 Survey Team & Training

Each survey team consisting of nearly 15-20 numbers of enumerators for RSI survey and 4 -6 numbers of enumerators for traffic volume count was selected depending on the volume and location (see in Figure 3-2). Enumerators were trained on methods of filling the survey formats, methods of interviewing the road user. Enumerators were given the description of the project and the Study area; survey stations/traffic characteristics etc. The selection of enumerators was made in week advance of the commencement of the traffic surveys, As RSI survey involves the stopping of vehicles and interviewing them,

police help is indispensable. The assistance of two traffic police constables at each RSI survey stations was sought during entire period of survey (in two shifts of 8 hours) at each station. In total, four traffic police personnel were used for each location for 16 Hours. These personnel were allocated mostly from the local police station in the vicinity of the survey location.

Figure 3-2: Survey Training Process

3.8 Survey Execution

With prior finalization of the schedule, duration of the survey, sample to be collected, and with trained enumerators, the surveys at all locations have been executed. Trained enumerators were moved to the sites at least an hour before the actual survey start and allowed to organize themselves under the guidance of traffic engineers. Adequate precautions were taken to maintain the quality of work during the survey period. Every care was taken to organize the survey in an efficient manner. Information to the concerned Government officials like Traffic Police, City Engineers is also provided about the survey locations, schedule and execution of the surveys. The survey formats were provided in the Inception Report submitted earlier. The survey locations marked on map are given in Annexure-I.

3.9 Classified Volume Counts

An imaginary line circumscribing the boundary of the study area is termed as the cordon line. Similarly, imaginary lines along the physical and natural barriers, having limited road crossing points within the study area, are termed as screen lines. The screen lines were delineated in order to check the accuracy of the data collected and for validation of demand forecasting entering/leaving models for north -south and east-west travel. The

cordon points were selected on all the major entries/exits of the Cities (say external points) that will catch all the traffic the city. Classified Traffic Volume Survey for 16 hours has been carried out at all these entry/exit locations. The outer cordon point locations are presented in Table 3-3.

Table 3-3: List of Outer Cordon Locations

S. No.	Survey Location	Location ID	Schedule	Day
1	Solapur-Hyderabad Road (NH-9)	OC-1	23/07/2015	Thursday
2	Solapur-Akkalkot Road (SH-151)	OC-2	23/07/2015	Thursday
3	Solapur-Mangalore Road (NH-13)	OC-3	23/07/2015	Thursday
4	Solapur-Mangalwedha Road	OC-4	23/07/2015	Thursday
5	Solapur-Pune Road (NH-9)	OC-5	23/07/2015	Thursday
6	Solapur-Barshi Road (To SH-151)	OC-6	23/07/2015	Thursday
7	Solapur-Tuljapur Road (NH-204)	OC-7	23/07/2015	Thursday

In addition to the 7 outer cordon locations, traffic count was carried out on Screen Line Points (SLPs) at Rail Crossings to understand the traffic movement among different zones. The survey locations are presented in Table 3-4.

Table 3-4: List of Screen line Point Locations

S. No.	Survey Location	Location ID	Schedule	Day
1	Kumthe-Aherwadi Railway crossing	SC-1	24/07/2015	Friday
2	Asara bridge, Konark Nagar crossing	SC-2	24/07/2015	Friday
3	Old vijapur Naka	SC-3	24/07/2015	Friday
4	Modi Railway Crossing	SC-4	24/07/2015	Friday
5	Sangola Mangalweda Crossing	SC-5	24/07/2015	Friday

3.10 Turning Movement Survey

Turning movement count has been conducted for 16 hours at all major intersections identified. At each identified locations, all turning movements have been covered and the data has been collected by vehicle category. The format and classification used is same as that used for classified volume count survey. The survey locations are provided in Table 3-5.

Table 3-5: List of Major Intersections

S. No.	Survey Location	Location ID	Schedule	Day
1	Saat Rasta Junction	IC-1	24/07/2015	Friday
2	PatrakaarBhawan	IC-2	21/07/2015	Tuesday
3	Bhaji Market	IC-3	21/07/2015	Tuesday
4	Railway Station Junction	IC-4	21/07/2015	Tuesday
5	Old Employment Junction (DadaSahebJunction)	IC-5	21/07/2015	Tuesday
6	Park Chowk Junction	IC-6	22/07/2015	Wednesday
7	Shivaji Chowk	IC-7	22/07/2015	Wednesday
8	Vijapurves junction	IC-8	22/07/2015	Wednesday
9	MadhalaMaruti Chowk	IC-9	22/07/2015	Wednesday
10	Shanti Chowk (Govt. Polytechnique Junction)	IC-10	23/07/2015	Thursday
11	Market Yard (JunaBoramani Naka Bus stop)	IC-11	23/07/2015	Thursday
12	Rang Bhawan Junction	IC-12	23/07/2015	Thursday
13	Civil Hospital Chowk	IC-13	23/07/2015	Thursday
14	Aasara Chowk	IC-14	24/07/2015	Friday
15	Bhayiya Chowk	IC-15	24/07/2015	Friday

The Vehicle classification has been developed based on the guidelines by IRC, project requirements and approved by the client. The counting has been done manually through trained enumerators and the data has been collected in 15 minute intervals. For outer cordon surveys, mid-block counts and screen line counts the formats used are presented in the earlier submitted Inception Report.

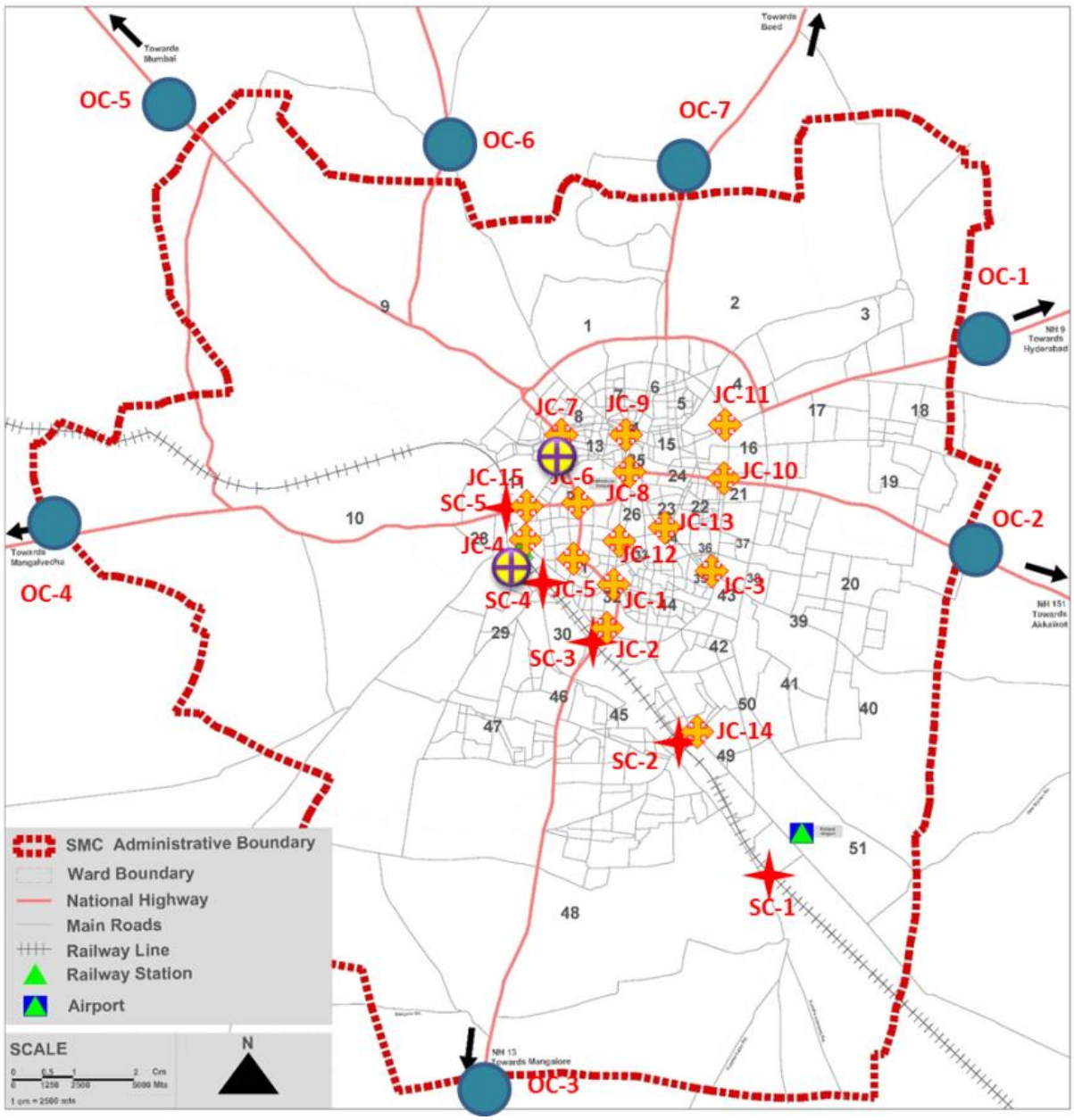


Figure 3-3: outer cordon, screen lines and junctions locations

Passenger Car Equivalency Units (PCU)

Many Vehicle types different in size and performance can be observed on Indian roads occupying the same space. In addition to the motorized vehicles presence of non-motorized vehicles such as animal/hand drawn, cycle etc., is a common sight. In order to express the intensity of traffic, it would be convenient to express all these different vehicle types in single unit terms. For this purpose, IRC has recommended a set of Passenger Car Units for various vehicle types considering their characteristics both physical and mechanical. These factors are considered as per IRC 106:1990 for Urban

Areas. The factors were considered (see in Table 3-6) based on the percentage composition of the vehicle type in the traffic stream.

Table 3-6: PCU Factors

Vehicle type		PCU factor	
		5%	5 % above
Two Wheeler	Motorised Vehicles	0.5	0.75
Auto		1.2	2
7 Seater Auto//Maxi Cabs		1.2	2
Taxi		1	1
Car/ Jeep/ Van/ Tempo		1	1
Mini Bus		1.4	2
APSRTC Bus		2.2	3.7
Private Bus		2.2	3.7
LCV		1.4	2
2-Axle		2.2	3.7
3- Axle		3	5
MAV		4.5	7.6
Agricul. Tractor & Trailer		4	5
Agricul. Tractor		4	5
Cycle	Non-Motorised Vehicles	0.4	0.5
Cycle Rickshaw		1.5	2
Animal Drawn		1.5	2
Others		2	3

Source: IRC 106:1990 for Urban Areas

The main objective of the classified traffic volume count was to assess the traffic characteristics in terms of average daily traffic, hourly variation of traffic, peak hour traffic, traffic composition, modal share and directional distribution. The surveys were conducted manually on a normal working day for 16hrs at 7 outer cordon (OC) locations and 16hrs at 15 intersections. The analysis of the same is presented in further sections.

3.11 Parking Surveys

Parking survey has been conducted for 16 hours containing the peak and off peak periods. The main objective was to appreciate the parking demand and supply characteristics, identify issues and constraints & suggest appropriate policies for meeting the horizon year parking demand. The survey was conducted in order to assess the level of usage of on-street and off-street parking facilities at pre-selected locations like Central Business District (CBD), and other commercial locations. The locations of the parking surveys were

presented in Table 3-7 and pictures taken while surveys are in progress are shown in Figure 3-4.

Table 3-7: List of Locations/Stretches for Parking Survey

S. No	Location	Schedule	Day
On-Street Parking			
1	Bhaji Market to Kamat Hotel	30/07/2015	Thursday
2	Civil Chowk - Star Hotel	30/07/2015	Thursday
3	Datta Chowk - Unique Hospital	30/07/2015	Thursday
4	Duffrin Chowk	30/07/2015	Thursday
5	MadhalaMaruti Temple	31/07/2015	Friday
6	MousirMagleeBanu	31/07/2015	Friday
7	Naval Petrol Pump	31/07/2015	Friday
8	NaviPeth	31/07/2015	Friday
9	Unique Hospital - Datta Chowk	31/07/2015	Friday
10	Unique Hospital - Samachar Circle	31/07/2015	Friday
11	Wadia Hospital	31/07/2015	Friday
Off-Street Parking			
1	District Court	29/07/2015	Wednesday
2	Employment Chowk	29/07/2015	Wednesday
3	Railway Station	29/07/2015	Wednesday
4	Temple	29/07/2015	Wednesday

On Street and Off-Street Parking

Figure 3-4: Parking Surveys

3.12 Origin-Destination Surveys

The main objective of Origin Destination (O–D) survey was to obtain information on travel pattern of passenger and goods vehicles at the cordon line along with the trip desire in terms of destined to/originated from and through trips to the study area. The origin and

destination of the trip, trip length, frequency, occupancy, commodity carried are collected during the survey. The vehicles are stopped on sample basis with the help of the police and the above information is collected through road side interview technique. The Origin-Destination survey is conducted for a period of 16 hours (1day). The survey locations are presented in Table 3-8.

Table 3-8: List of Origin Destination (Outer Cordon) Locations

S. No.	Survey Location	Location ID	Schedule	Day
1	Solapur-Hyderabad Road (NH-9)	OC-1	23/07/2015	Thursday
2	Solapur-Akkalkot Road (SH-151)	OC-2	23/07/2015	Thursday
3	Solapur-Mangalore Road (NH-13)	OC-3	23/07/2015	Thursday
4	Solapur-Mangalwedha Road	OC-4	23/07/2015	Thursday
5	Solapur-Pune Road (NH-9)	OC-5	23/07/2015	Thursday
6	Solapur-Barshi Road (To SH-151)	OC-6	23/07/2015	Thursday
7	Solapur-Tuljapur Road (NH-204)	OC-7	23/07/2015	Thursday

3.13 Speed-Delay Surveys

The objective of this survey is to assess the speed and delay characteristics along the existing road network and to identify bottleneck locations and their probable causes, to identify significant road conditions influencing the observed travel times. Speed & Delay survey along the identified road network was carried out by 'Moving Car Observer Method' by traversing along the road sections, in the peak and off peak hours. Information regarding number of vehicles overtaking the test car, overtaken by test car, number of vehicles in opposite direction to the test car, journey and running time along with cause and quantum of delay were recorded. Following outputs are derived from the surveys:

- Journey speeds along the corridors
- Running speeds along links between intersections
- Nature and extent of delay at intersections and mid blocks

The speed data is being used to develop zone-to-zone travel time matrices for use in trip distribution and traffic assignment stages of demand modeling. The Speed and Delay surveys are carried out on all major and important corridors of the study area.

3.14 Public Transport Passenger Surveys

Presently bus transport is the only public transport available for the study area. The number of routes presently operating and the number of services in operation are collected from the DPR for Bus Funding Project. The fare details are also collected. Based on the details available, on board passenger survey is conducted on sample basis. This data will capture the portrait of the public transport riders at the system wide level, by service type, by time of day / time of week and the route level. The data collected includes trip characteristics, fare, and frequency of use.

On sample basis the bus transport passenger survey was carried out to get the overall picture of the public transport passengers.

3.15 Commuter Surveys

Commuter survey was carried out to assess the inter-city and intra-city trips using public transits. The survey was carried out at terminals within the city that carry majority of the trips. These locations include 1 railway station and 1 bus stand terminal. The survey was conducted for 24 hours. The details collected include the count of passengers entering and exit the terminal and also the personal trip details. The counts of passengers were collected by counting at the entry/exit gates and personal trip details were collected by interviewing the passengers on sample basis.

These Surveys were conducted for 24hrs at railway and bus stations to estimate the Public and private trips of all modes which originate/terminate outside the city. The survey locations are presented in Table 3-9.

Table 3-9: List of Terminals

S. No.	Survey Location	Schedule	Day
1	Bus Terminal	27/07/2015	Monday
2	Rail Terminal	27/07/2015	Monday

3.16 Household Travel Surveys

The Objective of the Household Interview Survey (HIS) is to assess the household characteristics, Socio-economic and trip characteristics of residents in study area. The Survey was carried out on a sample basis that accounts to representing 2% of households

within the study area. The sample households were selected based on stratified random sampling technique out of the ward wise Electoral Lists. The number of households within each zone was based on the respective number of households in each zone. The main steps involved in conduction of the Surveys were:

- ✓ Design of Questionnaire
- ✓ Selection and Training of Enumerators
- ✓ Conduction of Pilot Surveys and Main Surveys
- ✓ Data Coding, Punching, Checking and Data Analysis.

The questionnaire presented in inception report is used for data collection. The questionnaire was divided into three main modules, viz. household information, personal level information and trip information. The questionnaire was designed to incorporate cross-checks on some of the most important responses for which it may be difficult to obtain reliable information like household/ personal income etc., Details were collected for trips performed by the respondent and the family members on the previous working day. The trip details were broken down into individual stages to study the characteristics of linked trips. As mentioned earlier, the enumerators were trained for the collection of the Household data. The household samples were collected in all the wards of the Municipal Corporations. Pictures taken while surveys are in progress are shown in Figure 3-5.

Figure 3-5: Household Survey Progress

3.17 Vehicle Operator's Survey

A sample survey of operators of taxis, auto rickshaws, and goods vehicles along with slow moving goods vehicles were conducted inside the city area with Vehicle Owners'

associations. Information on vehicle and operating characteristics was collected. The main objective is to elicit information on the issues connected to operators in a city – their facilities and requirements.

3.18 Pedestrian Survey

Pedestrian survey is carried out at junctions where the pedestrian movement is more. Pedestrian counts are carried out at both the peak and off peak hours. This will be useful in developing pedestrian proposals. The survey locations are presented in Table 3-10.

Table 3-10: List of Pedestrian Survey Locations

S. No.	Survey Location	Location ID	Schedule	Day
1	Saat Rasta Junction	PC-1	24/07/2015	Friday
2	PatrakaarBhawan	PC-2	21/07/2015	Tuesday
3	Bhaji Market	PC-3	21/07/2015	Tuesday
4	Railway Station Junction	PC-4	21/07/2015	Tuesday
5	Old Employment Junction (DadaSaheb Junction)	PC-5	21/07/2015	Tuesday
6	Park Chowk Junction	PC-6	22/07/2015	Wednesday
7	Shivaji Chowk	PC-7	22/07/2015	Wednesday
8	Vijapurves junction	PC-8	22/07/2015	Wednesday
9	MadhalaMaruti Chowk	PC-9	22/07/2015	Wednesday
10	Shanti Chowk (Govt. Polytechnique Junction)	PC-10	23/07/2015	Thursday
11	Market Yard (JunaBoramani Naka Bus stop)	PC-11	23/07/2015	Thursday
12	Rang Bhawan Junction	PC-12	23/07/2015	Thursday
13	Civil Hospital Chowk	PC-13	23/07/2015	Thursday
14	Aasara Chowk	PC-14	24/07/2015	Friday
15	Bhayiya Chowk	PC-15	24/07/2015	Friday

3.19 Road Inventory

Road Inventory survey is carried out for all major and important corridors of the study area. The details of the carriageway width, divided/undivided carriageway, footpath availability, etc., are collected. This data will be used as parameters of the network.

4. Primary Survey Data Analysis

4.1 Introduction

This chapter covers the analysis of primary data collected from surveys to understand the traffic and travel characteristics. The section below discusses the analysis and the findings.

4.2 Classified Traffic volume count

Cordon Locations

The survey has been conducted at 7 outer cordon locations, which are primarily the major entry points from Pune, Hyderabad, Mangalore, Barshi and Tuljapur. The quantum and temporal variation of total daily traffic, Intensity and composition of vehicles and passenger trips moving in the study area are presented in the following sections. Table 4-1**: Daily traffic volume at outer cordon and screen line points** represents the daily traffic volume at outer cordon and screen line points. Summary of Classified Traffic Volume Counts at Outer Cordon and Screen line locations is presented in Annexure-II.

Table 4-1: Daily traffic volume at outer cordon and screen line points

S. No.	Survey Location	Location ID	Total Vehicles	Total PCUs
Outer Cordon				
1	Solapur-Hyderabad Road (NH-9)	OC-1	15,178	25,607
2	Solapur-Akkalkot Road (SH-151)	OC-2	15,188	15,854
3	Solapur-Mangalore Road (NH-13)	OC-3	16,440	20,538
4	Solapur-Mangalwedha Road	OC-4	14,459	16,899
5	Solapur-Pune Road (NH-9)	OC-5	28,346	41,611
6	Solapur-Barshi Road (To SH-151)	OC-6	9,664	10,579
7	Solapur-Tuljapur Road (NH-204)	OC-7	13,396	20,266
Screen Points				
1	KumtheAherwadi Road	SC-1	6,766	5,818
2	Asara bridge, Konark Nagar Crossing	SC-2	51,987	43,899
3	Old Bijapur Naka	SC-3	72,782	69,930
4	Modi Railway Crossing	SC-4	29,871	26,440
5	SangolaMangalweda Crossing	SC-5	55,711	50,397

Source: Primary Survey, 2015

The incoming and outgoing vehicles at outer cordon points and eastbound westbound vehicles at screen line points are given in Table 4-2 and Table 4-3.

Table 4-2: Incoming and Outgoing vehicles at Outer Cordon Locations

S. No.	Survey Location	Location ID	Incoming Vehicles to City		Out Going Vehicles from City		Total Vehicles	Total PCUs
			Vehicles	PCUs	Vehicles	PCUs		
Outer Cordon								
1	Solapur-Hyderabad Road (NH-9)	OC-1	7,581	12,926	7,597	12,681	15,178	25,607
2	Solapur-Akkalkot Road (SH-151)	OC-2	7,830	8,091	7,358	7,763	15,188	15,854
3	Solapur-Mangalore Road (NH-13)	OC-3	8,173	10,165	8,267	10,372	16,440	20,538
4	Solapur-Mangalwedha Road	OC-4	6,192	6,527	8,267	10,372	14,459	16,899
5	Solapur-Pune Road (NH-9)	OC-5	14,201	20,566	14,145	21,045	28,346	41,611
6	Solapur-Barshi Road (To SH-151)	OC-6	4,760	5,226	4,904	5,353	9,664	10,579
7	Solapur-Tuljapur Road (NH-204)	OC-7	6,672	10,189	6,724	10,077	13,396	20,266

Source: Primary Survey, 2015

Table 4-3: Eastbound and Westbound vehicles at Screen line Locations

S. No.	Survey Location	Location ID	East Bound Vehicles		West Bound Vehicles		Total Vehicles	Total PCUs
			Vehicles	PCUs	Vehicles	PCUs		
Screen Line								
1	KumtheAaharwadi Road	SC-1	3361	2884	3405	2934	6,766	5,818
2	Asara bridge, Konark Nagar crossing	SC-2	26063	22017	25924	21882	51,987	43,899
3	Old Bijapur Naka	SC-3	35585	34148	37197	35782	72,782	69,930
4	Modi Railway Crossing	SC-4	14968	13161	14903	13280	29,871	26,440
5	SangolaMangalweda Crossing	SC-5	28260	25640	27451	24757	55,711	50,397

Source: Primary Survey, 2015

4.2.1 Composition of traffic

The daily traffic composition at outer cordon locations exhibits predominance of fast moving traffic varying from 74% to 87%. The traffic at cordons location of the study area

consists of higher percentage of two wheeler vehicles. The share of slow moving vehicles at outer cordon points varies from 0.3% to 6.8% with the average of about 2.7%. Composition of traffic at outer cordon locations is presented in Table 4-4.

Table 4-4: Daily Traffic Composition (%) at Outer Cordon Locations

S. No.	Survey Location	Location ID	Two Wheeler	Auto	Car/ Taxi	Buses	Goods Vehicles	Slow moving Vehicles
Outer Cordon								
1	Solapur-Hyderabad Road (NH-9)	OC-1	56.3	4.3	11.4	1.8	24.2	2.0
2	Solapur-Akkalkot Road (SH-151)	OC-2	57.7	6.7	17.4	3.7	7.7	6.8
3	Solapur-Mangalore Road (NH-13)	OC-3	61.2	8.9	13.4	2.4	12.3	1.8
4	Solapur-Mangalwedha Road	OC-4	64.0	7.2	13.1	2.3	10.5	2.9
5	Solapur-Pune Road (NH-9)	OC-5	48.1	4.9	20.8	4.3	21.6	0.3
6	Solapur-Barshi Road (To SH-151)	OC-6	67.0	5.5	10.5	3.1	11.3	2.7
7	Solapur-Tuljapur Road (NH-204)	OC-7	49.0	2.4	18.2	5.2	23.0	2.2
Screen-lineLocations								
1	KumtheAaharwadi Road	SC-1	70.7	8.4	2.4	0.3	3.3	15.0
2	Asara bridge, Konark Nagar crossing	SC-2	76.0	6.5	6.6	0.3	2.2	8.3
3	Old Bijapur Naka	SC-3	72.6	10.9	9.2	0.9	3.8	2.5
4	Modi Railway Crossing	SC-4	71.3	11.4	3.1	0.1	1.5	12.6
5	Sangola-Mangalweda Crossing	SC-5	67.5	10.8	5.5	0.6	2.7	12.9

Source: Primary Survey, 2015

4.3 Turning Movement Count Survey

Turning movement count has been conducted for 24 hours at all major intersections identified. At each identified locations, all turning movements have been covered and the data has been collected by vehicle category.

4.3.1 Traffic Volume (Average Daily Traffic – 24hrs)

The traffic counts both in terms of numbers of vehicles and passenger car units (PCUs) have been computed for the total daily (24 hour) traffic at various intersection locations and presented in Table 4-5.

Table 4-5: Daily Traffic Volume (24 Hours) at Intersections

S. No.	Survey Location	Location ID	Junction Type	Total Vehicles	Total PCUs
1	Saat Rasta Junction	IC-1A	6-Arm	146,564	1,52,003
2	PatrakarBhawan	IC-1B	3-Arm	84,313	89,094
3	PatrakaarBhawan (Hyderabad Bijapur Bypass junction)	IC-2	4-Arm	81,377	78,061
4	Bhaji Market (Old Kumbhari road-New Paccapeth)	IC-3	4-Arm	81,571	75,148
5	Railway Station Junction	IC-4	3-Arm	37,891	43,250
6	Old Employment Junction	IC-5	4-Arm	77,761	77,500
7	Park Chowk Junction	IC-6	4-Arm	106,331	103,462
8	Shivaji Chowk	IC-7	3-Arm	64,104	73,920
9	Vijapurves junction (Jodabasvanna Stop Location)	IC-8	5-Arm	146,196	142,933
10	MadhalaMaruti Chowk (SarafKhattaShanivarPeth junction)	IC-9	4-Arm	63,503	58,923
11	Shanti Chowk (Govt. Polytechnique Junction)	IC-10	4-Arm	84,469	3,006
12	Market Yard (JunaBoramani Naka Bus stop)	IC-11	4-Arm	80,376	79,183
13	Rang Bhawan Junction	IC-12	4-Arm	112,010	114,134
14	Civil Hospital Chowk (Kumta Naka Chowk which is ahead)	IC-13	6-Arm	102,495	104,824
15	Aasara Chowk	IC-14	4-Arm	75,717	70,128
16	Bhayiya Chowk	IC-15	4-Arm	77,761	7,500

Source: Primary Survey, 2015

4.3.2 Peak Hour Traffic

The peak hour traffic at junction locations is presented in Table 4-6. Peak hour share is observed to be 6.6% to 8.5% at various locations.

Table 4-6: Peak Hour Traffic at the junctions

S. No.	Location	Total Vehicles	Total PCUs	Morning Peak		Evening Peak	
				PCUs	% of Total PCUs	PCUs	% of Total PCUs
1	Saat Rasta Junction	146,564	52,003	11764	7.7	11449	7.5

S. No.	Location	Total Vehicles	Total PCUs	Morning Peak		Evening Peak	
				PCUs	% of Total PCUs	PCUs	% of Total PCUs
2	PatrakarBhawan	84,313	89,094	6936	7.8	6470	7.3
3	PatrakaarBhawan (Hyderabad Bijapur Bypass junction)	81,377	78,061	6122	7.8	5769	7.4
4	Bhaji Market (Old Kumbhari road-New Paccapeth)	81,571	75,148	6030	8.0	5337	7.1
5	Railway Station Junction	37,891	43,250	2996	6.9	3273	7.6
6	Old Employment Junction	77,761	77,500	5812	7.5	5486	7.1
7	Park Chowk Junction	106,331	103,462	8447	8.2	7791	7.5
8	Shivaji Chowk	64,104	73,920	5227	7.1	5704	7.7
9	Vijapurves junction (Jodabasvanna Stop Location)	146,196	142,933	11321	7.9	10784	7.5
10	MadhalaMaruti Chowk (SarafKhattaShanivarPeth junction)	63,503	58,923	4838	8.2	4373	7.4
11	Shanti Chowk (Govt. Polytechnique Junction)	84,469	3,006	6643	8.0	5891	7.1
12	Market Yard (JunaBoramani Naka Bus stop)	80,376	79,183	6452	8.1	5560	7.0
13	Rang Bhawan Junction	112,010	114,134	8811	7.7	9080	8.0
14	Civil Hospital Chowk (Kumta Naka Chowk which is ahead)	102,495	104,824	7961	7.6	8231	7.9
15	Aasara Chowk	75,717	70,128	5415	7.7	4612	6.6
16	Bhayiya Chowk	77,761	7,500	6560	8.5	5953	7.7

Source: Primary Survey, 2015

4.4 Occupancy of Passenger Vehicles

Occupancy of passenger vehicles is surveyed at Screen line locations. Average occupancy of fast passenger vehicles at Screen line locations is present in Table 4-7.

Table 4-7: Occupancy of Passenger vehicles

S. No	Vehicle Type	Average occupancy
1	Two Wheeler	1.9
2	Car	3.0
3	Auto	4.2
4	Share Auto	5.0
5	Mini Bus	15.9

S. No	Vehicle Type	Average occupancy
6	Bus	21.4

Source: Primary Survey, 2015

4.5 Household Survey

The existing traffic /transport conditions are analysed by doing the household survey and 2% of samples are collected for household surveys.

4.5.1 Vehicle ownership

Two-wheeler owned percentage is more (i.e. 52%) compared to other modes in Solapur following cycle owned percentage (i.e. 38%).Distribution of Vehicle Ownership in the study area is given in Table 4-8.

Table 4-8: Vehicle Ownership Percentage

Vehicle Type	% Distribution
Cycles	38%
2-Wheelers	52%
Cars	5%
Auto	4%
Others	1%
Total	**100%**

Source: Primary Surveys, 2015

Vehicle Ownership per 1000 population in the study area is given in Table 4-9.

Table 4-9: Vehicle Ownership per 1000 population

Vehicle Type	Vehicles per 1000 Population
Cycles	112
2-Wheelers	152
Cars	14
Auto	12
Others	2
Total	**291**

Source: Primary Surveys, 2015

Distribution of Vehicle Ownership by Households in the study area is given in Table 4-10.

Table 4-10: Vehicle Ownership Distribution by Households

Vehicle Ownership	% Distribution
Cycles only	22%
2W only	30%
Cars only	1%

Vehicle Ownership	% Distribution
Cycles + 2W	10%
Cycles + Car	0%
2W + Car	2%
Cycles + 2W + Car	1%
No Vehicle	35%
Total	**100%**

Source: Primary Surveys, 2015

Distribution of Vehicle Ownership by age of the vehicles in the study area is given in Table 4-11.It is observed that majority of vehicles owned by households are having an age of 5-10 years (i.e. 65%).

Table 4-11: Vehicle Ownership Distribution by Households

Vehicle Type	Age of Vehicle (Years)			Total
	0-5	5-10	>10	
No. of Cycles	15%	71%	14%	100%
No. of 2W	23%	60%	17%	100%
No. of Cars	18%	69%	14%	100%
No. of Auto	22%	60%	18%	100%
No. of Others	0%	100%	0%	100%
Total	**20%**	**65%**	**16%**	**100%**

Source: Primary Surveys, 2015

It is also observed from household survey that only 56% of households are having parking space in dwelling premises.

4.5.2 Analysis of Travel Characteristics

Per-Capita Trip Rate (PCTR)

It is observed that PCTR including walk in study area is 0.89 whereas PCTR excluding walk is 0.61.

Distance Range Travelled by Households:

In total samples, Majority of the households are travelling up to a distance range of 4 kms for getting their daily needs, going to school and visiting a Doctor. Table 4-12 represents the distance range travelled by households.

Table 4-12: Distance Range Travelled by Households

Distance Range (Kms)	Percentage of Households		
	Daily need shop	School	Doctor
0-1	19.0%	9.4%	13.8%
1-2	30.2%	45.5%	0.5%
2-4	33.2%	36.2%	2.0%
4-6	15.4%	8.3%	1.9%
6-8	2.0%	0.6%	2.3%
8-10	0.3%	0.0%	3.1%
>=10	0.0%	0.1%	76.3%
Total	**100.0%**	**100.0%**	**100.0%**

Source: Primary Survey, 2015

Walking Time by Households

In total samples, Majority of the households are walking up to a time of 15min for getting their daily needs, going to school and visiting a Doctor. Table 4-13 represents the time range travelling by households.

Table 4-13: Walking Time by Households

Time Range (Min)	Percentage of Households		
	Daily need shop	School	Doctor
0-5	0.1%	0.5%	5.0%
5-10	0.0%	0.0%	95.0%
10-15	83.7%	1.5%	0.0%
15-20	15.7%	26.7%	0.0%
20-25	0.5%	15.5%	0.0%
25-30	0.0%	21.6%	0.0%
>=30	0.0%	34.1%	0.0%
Total	**100.0%**	**100.0%**	**100.0%**

Source: Primary Survey, 2015

Waiting Time by Persons

Average waiting time of passengers for various modes is presented in Table 4-14.

Table 4-14: Waiting Time of Passengers

Mode	Average Waiting Time (minutes)
Public Bus	12.1

Mode	Average Waiting Time (minutes)
Auto	10.9
Cycle Rickshaw	11.0
Total	**11.3**

Distribution of trips by purpose for Solapur is given below (Figure 4-1)

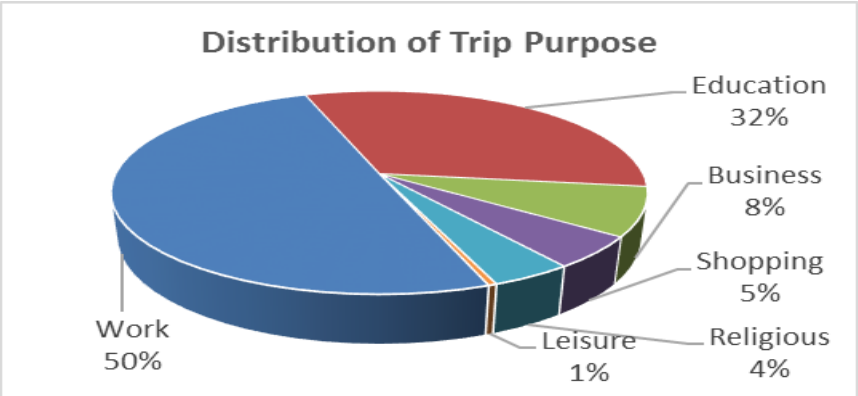


Figure 4-1: Distribution of Trips by Purpose in Solapur

From the Figure 4-1 it is observed that majority of the trips are work (50%) followed by Education (32%), Business (8%), Shopping (5%), Religious (4%) and Leisure (1%) based trips.

From the below table it is observed that majority of the mode share of person trips is by 2-wheelers and walk based trips.

Distribution of Trips by Mode:

Distribution of trips by mode is given below:

Table 4-15: Distribution of Trips by Mode

Mode of Travel	% Share
Car	5.7%
2W	26.2%
Public Bus	11.8%
Auto	10.6%
Cycle	13.5%
Train	0.2%
Cycle Rickshaw	0.2%
Walk	31.8%
Total	**100.0%**

Source: Primary Survey, 2015

In total samples, Mode of Travel for Majority of the households is by walk (31.8%) and two wheelers (26.2%).Table 4-15 represents the distribution of trips by mode.

Distribution of Trip Lengths by Mode of Travel:

Distribution of trip lengths by various modes of travel is given in Table 4-16.

Table 4-16: Distribution of Trip Lengths by Mode of Travel

Distance (Km)	Car	2W	Public Bus	Auto	Cycle	Train	Cycle Rickshaw	Walk	Trips IncludingWalk	Trips Excluding Walk
<0.5	5%	5%	5%	2%	3%	50%	0%	17%	8%	4%
0.5-1	3%	8%	7%	7%	16%	17%	0%	30%	16%	9%
1-2	8%	7%	5%	5%	9%	0%	0%	15%	9%	7%
2-4	25%	26%	15%	30%	26%	17%	50%	27%	26%	25%
4-6	19%	21%	19%	31%	24%	0%	25%	6%	17%	22%
6-8	4%	6%	10%	7%	7%	0%	0%	1%	5%	7%
8-10	9%	5%	10%	9%	5%	0%	0%	1%	5%	7%
>10	26%	22%	28%	10%	9%	17%	25%	2%	14%	19%
Total	**100%**	**100%**	**100 %**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Average Trip Length (Km)	**5.7**	**5.4**	**6.6**	**4.6**	**4.0**	**34.1**	**6.0**	**1.7**	**4.2**	**5.3**

Source: Primary Survey, 2015

Distribution of Trips by Second Preferred Mode:

Distribution of trips by second preference mode is given in Table 4-17.

Table 4-17: Distribution of Trips by second preferred Mode

Mode of Travel	% Share
Car	2.3%
2W	17.2%
Public Bus	24.7%
Auto	20.9%
Cycle	8.3%
Train	0.3%
Cycle Rickshaw	0.4%
Walk	25.9%
Total	**100.0%**

Source: Primary Survey, 2015

From the above table, it is observed that percentage of public transport trips have increased if the primary mode of travel is not available.

Accessibility of Public Transport Facilities:

Distance to Nearest PT/IPT:

Distance to nearest PT/IPT stops is given in Table 4-18. From the below table it is observed that majority of the households are accessible to PT/IPT stops within 0-2 kms of distance.

Table 4-18: Distance to Nearest PT/IPT Stops

Distance (Km)	Public Bus	Cycle Rickshaw	Shared Auto	Total
0-1	66.6%	74.5%	76.1%	70.7%
1-2	23.0%	19.1%	18.0%	20.9%
2-3	2.0%	2.1%	3.2%	2.5%
3-4	1.6%	0.0%	0.1%	0.9%
4-5	0.4%	0.0%	0.4%	0.4%
>=5	6.4%	4.3%	2.1%	4.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Primary Survey, 2015

Time Taken to Reach the Nearest PT/IPT Stop:

Time taken to reach nearest PT/IPT stops is given in Table 4-19. From the below table it is observed that majority of the households are accessible to PT/IPT stops within 0-15 minutes.

Table 4-19: Distance to Nearest PT/IPT stops

Time (Minutes)	Public Bus	Cycle Rickshaw	Shared Auto	Total
0-5	3.7%	10.8%	8.1%	5.7%
5-10	32.1%	62.2%	56.3%	43.1%
10-15	40.5%	16.2%	25.5%	33.6%
15-30	20.6%	10.8%	8.9%	15.4%
30-45	2.4%	0.0%	0.6%	1.6%
>=45	0.6%	0.0%	0.5%	0.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Primary Survey, 2015

Average Waiting Time at Bus Stop:

Average Waiting Time nearest PT/IPT stops is given in Table 4-20. From the below table it is observed that majority of the households average waiting time at nearest PT/IPT stops is 0-15 min.

Table 4-20: Average Waiting Time at Bus Stop

Time (Minutes)	Public Bus	Cycle Rickshaw	Shared Auto	Total
0-5	13.2%	10.0%	31.4%	19.8%
5-10	23.0%	76.7%	41.0%	30.8%
10-15	37.5%	6.7%	19.8%	30.3%
15-30	21.2%	3.3%	4.8%	14.8%
30-45	3.0%	3.3%	0.8%	2.2%
>=45	2.1%	0.0%	2.3%	2.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Primary Survey, 2015

Frequency of Public Transport Usage:

Frequency of public transport usage in the study area is presented in the below Table 4-21. From the below table it is observed that majority of the households using public transport is more than twice per week.

Table 4-21: Frequency of Public Transport Usage

Mode	Once	Twice	More than Twice	Total
Public Bus	23%	30%	47%	100%
Cycle Rickshaw	0%	0%	100%	100%
Shared Auto	23%	30%	47%	100%
Total	**23%**	**30%**	**47%**	**100%**

Source: Primary Survey, 2015

4.5.3 Analysis of Social Conditions

The socio economic characteristics of the people of study area by their spatial distribution have been analyzed to discuss their travel behavior and pattern. The following sections present the socio economic characteristics of the people in the study area.

Household Size:

The average Household size at city level is observed to be 3.8.

Age group:

Distribution of households by age group is presented in Table 4-22. From the below table it is observed that in the study area majority of the males are in the age group between 5 to 34 years and females are in the age group between 5 to 34 years.

Table 4-22: Age Group

Age	0-5	6- 17	18-24	25-34	35-44	45-58	59-64	65-74	>75	Total
Male	4%	20%	13%	21%	15%	15%	5%	5%	2%	100%
Female	4%	21%	18%	19%	16%	13%	3%	4%	2%	100%

Source: Primary Survey, 2015

Household Income and Expenditure:

The average monthly household income was observed to be Rs. 10,152 for assessing distribution of households by the income groups, the following categorization based on HUDCO practice (see in Table 4-23), has been adopted. The average monthly household expenditure was observed to be Rs. 876 which was 8.6% of average monthly household income.

Table 4-23: HUDCO Income Groups

Category	Monthly Household Income	% Households	Average Household Income (Rs.)	Avg. Expenditure on Travel (Rs.)	% Expenditure on Travel
Economically weaker Sections	Up to 5000	38%	3792	456	12.0%
Low Income Group	5001-10000	39%	8122	874	10.8%
Middle Income Group	10001-15000	9%	13940	1376	9.9%
High Income Group	Above 15000	14%	30664	1710	5.6%

Source: Primary Survey, 2015

Nearly 39% of the people are coming under Low Income Group, 38% of the Households are coming under Economically Weaker Sections, 14% under Higher Income Group and 9% of the households are coming under Middle Income Group.

4.6 Road Inventory Survey

4.6.1 Right of Way

Right of way of various roads having a total length of 112.4kms was measured during the survey. Table 4-24 represents the distribution of road network by right of way. Majority of the roads (57.1%) are having a ROW ranging from 20m to 30m. ROW ranging upto 20m are 42.5%. Remaining 0.4% of the roads are greater than 30m wide.

Table 4-24: Distribution of Road network by Right of Way

Distribution of Road network by Right of Way		
Right of Way (m)	**Road Length (km)**	**Percentage (%)**
Upto 10	4.9	4.4%
10 to 20	42.8	38.1%
20 to 25	31.9	28.4%
25 to 30	32.3	28.7%
Upto 35	0.5	0.4%
Total	**112.4**	**100.0%**

Source: Primary Surveys, 2015

4.6.2 Carriage way Width

Distribution of network according to their carriage way width is given in Table 4-25. Majority of the roads have 4 lanes and 6 lanes having 61% share of total length. Remaining are having Two Lane configuration.

Table 4-25: Distribution of Road network by Carriage way width

No of Lanes	Length (Km)	% Road Length
Single	0	0%
Two-Lane	43	38%
Three Lane	0	0%
Four Lane	55.4	49%
Six Lane	14	12%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.3 Presence of Median

Table 4-26 illustrates the distribution of roads based on the median. From the below table it is observed that 62% of surveyed roads have the median.

Table 4-26: Distribution of Road Length by Availability of Median

Median Width (Mtrs)	Length (Km)	% Road Length
No Median	42.4	38%
Upto 1m	28.6	25%
1 to 2	29.6	26%
Upto 3m	0	0%
Morethan 3m	11.8	10%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.4 Street lighting

It was observed that around 11% of the roads are not having street lighting. Remaining 89% of the roads are provided with Sodium Vapor lamp, fluorescent lamp or filament lighting, etc. Distribution of road network as per street lighting is given in Table 4-27.

Table 4-27: Distribution of Road Length by Street Lighting

Street Lighting	Length (Km)	% Road Length
Nil	12.9	11%
Central	60.1	53%
Road Side	29.1	26%
Central/Road Side	10.3	9%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

Lux level of the street lighting is presented in Table 4-28. The average Lux level of street lighting existing in Solapur is about 23.44 luminous.

Table 4-28: Lux Level of Street Lighting

Lux Level	LHS		RHS		Both	
	Length (Km)	% Road Length	Length (Km)	% Road Length	Length (Km)	% Road Length
Upto 10	15.3	14%	26.6	24%	21.0	19%
10 to 20	2	2%	33.2	30%	17.6	16%
20 to 30	28.4	25%	32.1	29%	30.3	27%
30 to 40	1.5	1%	5	4%	3.3	3%
40 to 50	24	21%	12	11%	18.0	16%
50 to 60	3.4	3%	0.5	0%	1.9	2%
More than 60	37.8	34%	3	3%	20.4	18%
Total	**112.4**	**100%**	**112.4**	**100%**	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.5 Parking Facilities

On-street parking facility is available on 12% of roads as shown in Table 4-29.

Table 4-29: Distribution of Road Length based on significant on-street parking facility

Parking	Length (Km)	% Road Length
No Parking (Parking Absent)	97.9	87%
On Street	14	12%
Off Street	0.5	0%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.6 Traffic Control Facilities

As per the road inventory survey, there are no traffic regulations in Solapur. Table 4-30 shows traffic regulations for overall distribution of roads.

Table 4-30: Distribution of Road Length by Presence of Traffic Management Rules

Traffic Management	Length (Km)	% Road Length
One way	0	0%
Two way	112.4	100%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.7 Pedestrian Facilities

Pedestrian facilities are dedicated services provided for pedestrians for their safe and convenient travel. These essentially include footpaths, guard rails and cross walks.

Table 4-31 shows the distribution of roads according to footpath availability. Only 36% of roads are having footpath. Remaining 64% of roads are not having footpath facility on either side.

Table 4-31: Distribution of Road Length by Availability of Footpath

Footpath Width (Mtrs)	Length (Km)	% Road Length
No Footpath	72.2	64%
Upto 1m	8	7%
1 to 2	17.3	15%
Upto 3m	8.9	8%
More than 3m	6	5%
Total	**112.4**	**100%**

Source: Primary Surveys, 2015

4.6.8 NMV Facilities

Currently there are no dedicated Non Motor Vehicle facilities (corridors) existing within the Solapur area. Bicycle parking is available at the bus and rail terminals.

4.6.9 Intersections

In the Solapur due to the heavy traffic flow, most of the junctions are highly congested during the peak hours. The Major Intersections within the Solapur are Saat Rasta Junction, Patrakaar Bhawan (Hyderabad Bijapur Bypass junction), Bhaji Market (Old Kumbhari road-

New Paccapeth), Railway Station Junction, Old Employment Junction, Park Chowk Junction, Shivaji Chowk, Vijapurves junction (Jodabasvanna Stop Location), Madhala Maruti Chowk (Saraf Khatta Shanivar Peth junction), Shanti Chowk (Govt. Poly Technique Junction), Market Yard (Juna Boramani Naka Bus stop), Rang Bhawan Junction, Civil Hospital Chowk (Kumta Naka Chowk which is ahead), Aasara Chowk and Bhayiya.

4.6.10 Guard rails

There are no pedestrian guard rails within the Solapur.

4.7 Speed and Delay Surveys

Speed and Delay Surveys have been carried out for the study area Major roads and the survey results are given below. It is observed that the main reason for delay is traffic congestion on the stretches. The running speed for car passing through city is observed that 20-38 kmph and for bus it is coming 17- 27 kmph. Table 4-32 represents the summary of the speed and delay survey in Solapur.

Table 4-32: Summary of speed and Delay Survey

S. No	Road Name	Car		Bus	
		Total Journey Speed (kmph)	Total Running Speed (kmph)	Total Journey Speed (kmph)	Total Running Speed (kmph)
1	Saiful to Panjarapole Chowk	30	30	24	27
2	Degaon Naka to Rajendra Nagar	18	21	20	20
3	Railway Station to Kardehalli	20	20	21	24
4	Panjarapole Chowk to Saiful	23	27	21	25
5	Kontam Chowk to Pratap Nagar	24	24	21	23
6	Ashok Chowk to Railway Station	30	32	16	17
7	Gharkul to Kontam Chowk	30	36	19	23
8	RajendraNgr to SiddheswaKaekh	30	30	17	21
9	Gharkul to Station (Bus No. 16)	31	32	17	19
10	Sidheswa to KontamChowk	32	38	17	20
11	Kontam Chowk to Gharkul	32	34	23	24
12	Other Roads	31	35	18	21
	Average Speed (kmph)	**29**	**32**	**19**	**21**

Source: Primary Survey, 2015

Major causes for the delay in the study area are due to Traffic and Junction signals. Table 4-33 represents the causes of delay.

Table 4-33: Causes for the Delays in Study Area

Causes of Delay	Percentage (%)
Bus Stop	20
Road Condition	4
School	4
Signal	24
Traffic	48
Total	**100**

Source: Primary Survey, 2015

4.8 Parking Survey Analysis

The survey was conducted at various Off-Street and On-Street locations in Solapur. The results are presented in the following section. The Equivalent Car Spaces (ECS) adopted for different vehicle types for the analysis are given in Table 4-34.

Table 4-34: Equivalent Car Spaces (ECS) Values Adopted for Various Vehicle Types

S. No.	Vehicle Category	ECS
1	Car	1
2	Two Wheelers	0.25
3	Bus	2.5
4	Trucks	2.5
5	LCV	1.75
6	Auto Rickshaws (IPT)	0.5
7	Bi-Cycles	0.1
8	Cycle Rickshaw	0.8
9	Bullock Cart/ Hand Driven Cart	3.2

Source: Guidelines for Parking (ADB Guidelines)

4.8.1 Off-Street Parking Results:

Parking at present is provided at various locations closer to the demand in Solapur. It is observed from the parking surveys that the present provision meets the demand. However it is observed that on street parking is followed, though off street parking is available. The Off-Street Parking survey Summary is given in Table 4-35.

Table 4-35: Location Wise Off-Street Parking and Peak Hour Accumulation in ECS

S. No	Location	Peak Time	Peak Hour Accumulation Equivalent Car Spaces (ECS)	Daily Accumulation Equivalent Car Spaces (ECS)	Parking Type
1	District Court	10:15 - 11:15	99	519	Off-Street

S. No	Location	Peak Time	Peak Hour Accumulation Equivalent Car Spaces (ECS)	Daily Accumulation Equivalent Car Spaces (ECS)	Parking Type
2	Employment Chowk	9:45 - 10:45	32	219	Off-Street
3	Railway Station	13:00 - 14:00	106	334	Off-Street
4	Temple	17:30 - 18:30	29	251	Off-Street

Source: Primary Survey, 2015

On-Street Parking Results:

At Various locations On-Street parking surveys are conducted in Solapur. Location wise Peak hour accumulations in Equivalent Car Spaces are presented in Table 4-36.

Table 4-36: Location Wise On-Street Parking and Peak Hour Accumulation

S. No	Location	Peak Time	Peak Hour Accumulation Equivalent Car Spaces (ECS)	Daily Accumulation Equivalent Car Spaces (ECS)	Parking Type
1	Bhaji Market to Kamat Hotel	8:00 - 9:00	82	613	On-Street
2	Civil Chowk - Star Hotel	17:00 - 18:00	58	172	On-Street
3	Datta Chowk - Unique Hospital	18:45 - 19:45	41	275	On-Street
4	Duffrin Chowk	9:15 - 10:15	104	553	On-Street
5	MadhalaMaruti Temple	10:30 - 11:30	190	1221	On-Street
6	MousirMagleeBanu	10:45 - 11:45	109	256	On-Street
7	Naval Petrol Pump	11:45 - 12:45	64	468	On-Street
8	NaviPeth	12:30 - 13:30	52	348	On-Street
9	Unique Hospital - Datta Chowk	12:00 - 13:00	97	288	On-Street
10	Unique Hospital - Samachar Circle	19:45 - 20:00	11	284	On-Street
11	Wadia Hospital	8:30 - 9:30	67	250	On-Street

Source: Primary Survey, 2015

4.9 Pedestrian Survey

It is observed that major roads do not have proper footpaths or altogether it is absent. This is major issue that needs to be attended to on priority. Further the roads in commercial areas are encroached by shops and that needs to be cleared. Provision of continuous footpaths is the need of every city. Further this adds to safety concerns due to movement of pedestrians on carriageway. Segregation of pedestrians and vehicles is required to be achieved. Pedestrian Survey Summary is presented in Table 4-37.

Table 4-37: Pedestrian Survey Summary

S. No	Location	Morning Peak Hour		Evening Peak Hour		Along and Across Pedestrians	Road Crossing Pedestrians
		Volume	Time	Volume	Time		
1 (A)	Saat Rasta Junction	2808	1030 – 1130	1912	1815 - 1915	26765	21415
1 (B)	Patrakar Bhawan	478	0845 – 0945	529	1715 - 1815	5934	3107
2	PatrakaarBhawan (Hyderabad Bijapur Bypass junction)	392	1100 – 1200	256	1815 - 1915	3498	2882
3	Bhaji Market (Old Kumbhari road-New Paccapeth)	1004	1100 – 1200	1049	1815 - 1915	12045	6773
4	Railway Station Junction	2868	0945 – 1045	2606	1730 - 1830	35704	22873
5	Old Employment Junction	715	1100 – 1200	637	1700 - 1800	7393	4816
6	Park Chowk Junction	941	1100 – 1200	906	1730 - 1830	11752	8316
7	Shivaji Chowk	4197	1100 – 1200	3912	1745 - 1845	52151	19863
8	Vijapurves junction (Jodabasvanna Stop Location)	1641	1045 – 1145	2016	1745 - 1845	23936	18401
9	MadhalaMaruti Chowk (SarafKhattaShanivarPeth junction)	1208	1100 – 1200	1659	1745 - 1845	16529	10343

S. No	Location	Morning Peak Hour		Evening Peak Hour		Along and Across Pedestrians	Road Crossing Pedestrians
		Volume	Time	Volume	Time		
10	Shanti Chowk (Govt. Polytechnique Junction)	782	0900 – 1000	594	1730 - 1830	7674	5617
11	Market Yard (JunaBoramani Naka Bus stop)	569	1100 – 1200	459	1900 - 2000	6321	4180
12	Rang Bhawan Junction	614	1100 – 1200	476	1645 - 1745	5882	2722
13	Civil Hospital Chowk (Kumta Naka Chowk which is ahead)	608	1015 – 1115	497	1745 - 1845	6468	4724
14	Aasara Chowk	937	1100 – 1200	796	1830 - 1930	10694	9453
15	Bhayiya Chowk	458	1100 – 1200	572	1700 - 1800	6692	5375

Source: Primary Survey, 2015

From the above table it is observed that maximum number of pedestrians is walking along the road and also crossing the road is at Shivaji Chowk, railway station junction followed by Railway station junction, Saat Rasta Junction, and Vijapurves junction (Jodabasvanna Stop Location).

Table 4-38 represents the calculations for PV2/(2*108) at major locations. It was observed that most of the locations has $PV^2/(2*10^8)$ values higher than 2, this indicates a considerable need to improve the pedestrian crossing facilities.

- It is observed that maximum pedestrian-vehicular conflicts at Saat rasta junction, Railway station junction, Aasara Chowk, Vijapur junction etc.
- It is observed that Saat Rasta junction and Railway station junction roads are having more PV2 values.

Table 4-38: PV^2 Values at Major Important Intersections3

S. No	Location	Maximum [(PV^2)/(1* 10^8)] Observed	Warrant for Controlled Measures
1	Saat Rasta Junction	1806	Yes
2	PatrakarBhawan	114	Yes
3	PatrakaarBhawan (Hyderabad Bijapur Bypass junction)	80	Yes
4	Bhaji Market (Old Kumbhari road-New Paccapeth)	225	Yes
5	Railway Station Junction	118	Yes
6	Old Employment Junction	122	Yes
7	Park Chowk Junction	355	Yes
8	Shivaji Chowk	513	Yes
9	Vijapurves junction (Jodabasvanna Stop Location)	1352	Yes
10	MadhalaMaruti Chowk (SarafKhattaShanivarPeth junction)	226	Yes
11	Shanti Chowk (Govt. Polytechnique Junction)	179	Yes
12	Market Yard (JunaBoramani Naka Bus stop)	122	Yes
13	Rang Bhawan Junction	244	Yes
14	Civil Hospital Chowk (Kumta Naka Chowk which is ahead)	197	Yes

Source: Primary Survey, 2015 and UMTC Estimates

4.10 Public Transport

The Passenger Surveys were conducted to ascertain travel characteristics of Passengers at Four Bus stands and four Railway Stations in the study area. The survey was administered by counting the number of passengers boarding and alighting the bus/train along with origin–destination (O-D)survey on random sampling basis by interviewing passengers waiting to board the bus/train at stations. This survey was conducted within the study area for a period of 24 hours. The information included:

Boarding/Alighting passenger volume count

[3] The degree of conflict between pedestrians and vehicles is determined by PV^2 where V is the two-way total hourly flow of vehicles and P is the two-way total hourly flow of pedestrians crossing the road within 50 m on either side of the site during peak hours. If the value of PV^2 exceeds 10^8 (or 1 = $PV^2/10^8$) for an undivided road or 2 x 10^8 (or 2 = $PV^2/10^8$) for a divided road, then there is requirement of pedestrian crossing facility.

O-D survey of Boarding/Alighting passengers at terminal locations

Trip purpose, travel time, etc.

Travel frequency of passengers

The surveys are conducted at Bus stands and at Railway stations and the results are shown in Table 4-39.

Table 4-39: Passengers at Terminal Stations

Terminal Name	Gate	In	Out	Total
Solapur Bus Terminal	Gate 1	8564	9561	18125
	Gate 2	3865	3637	7502
	Gate 3	3813	2899	6712
	Gate 4	7057	6058	13115
	Total	**23299**	**22155**	**45454**
Solapur Railway Station	Gate 1	9116	8051	17167
	Gate 2	4270	1723	5993
	Gate 3	8697	6524	15221
	Total	**22083**	**16298**	**38381**

Source: Primary survey, 2015

4.11 Boarding and Alighting at Bus Stop Locations

Bus stop boarding and alighting survey was conducted at major bus stops and auto stands (6 Bus stops and Auto Stands) within Solapur for a period of 16 hrs covering peak and non-peak periods. For these bus stops, peak hour boarding and alighting along with total passengers for 16 hrs are presented in Table 4-40.

Table 4-40: Peak Hour Boarding and Alighting

S. No.	Bus Stop	Mode	Peak Hour	Boarding	Alighting	Total	Total Passengers (16 hours)
1	BhaliVesAuto Taxi	Auto	10:00 - 11:00	4	70	74	637
		Share Auto	17:00 - 18:00	19	110	129	907
		Bus	18:00 - 19:00	187	54	241	1684
2	Chowk Auto Taxi	Auto	12:00 - 13:00	26	84	110	1052
		Share Auto	14:00 - 15:00	46	37	83	471
		Bus	12:00 - 13:00	16	80	96	896
3	Mangalweda Bus Stop	Auto	12:00 - 13:00	47	91	138	998
		Share Auto	14:00 - 15:00	15	14	29	122
		Bus	12:00 - 13:00	181	82	263	1654
4	Market Yard Auto Taxi	Auto	12:00 - 13:00	27	48	75	637
		Share Auto	14:00 - 15:00	1	22	23	170

S. No.	Bus Stop	Mode	Peak Hour	Boarding	Alighting	Total	Total Passengers (16 hours)
		Bus	12:00 - 13:00	0	5	5	17
5	Rang Bhavan Bus Stop	Auto	12:00 - 13:00	36	8	44	346
		Share Auto	14:00 - 15:00	39	3	42	173
		Bus	12:00 - 13:00	57	24	81	663
6	Sivaji Chowk Bus Stop	Auto	12:00 - 13:00	66	189	255	2572
		Share Auto	14:00 - 15:00	229	130	359	3621
		Bus	12:00 - 13:00	200	56	256	2183

Source: Primary survey, 2015

From the above tables it is observed that in the city area, maximum number of passengers is observed in Sivaji Chowk bus stop and the peak hour is from 12:00-13:00PM with 2183 passengers and at Mangalweda bus stop with 1654 passengers.

4.12 Truck Operator Survey

Truck operator survey has been carried out to assess the characteristics of the operators in terms of their operating characteristics. This would act as a major input towards economic analysis, model development and preparation of truck routing /terminal plans.

4.12.1 Trip Frequency

Trip frequency is presented in Table 4-41. Majority of the trips are Weekly trips (50%) followed by Monthly trips with 35%.

Table 4-41: Trip Frequency

S. No	Trip Frequency	% Share
1	Daily	8%
2	Alternate Days	7%
3	Weekly	50%
4	Monthly	35%
5	Quaterly	0%
Grand Total		**100**

Source: Primary survey, 2015

4.12.2 Commodity Type

The type commodities carried by trucks are shown in Figure 4-2. Majority of the commodities carried are Industrial Material (58%) followed by Food grains/ Vegetables/ Cereals with 35%.

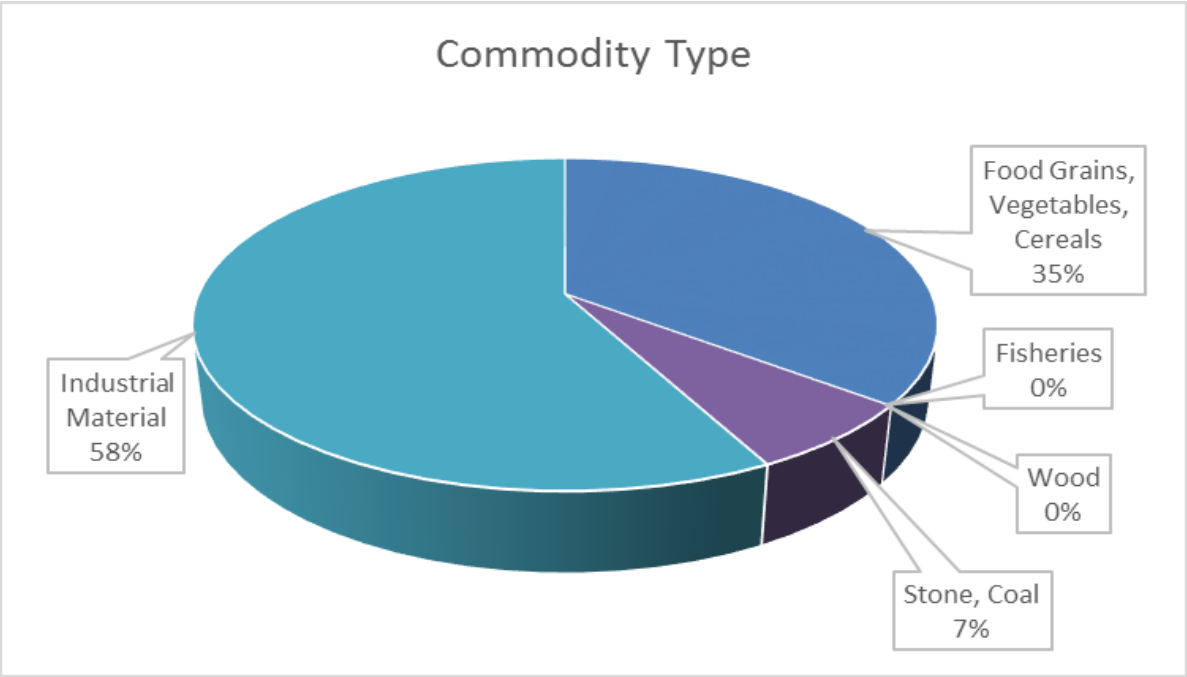


Figure 4-2: Commodity Type

4.12.3 Operational Difficulties

The truck operators were asked to specify their operational difficulties. Usual problems were identified and asked them. The operational difficulties mentioned by truck operators are given in Table 4-42.

Table 4-42: Operational Difficulties

S. No	Operational Difficulties	% Share
1	No Parking facility	23%
2	Ban on some roads or time	13%
3	Poor quality of roads	28%
4	Narrow roads	21%
5	No terminal facilities	10%
6	Lack of general facilities	3%
7	No weighing facilities	0%
8	Others	2%

Source: Primary survey, 2015

From the above table it is observed that most of the truck operators facing operational difficulties due to No parking facility, Ban on some roads, No terminal facilities and Poor quality of roads. This illustrates the requirement of truck terminal.

4.12.4 Observations

- No parking and truck terminal facilities within study area. So vehicles are parking. on the road side along major arterial roads.
- Average trip distance travelled: 1065kms.
- Market value of goods range from Rs. 3,000 to Rs. 20,00,000.
- Average loading capacity: 16Tonnes.
- Average designated time duration for loading and unloading inside the city 6hours.
- The truck operating routes in the study area are from Bangalore, Bellary, Hyderabad, Pune, Chennai, Mumbai, Vijapur, etc.

4.12.5 Review of Traffic safety and enforcement

There are many measures in place with regards to Traffic safety and enforcement. Because of lack of enforcement, safety has become one of the main concerns at major intersections. Certain junctions became accident prone areas due to lack of safety and more vehicular-pedestrian conflicts. Overall the pedestrian facilities are very poor not only at the junctions even at the mid-block pedestrian crossings.

4.12.6 Review of Existing Environmental and Social Conditions

Because of the increasing private/personalized mode of transport there is a huge deterioration in environment levels and social conditions. The elements of emissions from vehicles such as Carbon-mono-oxide, Hydrocarbons and Particulate matter have significantly increased during the years. Introduction of Public Transport Systems will definitely reduce the carbon emissions. As the traffic will get choked in peak hours, travel time is increasing with huge vehicular growth. The implementation of proposed projects will definitely enhance the mobility and reduce travel time, thus have some positive social impact.

5. Service Level Benchmarks

5.1 Introduction

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

5.2 Need for Benchmarking for Solapur

The National Urban Transport policy (NUTP) 2006 highlights the crucial link between transport demand and land use planning and the need to develop an integrated mobility plan for each city. Accordingly, each city should develop comprehensive mobility plan during the 12th five year plan with focus on accessibility, mobility and traffic flow (in that order). Rather than the present approach of "predict and provide" it has to be "Planning for the desirables". However, there need to be some yardstick to measure and compare the effectiveness of policies and urban projects across cities. Urban agencies in India currently do not have any system for measuring performance of urban transport activities, assessing impacts of projects and taking further action on them. The service level benchmarks (SLB) issued by MOUD specify parameters to measure the effectiveness of land use-transport planning in Solapur.

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

5.3 Performance Bench Marks for Urban Transport

Service level benchmarks have been identified for the following parameters by the Ministry of Urban Development (MoUD):

1. Public transport facilities
    - Presence of organized public transport system in urban area (%)
    - Extent of supply availability of public transport
    - Service coverage of public transport in the city
    - Average waiting time for public transport users (mins)
    - Level of comfort in public transport
    - % of fleet as per urban bus specification
2. Pedestrian infrastructure facilities
    - Signalized intersection delay (%)
    - Street Lighting (Lux)
    - % of city covered
3. Non Motorized Transport (NMT)facilities
    - % of network covered
    - Encroachment on NMT roads by vehicle parking (%)
    - NMT parking facilities at interchanges (%)
4. Level of usage of Intelligent Transport System (ITS) facilities
    - Availability of traffic surveillance (%)
    - Passenger Information System (PIS) (%)
    - Global Positioning System (GPS)/ General Pocket Radio Service (GPRS) (%)
    - Signal Synchronization (%)
    - Integrated ticketing System (%)
5. Travel speed (Motorized and Mass Transit) along major corridors

- Average travel speed of personal vehicles (Kmph)
- Average travel speed of public transport (Kmph)

6. Availability of parking spaces
    - Availability of on street paid public parking spaces (%)
    - Ratio of maximum and minimum parking fee in the city
7. Road safety
    - Fatality rate per lakhs population
    - Fatality rate for pedestrian and NMT (%)
8. Pollution levels
    - Sulpher di Oxide (So2)
    - Oxides of Nitrogen
    - Suspended Particulate Matter(SPM)
    - Respirable Suspended Particulate Mattetr(RSPM) (Size less than 10 microns)
9. Integrated land use transport system
    - Financial Population Density – Gross (Persons/Developed area in hectare)
    - Mixed Land-use on Major Transit Corridors / Network (% area under non residential use)
    - Intensity of Development – City wide (FSI)
    - Intensity of development along transit corridor (FSI transit corridor/FSI)
    - Clear Pattern and Completeness of the network
    - % of area under Roads
    - %age network having exclusive ROW for Transit network

5.4 Computation of Indices

In Service Level Benchmark, four levels of Service (LoS) have typically been specified. They are LOS1, LOS2, LOS3 and LOS4. The LOS1 represents the highest performance level

whereas LOS4 represents the Lowest. Hence, the goal is to attain LOS1. This section describes the computation process for all the indicators.

5.4.1 Public transport facilities

1. Presence of organized public transport system in urban area (%)
2. Extent of supply availability of public transport
3. Service coverage of public transport in the city
4. Average waiting time for public transport users (mins)
5. Level of comfort in public transport
6. % of fleet as per urban bus specification

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

Solapur's public transportation system is operating and maintaining by Maharashtra State Road Transport Corporation (MSRTC). City buses, auto rickshaws, three-wheelers and cycle rickshaws provide public transport service in the city. In addition to its own buses, city has received buses under JNNURM funding scheme also.

The Average Trip Length (ATL) for city bus users is approximately 7.7 km. The service span for the city buses is about 18 hours in a day (from morning 5.00 am to 11.00 pm) with variance in frequency during peak/off-peak hours. The operator operates the buses within the urban area (Solapur) on approximate 34 routes. A fleet size of approximately 71 buses plies on these routes. The service connects most of the major nodes/activity areas, business centers, education hub/areas, major terminals/interchanges and major residential areas of the city.

A = Total Number of Buses in Solapur operating – 71 buses

B = Total Number of operating Buses under the ownership of STU/SPV - 71 buses

Presence of Public Transport System in Urban Area (%)

= (B/A)*100

= 100 %, Therefore LoS**1 = 1**

Extent of Supply Availability of Public Transport:

In Solapur, the sub urban train facility is absent. The trains operated in Study area are for interstate and intercity only. So for this calculation the train coaches are not taken into account. Only the buses operated inside Solapur city are taken into consideration.

The Population of Solapur urban Limits for the year 2015 is 10,61,866.

Los 2	Extent of Supply Availability of Public Transport
1	>= 0.6
2	0.4 – 0.6
3	0.2 – 0.4
4	< 0.2

A = Total Number of Buses in Solapur – 202 buses

B = Total Population of Solapur Urban limits – 10,61,866.

Availability of Public Transport / 1000 Population

= A/ (B/1000)

= 0.19, Therefore LoS**2** = **4**

Service coverage of public transport in the city:

The study area is around 179sq.km. The total length of corridor on which public transport system is plying is 112.4km.

Los 3	Service coverage of public transport in the city
1	>= 1
2	0.7 - 1.0
3	0.3 – 0.7
4	< 0.3

A=Total length of road Kms of the corridors on which the PT systems ply in study area=112.4 (in Road Kilometers) for metropolitan area

B = Area of the Urban Limits (study area) = 179 (in Square Kilometers)

Service Coverage of public transport in the city = (A/B)

=0.63. Therefore LoS**3** = **3**

Average waiting time for public transport users (mins):

Los 4	Average waiting time for public transport users (mins)
1	<=4
2	4 - 6
3	6 - 10
4	> 10

The average headway for each bus route is more than 30 minutes. Therefore the average waiting time is half the headway i.e. 15 minutes.

Therefore LoS**4** = **4.**

Level of comfort in public transport:

Los 5	Level of Comfort of public transport in the city
1	<=1.5
2	1.5 – 2.0
3	2.0 – 2.5
4	>2.5

A = Key public transport corridors are identified through the Google map and Bus passenger occupancy survey were done at that selected bus stops.

B = Passenger count on bus at key identified routes=21

C = Seats available in the bus is taken based on its type= 50

Passenger comfort – Load factor (passengers per seat) = B/C =21/50=0.43

Therefore Los **5**= **1**

% of Fleet as per Urban Bus Specification:

Los 6	% of fleet as per urban bus specification
1	75 - 100
2	50 - 74
3	25 - 49

Los 6	% of fleet as per urban bus specification
4	<=25

The information collected as a part of secondary data collection.

A = Total Number of Buses in the City operating – 71 buses

B = Total number of buses as per the Urban Bus specifications in Solapur operating – 45 buses

% of fleet = (B/A)*100 =63%,

Therefore LoS **6** = **2**

Overall Level of Service of Public Transport Facilities:

Table 5-1: Reference Table for Computing Overall Level of PT Facilities

Overall Level of Service of Public Transport facilities City wide		
Calculated LoS = (LoS_1 + LoS_2 + LoS_3 + LoS_4 + LoS_5 + LoS_6) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	< 12	The City has a good public transport system which is wide spread and easily available to the citizens. The system provided is comfortable.
2	12 - 16	The City has public transport system which may need considerable improvements in terms of supply of buses/ coaches and coverage as many parts of the city are not served by it. The frequency of the services available may need improvements. The system provided is comfortable.
3	17 - 20	The City has a public transport system which may need considerable improvements in terms of supply of buses / coaches and coverage as most parts of the city are not served by it. The frequency of the services available needs improvements. The system provided is not comfortable as there is considerable over loading.
4	21-24	The city has very poor/no organized public transport system

The overall LoS of Public Transport Facilities is obtained by summing up the LoS of individual parameters.

Overall Level of Service of Public Transport facilities in Solapur = LoS 1+ LoS 2 + LoS 3 + LoS 4 + LoS 5 + LoS 6 = 1+4+3+4+1+2=15. Therefore, overall LoS= 2.

The City has public transport system which may need considerable improvements in terms of supply of buses/ coaches and coverage as many parts of the city are not served by it. The frequency of the services available may need improvements. The system provided is comfortable.

5.4.2 Pedestrian infrastructure facilities

1. Signalized intersection delay (%)
2. Street Lighting (Lux)
3. % of city covered by footpaths

Signalized Intersection Delay (%):

Los 1	Signalized intersection delay (%)
1	**< 25**
2	**25 – 50**
3	**50 – 75**
4	**>= 75**

A = Total Number of signalized intersections in the city = 7

B = No of intersections having average waiting time of pedestrian more than 45 seconds = 7

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

Signalized intersections delay (%) = (B/A) =100%

Therefore LoS**1** =**4**

Street Lighting (%)

Los 2	Street Lighting (Lux)
1	>= 8
2	6 - 8
3	4 - 6
4	< 4

Average Lux value in the study area is 23 luminous.

It is estimated that the LoS 2 for the study area is **1**

Percentage of City Covered by footpaths:

Los 3	% of city covered
1	>= 75
2	50 - 75
3	25 - 50
4	< 25

Almost 36% of surveyed network has paved footpaths. Some of the roads have footpaths on the both sides but the width is less than 1.2 m. Almost 8.8 running km of roads have footpaths on both the sides with more than 1.2m width.

A = Total length of road network in the city and multiplied by 2 = 224.8 km

B = Total length of the footpath having minimum width of 1.2 m and available on both sides =62.8 in Kilometers.

Percentage of Solapur covered = (B/A)*100 = 28%

Therefore LoS 3 = **3**

Overall Level of Service of Pedestrian Infrastructure Facilities:

Table 5-2: Reference Table for Computing Overall Level of Pedestrian Infrastructure Facilities

Overall Level of Service of Pedestrian Infrastructure Facilities City wide		
Calculated LoS = (LoS_1 + LoS_2 + LoS_3) and identify overall LoS as mentioned below		
Overall LoS	**Calculated LoS**	**Comments**
1	**3 – 5**	The City has adequate barrier free pedestrian facilities along overall road network.
2	**6 - 8**	The City has pedestrian facilities which may need some improvements in terms of improvements in intersections, footpaths, and street lighting as some parts of the city are not served by it. The footpath available needs improvements. The system provided is otherwise comfortable and sustainable
3	**9-10**	The City has pedestrian facilities which may need considerable improvements. The pedestrian facilities at intersections, availability of footpath etc needs improvements as also many parts of the city are not served by it.
4	**11 - 12**	The city lacks adequate pedestrian facilities

The overall LoS of Pedestrian Infrastructure Facilities is obtained by summing up the LoS of individual parameters.

Overall Level of Service of pedestrian infrastructure facilities study area wide = LoS 1+ LoS 2 + LoS 3 = 4+1+3 = 8, therefore, overall Los = 2.

The City has pedestrian facilities which may need some improvements in terms of improvements in intersections, footpaths, and street lighting as some parts of the city are not served by it. The footpath available needs improvements. The system provided is otherwise comfortable and sustainable.

5.4.3 Non-Motorized Transport (NMT) Facilities

1. % of network covered
2. Encroachment on NMT roads by vehicle parking (%)
3. NMT parking facilities at interchanges (%)

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

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

LoS	% of network covered	Encroachment on NMV roads by vehicle parking (%)	NMT parking facilities at Interchanges (%)
1	>= 50	<= 10	>= 75
2	50 - 25	10 - 20	50 – 75
3	25 - 15	20 - 30	25 – 50
4	< 15	>30	< 25

The overall level of NMT facilities:

Table 5-3: Reference Table for Computing Overall Level of NMT Facilities

Overall Level of Service (LoS) of Non Motorized Transport facilities (NMT) City-wide		
Calculated LoS = (LoS_1 + LoS_2 + LoS_3) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	3-5	The City has adequate NMT facilities along overall road network.
2	6 – 8	The City has NMT facilities which may need some improvements in terms of encroachments, parking facilities at interchanges etc as some parts of the city are not served by it. The system provided is otherwise comfortable and sustainable
3	9-10	The City has NMT facilities which may need considerable improvements as many parts of the city are not served by it.
4	11 – 12	The city lacks adequate NMT facilities

Overall Level of Service of NMT facilities study area wide = LoS 1+ LoS 2 + LoS 3 = 4+4+4=12.

There is no designated NMT facility available which can take care of safety and comfort issues for NMT modes in Solapur. Leading towards the sustainable development of the city, it is very essential to consider NMT strategies with higher consideration with priority.

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

1. Availability of Traffic Surveillance (%)
2. Passenger Information System (%)
3. Global Positioning System (GPS)/ General Pocket Radio Service (GPRS) (%)
4. Signal Synchronization (%)
5. Integrated ticketing System (%)

Availability of Traffic Surveillance (%):

Los 1	Availability of Traffic Surveillance (%)
1	>= 75
2	50 - 75
3	25 - 50
4	< 25

A = Total no of bus stations on BRTS, major bus stops, terminals, metro stations and signalized intersection having CCTVs = 0

B = 13 Total no of bus stations on BRTS, major bus stops, terminals, metro stations and signalized intersections = (in No) (important Bus stands, major Railway stations, signalized intersections)

Availability of traffic surveillance (%) = (A/B)*100 = 0%. Therefore LoS**1** = **4**

Passenger Information System (%):

Los 2	Passenger Information System (PIS)
1	>= 75
2	50 - 75
3	25 - 50
4	< 25

A = Total no of bus stops, terminals, metro stations having Passenger Information System facility = 0

B = Total no of bus stops, terminals, metro stations =6

Passenger Information System= (A/B)*100 =0

Therefore LoS**2** = **4**

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

Los 3	Global Positioning System / GPRS
1	>= 75
2	50 – 75
3	25 – 50
4	< 25

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

B = Total no of public transport vehicles and IPT = 15544 (in No) (Auto Rickshaws, taxis, Buses, etc)

Global Positioning System = (A/B)*100 = 0%, Therefore LoS**3** = **4**

Signal Synchronization (%):

Los 4	Signal Synchronization (%)
1	>= 75
2	50 - 75
3	25 - 50
4	< 25

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

B = Total number of signalized intersections =7 (in No.)

Signal Synchronization (%) = (A/B)*100 = 0%

Therefore LoS**4** = **4**

Integrated Ticketing System (%):

Los 5	Integrated Ticketing system (%)
1	>= 75
2	50 - 75
3	25 - 50
4	< 25

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

The overall level of ITS service:

Table 5-4: Reference Table for Computing Overall Level of ITS Facilities

Overall Level of Service (LoS) of usage of Intelligent Transport System (ITS) City-wide		
The calculated LoS = ($LoS_1 + LoS_2 + LoS_3 + LoS_4 + LoS_5$) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	**5 - 7**	The city has adequate ITS facilities
2	**8 - 10**	The city has ITS facilities which may need some improvements in terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as some parts of the city are nor served by it.
3	**11 - 15**	The city has bare minimum ITS facilities and may need considerable improvements terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as many parts of the city are nor served by it.
4	**16 - 20**	The city lacks adequate ITS facilities

Level of Service of ITS facilities study area wide = LoS 1+ LoS 2 +LoS 3 +LoS 4 +LoS 5 = 4+4+4+4+4= 20 Overall Los is therefore, **4**

The study area lacks adequate ITS facilities.

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

1. Average travel speed of personal vehicles (Kmph)
2. Average travel speed of public transport (Kmph)

Average travel speed of personal vehicles (Kmph):

Los 1	Average travel Speed of personal vehicles (Kmph)
1	>=30
2	25 - 30
3	15 - 25
4	<15

A = Delineate the key corridors of the road traffic (personal vehicle) in the study area

B = Compute average speed on the key corridors

From the speed and delay survey for private vehicles, the average journey speed for major corridors for the private vehicles = 28Kmph

C= Level of service for personal vehicle along each corridor.

D = Weight of each corridor based on volume of personal traffic

Weight age of the nth corridor (Wn) = Length for nth corridor / Total length

Based on the above formula, the weight ages of all the corridors as share of total length have been calculated for both the directions.

City-wide Level of Service for travel speed of motorized vehicles = (W1*LoS corridor1) + (W2 * LoS corridor 2) + (W3 * LoS Corridor 3) +….(Wn * LoS corridor n) = 1.89 = 2 (Rounded off to the next whole number). Therefore LoS 1 = **2**

Average travel speed of Public Transport vehicles (Kmph):

Los 2	Average travel Speed of Public Transport vehicles (Kmph)
1	>=20
2	15 – 20
3	10 – 15
4	<10

This indicator is computed based on the existing city buses in the study area.

A = Delineate the key corridors of the road traffic (Public transport) in the study area.

B = Compute average speed on the key corridors

C= Level of service for personal vehicle along each corridor.

D = Weights of each corridor based on volume of personal traffic

From the speed and delay survey for public transport, the average journey speed on major corridors for the public transport =19Kmph

The percentage of LoS on corridors based on its travel speed in public transport vehicles for the study area is given in the table below.

Level of Service with	Percentage (Public Transport vehicles) of LoS on Corridors
1 (>=20 Kmph)	26%
2 (15 – 20 Kmph)	74%
3 (10 -15 Kmph)	0%
4 (<10 Kmph)	0%

Around 74 % of the corridors in the city have a journey speeds between 15 to 20 kmph.

Based on the above said formula, the weightages of all the corridors as share of total length is calculated for both the directions.

Study area-wide Level of Service of motorized vehicles = (W1*LoS corridor1) + (W2 * LoS corridor 2) + (W3 * LoS Corridor 3) +….(Wn * LoS corridor n) = 1.73 = 2 (Rounded off to the next whole number). Therefore LoS 2 = **2**

Overall Level of Service of travel Speed along Major Corridors:

Table 5-5: Reference Table for Computing Overall Level of Travel Speed

Overall Level of Service of Travel Speed along major corridors City wide		
Calculated LoS = (LoS_1 + LoS_2) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	2	Primarily free flow- movement at average travel speeds usually about 70% of the free flow speed for the key corridors.
2	3 -4	Small increase in traffic causing substantial increase in approach delay and hence, decrease in arterial speed.
3	5 -6	Significant approach delays and average travel speed of 1/3 the free flow speed or lower. Such conditions causinga combination of one or more reasons such as high signal density, extensive queuing at critical intersections and inappropriate signal timing.
4	7 -8	Key corridors at extremely low speeds below 1/3 to 1/4 of the free flow speed. Intersection congestion is likely at critical signalized locations, with high approach delays.

Overall Level of Service of Travel Speed facilities study area wide = LoS 1+ LoS =2+2 =4

As the calculated LoS is 4, the overall LoS can be rated as **2**

Small increase in traffic causing substantial increase in approach delays and hence, decrease in arterial speed.

5.4.6 Availability of parking spaces

1. Availability of On-street paid public parking spaces (%)
2. Ratio of maximum and minimum parking fee in the city

LoS	Availability of on street public parking spaces (%)	Ratio of Maximum and Minimum parking Fee in the City
1	>= 75	>4
2	50 – 75	2 – 4
3	25 – 50	1 – 2
4	< 25	1

Availability of On-street paid public parking spaces (%):

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

Ratio of maximum and minimum parking fee in the study area:

The ratio of maximum and minimum parking fee is 1 for the study area. Therefore LoS 2 = **4**.

The Overall LoS for availability of parking spaces:

Table 5-6: Reference Table for Computing Overall Level of Parking Space

Overall Level of Service (LoS) for Availability of Parking Space City-wide		
Calculated LoS = (LoS_1 + LoS_2) and identify overall LoS as mentioned below.		
Overall LoS	Calculated LoS	Comments
1	2	Paid parking spaces are available in the city and the demand is well managed by incorporating differential parking rates for the CBD.
2	3 - 4	Paid parking spaces are available in the city and the demand is well managed by incorporating differential parking rates for the CBD. However some improvements may be required
3	5 - 6	Paid parking spaces provided in the city need to be improved upon and to cater to the demand some differential parking rates for the CBD have been adopted. The city authorities need to imitative considerable improvements measures.
4	7 - 8	The city authorities need to initiate immediate actions with respect to providing paid parking spaces and demand management for parking.

The overall Level of Service of Parking Facilities in study area = LoS 1+ LoS 2 = 4+ 4 = 8, therefore, overall Los = **4**

The study area authorities need to initiate immediate actions with respect of providing paid parking spaces and demand management for parking.

5.4.7 Road safety

1. Fatality rate per lakh population
2. Fatality rate for pedestrian and NMT (%)

Fatality Rate per Lakh of Population (%):

Los 1	Fatality rate Per Lakh of Population
1	<=2 persons
2	2 – 4 persons
3	4 – 6 persons
4	>6 persons

Accident Data for the entire study area was collected from Traffic police, Calculation was done based on 2011 data and the corresponding year population.

A = Total number of fatalities recorded in road accidents within study area limits in the given calendar year = 87 (in nos.)

B = Population of the study area urban limits in 2011 year – 9,51,558

Fatality rate per 100000 Population (ratio)

= (A * 100000)/B = 9

Approximately 9 persons, Therefore LoS 1 = **4**

Fatality Rate for Pedestrian and NMT:

LoS 2	Fatality rate Per Lakh of Population
1	<=20
2	20 - 40
3	40 - 60
4	>60

A = Total number of fatalities recorded of persons who were pedestrians /cyclists in road accidents for the year 2011 = 10 (in nos.)

B = Total number of fatalities recorded in road accidents within study area limits for the year 2011 = 87 (in nos.)

Fatality rate for pedestrian and NMT (%) = (A/B)*100

= 11%, Therefore LoS 2 = **1**

Overall Level of Service of Road Safety:

The overall LOS of Availability of safety is obtained by summing up the LOS of individual parameters.

Table 5-7: Reference Table for Computing Overall Level of Road Safety

Overall Level of Service (LoS) for Road Safety City-wide		
Calculated LoS = (LoS_1 + LoS_2) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	2	Level of Fatality rate in a city is very low.
2	3 - 4	Need some improvements in road design and available road infrastructure, traffic management and in other such reasons which significantly contribute to road safety.
3	5 - 6	Need considerable improvements in road design and available road infrastructure, traffic management and in other such reasons which significantly contribute to road safety.
4	7 - 8	Level of Fatality rate in a city is very high.

Overall Level of Service of Public Transport facilities study area wide = LoS 1+ LoS 2= 4+1 = 5, Overall LoS = **3**.

Need considerable improvements in road design and available road infrastructure, traffic management and other such reasons which contribute significantly to road safety.

5.4.8 Pollution levels

The indicator indicates the level of air pollutants in the study area i.e., average level of pollution in urban areas. The indicator to calculate the pollution level is Annual Mean Concentration Range.

The pollution data that needs to be collected includes:

1. Sulphur Dioxide (SO2)
2. Oxides of Nitrogen
3. Suspended Particle matter (SPM)
4. RSPM (Size less than 10 microns)

The level of service for the pollutants is divided into four categories i.e., low, moderate, high and critical. The level of service for each of the above parameters is determined using the table below as recommended by MoUD.

Level of Service	1.SO2	2. Oxides of Nitrogen	3. SPM	4. RSPM (size less than 10 microns)
1 (Low)	0-40	0-40	0-180	0-40
2 (Moderate)	40-80	40-80	180-360	40-80
3 (High)	80-120	80-120	360-540	80-120
4 (Critical)	>120	>120	>540	>120

For study area, the pollution levels data is available for the year 2013-14 and is as shown below.

Name of city	1.SO2	2. Oxides of Nitrogen	3. SPM	4. RSPM (size less than 10 microns)
Study Area	16	37	172	172

Overall level of service of pollution levels:

The overall LoS of availability of pollution levels is obtained by summing up the LoS of individual parameters.

Table 5-8: Reference Table for Computing Overall Pollution Level

Overall Level of Service (LoS) for Pollution level City-wide		
Calculated LoS = (LoS_1 + LoS_2 + LoS_3 + LoS_4) and identify overall LoS as mentioned below		
Overall LoS	Calculated LoS	Comments
1	< = 5	Level of pollution in a city is very low.
2	6 - 9	Need some improvements in emission standards, checking pollution etc.
3	10 - 13	Need considerable improvements in emission standards, checking pollution etc.
4	14 - 16	Level of pollution in a city is very high.

Overall level of service of pollution study area wide = LoS 1+ LoS 2+ LoS 3 + LoS 4 = 1+1+1+4=7. Therefore, Overall LoS is **2**.

Need some improvement in emission standards, checking pollution etc.

5.4.9 Integrated land use transport system

1. Financial Population Density – Gross (Persons/Developed area in hectare)
2. Mixed Land-use on Major Transit Corridors / Network (% area under non residential use)
3. Intensity of Development – City wide (FSI)
4. Intensity of development along transit corridor (FSI transit corridor/FSI)
5. Clear Pattern and Completeness of the network
6. % of area under Roads
7. %age network having exclusive ROW for Transit network

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

Los 1	Population density / Gross
1	>= 175
2	150 – 175
3	125 – 150
4	< 125

A = Developed area (in Hectare) computed from Draft Development Plan = 11509 hectares

B = Population of the year for which data is available =11,14,380

Population density (No.) = B/A = 97

Therefore LoS**1** = **4**

Mixed Land Use Zoning (Proportion of non-residential area):

Los 2	Mixed Land Use Zoning
1	>= 30
2	15 – 30
3	5 – 15

Los 2	Mixed Land Use Zoning
4	<5

For this study area, the mixed land use proposed by draft developed plan for Solapur municipal corporation area is around 64%. Thus the level of service for the inventory of land use along major transit corridors is 1.

Therefore LoS**2** = **1**

Intensity of Development Citywide – FSI:

Los 3	Intensity of development citywide FSI
1	>= 2
2	1.5 – 2.0
3	1.0 – 1.5
4	<1

As per the Development plan Floor Space Index (FSI) as applicable to the developed area lies in the range 0-1.5.

Normally, FSI varies due to plot size, ground coverage and road width.

In the study area, Floor Space Index is between 0-1.5. Therefore LoS**3** =**2**

Intensity of Development Citywide along transit corridor – FSI:

Los 4	Intensity of development along transit corridor
1	>= 2
2	1.5 – 2.0
3	1.0 – 1.5
4	<1

A = Floor Space Index (Applicable to most part of the study area) is 1.5.

B = FSI for the proposed transit corridor is 1.5.

Intensity of development along transit corridor = B/A= 1, Therefore LoS**4** = **3**

Clear pattern and completeness of network:

Los 5	Clear pattern and completeness of network
1	Clear pattern (ring radial or grid iron)and complete network
2	Somewhat clear pattern (ring radial or grid iron) but somewhat in complete network
3	Somewhat un clear pattern and in complete network
4	No clear pattern incomplete / sparse network

The entire network in study area is growing in somewhat clear pattern in all the four directions. Hence LoS 5 = **2**

% of area under roads (%):

Los 6	% of area under roads
1	>=15
2	12 – 15
3	10 – 12
4	< 10

As per zonal development plan, the average area under transport for study area is around 5.8%. Therefore LoS**6** = **4**

% network with exclusive ROW for transit (For >1 million as per 2001 census):

Los 7	% network having exclusive ROW for transit network
1	>=30
2	20-30
3	20-10
4	< 10

A = total Length of roads (Arterial and sub arterial) having ROW 9m and above plus total length of urban rail network = 110.4 km.

B=Total length of road having exclusive BRT/Metro/LRT/Monorail = 0kms

% network with exclusive ROW for transit = B/A*100 = 0%, Therefore LoS 7 = **4**

Overall level of service of Integrated Land use System:

Table 5-9: Reference Table for Computing Overall Level Integration for Land Use and Transport System

Overall Level of Service (LoS) for Integrated Land Use Transport system City-wide			
For > =1 million population: Calculated LoS = ($LoS_1 + LoS_2 + LoS_3 + LoS_4 + LoS_5 + LoS_6 + LoS_7$) and identify overall LoS as mentioned below			
For < 1 million population: Calculated LoS = ($LoS_1 + LoS_2 + LoS_3 + LoS_4 + LoS_5 + LoS_6$) and identify overall LoS as mentioned below			
Overall LoS	**Calculated LoS**		**Comments**
	>= 1 million population	**< 1 million population**	
1	**<=8**	**<= 9**	City structure is appropriately planned in a manner which patronizes public transport.
2	**8 -15**	**9 - 14**	City structure is some what in coherence with the public transport system
3	**15 - 22**	**14 - 20**	Faint coherence between city structure and public transport system
4	**22- 28**	**20 - 24**	Inconsistency in the city structure and public transport system leading to lesser ridership and high dependence on personalized motor vehicles

For a population of almost > 1 million, overall Level of Service of Integrated Land use system= LoS 1+ LoS 2 + LoS 3 + LoS 4 + LoS 5 + LoS 6 + LoS 7= 4+1+2+3+2+4+4 = 16. Overall LoS is **3**.

Faint coherence between study area structure and public transport system.

5.4.10 Financial Sustainability

This benchmark indicates the financial sustainability of public transport by bus. As mentioned earlier, this information has been collected from APSRTC the bus operators in Vijayawada. The overall level of service for this benchmark is based on the level of service for the following indicators:

1. Extent of Non-fare Revenue
2. Staff / bus ratio
3. Operating Ratio

It is observed that there hasn't been slight change in the LoS of the financial sustainability parameter in the city.

Extent of Non-Fare Revenue

The calculation of Extent of Non-Fare Revenue is shown:

S.No.	Calculation	Unit	Description	Data Source	Value (Rs.)
a.	Revenue collections per annum from non-fare related sources	INR		Bus DPR	5,62,50,000
b.	Total revenue per annum from all sources	INR	This should be the aggregate of revenue sources from all service providers engaged in public transport services, as defined above. This will include both government and private service providers.	Bus DPR	18,57,50,000
c.	Extent of non-fare revenue	%	Calculate = [a/ b] * 100.		3.3

The indicator's LoS ranges are given in table.

LoS range for financial sustainability

LOS	Extent of Non-fare Revenue
1	>= 40
2	20 – 40
3	10 – 20
4	< 10

Based on the above, the corresponding LoS value for the indicator 'Extent of Non-Fare Revenue' is 4, this also shows that Solapur Municipal Transport will have to take steps to increase the non-fare box revenue.

Staff per Bus Ratio

The calculation of Staff per Bus Ratio is shown:

S.No.	Calculation	Unit	Description	Data Source	Value
a.	The total staff of bus operation and maintenance	INR	Total staff includes number of drivers, conductors and supporting staff / officials for operations and maintenance	Bus DPR	720
b.	The total number of Buses	INR	Calculate the total number of buses in a city (only public operator).	Bus DPR	73
c.	Staff per bus ratio	Ratio	Calculate = [a / b]		9.9

The indicator's LoS ranges are given:

LoS range for staff per bus ratio

LOS	Staff per Bus Ratio
1	<=5.5
2	5.5 – 8.0
3	8.0 – 10.0
4	> 10

The LoS value for the staff to bus ratio is 3.

Operating Ratio

The calculation of Operating Ratio is shown:

S.no	Calculation	Unit	Description	Data Source	Value (lakh/bus)
a.	Calculate cost / bus	INR	Cost includes Depreciation cost, Operation & Maintenance Cost, Manpower cost etc	Bus DPR	31.85
b.	Calculate earning/ bus	INR	Total revenue generated from all sources such as Fare revenue and non-fare revenue	Bus DPR	25

S.no	Calculation	Unit	Description	Data Source	Value (lakh/bus)
c.	Operating Ratio	Ratio	Calculate = [a / b]		**1.3**

The indicator's LoS ranges are given in table below.

LoS range for operation ratio

LOS	Operating Ratio
1	<=0.7
2	0.7 – 1
3	1 – 1.5
4	> 1.5

The LoS value for the indicator 'Operating Ratio' is 3. This indicates that SMT authorities should explore alternative revenue sources to reduce the financial losses.

Level of Service for Financial Sustainability

Financial sustainability of public transport

Level of Service (LoS)	1. Extent of non-fare revenue	2. Staff per Bus ratio	3. Operating Ratio
1	> = 40	< = 5.5	<= 0.7
2	20 – 40	5.5 - 8.0	0.7 - 1
3	10 – 20	8 – 10	1 - 1.5
4	< 10	< 10	> 1.5
Indicator LoS	**4**	**3**	**3**

Based on the above indicators, the overall score of the Benchmark for **Solapur comes to 10**. The Benchmark's LoS ranges are given in table.

Overall LoS for financial sustainability for PT

Overall LOS	Sum of LoS of Indicators
1	< = 4
2	5 – 7
3	8 – 9
4	10 – 12

The overall score for "Financial Sustainability" is 10. This indicates that the financial sustainability of public transport shall need considerable improvements.

The public transport of the city is not financially sustainable.

5.4.11 Summary Table

Summary table of Overall LoS and calculated LoS for Solapur is presented in Table 5-10.

Table 5-10: Overall LoS Calculated for Solapur

S. No	Bench mark	Overall LoS	LOS calculated	Inference as per MOUD Guidelines
1	Public Transport Facilities	2	13	The City has public transport system which may need considerable improvements in terms of supply of buses/ coaches and coverage as many parts of the city are not served by it. The frequency of the services available may need improvements. The system provided is comfortable.
2	Pedestrian infrastructure facilities	2	8	The City has pedestrian facilities which may need some improvements in terms of improvements in intersections, footpaths, and street lighting as some parts of the city are not served by it. The footpath available needs improvements. The system provided is otherwise comfortable and sustainable.
3	Non-motorised Transport Facilities	4	12	There is no designated NMT facility available which can take care of safety and comfort issues for NMT modes in Solapur. Leading towards the sustainable development of the city, it is very essential to consider NMT strategies with higher consideration with priority.
4	Level of usage of Intelligent Transport System(ITS) Facilities	4	20	The study area lacks adequate ITS facilities.
5	Travel speed (Motorized and Mass transit)	2	4	Small increase in traffic causing substantial increase in approach delays and hence, decreases in arterial speed.
6	Availability of Parking places	4	8	The study area authorities need to initiate immediate actions with

S. No	Bench mark	Overall LoS	LOS calculated	Inference as per MOUD Guidelines
				respect of providing paid parking spaces and demand management for parking.
7	Road safety	3	5	Need considerable improvements in road design and available road infrastructure, traffic management and other such reasons which contribute significantly to road safety.
8	Pollution levels	2	7	Need some improvement in emission standards, checking pollution etc.
9	Integrated land use Transport system	3	16	Faint coherence between study area structure and public transport system.
10	Financial Sustainability of the Municipal Corporation	4	10	The public transport of a city is not financially sustainable

6. Travel Demand Modelling and Forecast

The current chapter discusses the development of base year travel demand model, its validation. Based on Calibrated base year models, horizon year models are developed to forecast traffic for various scenarios. CUBE Voyager Software has been used for development of travel demand model. CUBE Voyager is the state of the art Transportation Planning software. It is designed to be integrated modelling system for transportation planning applications.

6.1 Pre-Modelling Analysis

6.1.1 Study Area and its Delineation

The study area comprises of Solapur Municipal Corporation Area (SMC) with an area of 178.57 sq.km. It has been subdivided into smaller physical units, termed as Traffic Analysis Zones (TAZs) to facilitate analysis of travel demand. Consultants have chosen current demarcated wards as zones for which demographic, socio-economic and other planning data is readily available from secondary sources. Zoning system adopted for the current study is presented in Figure 6-1. Details of zoning are provided in Annexure 6-1.

6.1.2 Internal Zones

The Solapur Municipal Corporation (SMC) Area is divided into 51 wards as per prevailing demarcation of wards. These wards are taken as internal zones.

6.1.3 External Zones

Regions beyond the SMC have been delineated into external zones based on the catchment of the existing transport links feeding into the study area. A total of 7 external zones are considered representing the world outside the study area. In summary, the study area is divided into total 58 zones as given below:

Table 6-1: Study Area Zoning

S. No.	Zones	Details
Internal Zones		
1	1 - 51	Solapur Municipal Corporation Wards
External Zones (Outer Cordons)		

S. No.	Zones	Details
2	52	Solapur-Hyderabad Road (NH-9)
3	53	Solapur-Akkalkot Road (SH-151)
4	54	Solapur-Mangalore Road (NH-13)
5	55	Solapur-Mangalwedha Road
6	56	Solapur-Pune Road (NH-9)
7	57	Solapur-Barshi Road (To SH-151)
8	58	Solapur-Tuljapur Road (NH-204)

6.1.4 Plan Period

Year 2015 is considered as Base Year. As per Terms of Reference (TOR) travel demand forecasts is to be prepared upto 2035. Therefore for the purpose of sequential planning and design of the systems, these travel demand forecasts are presented at ten-year intervals i.e., for the years 2026 and 2035.

6.1.5 Preparation of Data Base

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

1. Planning variables

2. Transport network

3. Travel Demand and Characteristics

The base year data is summarized in the following sections.

6.1.5.1 Planning Variables

Planning variables i.e. population and employment are some of the important data required for estimating the travel demand generated at zonal level. Base year demographic data is obtained from the Census and SMC database. Zonewise employment is collated from various published reports. Compilation of zone-wise planning variables and forecast is discussed in detail in Chapter 2.

6.1.5.2 Transport Network

The transport network in the study area includes road network, public transport network. Figure 6-1 shows the base year transport network in the study area. All the characteristics of the road links are collected by network inventory and, speed and delay surveys. Link characteristics collected include length, carriageway type (divided/ undivided), type of

operation (one-way/ two-way), number of lanes, average speed, capacity etc. Table 6-2 shows different types of road links in the study area and their characteristics.

Table 6-2: Link Details of Base Year Transport Network

S. No	Area	Number
1.	Links	3766
2.	Nodes	2188
3.	Centroids	58
4.	Traffic Analysis Zones	58

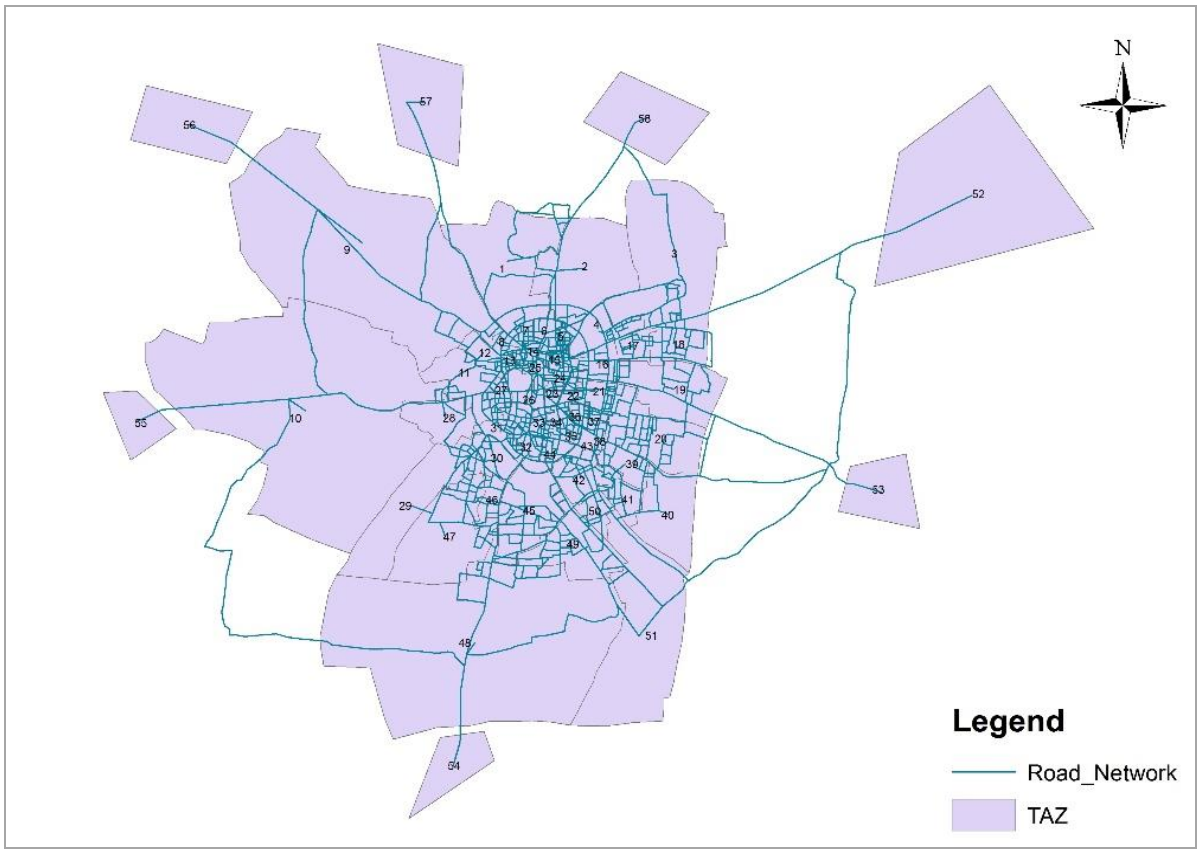


Figure 6-1: Study Area Zoning and Base Year Road Network (2015)

Public Transport Network includes all roads on which public transport buses operate. Details of bus routes, frequencies, seating capacities, maximum load factor, fares have been collected and coded. In addition, in this study, Auto rickshaw is considered as an intermediate public transport and is made available on the road links. The road network is properly connected to all zone centroids by means of dummy links. **The base year transport network has about 3766 road links and 38 bus lines (routes).**

6.1.6 Travel Demand and Characteristics

Various traffic surveys are conducted to assess the base year traffic and travel characteristics in the study area. Home Interview Survey is conducted to obtain the socioeconomic and travel characteristics of resident population. Outer cordon O-D and Public Transport terminal surveys are conducted to assess the intercity travel demand and its characteristics. Details of Field surveys and analysis are presented in chapter 4.

6.1.7 Generation of O-D Person-Trip Matrices

Using the zonal expansion factors, O-D trip matrices have been generated for the intra-city and inter-city trips by mode using the data source as presented in Table 6-3.

Table 6-3: Data Sources for Generation of O-D Person Trip Matrices

Intra/Intercity Trips	Category	Data Source
Intra-city Trips	Home based trips	HIS
	Non-home based trips	HIS (Supplemented by O-D surveys at terminals)
Inter-city Trips	Internal – External	Outer Cordon O-D surveys (Supplemented by HIS and O-D surveys at Terminals)
	External – Internal	Outer Cordon O-D surveys (Supplemented by HIS and O-D surveys at Terminals)
	External – External	Outer Cordon O-D surveys

Table 6-4 summarizes the trips obtained from the above listed sources. The procedure adopted to obtain validated O-D matrices is shown by a flow chart in Figure 6-2.

Table 6-4: Summary of Base Year Trips

Vehicle	I-I	I-E	E-I	E-E	Total	I-I	I-E	E-I	E-E	Total
Car	51738	13097	12850	7902	85586	60%	15%	15%	9%	100%
2W	270820	72653	74745	36937	455155	60%	16%	16%	8%	100%
Public Bus	116722	41421	38426	26846	223415	52%	19%	17%	12%	100%
Auto	102919	12101	14402	4702	134124	77%	9%	11%	4%	100%
Total	542198	139272	140424	76387	898281	60%	16%	16%	9%	100%

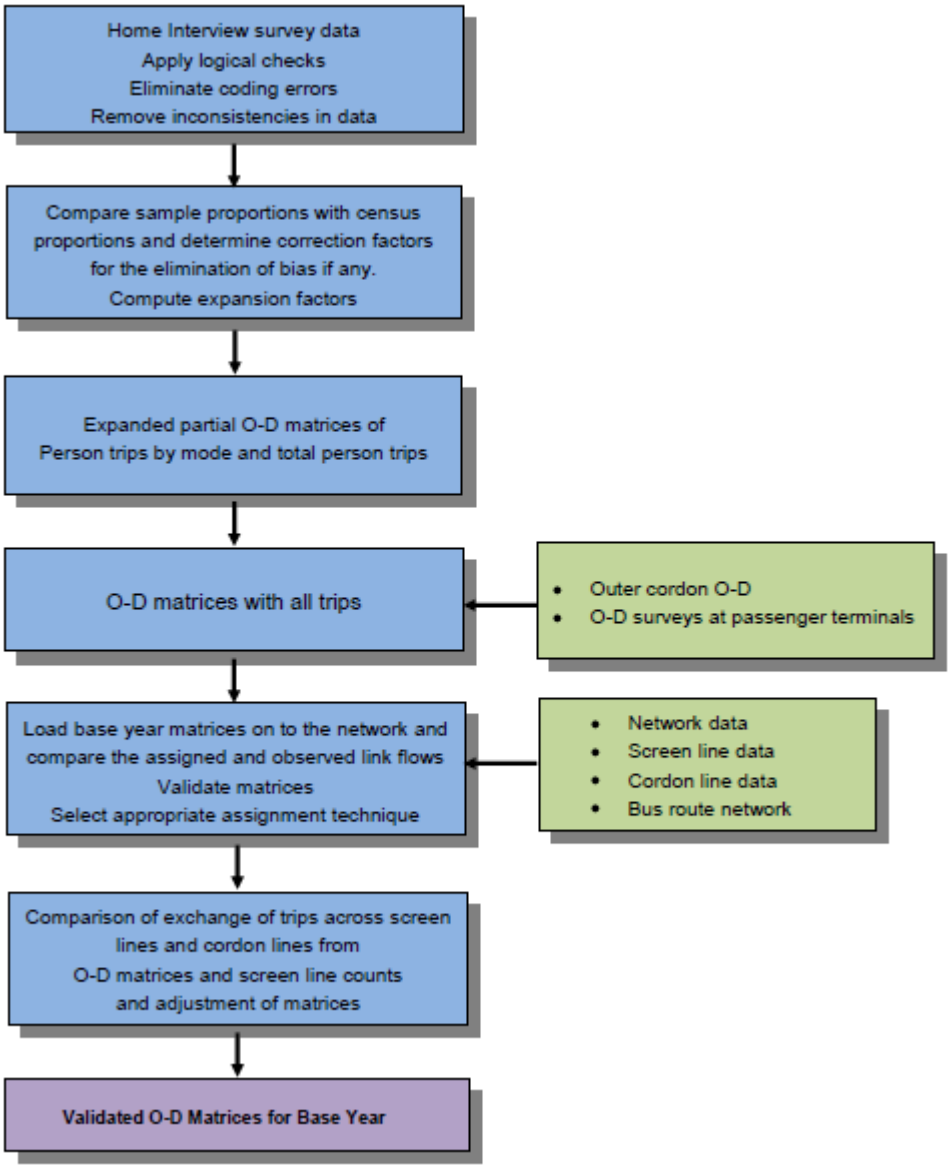


Figure 6-2: Procedures for Estimation of Base Year Matrices

Mode wise person trip matrices are prepared from the data sources mentioned. Following OD matrices are prepared:

- Mode wise (Walk, Bicycle, Two-wheeler, Car, IPT, Bus and Train) O-D matrices for Intra-city trips made by residents.
- Mode-wise (Two-wheeler, Car, IPT, Bus and Train) O-D matrices for intercity trips (i.e. IE, E-I and E-E) by residents and non-residents.

Desire line diagram of Base Year Trips (in person trips excluding cycle and walk trips) is prepared and presented in Figure 6-3.

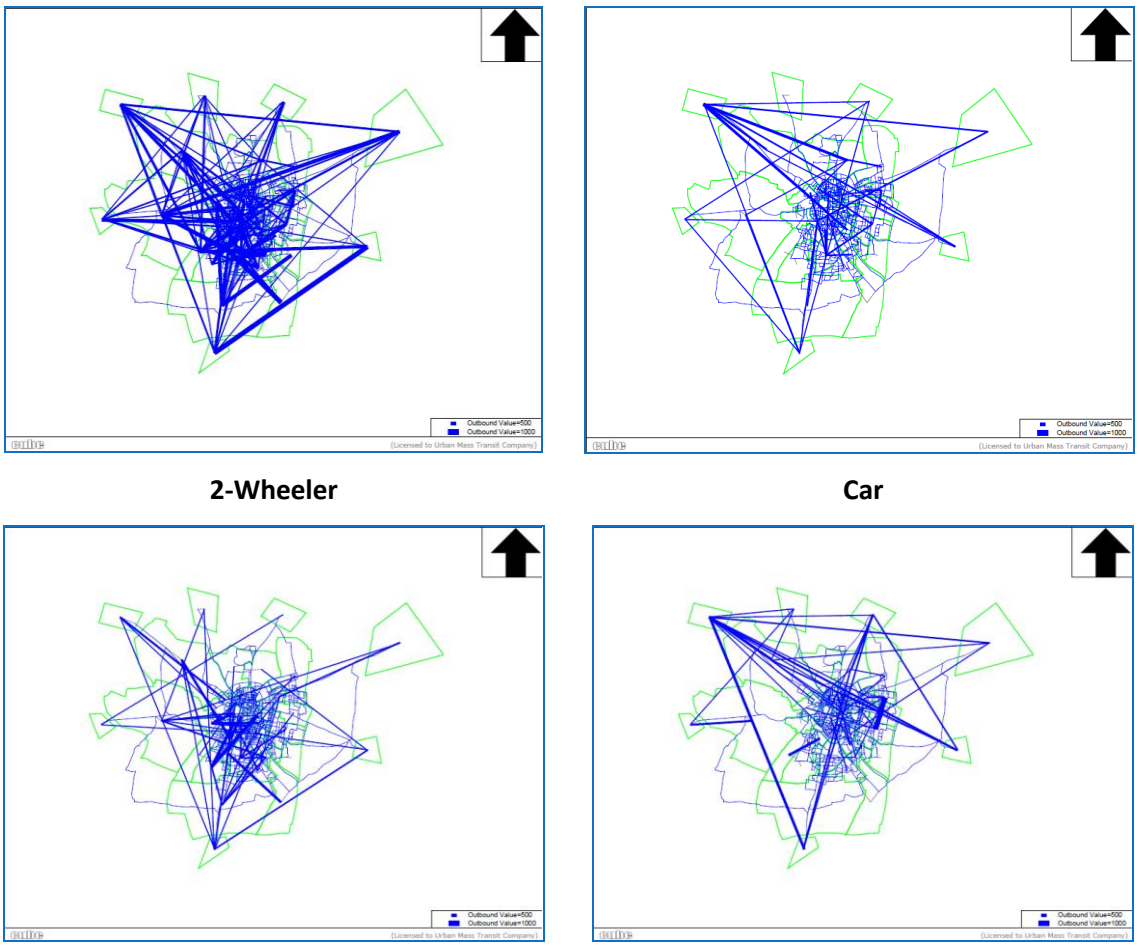


Figure 6-3: Desire line Diagram for Base Year Trips

6.2 Base Year Travel Demand Modelling

The base year travel pattern has been modelled as accurately as possible, and the calibrated models along with the horizon year planning variables and network information is used to forecast the trips for various horizon years. Traditional four-stage model using the CUBE Voyager Software package has been used for travel demand modelling. Following subsections give a detailed account of the base year modelling process and the calibration results. Flowchart outlining overall 4-stage modelling process and Development of Base Year Model is given in Figure 6-4 and Figure 6-5.

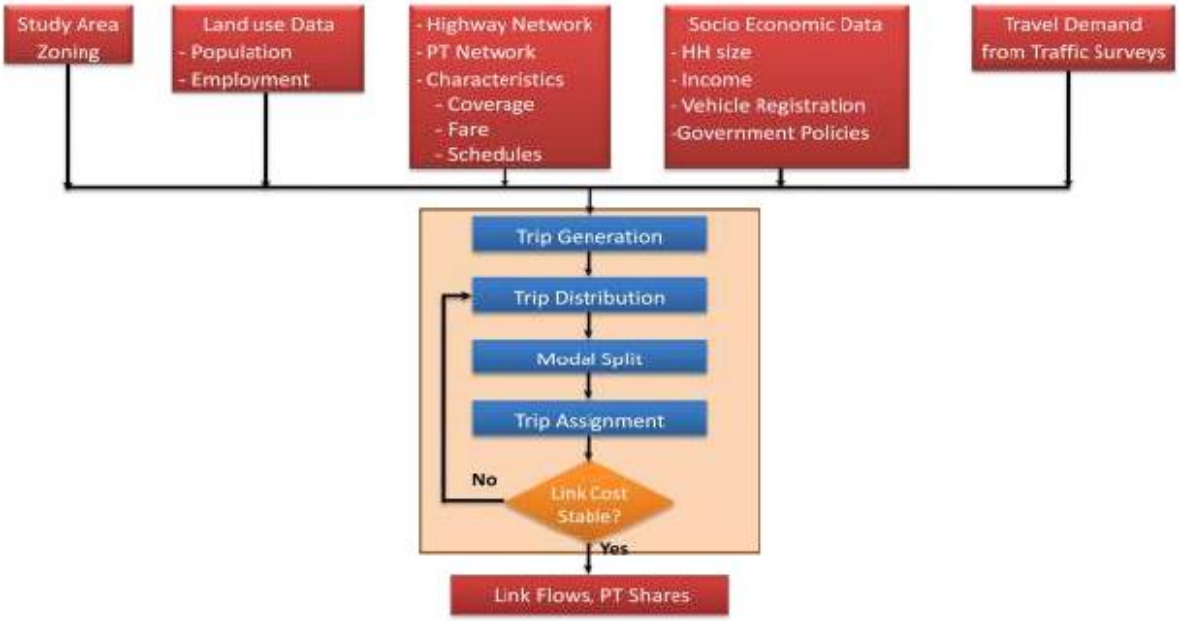


Figure 6-4: Base Year Modelling Process

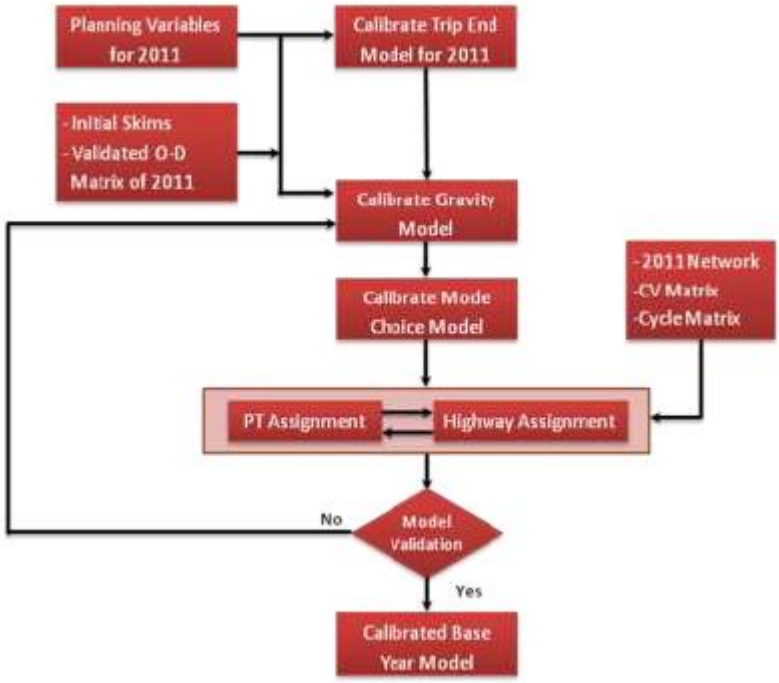


Figure 6-5: Calibration of Base Year Model

6.2.1 Trip End Modelling

Trip end models are developed for the intra-city trips made by the residents of the study area. All the other trips viz., internal to external, external to internal and external to external trips are modelled mode-wise by growth factors. Trip ends of internal trips for the base year (2015) are calculated from the validated O-D matrices. Trip end models are

developed using stepwise multiple linear regression technique. The variables used for the development of linear regression models for the trip ends are Population and Workers. The Trip End models developed for this study is presented in Table 6-5.

Table 6-5: Trip End models – SMC

Trip Type	Productions Model	R 2 value	F test value	T test Value
Trip Productions	0.49*Population	0.7	118	10.85
Trip Attractions	1.25*Workers	0.68	109	10.42

It can be observed that t-values are significant for developed coefficients.

6.2.2 Growth Factors for External Trips

Since past traffic data at the external cordon points are not available, traffic growth rates have been assumed as 6% and 5% respectively upto till 2026 and beyond 2035 for commercial vehicles whereas it is 7.2% and 5.8% respectively for passenger trips.

6.2.3 Trip Distribution Model for Intra-City Trips

A gravity type trip distribution model of the following form is calibrated to represent base year travel pattern for the study area.

Tij =Ai Oi Bj Dj Fij

Fij = aCbije – cCij

'O' Trip Productions; 'D' Trip Attractions

A & B are balancing factors; 'F' Deterrence Function

'C' is the travel distance between zones; 'e' Euler's Number

This gravity model is calibrated on the intra-city trips performed by the residents of the study area using zone to zone shortest distance matrix generated by computer program. Friction Factors were calibrated for obtaining least error between observed and estimated trip lengths. Maximum likelihood method of calibration is used in order to estimate the friction factor. Iterative procedure has been used to calibrate the friction factors for each trip length range. The table below gives the results for calibration of the gravity type trip distribution model.

Table 6-6: Results of Trip Distribution Model Calibration

Trip Distribution	Avg. Trip Length	Error (%)
Estimated Mean Trip Length (Excluding Intra-Zonal)	5.30 km	-12
Observed Mean Trip Length (Excluding Intra-Zonal)	5.95 km**	
**Excluding Cycle and Walk Trips		

Figure 6-6 gives the trip length frequency distributions for the observed trips. As modelled no. of trips increases initially with trip length and then decreased gradually.

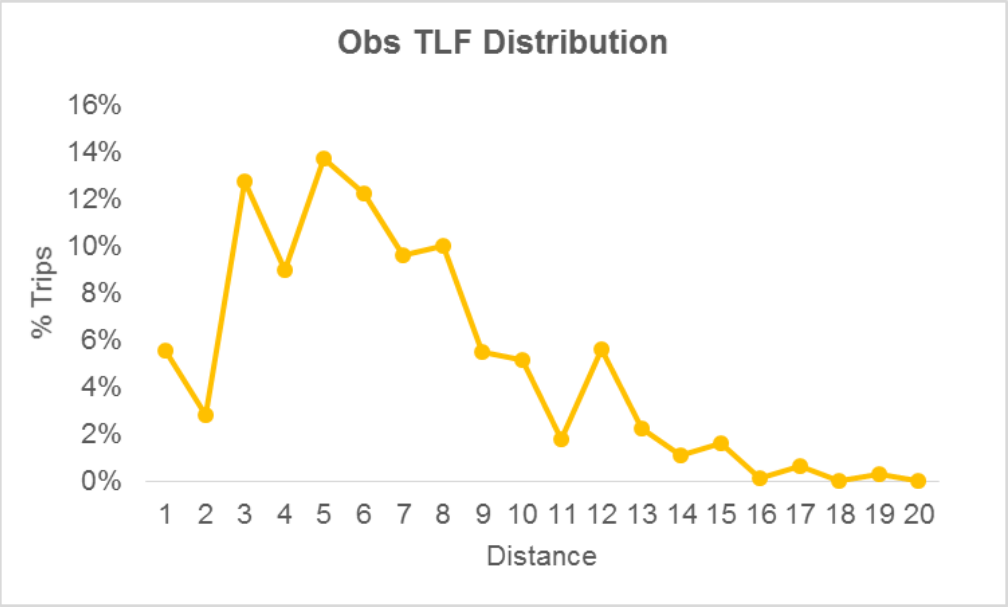


Figure 6-6: Trip Length Distribution Curve

6.2.4 Mode Choice Model for Intra-City Trips

Incremental logit model has been used for Modal split. This model forecasts the change in demand based on change in cost from the known base situation. Initially total trips are split into private trips and public transport trips. Private trips comprises of Car and Two wheeler. Public transport trips comprises of Bus, IPT and Walk trips. In the next step private vehicles and public transport has been split. The procedure adopted is presented below:

The model inputs are base demand by mode (DPvt, DPt), base costs by mode (CPvt, CPt) and forecast costs by mode (C'Pvt, C'Pt). The change in cost is denoted by DCPvt and DCPt where:

$\Delta CPvt = C'Pvt - CPvt$

$\Delta CPt = C'Pt - CPt$

Base probabilities are denoted by PPvt and PPt where:

$$P_{Pvt} = \frac{D_{Pvt}}{D_{Pvt} + D_{Pt}}$$

$$P_{Pt} = \frac{D_{Pt}}{D_{Pvt} + D_{Pt}}$$

The choice model now takes the form of the equation below where P' denotes the forecast choice probability and λ is the scale parameter.

D'Pvt =(D'Pvt + D'Pt) P'Pvt

D'Pt =(D'Pvt + D'Pt) P'Pt

The incremental composite cost (DC) is given by:

$$\Delta C = -\frac{1}{\lambda} \log \left(P_{Pvt} \exp(-\lambda \Delta C_{Pvt}) + P_{Pt} \exp(-\lambda \Delta C_{Pt})\right)$$

6.2.5 Commercial Vehicle (CV) Matrix Estimation

Base year CV matrix has been estimated from link counts. Daily directional volumes of commercial vehicles are available on links within the study area at the external cordon (from the primary traffic surveys). These links are spread all over the study area. Using the Analyst module of Cube, which works on the principle of entropy maximisation, a reasonable estimate of the daily CV matrix is obtained. The total number of commercial vehicles estimated using Analyst program is 42,067 PCUs. The program uses the paths that are built during highway assignment, the observed link volumes of commercial vehicles, seed matrix and the associate confidence levels for the link volumes. During the estimation process the links on which CVs are not allowed are switched off to get a realistic estimation of the CV matrix. It reproduced the observed link volumes when assigned on to the highway network. The future CV matrices are obtained by applying appropriate growth factors and by furnessing.

6.2.6 Assignment of Base year O-D Matrices and Validation

The O-D matrices generated from various data sources are combined appropriately to get the public transport and highway O-D matrices. Public transport O-D matrix contains all person trips made by residents and non-residents by the public transport modes, viz., bus and IPT. Trips made for Intracity travel by rail are few and therefore not assigned. The highway O-D matrix consists of person trips made by residents and non-residents by car/ two-wheeler. Trucks trip matrices (which are not part of either public transport or highway O-D matrices) are preloaded on to the network.

6.2.6.1 Public Transport Assignment

The public transport network consists of all the road links coded with appropriate characteristics like length, speed, etc. The bus routes are defined by specifying the links on which these routes traverse. Each route is characterised by its frequency, capacity, crush load, fares etc. The characteristics of these routes are coded accordingly. In addition access and egress connectors for walk and transfers are built using Public Transport Program. Public transport assignment is done based on generalised time approach. First the network is pre-loaded with the truck peak hour PCU matrix. The daily O-D matrix of public transport passenger trips is assigned on to the preloaded network. The bus passenger link loadings obtained after public transport assignment are transferred on to the road network as peak hour PCU flows by employing appropriate passenger-PCU conversion factors and peak flow to daily flow ratios applicable to bus flows.

6.2.6.2 Assignment of Private Trips

The daily matrices of car and two-wheeler person trips are converted to peak hour O-D matrices in passenger car units (PCU) by applying regional peak hour to daily flow ratios and passenger to PCU conversion factors. Then the network loaded with trucks and PT trips is used for private trips assignment. The car and two-wheeler peak hour PCU matrix is then loaded using incremental capacity restraint procedure.

6.2.6.3 Public Transport and Private Traffic Assignment Iterations

A loop of iterations is carried out between the distribution step and assignment step to iterate the assignment process. The final highway skim costs obtained from the

assignment step is taken back to the distribution stage, then modal split and assignment. Travel time considered for assignment is based on the Bureau of Public Roads formulae:

TC = T0*(1+0.15*(V/C)^4)

Where,

TC - Change in Travel Time

T0 - Initial free flow travel time

V - Volume

C – Capacity

The public transport and highway time/cost skims are worked out based on these final link costs. These cost/time skims are used to update the matrices by applying gravity distribution and mode choice models. The whole process is then repeated till stable link costs are achieved. At this stage the loadings on bus links are taken as final. At this stage the loadings on bus, Autorickshaw links are taken as final. The observed and modelled trips for base year by mode are presented in Table 4-8.

Table 6-7: Observed and Modelled Trips

Vehicle	Observed	Modelled	Error %
Car	51738	56498	9%
2W	270820	296946	10%
Public Bus	116722	110431	-5%
Auto	102919	106105	3%
Total	**542198**	**569980**	**5%**

6.2.7 Calibration and Validation of Base Year Network

Base year network has been calibrated and validated for the observed counts at Screen line locations and cordon locations. It has been observed that the error between the observed and modelled flows at screen lines and cordon locations are within +/- 15% and validation results are presented in Table 6-8. Hence the base year network is validated.

Table 6-8: Validation of Base Year Network

S. No	Code	Name of the Road	TW	CAR	AUTO	BUS
1	OC 1	Mumbai Highway/ Solapur-Hyderabad Road (NH-9)	10	4	12	-3
2	OC 2	Solapur-Akkalkot Road (SH-151)	12	8	9	-11
3	OC 3	Solapur-Mangalore Road (NH-13)	15	11	13	9

S. No	Code	Name of the Road	TW	CAR	AUTO	BUS
4	OC 4	Solapur-Mangalwedha Road	9	-4	7	1
5	OC 5	Solapur-Pune Road (Near Singhad College Road) - (NH-9)	9	-3	6	-13
6	OC 6	Solapur-Barshi Road (To SH-151)	6	-2	-3	3
7	OC 7	Solapur Beedh Road/ Solapur-Tuljapur Road (NH-204)	1	3	-4	7
		Both Directions	**10**	**2**	**8**	**-4**
1	SC 1	Kumthe Aaharwadi Road	-12	7	-14	15
2	SC 2	Asara bridge, Konark Nagar crossing	-7	-3	-6	-9
3	SC 3	Old Bijapur Naka	-10	-4	-7	9
4	SC 4	Modi Railway Crossing	-7	-6	-10	-7
5	SC 5	Sangola Mangalweda Crossing	-3	-3	-7	-13
		Both Directions	**-7**	**-4**	**-7**	**-1**

6.2.8 Base Year Model Results

Base year model stands validated and V/C ratios on along some of the major roads have been compiled and presented in Table 6-9. Link flow diagram is presented in Figure 6-7.

Table 6-9: V/C at Major Roads for Base Year 2015

S. No	Name of the Road	Length (Km)	Existing Lanes	Volume (PCUs)	Capacity (PCUs)	V/C Ratio
1	Akkalkot Road	8.50	2.0	1601	2081	0.78
2	Budhwar Bazar Rd	0.93	2.0	1258	1286	0.98
3	Joshi Gali	1.15	2.0	2196	1500	1.53
4	Jule Solapur Road	2.34	4.0	2050	2785	1.02
5	Limayewadi Rd	2.79	2.0	1231	1286	0.96
6	Mahatma Gandhi Rd	0.78	2.0	1041	1286	0.81
7	Model Colony Rd	1.15	1.5	1273	680	1.87
8	Mumbai Hwy	7.31	2.0	2448	2142	1.14
9	Murajeta	0.42	2.0	3630	1286	2.82
10	Old Karamba Rd	7.06	2.0	904	1857	0.51
11	Rajaswa Nagar Road	1.73	2.0	1067	1286	0.83
12	Rajiv Nagar Road	1.80	2.0	917	1026	1.00
13	Ravivar Peth Marg	0.52	2.0	1477	1286	1.15
14	Rupa Bhavani Rd	3.64	2.0	1907	2333	1.01
15	Siddheshwar Nagar	0.87	1.5	1057	680	1.55
16	Solapur Aurangabad Hwy	6.44	2.0	1866	2142	0.87
17	Solapur Mangalvedha Road	9.59	2.0	3321	2415	1.45
18	Solapur Mumbai Highway	1.82	2.0	2234	2142	1.04
19	Tilak Road	1.42	2.0	1651	1286	1.28
20	Vijapur Road	9.36	4.0	3391	4897	0.71
21	Mangalwedha-Pune Road	5.73	2.0	369	1286	0.29

Observations:

- It has been observed that almost 40% of the existing major roads have V/C greater than 1, the prominent ones being Murajeta Road, Model Colony Road, Siddheshwar Nagar Road, Joshi Gali Road, Solapur Mangalvedha Road etc.
- Of these major roads Murajeta Road, Model Colony Road, Siddheshwar Nagar Road, Joshi Gali Road have V/C more than 1.5 which needs immediate attention.

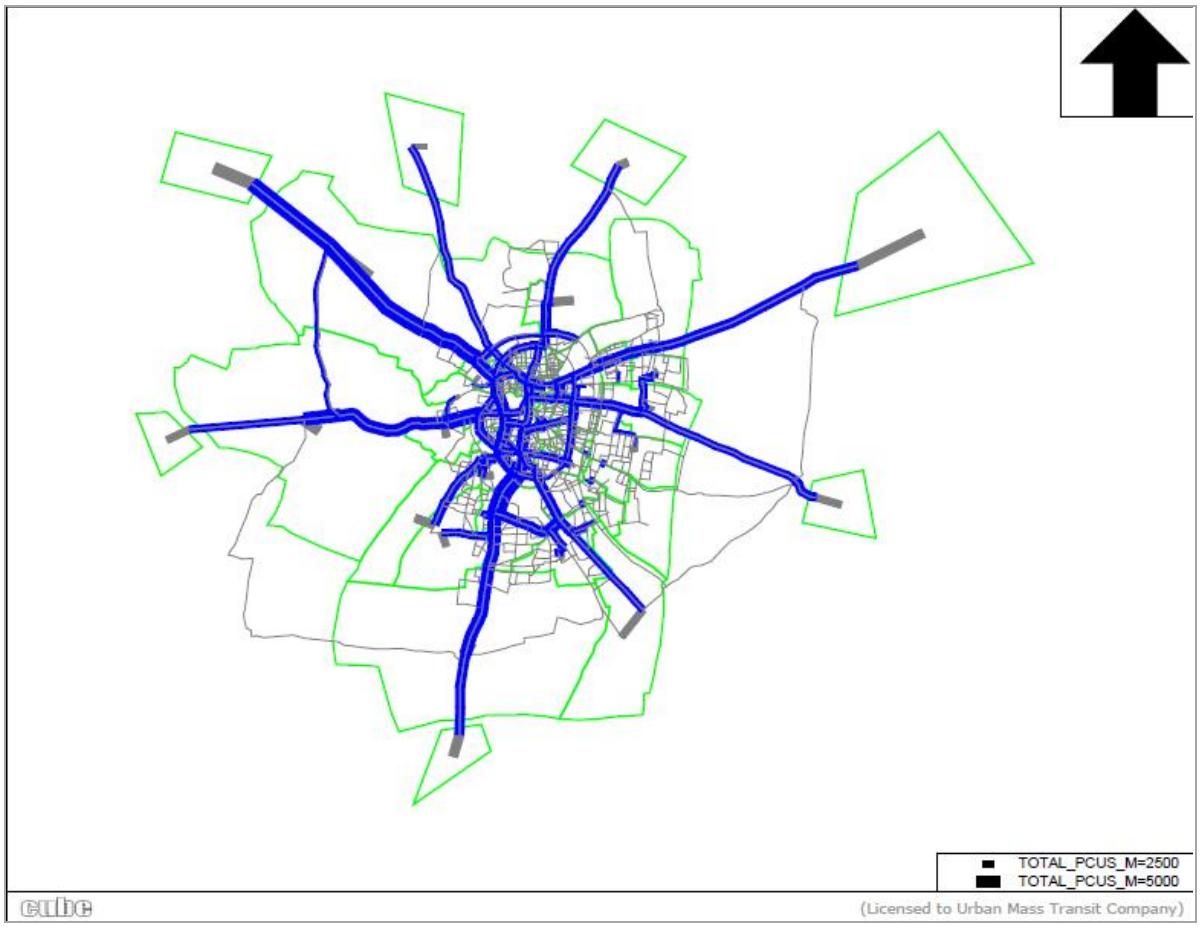


Figure 6-7: Link Flow Diagram (in PCUs) for Base Year (2015)

6.3 Horizon Year Travel Demand Modelling

There is no master plan available for the study area to assess future development directions and required transport network. A revised city development plan has been prepared statin the growth directions of the city. Considering the various transportation improvements consultants have arrived at 3 scenarios for horizon year modelling. They are:

1. Business As Usual (Do Nothing) Scenario

2. Network Improvement (Do Something) Scenario
3. Do Something with Public Transport Augmentation Scenario

Do Nothing scenario correspond to no major changes in the network i.e. no change would be made in the road network and the same road configuration is assumed to continue in the future.

Do Something Scenario comprises of incorporating some changes to road network like augmentation of road link capacities, addition of missing links and bypasses wherever necessary.

- Consultants have identified links whose V/C ratio is greater than 1.2 in 2035. These links have been taken up for capacity augmentation.
- 22% of goods traffic and 7% of passenger traffic which does not have the need to pass through the city are using up the internal city roads due to the absence of bypasses which adds upto the congestion inside the city. Hence, Consultants have proposed to include bypass links as well as improving the existing bypass links which have been under-utilized at present. Link speeds have been increased for improved links in the Scenario.

Do Something with Public Transport Augmentation Scenario include changes made in the Do Something Scenario along with additional bus routes and also increased frequency of certain bus routes.

Figure 6-8 shows the methodology for Horizon year travel demand modelling.

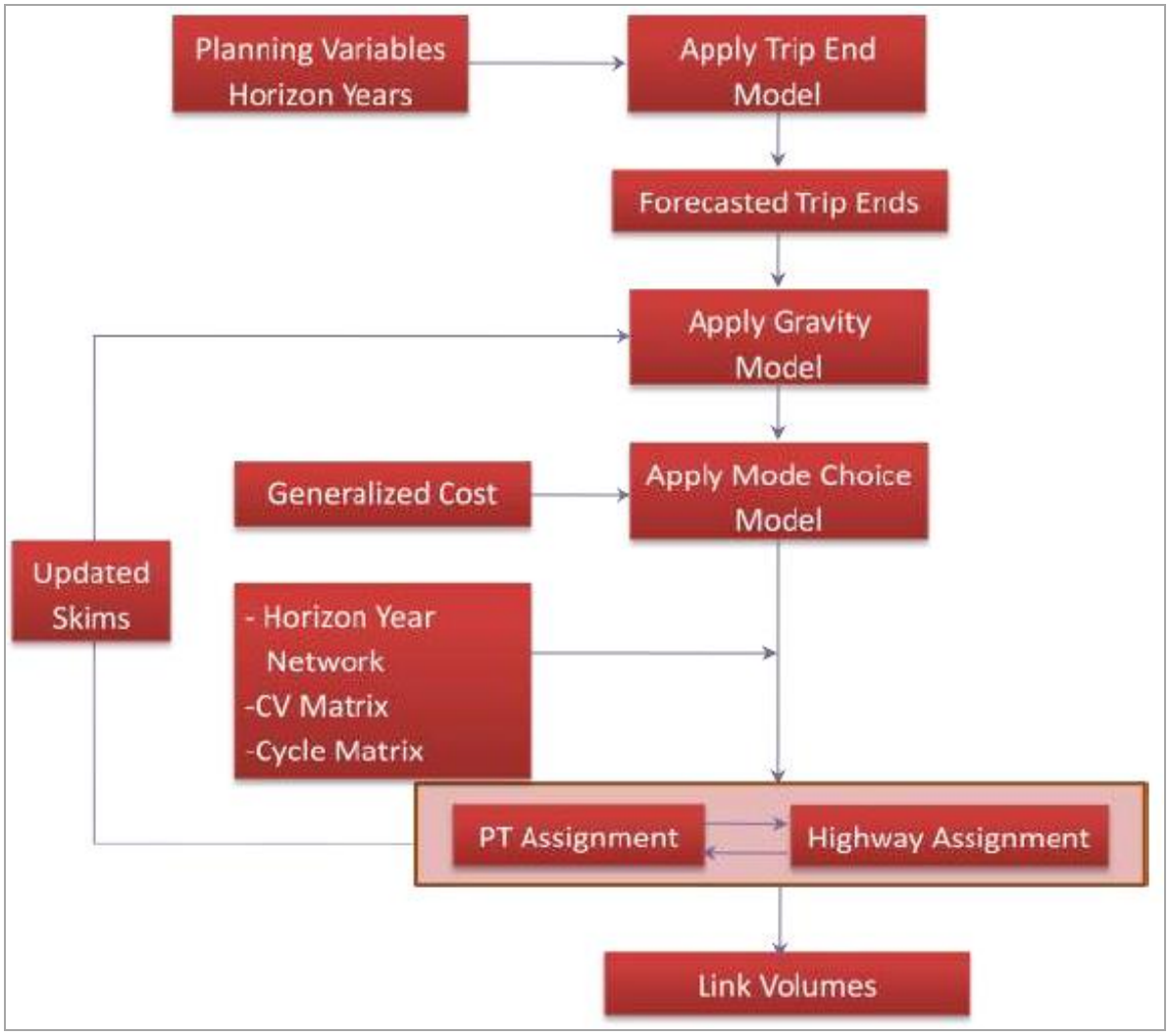


Figure 6-8: Flow Chart showing the Horizon Year Travel Demand Modelling

6.3.1 Forecasting of O-D Matrices

The calibrated trip end equations for the daily person trips made within the study area are applied on the projected planning variables for the horizon years (2026 and 2035) to get the future trip ends of intra-city trips. These future year trip ends are distributed by applying the calibrated gravity distribution model with the cost skims available for the initial run. The O-D matrix of daily person trips thus obtained for the future year under consideration is split into five O-D matrices – viz., Car Trip matrix, Two Wheeler Trip matrix, Bus Trip matrix and IPT (Auto) Trip matrix – using the calibrated mode choice model.

Truck O-D matrix Trips and mode-wise external trips (inter-city trips) are forecasted using zonal growth factors and by furness method. Truck trips are assumed to grow at 6% per

year upto 2026 and 5% thereafter upto 2035. External trips are assumed to grow at 6% per year upto 2026 and at 5% per year upto 2035.

Truck trips are preloaded onto the network before assignment and this loaded network is used for further assignment. The cost skims used in gravity distribution model and mode choice models are revised using the ones obtained by assigning the public transport trips and highway trips on to their respective networks. The cost/time skims obtained using the final stabilised link cost information is used to get the final mode wise O-D matrices of person trips. Table 4-13 gives the estimated future trips by various modes by various scenarios. The estimated above trips excludes intra-zonal trips which constitutes 5% in base year (2015).

Table 6-10: Summary of Horizon Year Trips

Code	Vehicle	Base Year (2015)		2026		2035	
		Passenger Trips	% Trips	Passenger Trips	% Trips	Passenger Trips	% Trips
Scenario-I: Business As Usual (Do Nothing) Scenario							
1	Car	56498	10	71187	10%	93222	11%
2	2W	296945	52	377121	55%	495900	57%
3	Public Bus	110445	19	140265	21%	184439	21%
4	Auto	106105	19	92312	14%	90191	10%
	Total	569994	100	680885	100%	863752	100%
	PT	216551	38	232577	34%	274630	32%
	PVT	353444	62	448308	66%	589122	68%
Scenario-II: Network Improvement (Do Something) Scenario							
1	Car	56498	10	71187	10%	93222	11%
2	2W	296945	52	377121	55%	495900	57%
3	Public Bus	110445	19	140265	21%	184439	21%
4	Auto	106105	19	92312	14%	90191	10%
	Total	569994	100	680885	100%	863752	100%
	PT	216551	38	232577	34%	274630	32%
	PVT	353444	62	448308	66%	589122	68%
Scenario-III: Do Something with Public Transport Augmentation Scenario							
1	Car	56498	10	67799	10%	85320	10%
2	2W	296945	52	359304	53%	454328	54%
3	Public Bus	110445	19	172298	25%	218687	26%
4	Auto	106105	19	83824	12%	78519	9%
	Total	569994	100	683225	100%	836854	100%
	PT	216551	38	256122	37%	297206	36%
	PVT	353444	62	427103	63%	539648	64%

*Excluding intra-zonal trips, Cycle and Walk Trips

It has been observed that the share of Bus and IPT Trips in Scenario 3 (Do Something with Public Transport Augmentation Scenario) has increased by 23% and -10% respectively compared to Scenario 1 (Business As Usual (Do Nothing) Scenario & Network Improvement (Do Something) Scenario).

6.3.2 Analysis of Travel Demand Modelling Output

6.3.2.1 Scenario I (Business as Usual (Do Nothing) Scenario)

This scenario assesses the problems that would emerge in the future if no changes are made to the present network. The same base network is adopted for the horizon years i.e. 2026, 2035 and modelled. Table 6-11 gives the traffic characteristics of the study area extracted from the model in terms of total load, average V/C etc. There would be an increase in traffic volume on most of the road network beyond its capacity.

Table 6-11: Traffic Characteristics for Scenario I

Network Characteristics	2015	2021	2026	2031	2035
Avg. Network Speed (kmph)	18.5	18.2	17.7	17.1	16.6
Total Passengers	1218.0	1379.0	1725.8	1959.0	2311.3
Total PCUs	400.9	475.1	604.4	701.3	837.0
Avg. V/C Ratio	0.40	0.47	0.59	0.70	0.84
Vehicle Distance Travelled (Veh-Km)	126.5	157.4	205.3	250.1	303.4
Vehicle Hours Travelled (Veh-Hr)	7.1	11.6	29.5	56.9	130.3
Total Vehicles	771.5	913.1	1155.8	1348.4	1590.0

The peak hour loadings and V/C ratio of the entire network for the base year as well as for horizon year 2035 is shown in Figure 6-9 and Figure 6-10.

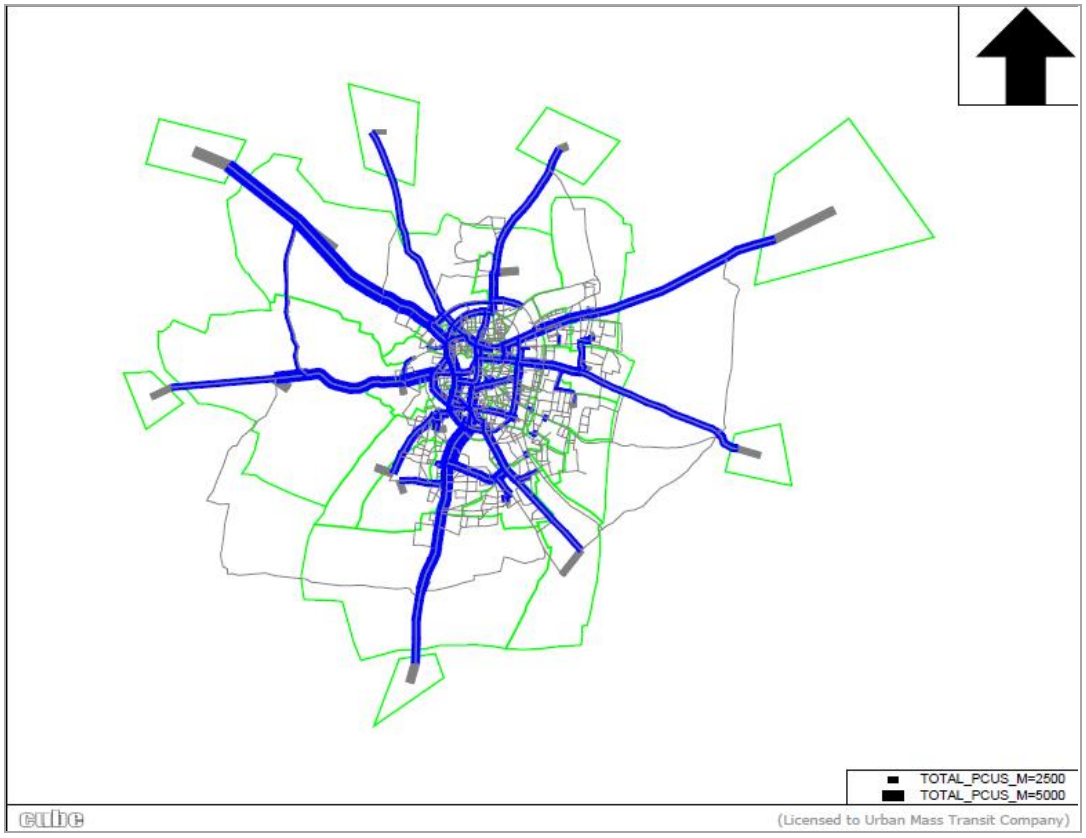


Figure 6-9: Peak Hour Traffic Loadings in PCUs for the Base Year

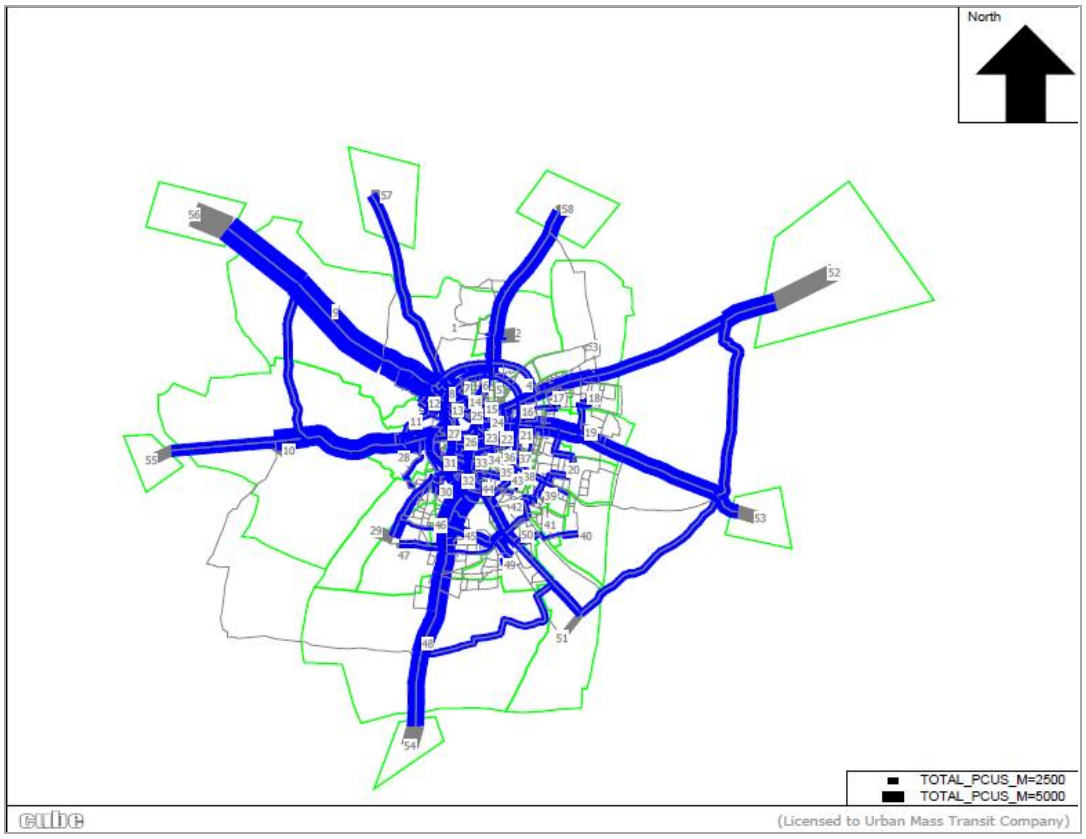


Figure 6-10: Peak Hour Traffic Loadings in PCUs for the Year 2035 (Scenario-I)

6.3.2.2 Scenario II (Network Improvement (Do Something) Scenario)

Major changes have been made in the transport network based on constraints identified through Scenario I are implemented in the Scenario II.

I. Consultants have included the committed road widening projects.

II. There are many roads where V/C is greater than 1 in Scenario-I. From these roads where the V/C is greater than 1.2 for the year 2035 have been selected for Scenario II for the horizon years 2021, 2026, 2031 and 2035.

III. Bypasses have also been included - the traffic does not have to pass through city and can reduce the congestion inside the city roads.

The following changes in the base network are implemented for the Scenario II (Network Improvement (Do Something) Scenario).

Table 6-12: Roads/ Sections identified with Constraints in the Base Network

S. No	Name of the Road	Length (Km)					Existing Lanes				
		2015	2021	2026	2031	2035	2015	2021	2026	2031	2035
1	Akkalkot Road	8.50		8.50			2.0		4.0		
2	Budhwar Bazar Rd	0.93	0.93				2.0	4.0			
3	Jodhbasavana Rd	0.53					2.0				
4	Joshi Gali	1.15	1.15				2.0	4.0			
5	Jule Solapur Road	0.54	0.54	0.54			2.0	2.0	4.0		
6	Kumte Road	5.43			5.43		2.0			4.0	
7	Limayewadi Rd	2.79	2.79				2.0	4.0			
8	Mahatma Gandhi Rd	0.78	0.78				2.0	4.0			
9	Model Colony Rd	1.15		1.15			1.5		2.0		
10	Mumbai Hwy	7.26	7.26				2.0	4.0			
11	Murajeta	0.42	0.42				2.0	4.0			
12	New bypass Road	6.40			6.40		2.0			4.0	
13	Old Karamba Rd	7.06			7.06		2.0			4.0	
14	Proposed Mangalore-Pune Bypass		1.97					6.0			
15	Proposed Manglore-Mangalwedha Bypass				8.95					4.0	
16	Rajaswa Nagar Road	1.73				1.73	2.0				4.0
17	Rajiv Nagar Road	1.80	1.80				1.8	4.0			
18	Ramwadi Road	2.83	2.83	2.93			1.8	1.9	1.9		
19	Ravivar Peth Marg	0.52	0.52				2.0	4.0			
20	Rupa Bhavani Rd	2.48	2.48	2.48			2.0	2.0	4.0		

S. No	Name of the Road	Length (Km)					Existing Lanes				
		2015	2021	2026	2031	2035	2015	2021	2026	2031	2035
21	Siddheshwar Nagar	0.87		0.87			1.5		2.0		
22	Solapur Aurangabad Hwy	6.44		6.44			2.0		4.0		
23	Solapur Mangalvedha Road	9.59	9.59				2.2	4.0			
24	Solapur Mumbai Highway	1.82	1.82				2.0	4.0			
25	Tilak Road	1.42	1.42				2.0	4.0			
26	Vijapur Road	2.25	2.25				2.0	2.0			
27	Mangalwedha-Pune Road	5.74		5.74			2.0		4.0		
28	Proposed ROB		1.42					4.0			

Table 6-13 gives the traffic characteristics of the study area extracted from the model in terms of total load, average V/C etc. There would be an increase in traffic volume on most of the road network beyond its capacity.

Table 6-13: Traffic Characteristics for Scenario II

Network Characteristics	2015	2021	2026	2031	2035
Avg. Network Speed (kmph)	18.5	19.0	18.8	18.8	18.5
Total Passengers	1218.0	1334.2	1698.1	1932.9	2269.1
Total PCUs	400.9	450.3	578.3	625.8	739.2
Avg. V/C Ratio	0.40	0.38	0.44	0.47	0.55
Vehicle Distance Travelled (Veh-Km)	126.5	167.9	225.6	286.6	343.5
Vehicle Hours Travelled (Veh-Hr)	7.1	9.3	18.2	36.0	80.3
Total Vehicles	771.5	866.5	1108.7	1201.3	1419.4

The peak hour loadings and V/C ratio of the entire network for the horizon year 2035 is shown in Figure 6-9.

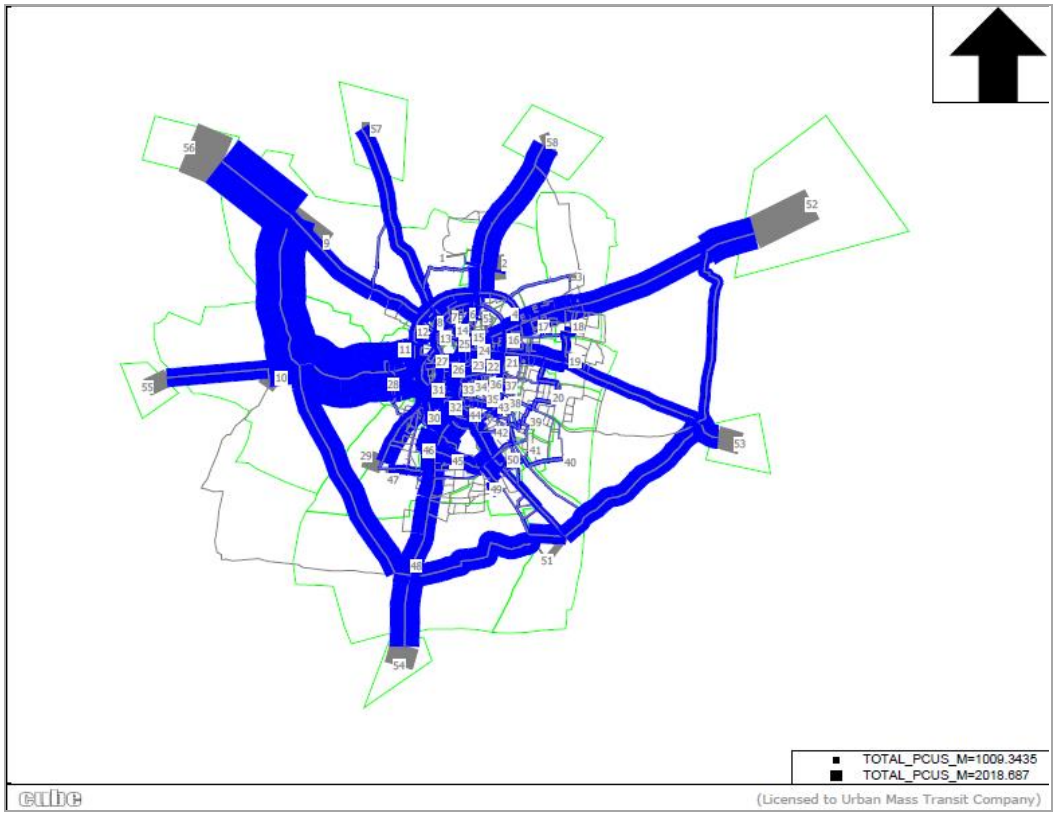


Figure 6-11: Peak Hour Traffic Loadings in PCUs for the Year 2035 (Scenario-II)

Traffic volumes on newly added bypasses and missing links are given in Table 6-14.

Table 6-14: Peak Hour Volumes on Bypasses and Missing Links for the Year 2035

S. No	Name of the Road	Length (Km)	Volume (PCUs)
1	New bypass Road	6.40	3767
2	Proposed Mangalore-Pune Bypass	8.50	2956
3	Proposed Manglore-Mangalwedha Bypass	0.93	4503
4	Proposed ROB	1.42	3597

6.3.2.3 Scenario III (Do Something with Public Transport Augmentation Scenario)

Major changes related to public transport have been made in the transport network of Scenario II and are implemented in the Scenario III. There are routes which are not properly served by Buses where the demand is more, these routes have been identified and included in the network scenarios. In addition to the existing 38 bus routes the following 17 Bus routes have been added. These routes are chosen based on the demand along these routes. Further, average headway has been reduced from 35 minutes to 15 minutes.

Figure 6-12 and Figure 6-13 shows the existing and proposed bus route network for Solpaur City.

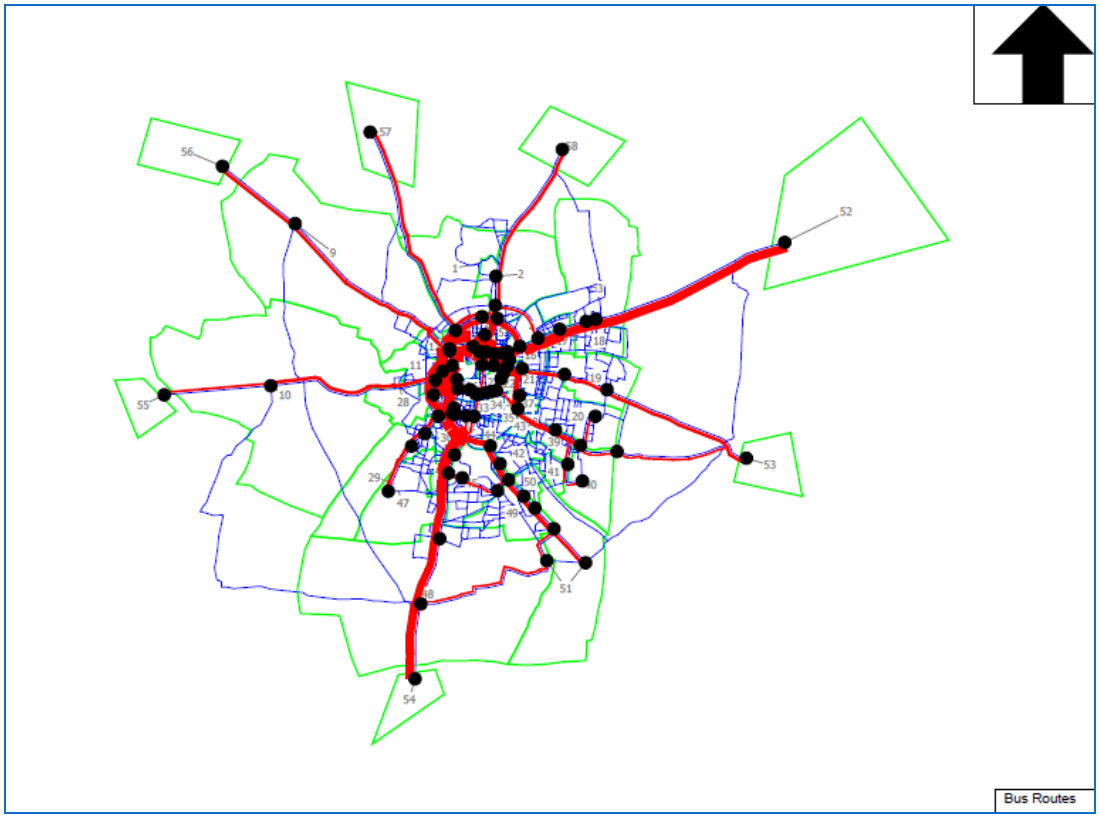


Figure 6-12: Existing Bus Routes

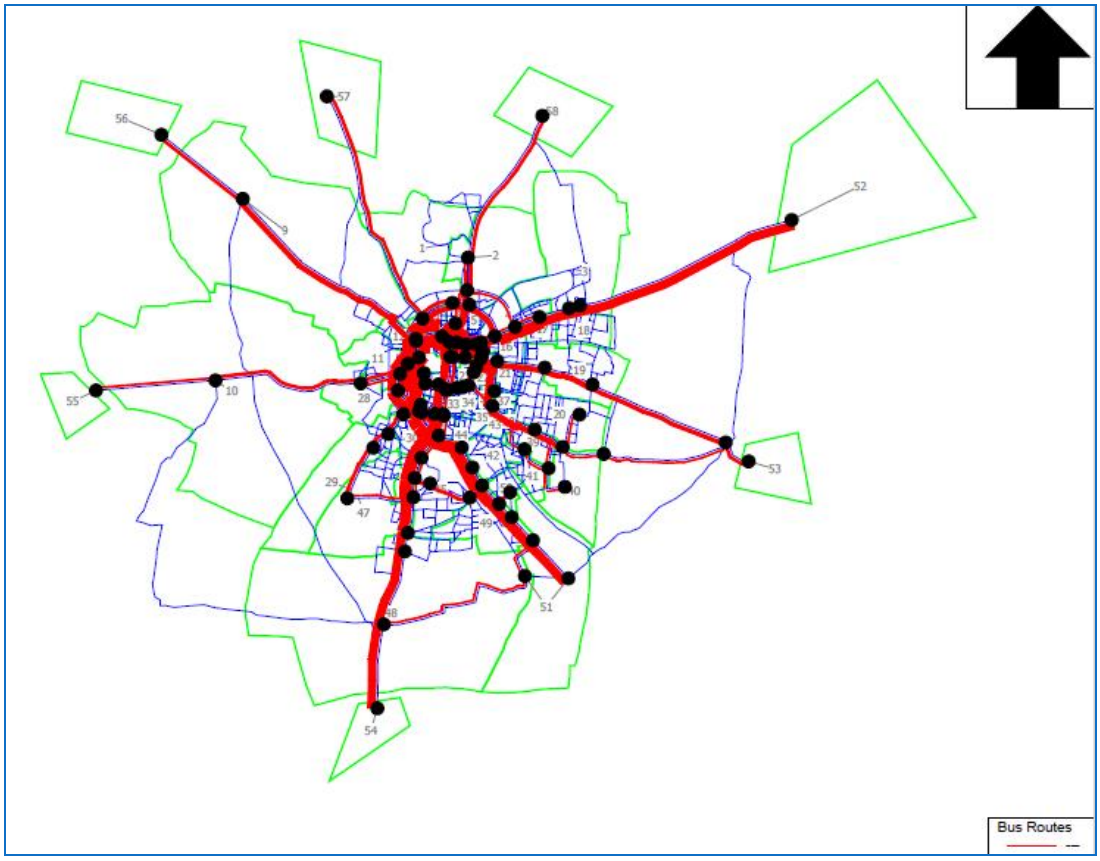


Figure 6-13: Proposed Bus Routes

Table 6-15 gives the traffic characteristics of the study area extracted from the model in terms of total load, average V/C etc. There would be an increase in traffic volume on most of the road network beyond its capacity.

Table 6-15: Traffic Characteristics for Scenario III

Network Characteristics	2015	2021	2026	2031	2035
Avg. Network Speed (kmph)	18.5	19.0	18.9	18.8	18.5
Total Passengers	1218.0	1329.2	1704.0	1947.0	2236.9
Total PCUs	400.9	449.9	570.3	618.5	718.2
Avg. V/C Ratio	0.40	0.38	0.43	0.47	0.53
Vehicle Distance Travelled (Veh-Km)	126.5	167.8	223.3	284.4	338.0
Vehicle Hours Travelled (Veh-Hr)	7.1	9.3	18.0	35.7	79.1
Total Vehicles	771.5	865.6	1093.3	1187.4	1379.0

The peak hour loadings and V/C ratio of the entire network for the horizon year 2035 is shown in Figure 6-9.

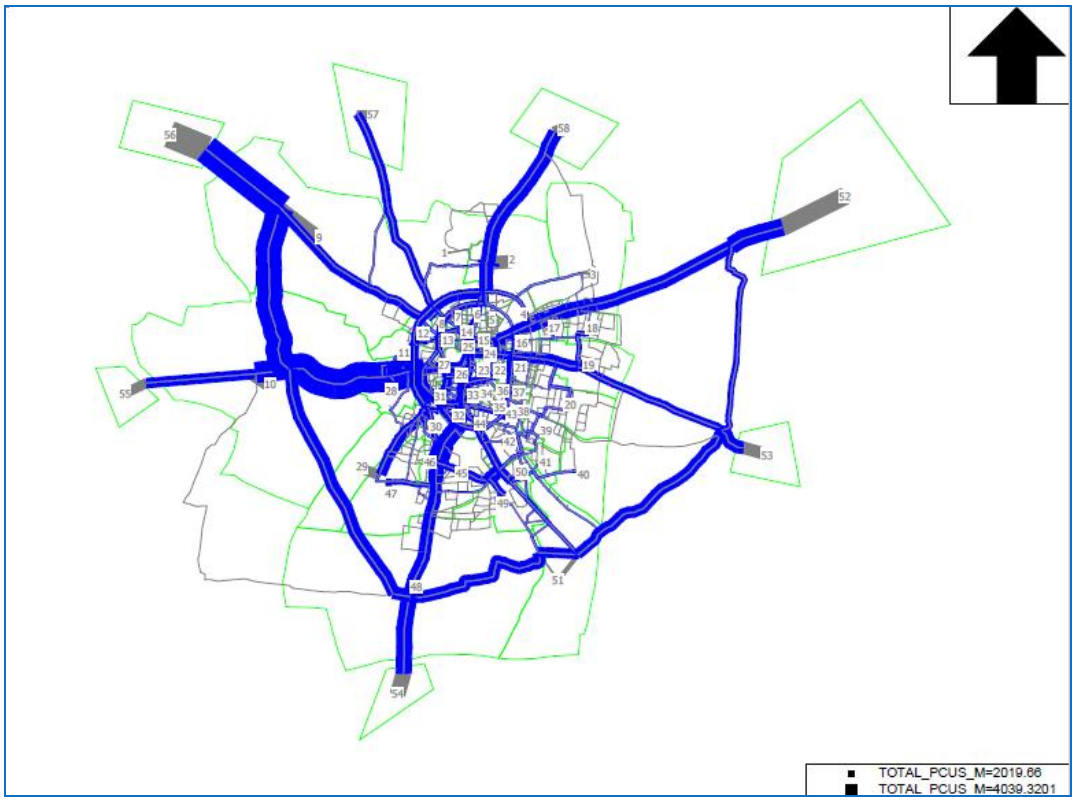


Figure 6-14: Peak Hour Traffic Loadings in PCUs for the Year 2035 (Scenario-III)

6.3.2.4 Summary

The Improvements like widening, augmentation of bus frequency tend to reduce the impact of V/C on some major roads and the overall network. Improvements along with

bypass further reduce the V/C on network. Comparison of various scenarios is presented in Table 6-16.

Table 6-16: Comparison of Network Attributes for Various Scenarios

	2015	2021	2026	2031	2035
Scenario-I: Business As Usual (Do Nothing) Scenario					
Avg. Network Speed (kmph)	18.5	18.2	17.7	17.1	16.6
Total Passengers	1218.0	1379.0	1725.8	1959.0	2311.3
Total PCUs	400.9	475.1	604.4	701.3	837.0
Avg. V/C Ratio	0.40	0.47	0.59	0.70	0.84
Vehicle Distance Travelled (Veh-Km)	126.5	157.4	205.3	250.1	303.4
Vehicle Hours Travelled (Veh-Hr)	7.1	11.6	29.5	56.9	130.3
Total Vehicles	771.5	913.1	1155.8	1348.4	1590.0
Scenario-II: Network Improvement (Do Something) Scenario					
Avg. Network Speed (kmph)	18.5	19.0	18.8	18.8	18.5
Total Passengers	1218.0	1334.2	1698.1	1932.9	2269.1
Total PCUs	400.9	450.3	578.3	625.8	739.2
Avg. V/C Ratio	0.40	0.38	0.44	0.47	0.55
Vehicle Distance Travelled (Veh-Km)	126.5	167.9	225.6	286.6	343.5
Vehicle Hours Travelled (Veh-Hr)	7.1	9.3	18.2	36.0	80.3
Total Vehicles	771.5	866.5	1108.7	1201.3	1419.4
Scenario-III: Do Something with Public Transport Augmentation Scenario					
Avg. Network Speed (kmph)	18.5	19.0	18.9	18.8	18.5
Total Passengers	1218.0	1329.2	1704.0	1947.0	2236.9
Total PCUs	400.9	449.9	570.3	618.5	718.2
Avg. V/C Ratio	0.40	0.38	0.43	0.47	0.53
Vehicle Distance Travelled (Veh-Km)	126.5	167.8	223.3	284.4	338.0
Vehicle Hours Travelled (Veh-Hr)	7.1	9.3	18.0	35.7	79.1
Total Vehicles	771.5	865.6	1093.3	1187.4	1379.0

I. In Scenario I - It has been observed that several major links carry volumes greater than its capacity for the year 2015. In 2035 the V/C ratio further increases to more than 2 to 3 at some links.

II. In Scenario III (Do Something with Public Transport Augmentation Scenario) - After the inclusion of Bypasses, missing links and augmentation of bus services it has been observed that there is a reduction in V/C. The proportion of bus trips and auto trips also changes by 1.5% and 4.2% for the year 2035. Bypasses reduce the load on congested roads and decrease their V/C ratios by around 34% on the core network.

7. Vision, Goals and Objectives

7.1 Vision Statement

The mobility plan seeks to “move people, not vehicles”. By emphasizing the pre-eminence of public transport and non-motorized transport, and integrating the land use with transport networks, it seeks to achieve the objectives of the National Urban Transport Policy (NUTP) in Solapur. The CMP vision for transport in Solapur ensures that the city will have a planned, best performing transport system(s) that addresses the needs and concerns of the city. Accordingly, the transport vision for Solapur can be defined as:

7.2 Mobility Pillars

The six most important pillars for ensuring Sustainable Mobility in urban areas are:

1. Integrating Land use and Transport in Planning Process
2. Recognizing the use of non-motorized means of movement by introducing NMT favorable strategies
3. Bringing a control on movement of personal vehicles
4. Managing parking in the city
5. Encouraging Public Transport System and other Sustainable modes
6. Directing city growth in a uniform manner with the help of better links and access roads

7.3 Goals

To ensure that Mobility solutions for Solapur that are sustainable and in conformity with sustainable mobility, 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, livable city for residents and visitors and support the public transport system.

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

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

Each goal can be achieved by meeting the following objectives:

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

Objectives

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

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

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

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

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

Objectives

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

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

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

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

(e) To provide segregated facilities for movement of cyclist in Solapur

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

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

Objectives

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

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

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

Objectives

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

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

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

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

7.4 Benchmarks and Scenarios

From the analysis of data, various Benchmarks have been computed and presented in the earlier chapter. Benchmarks are performance indicators of various existing transportation parameters. Currently, these indicators are at unsustainable levels, and it becomes

necessary to set desirable targets in this study. Accordingly, desirable targets to be achieved for Solapur are presented in Table

Having set the goals, objectives and the SMHS Principles to be looked in to, the next task in the CMP study is the formulation of mobility strategies based on various scenarios. Following are the different scenarios tested in the model.

- Do Nothing – Without Any Development
- Do Something – Considering Sanctioned Projects
- Do Everything - Higher Order Mass Transit System with Do Something

Based on the anticipated impacts of the various scenarios, the study recommends the scenario comprising transit oriented development , higher order mass transit system and route rationalization. This will help to increase the public transport share. The proposed strategies and proposals are discussed in the subsequent chapters. The anticipated impacts of the various scenarios are presented in the proposal chapter.

8. Transport Strategies

The mobility goals for Solapur 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 Solapur.

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

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

The mobility goals for Solapur 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 Solapur.

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

- Non-Motorized

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

8.1 Mobility Corridor Strategy

The city clearly indicates the radial road network development. Majority of these corridors are either state or national highways and are important mobility corridors of Solapur. The below Figure 8-1 shows the road network of Solapur City.

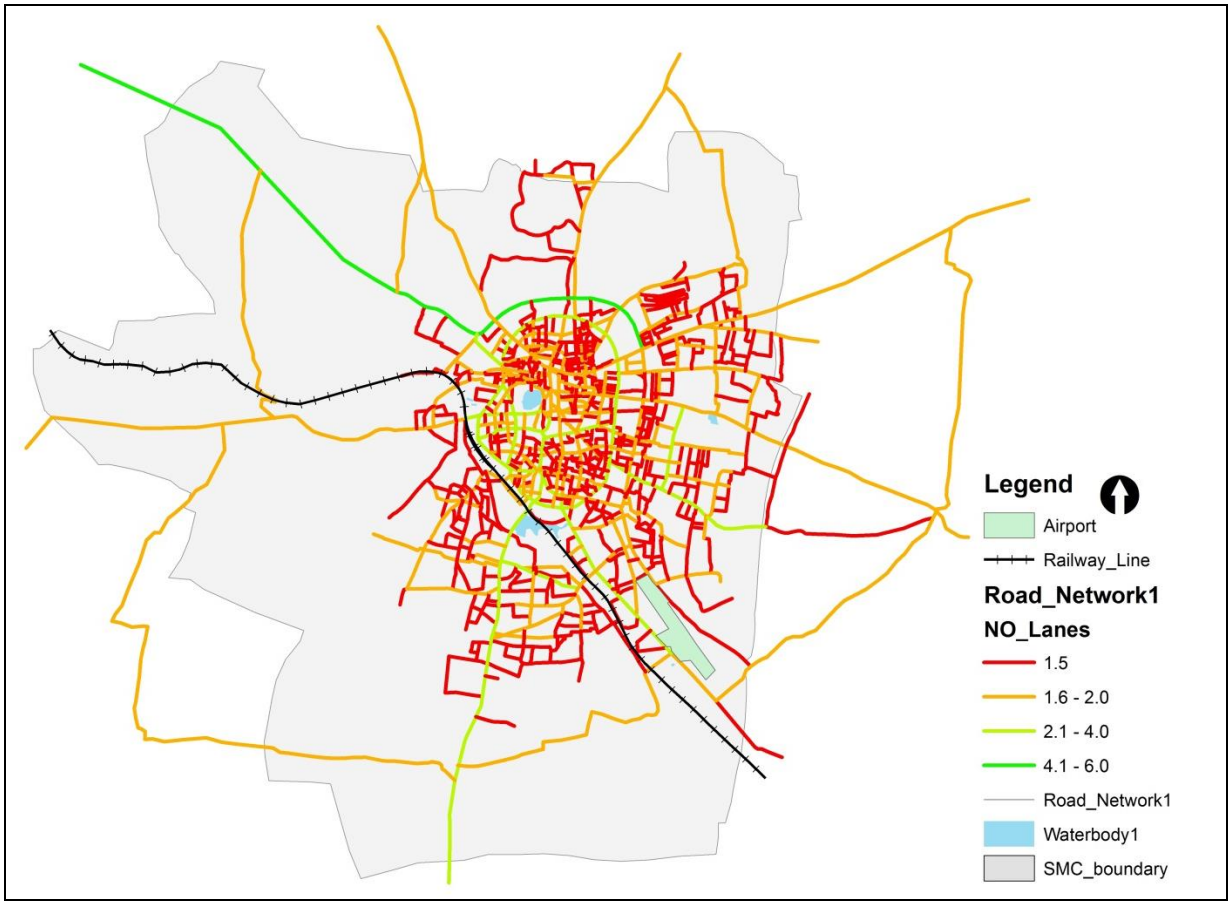


Figure 8-1 Road Network in Solapur City Network in Solapur City

In essence, mobility corridor maximizes throughput of people, focusing on mass transport and non-motorized traffic, rather than vehicle traffic. These mobility corridors offer a strong network providing connectivity to major attraction centers in the city along with regional connectivity. Mobility is achieved by augmenting the public transit service on

these designated corridors. The below Figure 8-2 shows the Mobility Corridors in Solapur City.

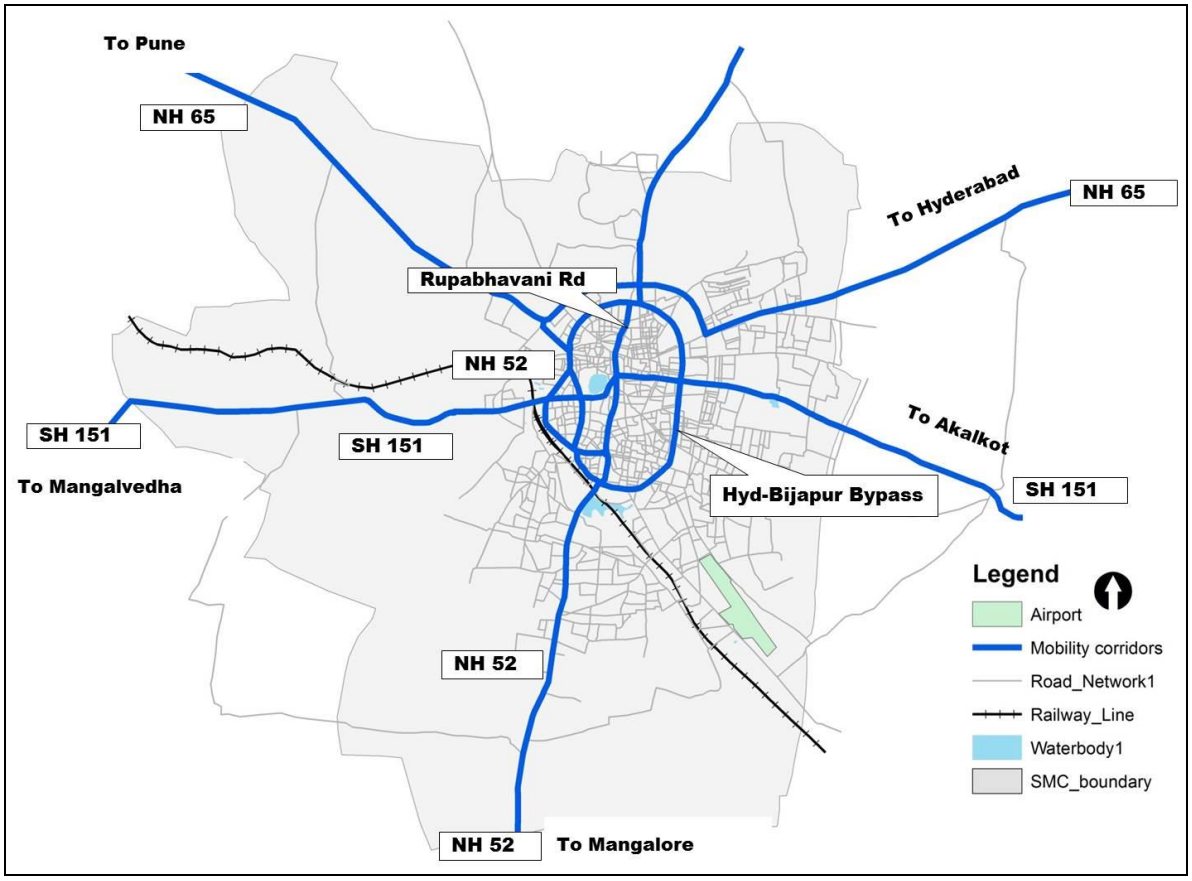


Figure 8-2: Mobility Corridors in Solapur city

As a part of this strategy, it has been proposed that some corridors will act as mobility corridors in the city. These corridors should be considered for an augmented public transport system. The study will need revision in the ridership estimation for the extension part in future.

The mobility corridors for the study area constitute of expressways, National highways complemented with major connecting roads for the smooth traffic. Following are the identified mobility corridors:

National Highway

1. NH 65

2. NH 52

State highway

1. Maharashtra state highway 151

Major Roads

1. Hyderabad-Bijapur Bypass
2. Rupabhavani Road
3. VIP Road

8.2 Land Use and Transport Strategy

8.2.1 Evaluation of Urban Growth and Transport Network Scenarios

Growth management is increasingly viewed not only as a strategy to limit growth, but also as a strategy to promote growth, spur economic development, and ensure the availability of affordable housing. An initial step toward a balanced approach to urban area growth is to identify those growth management issues that relate to urban land use and development trends.

Urban sprawl is perhaps the largest single issue of growth management that encompasses a wide array of subordinate issues. Urban sprawl is generally defined as growth that occurs in a haphazard fashion, with little thought given to the cost-effectiveness of municipal service delivery or land use compatibility. Sometimes urban sprawls are associated only with municipal boundary expansions, but many times the higher density rural development along urban borders also contribute to urban sprawl.

To accommodate the projected population of 18.12 lakh by the year 2035 the following strategies need to be adopted by Solapur Municipal Corporation:

- Intensification of central core
- Intensive growth along transport radials

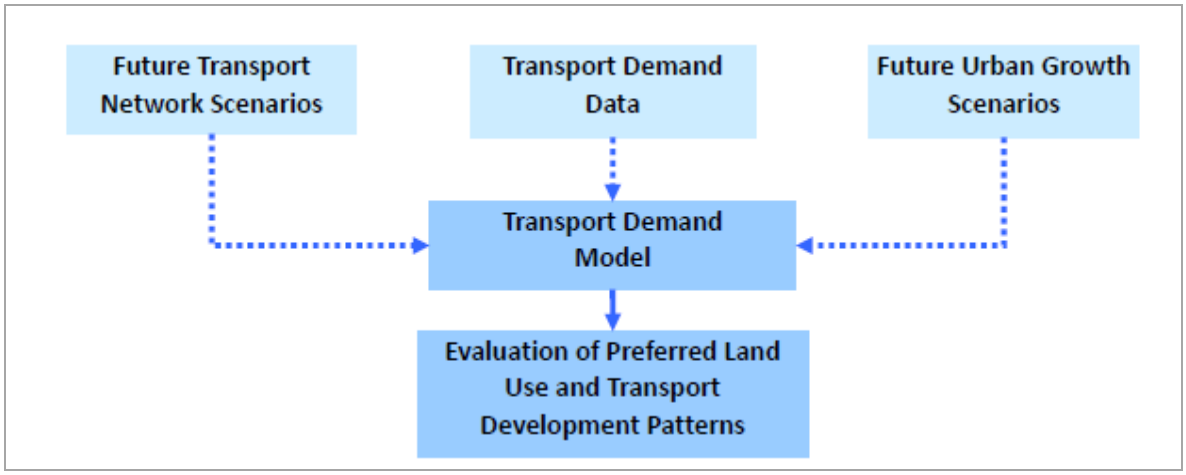


Figure 8-3: Indicative Process for the Evaluation of Preferred Development Scenarios

Generally, the development would take place along the corridors and the same happened in current scenario. The mobility corridors are already passing through dense areas. Providing better Public Transit Services on the corridor facilitates a faster and more reliable transit alternative and increase the accessibility of destinations throughout the street grid. And also mobility corridors provide access to important trip generators and attractors. In future along with the proposed developments, growth areas have to be identified along the proposed radial roads.

8.2.2 Strategies for Land Use and Transport Systems Development

Transportation's purpose is moving people and goods from one place to another, but transportation systems also affect community character, the natural and human environment, and economic development patterns. A transportation system can improve the economy, shape development patterns, and influence quality of life and the natural environment. Mobility, especially Motorised transport requires an increasing share of land within the cities. But car oriented life style is out of reach of most people in the cities and also it is not sustainable development path neither with respect to functions nor the environment. Only public transport can assure mobility in cities. And only in preserving good conditions of walking and cycling it is possible to maintain a satisfactory level of urban quality.

Land use and transportation are interdependent; development density and location influence regional travel patterns, and, in turn, the degree of access provided by the transportation system can influence land use and development trends. Urban or community design can facilitate alternative travel modes. For example, a connected

system of streets with higher residential densities and a mix of land uses can facilitate travel by foot, bicycle, and public transportation, in addition to automobile. Conversely, dispersed land development patterns may facilitate vehicular travel and reduce the viability of other travel modes.

The coordination of land use and transportation requires that those concerned with the well-being of a city assess and evaluate how land use decisions effect the transportation system and can increase viable options for people to access opportunities, goods, services, and other resources to improve the quality of their lives. In turn, the transportation sector should be aware of the effects the existing and future transportation systems may have on land use development demand, choices, and patterns.

Coordinating or integrating land use and transportation planning & development is commonly considered today as one facet of "*smart growth*", sustainable development, new urbanism, or other similar concept. These share policies, principles, and strategies intended to preserve and even enhance valued natural and cultural resources and facilitate "healthy", sustainable communities and neighborhoods. These approaches also tend to foster a balance of mixed uses (including housing, educational, employment, recreational, retail, and service opportunities) which recognize the importance of spatial or geographic proximity, layout, and design of those uses. In addition, the consideration of long term and broader (even global) impacts of land use decisions on our natural and human-made environment, including transportation systems and facilities, is critical to these concepts, as well.

8.2.3 Strategies and Approaches

- Transportation planning should be an inclusive and holistic process involving all communities and groups impacted by transportation infrastructure. To achieve equitable results, to support desired patterns of land use, and to promote sustainable economic growth, transportation planning should be conducted as part of a larger regional effort to coordinate transportation with overall land use and development goals.
- Partnerships with non-traditional stakeholders can provide a new perspective and therefore strengthen planning. These groups, who may often be uninvolved in traditional planning processes, can identify

particular aspects of the relationship between transportation and land use that might not be widely recognized and can help to identify needs in the community that are not commonly addressed. Likewise, positive relationships with the local media are important in raising awareness about issues of livability and growth.

- The development and implementation of new planning methods is a challenge, requiring consistent support and promotion from all involved. Strong leadership, both at the individual and institutional levels, is crucial to give momentum and credibility to new ideas.
- Private developments can be key components of public projects. Private retail and commercial developments can provide important revenue streams for public projects, particularly transportation projects, and can bring the crowds necessary to animate urban spaces and infrastructure. Furthermore, private development projects can also incorporate affordable housing and other important public services, such as grocery and drug stores.
- The creation of new planning tools should aim to increase public involvement in the development of transportation and land use policies.

Integrating Land-use and transport planning are essential for environmentally, socially and economically sustainable urban development. Design of urban settlements and choice of locations aim at

- Reducing the rate of growth of car trips
- Promoting public transportation
- Enhancing the healthy conditions for living
- Improving air quality through reducing fuel use and vehicle emissions
- more accessible land use patterns to reduce travel distances
- respond to the changing needs of the population
- providing high level of accessibility
- encourage mixed use development

- encouraging transit oriented development (TOD)
- promotion of higher vehicle occupancy rates

It is important to assess the transport demand caused by the various land use at a very early stage of urban planning, and assure early integration with transport planning. The minimum requirement is the establishment of joint working groups at the municipality level, consisting of urban planners from the involved offices, transport planners, and the traffic and public transport management units. But lack of experts in Govt., departments is posing a serious impediment to the whole process.

For Solapur, the main congestion areas are at the core city. Within the core area, many traffic problems result from too much concentrated development like Mangalwar Peth, Sakhar Peth, Budhwar Peth, Saniwar Peth, Udgiri Wada, etc. the housing spreads the outskirts of the cities, and work places as well as shopping centers attract travelers, congestion occurs. The more healthy way to cope with this situation is formation of sub centers i.e. second and third core areas within the SMC area as shown in the below Figure 8-4. The objective of that kind of urban development is to reduce traffic pressure on the roads leading to the main center and to keep the private household and commercial investors within the urban boundaries. In order to maintain compact urban forms in the city sub centers development is a necessary step. Sub centers can be served well by public transport and the development can be planned along the transit lines. Mixed use development should be encouraged at these sub centers so that the trips to the core area will be reduced.

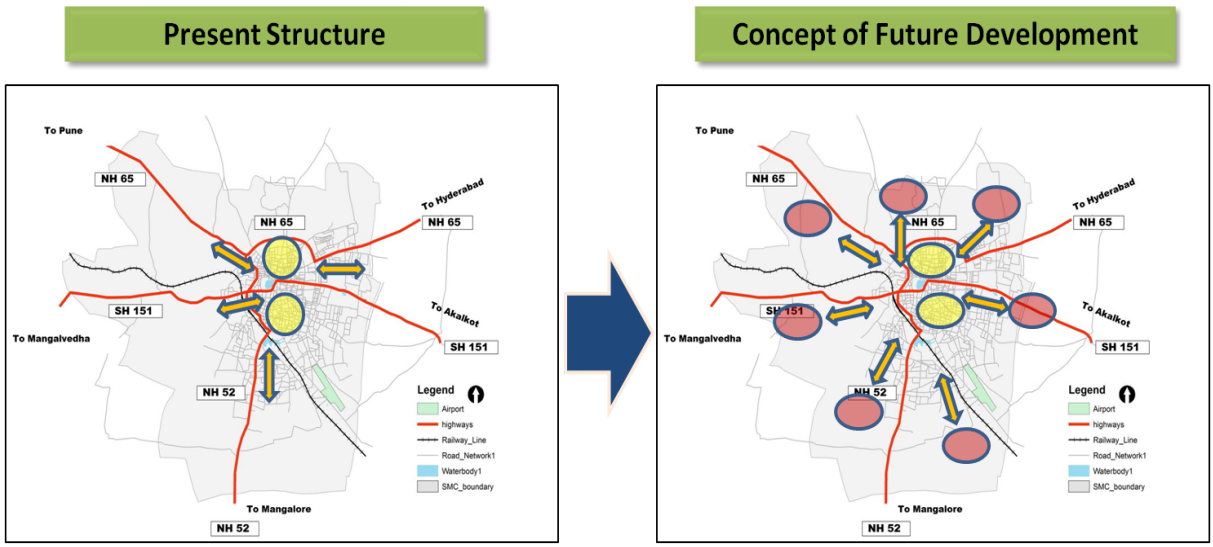


Figure 8-4: Urban Decentralization in to sub-centers

Development activities in sub centers will lead to more homogeneous distribution of activities, thus reducing the average trip distances and mitigating traffic increases.

8.3 Public Transport Improvement Plan

8.3.1 Bus Service Improvement Plan

Provision of Public transport is complex 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. Similarly, the internal sub-systems need to be fully appreciated. Adopting a correct and well-informed approach is a pre-requisite for improving public transport.

At present bus transport is the public transport system in operation. MSRTC (Maharashtra State Road Transport Corporation) provides the public transport services.

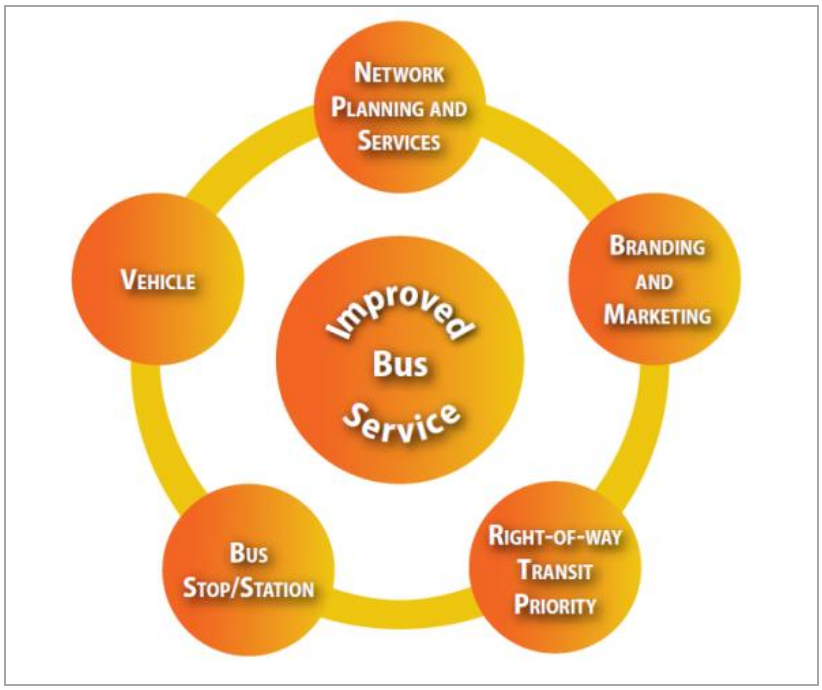


Figure 8-5: Framework for Bus Service Improvement Plan

8.3.2 Issues and Problems

SWOT analysis of Present system

Strengths

- Achieving 35% percentage of people preferring public transport
- Achieving 21% percentage of people preferring City Bus
- Overall adequate road network for public transport system
- Existing site ownership of terminal and depots areas for city bus services
- Existing public transportation routes and busses
- Having large land pockets for the mixed use land development

Weaknesses

- Lack of institutional structure responsible for ensuring coordination and for supplying of information to passengers about the services available
- Lack of Pedestrian, parking and land use policies
- Improper infrastructure of bus stops
- Lack of information system at bus stops
- Improper on street parking management
- Lack of NMT facilities and pedestrian facilities

Opportunities

- Formation of Unified Metropolitan Authority
- Formation of unified public transport agency which will work with Municipal Corporation
- Formation of strategies for bus service improvement and NMT improvement
- Promoting healthy life style for the Solapur residents
- Improving physical infrastructure like busses, bus stops and facilities at terminal areas
- Improving NMT facilities
- Improving pedestrian facilities
- Scope for Transit Oriented Development (TOD)

- By improving the world class transport, Solapur can become economically vital and could be a hub for various services like Industrial and educational institutions etc.

Threats

There are no potential threats identified but in Solapur higher levels of air pollution.

8.3.3 Strategy for Bus Service Improvement

The major factors that strive and would influence in achieving the User's requirements are like:

Connectivity includes modal integration, seamless travel,

Integrated ticketing Reliability includes Route Length, route bottlenecks, intersection control, ridership and passenger dispersal

Wait time includes fleet size and service planning

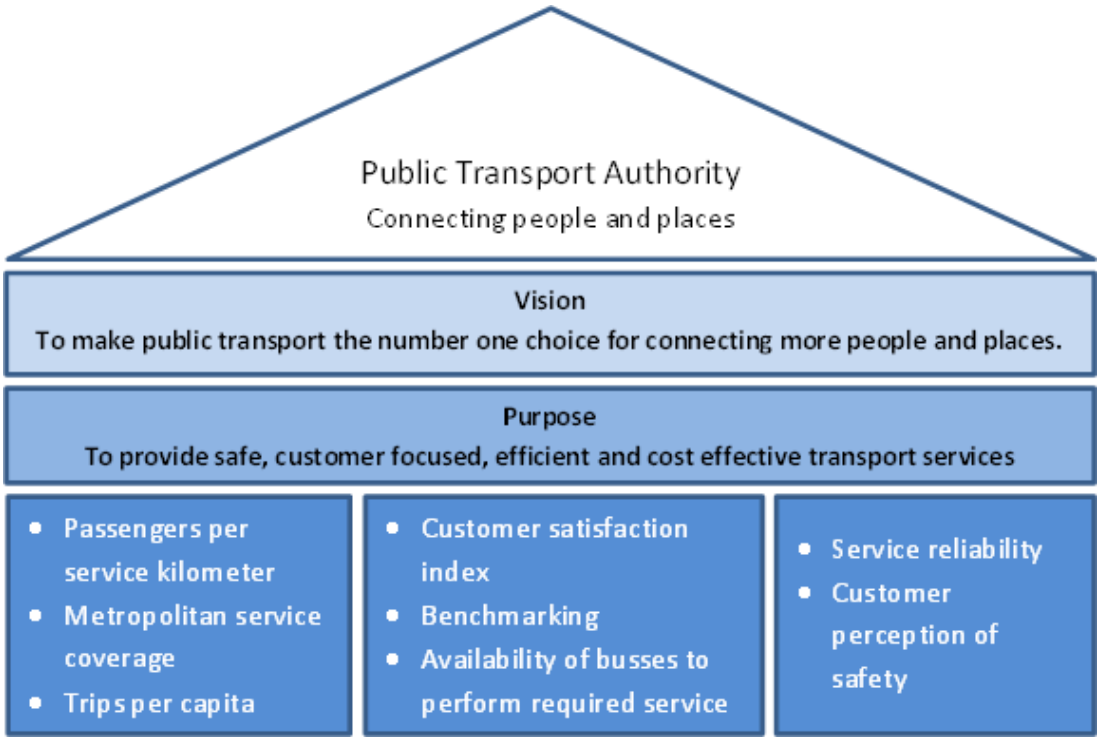


Figure 8-6: Strategy for Bus Service Improvement Plan

The main objective of the Bus operation is to meet the below mentioned user's requirements.

- Reliability
- Speed
- Frequency
- Comfort
- Accessibility
- Visibility
- Capacity
- Identity

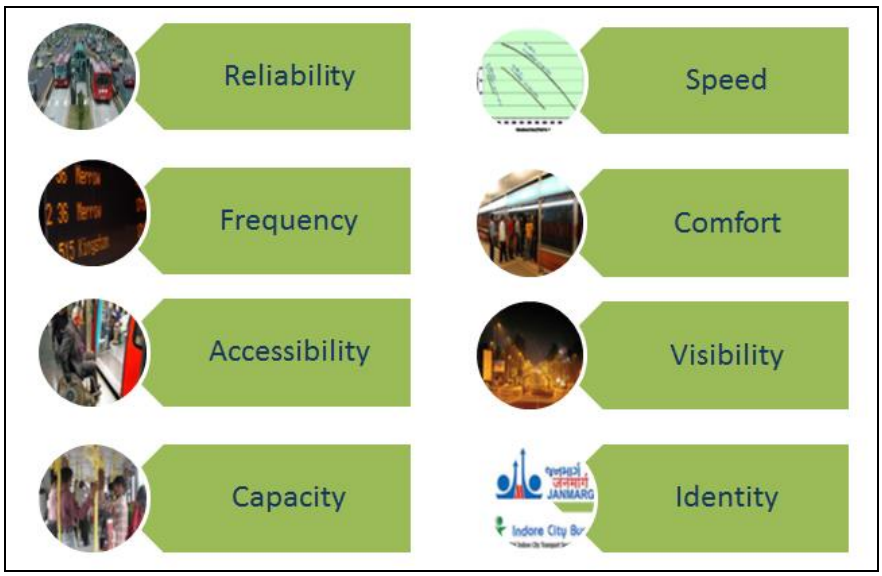


Figure 8-7: Key Attributes for Bus Service Improvement Plan

With the existing Bus service and infrastructure that offering level of service would not fulfill the requirement of commuters and thus discouraging the Public Transport System. Hence, after the capacity enhancement and introduction of Bus infrastructure, the bus service can be improved. Bus Improvement Plan Includes:

- Bus Infrastructure Plan
- Bus Operating Plan (Route Plan, Trunk with feeder etc.,)
- Route Rationalization
- Capacity enhancement
- Operations management

- Ticketing and revenue management
- Customer Orientation
- Human resource Development
- Modal Integration Plan
- Special Purpose Vehicle

8.3.4 System integration with other modes

When people move around in cities, they generally use more than one mode of transport; hence integration of all modes needs to be undertaken at both management and physical infrastructure levels. Poorly executed transfer services often share the following characteristics like long physical distances between two transfers, transfer in an area unprotected from extreme weather conditions and paying twice for transferring between lines.

At Solapur railway station the parking is in proper condition but the pedestrian facilities need to be improved and real time information about the public transportation should be provided at the entrance of the railway station.

8.3.5 Improvement in operations

In Solapur Municipal Corporation, the bulk of the public transport is operated by MSRTC. As described in *Guidelines for Bus service Improvement: Policy and Options,* Solapur comes under the category in which the government company is enjoying service provision.

There are no low floor urban busses plying within the city. The standard busses typically are not characteristic of modern busses, which have wide doors, low floors, pneumatic doors and rear engines etc.

Figure 8-8: Existing Standard buses in Solapur

The height of the bus floor and narrow doors makes boarding and alighting difficult and time consuming. Low floor busses can be introduced once the detailed study in framing the stringent and customer oriented service plan is prepared which reduces the busses spend time at bus stops. With proper marketing of the public transport we will achieve increased patronage, improved accessibility and features that allow all sections of society to use them.

Table 8-1 Existing Route description

S. No	Route No	Route Description	Route Length (Km)	Existing Headway / Frequency (Min)	No. Of Buses on Road	Existing Load Factor
1	41	Kanna Chowk to Gharkul	6	30	2	97
2	30	Station to Godutai Gharkul	15	25	6	93
3	39	Kontam Chowk to Najik Chincholi	40	240	1	84
4	18	Station to Ulegaon	18	120	1	84
5	22	Kontam chowk to Rajasva	10	120	1	80
6	82	Station to Honsal	21	150	1	78
7	24	Kontam Chowk to Pratap	12	120	1	78
8	29	Rajendra Chowk to Belati	15	150	1	77
9	37	Rajendra Chowk to Sindkhed	24	150	1	76
10	84	Station to Kadehalli	18.9	150	1	73
11	73 F	Panjrapol to Vinchur	36	240	1	73
12	55	Kontam Chowk to Kasegaon	14.9	60	2	71
13	52	Rajendra Chowk to	15.5	150	1	70

S. No	Route No	Route Description	Route Length (Km)	Existing Headway / Frequency (Min)	No. Of Buses on Road	Existing Load Factor
14	57	Railway Station to Desai	10.4	60	2	69.58
15	45	Railway Station to Gharkul	8	120	1	69.21
16	47	Kontam Chowk to	13	60	2	69
17	96	Rajendra Chowk to	36	240	1	67.88
18	15-C	Railway Station to Sangdari	24	180	1	66.45
19	62	Railway Station to Devkurli	33	300	1	65.49
20	73	Panjrapol to Mandrup	26	50	3	65.31
21	34	Railway Station to Sunil Nagar	11	120	1	65.24
22	77	Railway Staion to Pitapur	32	180	1	64.2
23	83	Kumbharves to Dhotri	22	150	1	63.72
24	80	Rajendra Chowk to Pathari	24	150	1	63.24
25	8	Kontam Chwok to Sakhar	11	25	5	63
26	12	Rajendra Chowk to Kamla	11	120	1	61.82
27	93	Panjrapol to Shingadgoan	23	150	1	60.29
28	94	Panjrapol to Vangi	23	150	1	59.23
29	43	Kontam Chowk to Nai Jindagi	9	45	2	57.45
30	75	Ranjendra Chowk to BB	25	75	2	55.74
31	72	Rajendra Chowk to Vadgoan	23	75	2	55.74
32	17	Kontam Chowk to Hatturgaon	19	120	1	54.23
33	95-B	Panjrapol to Panmangrul	42	120	2	54.19
34	79	Kontam Chowk to Nandur	20	150	1	52.3
35	70	Railway Station to Musti	32	180	1	50.68
36	95-A	Panjrapol to Mundewadi	40	240	1	48.03
37	92	Panjrapol to Akkalkot Station	42	90	2	41.94
38	65	Panjrapol to Chandramauli	31	50	6	41.42
39	78-B	Panjrapol to Aurad	28	150	1	41.05
Subtotal					**64**	
Routes operated by private operator					**9**	
Total					**73**	

At present SMT is operating on with headways ranging between 30 to 240 mins. The city bus operation with more than 30 min of headway becomes non reliable for the commuters results the use of alternative mode of travel. In order to minimize the waiting time for the passengers the peak headway of the bus on existing routes, the proposed headways are kept less than 20 mins. The priority is given for those routes with the average load factor more than 60. The details are presented in the table below.

The present city bus service in Solapur runs with limited number of buses with repetitive breakdowns. It hardly covers important areas comprising major residential zones, industrial areas, schools and hospitals. To provide better service network in the city and to improve the quality of service, city intends to introduce new routes which will serve to important places which are not covered with the present operation. The corridors are already developed in terms of new residential and industrial areas which are presented in the table below. The additional fleet required for these new routes is estimated and majority of routes are proposed with headway less than 20 min during peak hours.

The additional fleet requirement for the years 2015 – 2035 is given below in the table.

Table 8-2 Fleet Requirement over the years

Years	2015	2021	2026	2031	2035
Fleet Size	200	220	300	400	450
Additional Fleet Requirement	**127**	**20**	**80**	**100**	**50**

Based on the status of existing Depots vis-à-vis their capacity and facilities, existing fleet size and proposed increase in fleet size, supplemental bus depot is proposed in order to improve the kilometre efficiency of service and vehicles and to reduce the dead mileage. The proposed depot location along with the details is given in Table 8-3.

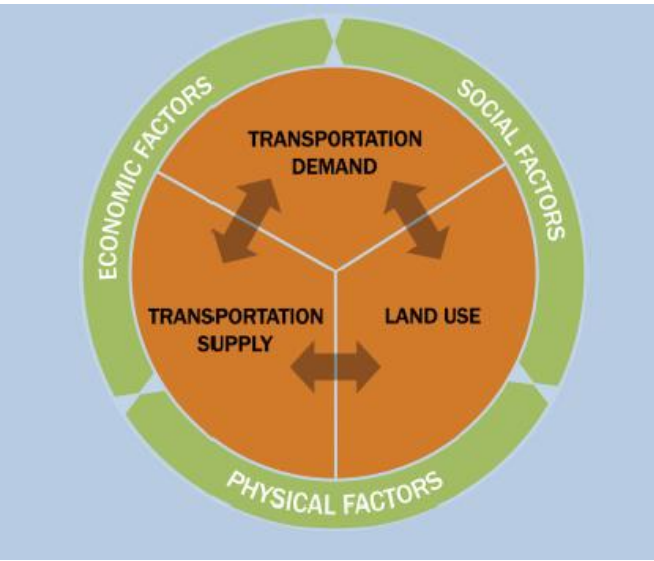
Table 8-3: Depot Locations

Item	Depot 1	Depot 2	Depot 3
Name	Main Depot (Budhwar Peth)	Sub Depot (Saat Rasta)	Rajendra Chowk Depot
Total Area	21610 Sq.mt.	11800 Sq.mt.	5700 Sq.m
Total No. of buses (Proposed)	100	50	25
Bus types	SLF, Midi, Low floor AC	SLF, Midi, Low floor AC	SLF, Midi, Low floor AC
Capacity (no. of buses)	100	50	25
Repair and Maintenance details	Preventive & major Breakdown maintenance	Preventive & major Breakdown maintenance	Preventive & major Breakdown maintenance

8.3.6 Recommendations for Infrastructure

- Services that align with future land use patterns
- Increased public transport mode share

- Service that meet customer needs
- Increased passenger numbers
- Earmarking lanes of public transport by optimizing the road space, banning the parking of vehicles on roads and removing encroachments
- new bus stops and additional raised kerbs to improve access
- bus priority at some traffic signals at peak hours
- improved bus journey information systems, with real-time displays at bus stops
- security with improved lighting and CCTV coverage in bus terminals
- Driver training and improvements to bus cleaning to improve passenger experience of bus journeys.



8.3.7 Benefits

The main benefits concern travel time, reliability and punctuality, as well as perceptions of improvement in safety, image and identity.

When running along exclusive right-of-ways or benefiting from priority signalization, enhanced bus services operate at a higher average speed. Travel time savings are strengthened when the system allows for pre-paid fare collection and level boarding. The most significant effect of these improvements is an increase in transit ridership.

Transit-Supportive land development

Significant positive development effects can result from the development of a new bus service or the improvement of an existing one. Transit infrastructures and facilities such as bus stations have the potential to shape urban development by fostering accessibility to employment and economic centers, increasing property values and creating more livable places. These new developments will feature higher densities and intensity of uses, emphasizing a greater mix of activities including housing, employment, retail, and leisure activities.

Environmental Quality

In terms of environmental impacts, additional ridership suggests that some people have given up their cars to opt for public transit, contributing to reduced traffic congestion and automobile emissions.

8.3.8 Model Road

It is observed the citizens have not experienced a properly designed road with all the facilities. They have been experiencing only make shift roads that fit into the existing land (ROW) availability and funds availability. In order to improve the awareness amongst the citizens a model road is proposed.

Road has been taken as the available road width is suitable for accommodating all the facilities. This cross section can be implemented with minimal construction. The cross section applicable for this Model Road is given in below

Figure **8-9**.

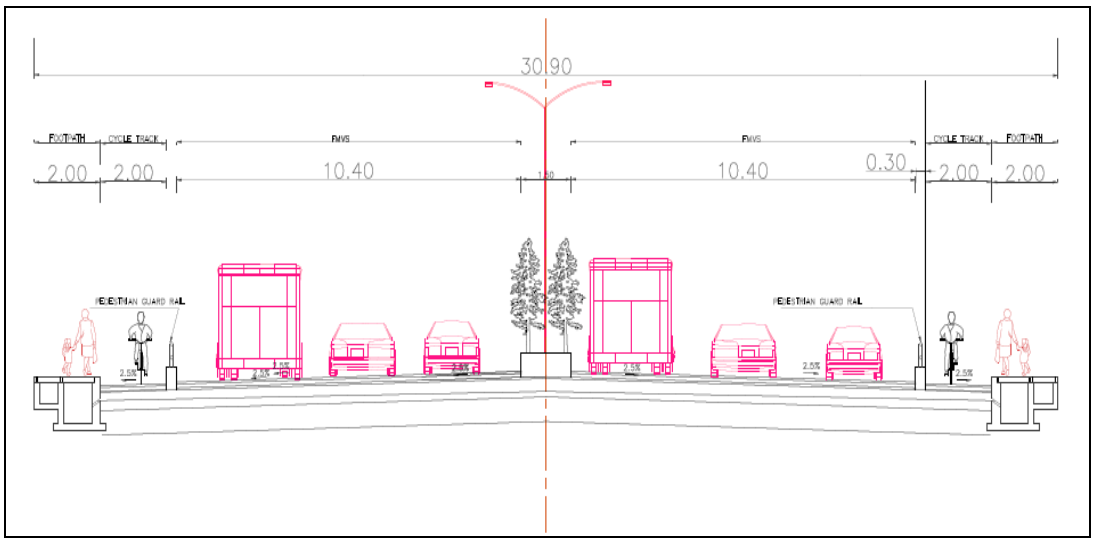


Figure 8-9: Cross Section for Model Road with all the facilities (Mixed Traffic)

8.3.9 Bus Bays

It is observed that the bus bays are not properly organized. Typical Bus Bay drawing is given in below

Figure 8-11. Footpath is made continuous at bus shelter area to give the proper access to pedestrians. On upcoming Bypass road proper Bus Bays can be implemented with proper signage.

Figure 8-10: Typical Bus Shelter Design

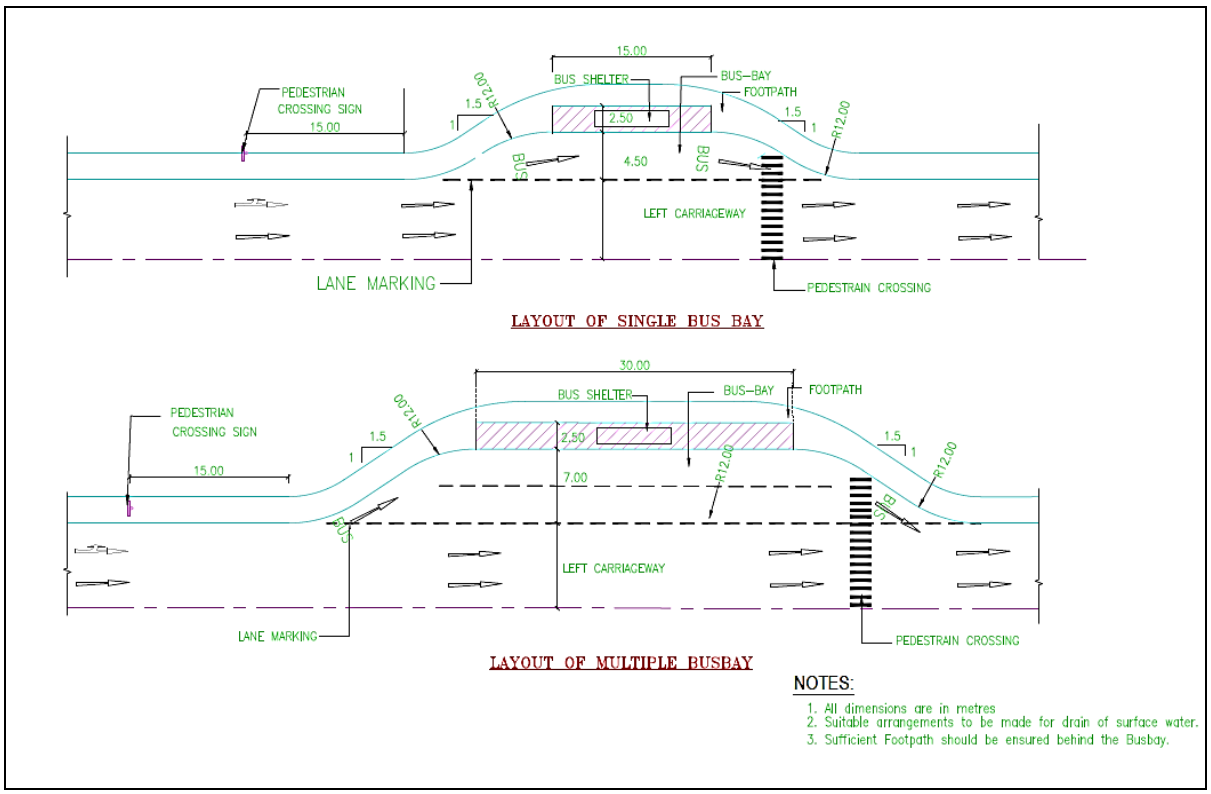


Figure 8-11: Typical Bus Bay

8.3.10 Transit Oriented Development

Usually, Transit oriented development (TOD) is a walkable, mixed-use form of area development typically focused within a 600m to 1000m radius of a transit station. Higher density development is concentrated near the station to make transit convenient for more people and encourage ridership. This form of development utilizes existing infrastructure, optimizes use of the transit network and creates mobility options for transit riders and the local community. Successful TOD provides a mix of land uses and densities that create a convenient, interesting and vibrant community for local residents and visitors alike.

TOD is also about enabling sustainable long-term urban growth. TOD is all about creating mixed-use communities in key strategic areas around the City, in our established communities to provide people with more choices of places to live that are less reliant on motor vehicle transportation.

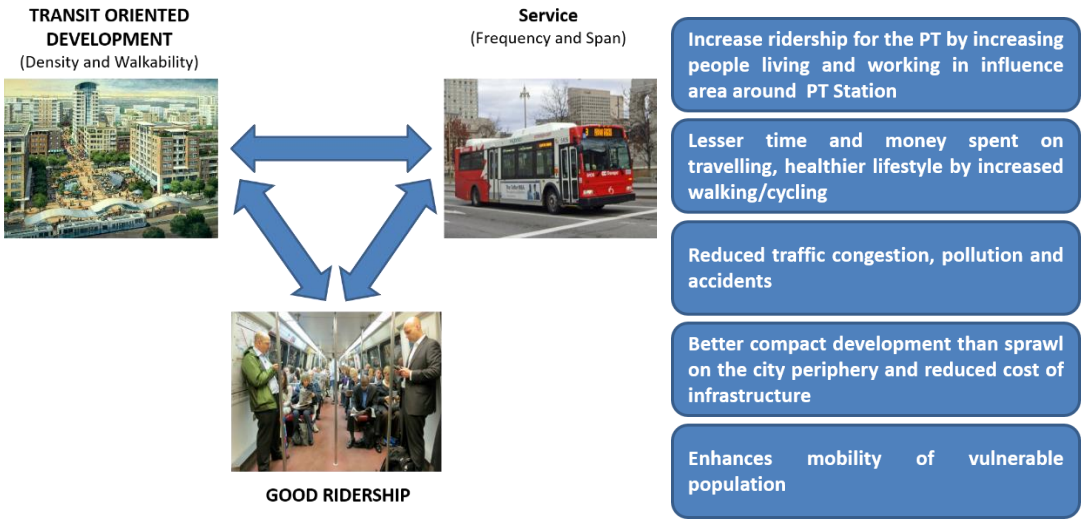


Figure 8-12: Transit Oriented Development Framework

8.3.11 ITS Application

Intelligent Transportation Systems (ITS) apply advanced technologies of communications, control, electronics and computer hardware and software to the surface transportation problems.

This improves the performance of a country's transportation system by maximizing the capacity of existing infrastructure, reducing to some degree the need to build additional highway capacity.

Table 8-4: Classification of Intelligent Transport Systems (ITS)

ITS category	Specific ITS Applications
1. Advanced Traveler Information Systems (ATIS)	Real-time Traffic Information Provision Route Guidance/Navigation Systems Parking Information Roadside Weather Information Systems
2. Advanced Transportation Management Systems (ATMS)	Traffic Operations Centers (TOCs) Adaptive Traffic Signal Control Dynamic Message Signs (or "Variable" Message Signs) Ramp Metering
3. ITS-Enabled Transportation Pricing	Congestion Pricing/Electronic Road Pricing (ERP) Fee-Based Express (HOT) Lanes

ITS category	Specific ITS Applications
Systems Electronic Toll Collection (ETC)	Vehicle-Miles Traveled (VMT) Usage Fees Variable Parking Fees
4. Advanced Public Transportation Systems (APTS)	Real-time Status Information for Public Transit System (e.g. Bus, Subway, Rail) Automatic Vehicle Location (AVL) Electronic Fare Payment (for example Smart Cards)
5. Vehicle-to-Infrastructure Integration (VII) and Vehicle- to-Vehicle Integration (V2V)	Cooperative Intersection Collision Avoidance System (CICAS) Intelligent Speed Adaptation (ISA)

ITS technologies that are specific to public transportation are grouped under Advanced Public Transportation Systems (APTS). APTS technologies can help improve transit and ridesharing services.

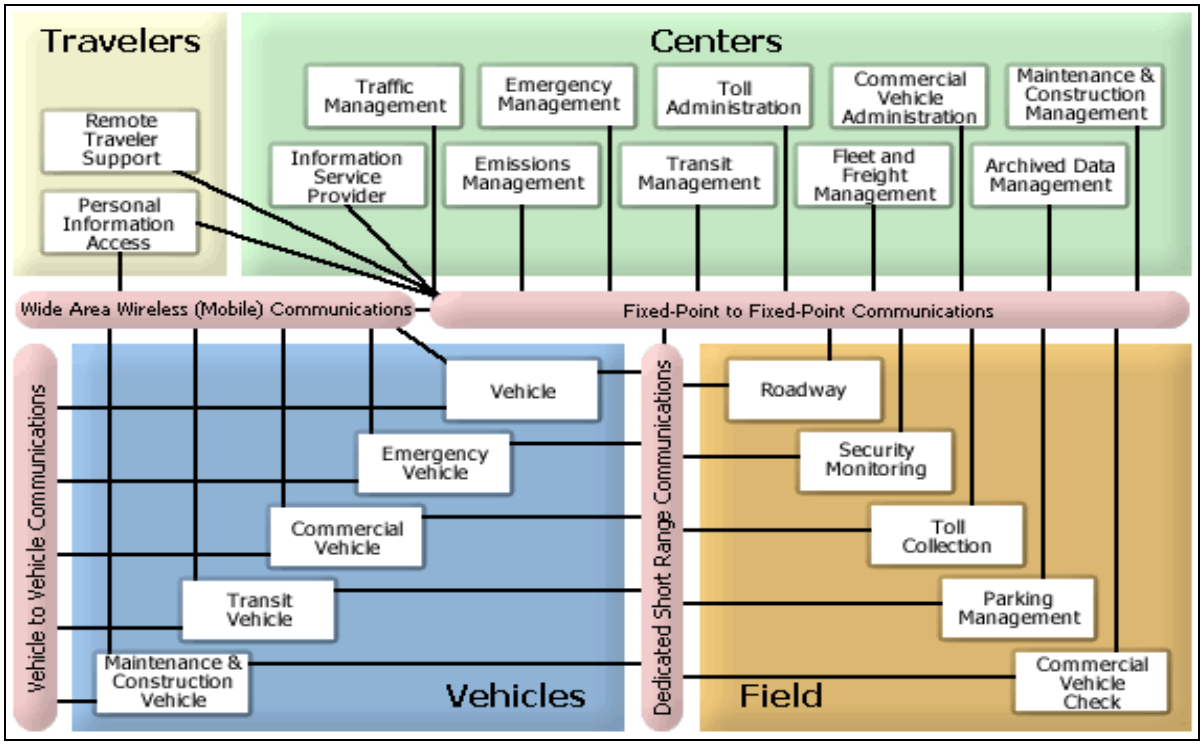


Figure 8-13: ITS Applications

Benefits of Intelligent Transport Systems (ITS)

Applying information technology to a country's transportation network delivers five key classes of benefits by:

- increasing driver and pedestrian safety,
- improving the operational performance of the transportation network, particularly by reducing congestion,
- enhancing personal mobility and convenience,
- delivering environmental benefits, and
- Boosting productivity and expanding economic and employment growth.

ITS enhance driver mobility and convenience by

- decreasing congestion and maximizing the operational efficiency of the transportation system
- Providing motorists and mass transit users with real-time traveler information and enhanced route selection and navigation capability.

For achieving the Users Satisfaction and the perfect Bus Service/mass Transit Service, ITS system is essential and the framework for the same is as shown below.

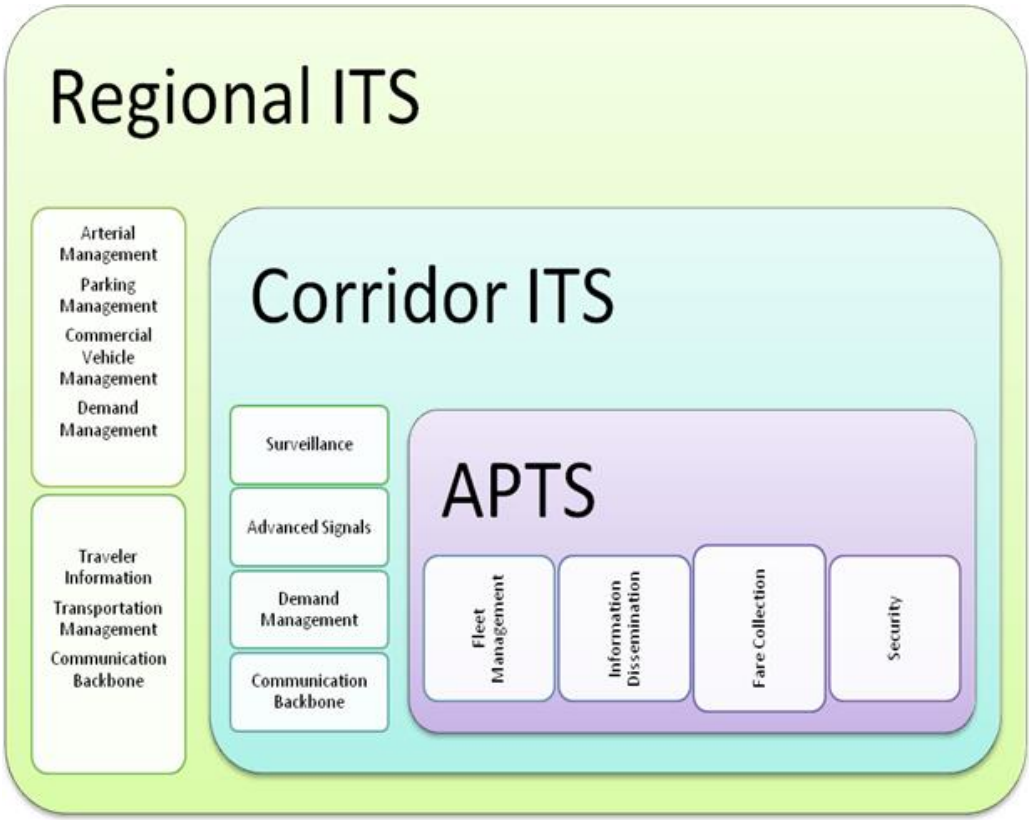


Figure 8-14: ITS System

The framework should be poised in three stages Regional ITS, Corridor ITS and APTS. These include Arterial Management, Parking management, Commercial vehicle management and Demand Management. The main aspect of ITS is the Traveler Information which can reduce the travel time and the bus routes can be optimized or re-routed. ITS System can be well integrated with the Ticketing systems and thus achieving the objective of MoUD's National Urban Transport Policy (NUTP) Seamless Travel.

Seamless Travel

The objectives of the seamless travel are

- Providing integrated fare media for use by patrons of all agencies.
- Improved convenience and seam-less travel
- Providing a platform for coordinated marketing of transit services throughout the region,
- Generating cost savings and increased rider-ship.
- Simplifying fare structures across multiple providers and reducing public avoidance due to perceived complexities of transit use.

The basic infrastructure of integrated ticketing is as shown in the figure below.

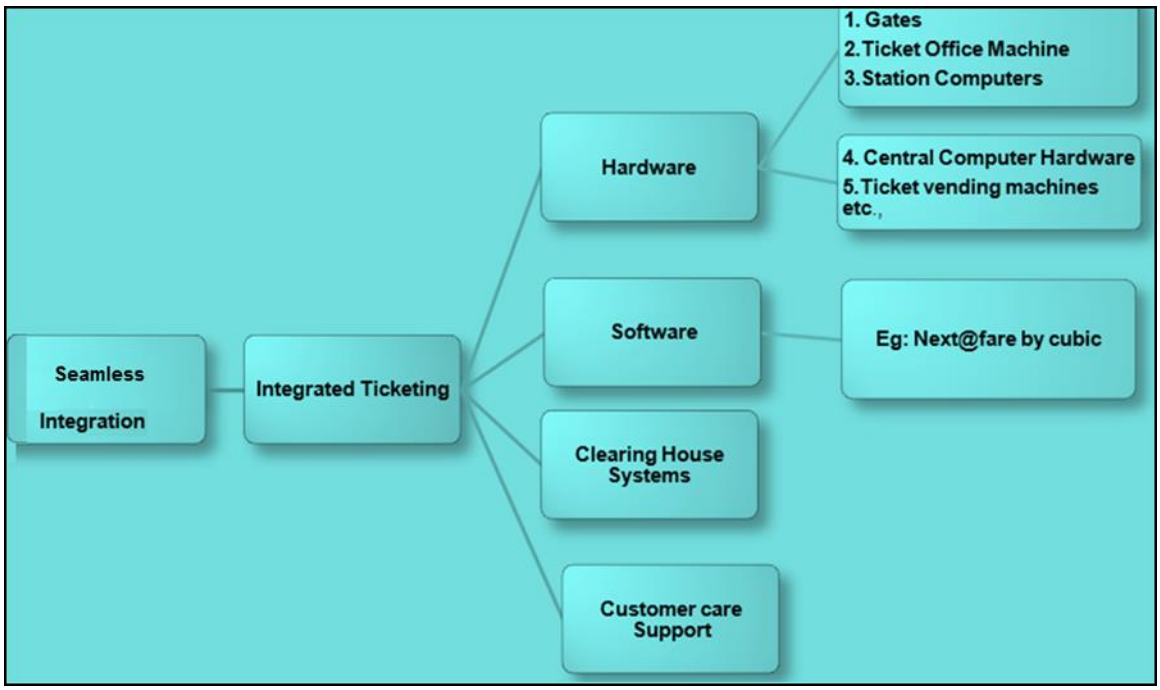


Figure 8-15: Components of Seamless Integration

Intelligent transport systems (ITS) are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Various ITS applications that can be implemented in the cities include the following

- Roadway applications
- Bus Applications
- Web based passenger information system
- Use of CCTV cameras for safety, security and traffic surveillance
- Variable Message Signboard system for traffic information

8.3.12 Roadway Applications

In Urban roads, improving the safety of roadway can increase overall efficiency. Bus dedicated way, which typically requires serving the highest volume and safety. Development of ITS application on the road way will provide system managers, passengers, drivers with timely information on current conditions on the road ways. It functions for smooth, safer flow of public transport bus with better tool for controlling flow and managing incidents and events. The direct benefits anticipated from actively managed ITS road application are reduced delay, increased throughput, smoother flow, fewer crashes and quicker response time. Secondary benefits expected are most consistent, reliable travel times and reduced air pollution emission (because of stoppage of vehicle due to traffic jam).

ITS road application designs proposed for the city corridors are described below:

1. Network surveillance: It is proposed to put video camera with CCTV cameras at regular intervals along the Corridor, which will cover whole Bus corridor. It will collect information on travel conditions through the intelligent camera placed at regular intervals. This will allow system manager to monitor traffic flow condition besides public

transport bus, identify location of bus at any instant, identify & verify incident, detect faults in indicator operations and collect data which can be used for traffic strategy development and long range planning. This can be installed at all major intersections, busy corridors so that traffic violations can be better monitored and managed through adopting appropriate measures to arrest them.

2. Meter Ramps: It is a system wherein meter ramps on corridors are installed, which will allow controlling freeway flow on corridors for motorized vehicles as well as Public Transport buses. Particularly, when the load on vehicular lanes increases, the system will release entering vehicle at a steadier rate, so that they can merge with less disruption.

3. On board Information Dissemination: This involves installation of ITS device to provide information to travelers on roadways. It will work either in form of advisory radios or in form of signage. The dynamic message signs deployed at locations where the travelers can adjust their trips on motorized vehicle lane. Similarly Bus driver will have awareness on information like road congestion, traffic jamming, weather etc. before reaching the destination. It will also provide information about parking facilities / space available for parking on motorize vehicle lane. The system will also help system manager in AITS control room, which is proposed to set in the center of the city to: 1) notify travelers of construction, incident or any other events and 2) potentially provide alternative travel suggestions on motorized vehicle lane traveler.

4. Incident Management System: As described above this also forms part of Area ITS in the city, Incident Management System will collect and correlate information from network and probe surveillance applications, weather information systems and other sources to detect and verify incident nature and location. This will be used by AITS system manager to coordinate and implement appropriate responses.

5. Data Marts: This involves setting up of establish a centralized AITS control center to use it for future traffic plans / system development. This will

require having strong database. Therefore, it is proposed to get data marts, which will collect and store data gathered from field devices for future analysis. The system managers use this data to develop improved operational plans and responses. The data so collected, will be useful for other transportation professional for future transportation planning activities.

8.3.13 Bus Applications Design

Intelligent vehicle technologies telemetric comprise electronic, electromechanical and electromagnetic devices, usually silicon micro-machined components operating in conjunction with computer controlled devices and radio transceivers to provide precision repeatability functions emergency warning validation performance reconstruction.

It is proposed to set ITS application in all the buses operated as Public Transport buses. These applications are developed for three major functions of Public Transport bus operation:

1. Vehicle Tracking system

GPS based vehicle tracking is advance technique through which an individual can track down any movable object. This GPS tracking system has lots of benefits to an individual. It provides the timely and detailed information about the location of private vehicle or public transport fleet position easily.

Benefits of vehicle tracking system are:

Improve Driving Skills: As the GPS vehicle tracking monitors capture each moment of vehicles, it can easily determine the drivers' behavior. By setting up alarms at exceeding

speed limit would remind them that they are being monitored by GPS system, and it is enough to alter/modify their driving skills. By adapting more conservative driving methods the fuel consumption will reduce and it'll also reduces the wear and tear of vehicles too. The main benefit though will be control of road accidents.

Updated reports of vehicles position: The GPS vehicle tracking system is more beneficial to the public /goods transporters. It provided the fleet's updated reports related to vehicle position, vehicle type and fuel consumption. It means:

- It measures the number of vehicles on road
- Provide the information about the vehicles which are overused.
- It checks the time taken to complete a delivery process.

2. Fleet management system

Fleet Management System (FMS) is a combination of mobile hardware devices, cellular data communications, GPS tracking and internet-based services to create integrated systems for the remote management of mobile vehicles, mobile workers and other high-value assets.

FMS is the third generation of a technology that began with basic, automated, vehicle location before moving into GPS Fleet Management. In addition to core Fleet Management technologies, FMS solutions provide seamless integration with third-party dispatch systems, vehicle operating diagnostics or driver monitoring for legislation compliance, back-end systems and efficient system monitoring process. If implemented in public transport management will provide efficient monitoring of the business processes which would enable efficient handling of passengers/commuters, effective monitoring of staff (drivers/conductors) and optimum utilization of fleet.

3. Passenger Information System

It is proposed to develop ITS correlated system to provide information to passenger on board about the current stations, next station, bus speed etc. It will also provide information about the concerned bus at bus stop arrival, by two way auto-communication.

Figure 8-16: Information System at Bus Stops

It will also provide the information to passenger at bus stop about cancellation of bus, route, diversion of route etc.

8.3.14 Web based passenger information system

The information gathered by the ITS system can be uploaded on to a website of city transport system to provide the passengers with the information regarding

- Nearest bus stop for the tourists/new comers to the city
- Bus(s) to be taken to reach a particular destination
- Present location of a bus
- IPT mode (auto rickshaw, taxi, mini bus, rickshaw) availability to reach nearest bus
- Fares of IPT modes
- Time of availability of next bus at a particular bus stop
- Total likely journey time and total fare

Installation of such a system would enable a seamless travel by tourists and newcomers to the city without any hurdles.

8.3.15 City Bus Applications

As specified above, City Buses can be developed by using ITS based on GPS module & CDMA / GSM module. City GIS mapping is essential for this purpose and will be used for preparing Bus station ITS application design. Following ITS application modules developed will be used for the following purposes:

- LED scrolling board will be fixed inside the bus terminals / stations from where one can know arrival / departure of the Bus.
- Probable arrival time of bus at particular bus stop.
- Automobile control / information transfer facility with centrally located AITS.

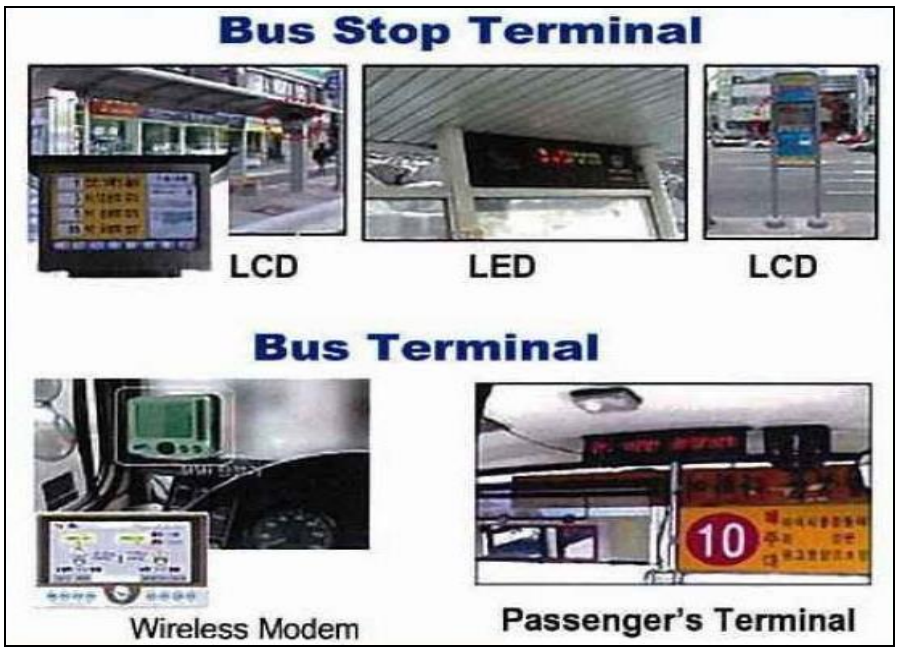


Figure 8-17: Example - Bus Information System

Figure 8-18: Example - Real Time Public transport information at a bus stop

8.3.16 CCTV Camera for safety, security and traffic surveillance

A traffic enforcement camera system, consisting of a camera and a vehicle-monitoring device, is used to detect and identify vehicles disobeying a speed limit or some other road legal requirement and automatically ticket offenders based on the license plate number. Traffic tickets are sent by mail.

Applications include:

- Speed cameras that identify vehicles traveling over the legal speed limit. Many such devices use radar to detect a vehicle's speed or electromagnetic loops buried in each lane of the road.
- Red light cameras that detect vehicles that cross a stop line or designated stopping place while a red traffic light is showing.
- Bus lane cameras that identify vehicles traveling in lanes reserved for buses. In some jurisdictions, bus lanes can also be used by taxis or vehicles engaged in carpooling.
- Level crossing cameras that identify vehicles crossing railways at grade illegally.
- Double white line cameras that identify vehicles crossing these lines.
- High-occupancy vehicle lane cameras for that identify vehicles violating HOV requirements.
- Turn cameras at intersections where specific turns are prohibited on red. This type of camera is mostly used in cities or heavy populated areas.
- These CCTV cameras should be installed in all the major intersections of Solapur City.

8.3.17 Variable Message Signboard system for traffic information

Generally Variable Message Sign Boards are used within parking guidance and information systems to guide drivers to available car parking spaces and accident prone areas, traffic congestion, accidents, incidents, roadwork zones etc. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of the incidents or just

inform of the traffic conditions. A complete message on a panel generally includes a problem statement indicating incident, roadwork, stalled vehicle etc; a location statement indicating where the incident is located; an effect statement indicating lane closure, delay, etc. and an action statement giving suggestion what to do traffic conditions ahead. These signs are also used for AMBER Alert and Silver Alert messages.

The information collected through various data collection system installed, can be used to disseminate the information to road users through installing variable signage boards to

- control the speed of the traffic
- divert the traffic to less congested routes in case of any traffic chaos
- congestion pricing to discourage vehicles to use congested corridors

Various sign boards are shown below:

Figure 8-19: Example – Variable Message Sign Boards

8.3.18 Lighting

The Lighting is a practical need and also becomes aesthetic element in night because of its dominant visibility. Proper lighting facilities and encourage safe pedestrian movement. Proper lighting enhances natural surveillance and reduces proneness to crime and anti-social activities. Street lighting along the roads and pedestrian paths are given importance. In general, three types of lightings are used predominantly, general lighting, pedestrian lighting and spotlighting.

General Lighting

These form the basic structuring of lighting with pole size of 6-7m. They exaggerate the avenue effect and plazas by highlighting geometrical boundary of space in the night. Placing at 20m distance can illuminate the place uniformly.

Pedestrian Lighting

These poles are 3-4.5m high and at a regular interval of 20m. These are placed along pedestrian paths and can be mounted on independent pole or on common pole with general lighting. These Lamps choice can be made on theme of the station, since they are visible at low height and become aesthetic elements of urban landscape. Traditional or contemporary designs can be chosen depending upon the station location.

Figure 8-20: Indicative traditional pedestrian Lamps

Figure 8-21: Indicative Contemporary Pedestrian Lamp Posts

Spot Lighting

These are primarily used to highlight, element in the space, either tree composition, sculpture or vertical element like signage or can be a wall up-lighter to create light patterns. Choice of these to be made based on their weathering and maintenance issues.

Predominantly two types are suggested one which light up the Pedestrian paths which can

be pole mounted on 3-4.5 m ht and will have good spread. The fixtures need to be such that they do not cause glare at eyelevel for comfort of the pedestrians. They can also be solar photovoltaic. The second one is spot highlighter used to accentuate vertical elements. These are used at important place to high light and dramatize the place as shown in Figure 8-22

Figure 8-22: : Indicative Spot Lighting

Street Furniture

Designed and comfortable street furniture, conveniently located with legible signage, bus tops with bus information system, comfortable seating arrangements, well-lit walkways, good quality material usage (like tactile paving which helps vision impaired people), barrier free access, shaded areas, etc. create the much required ambience for pedestrians to walk rather use private vehicles for shorter distances. Choice of street furniture and other installations should consider the performance in humid climates in terms of maintenance, durability and human comfort as indicated in Figure 8-23

Figure 8-23: Indicative Street Furniture

8.4 Sustainable and Low Carbon Technological Options

8.4.1 Introduction

Climate change is already happening. Even if we take immediate and drastic steps to reduce emissions, significant change is going to occur throughout the world. The rapid growth in transport activity, based primarily on private Motorised vehicles, generates social, environmental and economic costs. Transport already accounts for more than half of global liquid fossil fuel consumption and nearly a quarter of the world's energy related carbon dioxide (CO_2) emissions. If current trends continue, transport related CO_2 emissions are expected to increase by 57% worldwide between 2005 and 2030, mainly as a result of rapid motorization in developing countries.

India is currently the fourth largest greenhouse gas (GHG) emitter in the world. With the second largest population, its per capita emissions are though less than half of the world average. The transport sector is the second largest contributor to carbon dioxide (CO_2) emissions in India. Besides CO2 emissions, the sector also gives rise to negative impacts such as road congestion, local air pollution, noise and accidents. The burden of these impacts has been extremely high in the urban areas. In the last two decades modal switching from rail to road transport has taken place for both freight and passenger transport. In cities the public transport services have been burdened by population growth and urbanization and overtaken by a rapid increase in private vehicles.

Decarbonizing transport is an essential part of building a low carbon future for India. The possibilities are far-reaching – electrified road and rail (powered by clean electricity), lower carbon aircraft designs, radically different information and traffic management systems, and renewed enthusiasm for clean forms of movement such as walking and cycling.

India's transport sector is responsible for 13 per cent of the country's energy-related CO_2 emissions in 2004 as shown in

Figure 8-3 and the accompanying impacts on air quality, public health, road safety, and sustainable urban development. In recent years, increased vehicle use has led to an augmentation in congestion, accidents, and local air pollution. If this trend continues, all of these problems will get worse.

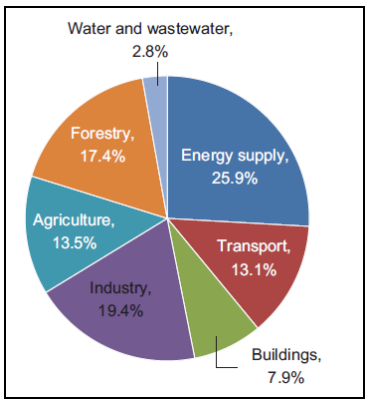


Figure 8-24: GHG Emissions by sector wise in 2004

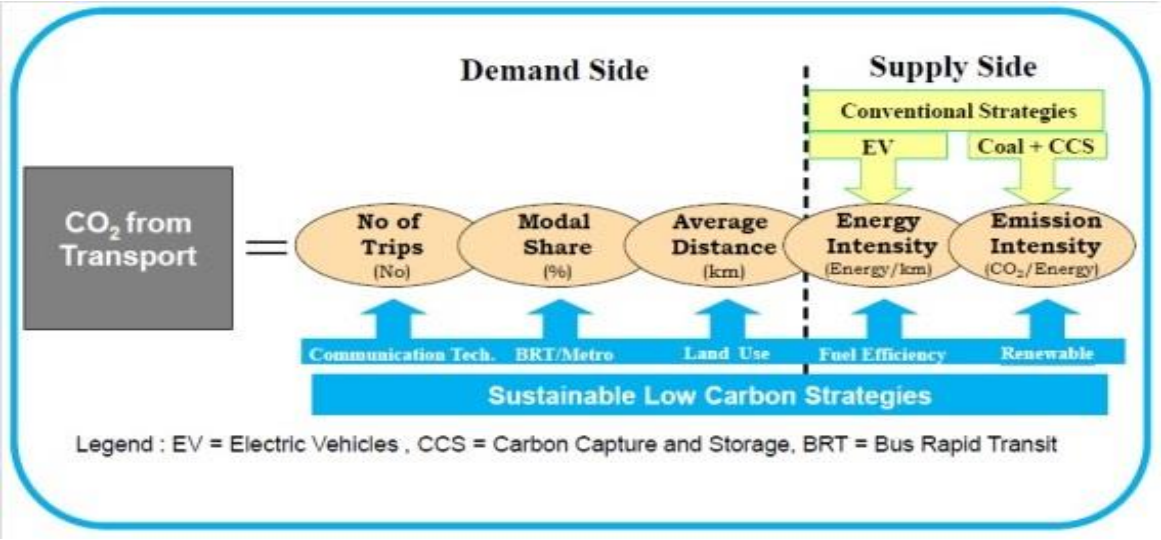
With greenhouse gas emissions from transport representing 13 per cent of total India's domestic emissions, decarbonizing transport must be part of the solution. This will be a major change, but moving to a low carbon economy and transport system also presents huge opportunities; not just for climate change but for our prosperity, health, and the wider environment. Working towards a form of mobility that is sustainable, energy-efficient and respectful of the environment is not only to improve citizens' quality of life but also to strengthen the economy by promoting sustainable urban mobility and increased use of clean and energy efficient vehicles.

Our aim should be to disconnect the mobility from its adverse effects. Transport underpins our quality of life and economic prospects and we want to give people and business more low carbon choices about when, where and how to travel, or to transport goods.

8.4.2 Strategies for reduction of GHG emissions

The main strategies for reduction of GHG emissions will be

- Technology Transitions - Supporting a shift to new technologies like solar and green fuels
- Promoting lower carbon transport choices
- Ensuring Equity in Transportation
- Ensuring Safety and accessibility of transportation



Source: United Nations Environment Programme (UNEP)

Figure 8-25: Framework for reducing emissions from Transport

8.4.3 Technology Transitions -Supporting a shift to new technologies like Solar and green fuels

Characterized by a heavy reliance on cars and trucks for both passenger and freight movement, transportation is a major consumer of fossil fuels and a big contributor to climate change. It is responsible for an estimated 23% of energy-related greenhouse gas emissions, with the fastest-rising carbon emissions of any economic sector. Road transport is heavily tilted toward cars and trucks. Producing more fuel-efficient vehicles is the most immediate way in which environmental impacts can be reduced. Hybrid vehicles can be an important part of the solution, provided the added electric motor is used to reduce gasoline consumption instead of adding to a vehicle's power and acceleration. Our aim is to deliver a transformative shift to low carbon road transport, maximizing the potential of technology to reduce substantially emissions from cars and vans.

To achieve this shift we are:

- Tightening vehicle standards at a National level
- Leading research, development and demonstration of low carbon vehicles
- Making ultra-low carbon vehicles more competitive for consumers
- Supporting the adoption of ultra-low carbon vehicles in lead cities and regions and
- Exploring other technologies to improve fuel efficiency.

Solar technology

Solar Technology can also be used extensively as an alternative to regular energy production as it enables energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower. Solar lights and signals can be installed within the city to minimise the energy consumption.

Figure 8-26: Solar Lights and Solar Signals

Green Fuels

Green fuel, also known as biofuel, is a type of fuel distilled from plants and animal materials, believed by some to be more environmentally friendly than the widely-used fossil fuels that power most of the world. In the desperate search for alternative energy sources, green fuel has evolved as a possible fuelling option. Biodiesel is a renewable fuel that can reduce carbon emissions, save money and have a positive health effect on communities across the world. Producing 85% less CO2 and generating fewer emissions such as sulphur, hydrocarbons and particulates, biodiesel offers a sustainable, renewable alternative to fossil fuel. Biodiesel also helps to solve the growing problem of how to dispose of used cooking oil safely, ensuring that used oil is recycled into fuel rather than poured into drainage systems or put back into the food chain.

In creating basic forms of biofuel, crops are broken down into two types: sugar producing and oil producing. Sugar and starch producing crops, such as sugar cane or corn, are put through a fermentation process to create ethanol. Oil producing plants, like those used in

vegetable oils, can be used much like fossil sources of oil; they create diesel that can be burned by cars or further processed to become biodiesel.

CNG has been used in many places of India as an alternative to fossil fuels. CNG is a readily available alternative to gasoline that's made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure. It's drawn from domestically drilled natural gas wells or in conjunction with crude oil production.

Fuel cells

Fuel cells create electricity from hydrogen and oxygen. The only by products from the reaction are water and heat. Vehicles powered by hydrogen fuel cells are all-electric, zero emission cars, SUVs and buses. In the movement towards cleaner transportation, fuel cell electric vehicles have much to offer. Like battery electric vehicles, fuel cells vehicles use electric motors for propulsion. No other energy technology offers the combination of benefits that fuel cells offer like low or zero emissions, high efficiency with low CO_2, wide range of applications, high quality power, reliable, quiet, fuel flexible, and economic benefits.

8.4.4 Promoting lower carbon transport choices

Technology measures are important in reducing transport emissions, but they are not enough on their own. We also need to think about the choices that we, as individuals and businesses, make on a daily basis about when, where and how to travel and transport goods. For some users of transport, lower carbon options may already be attractive. For example, measures such as shifting freight from road to rail can be competitive for business whilst reducing congestion and emissions. Policies that encourage people to take public transport or walk and cycle can bring these benefits too, as well as enhancing the local environment and supporting healthier lifestyles.

But for those with access to a car, their convenience and comfort is undeniable. Reducing emissions from all these journeys can be achieved through a combination of new low carbon technologies, different patterns of travel and new approaches to logistics. The onslaught of ever-growing motorized transportation threatens to overwhelm the gains derived from per-vehicle efficiency measures.

A more sustainable system will have to be based on shorter distances. Reduced distances and greater density of human settlements enables a re-balancing of transportation modes giving greater weight to public transit systems, as well as walking and biking. A modal shift away from private vehicles and toward rail and other public transport can generate considerable net employment gains, while reducing emissions and improving air quality.

To achieve these sustainable challenges, the aim should be to make public transport an accessible, attractive, low carbon and easy-to-use option for individuals and business. Buses, trams, and railways use far less energy per passenger- or freight-kilometer than road vehicles. By enhancing the cities to improve mobility with lower CO_2 emissions we can make transport growth more sustainable within the country.

Figure 8-27: Allocation of Road Space equally

There are opportunities for action at many levels. Individuals' choices about whether and how to travel have a significant cumulative impact on transport demand; Government also has an important role to play.

At a national level we seek to influence transport choices by providing strategies, guidance and information; as well as by setting technical standards or directly funding services. By

giving importance for the allocation of the road space for all road users and uses at national policy level as shown in the Figure 8-27 emissions will be reduced.

The special guidelines need to be prepared at national level such as Complete Streets Design manual, Universal Accessibility Design manual etc.

Figure 8-28: Complete Streets Design Concept

For promoting the low carbon technologies, the broad strategies are

- Strengthening public transport through promotion, regulation of private vehicles, and fiscal measures to incentivize public transport as shown in the Figure 8-29 and Figure 8-30.
- Modal shift to Non-Motorised transport
- Planning, monitoring and coordination
    - Improving access to goods and services through an integrated urban plan
    - Multi modal integration through the setting up of a Unified Urban Metropolitan Transport Authority

- Comprehensive Mobility Planning and Intelligent Transport Systems
- Central financial support
- Integrating intercity transport with urban transport
- Service level benchmarks

➢ Technology

- Shifting from fossil fuels to biofuels and alternative fuels (e.g., EVs)
- Improving and establishing fuel efficiency standards for vehicles Facilitating R&D
- Discouraging diesel propelled vehicles

Figure 8-29: Dedicated Public transport

Figure 8-30: Dedicated NMT Lane

To ensure the needs of pedestrians and cyclists are considered in planning and improvement projects, it may be appropriate for Municipalities to consider city level complete streets policy as stated in the National Urban Transport Policy. Achievement of sustainable transport can be realized through "Avoid-Shift-Improve "(ASI) approach, as shown in

Figure **8-31** which aims to: (1) improve access to jobs, goods and services while enabling users to Avoid motorized trips by smarter land use and logistics planning; (2) Shift the transport of goods and persons to the most efficient mode; and (3) Improve the efficiency and environmental performance of transport systems by improved vehicle, fuel, and network operations and management technologies.

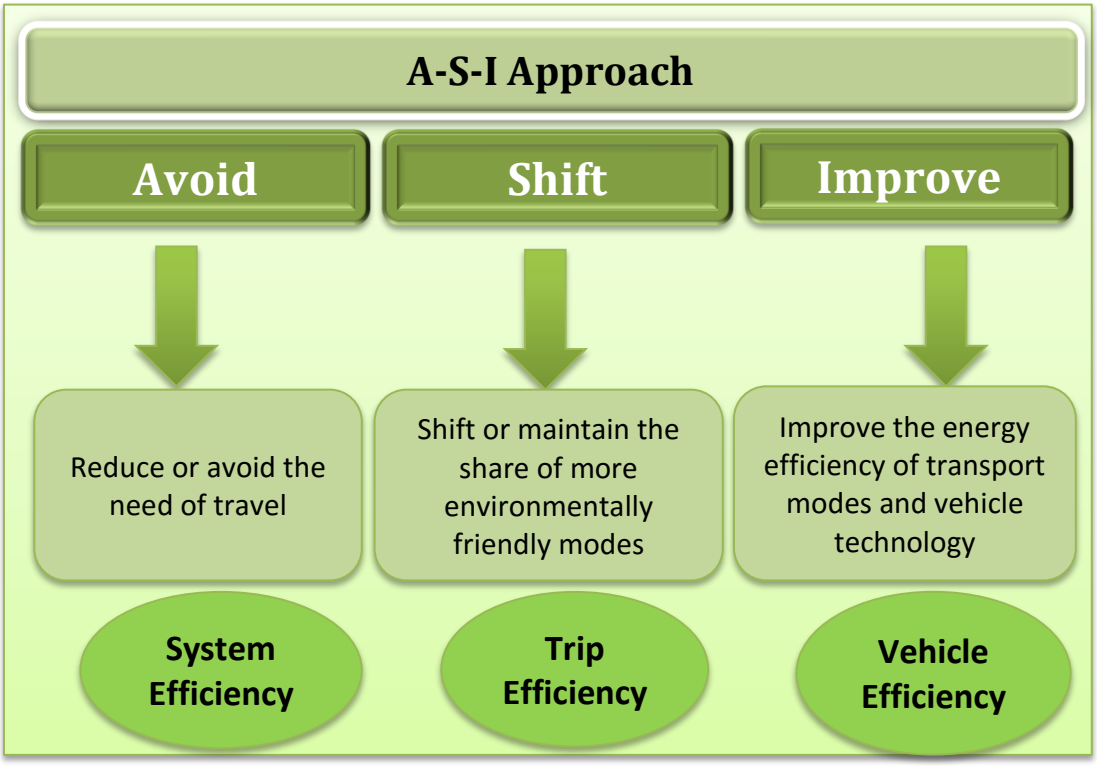


Figure 8-31: ASI Approach

Successful examples of the Avoid-Shift-Improve approach are given below.

Access while avoiding unnecessary travel:

- Vehicle quotas allocated through auction or lottery (Singapore, Shanghai and Beijing)
- Congestion charging (London, Stockholm, Milan)
- Freight charging (Germany)
- Integrated mixed land use plans in a large range of cities

Shift to transport-efficient modes:

- Bus Rapid Transit (over 100 cities, mostly in the developing world)
- Public bike schemes (over 200 cities, many in the developing world)
- Rail-based mass transit (many cities)
- Pedestrianisation (many cities)

Improve:

- Inspection and maintenance programs to reduce local pollution

- Fuel quality standards
- Electric bikes (millions — annual production in China is now more than 20 million)
- Electric cars, buses and other four-wheeled vehicles (plans for seven million by 2020)
- Fuel efficiency regulation (most of the developed world, increasing parts of the developing world)

8.4.5 Ensuring Equity in Transportation

Equity (also called justice and fairness) refers to the distribution of impacts (benefits and costs) and whether that distribution is considered fair and appropriate. Transportation should be made accessible to different of socio-economic groups and gender. Transport planning decisions can have significant and diverse equity impacts:

- The quality of transportation available affects people's economic and social opportunities.
- Transport facilities, activities and services impose various indirect and external costs, such as congestion delay and accident risk imposed on other road users, infrastructure costs not funded through user fees, pollution, and undesirable land use impacts.
- Transport expenditures represent a major share of most household, business and government expenditures.
- Transport facilities require significant public resources (tax funding and road rights of way), the allocation of which can favour some people over others.
- Transport planning decisions can affect development location and type, and therefore accessibility, land values and local economic activity.
- Transport planning decisions can affect employment and economic development which have distributional impacts.

Transportation activities and impacts can be measured in various ways that can affect analysis results. Impacts are often compared using various reference units, such as per-capita, per-trip, per-passenger-mile, or per-dollar. The scope of impacts considered in

analysis can vary significantly. The Equity implications of different reference units are given below in Table 8-5.

Table 8-5: Equity Implications of Different Reference Units

Unit	Description	Equity Implications
Congestion impacts	Transport system performance is evaluated based on roadway level-of-service (LOS) or estimated congestion costs, and improvements are evaluated based on their cost efficiency in reducing congestion delays	Favours people who most often drive on congested roads over people who seldom or never use such facilities
Vehicle Miles Travelled (VMT)	Transport investments are evaluated according to which route or mode can increase vehicle travel at the least cost	Favours people who drive their automobile more mileage than average
Passenger Miles Travelled (PMT)	Transport investments are evaluated according to the most cost-effective way of increasing personal mobility	Favours people who travel more than average. Tends to favour motor vehicle travel
Passenger Trips	Transport investments are evaluated according to the costs of each trip.	Provides more support for transit and Non-Motorized travel
Access	Transport investments are evaluated according to where improved access can be accommodated at the lowest cost.	Depends on how access is measured
Mobility Need	Transport investments are evaluated according to which provides the greatest benefits to disadvantaged people.	Favours disadvantaged people
Affordability	Transport user fees are evaluated with respect to users' ability to pay.	Favours lower-income people
Cost Recovery	Transport expenditures are evaluated according to whether users pay their costs.	Favours wealthier travellers because they tend to spend more and deserve the least

Unit	Description	Equity Implications
		equity-justified subsidies

8.4.6 Ensuring Safety and Accessibility of transportation

An efficient and effective urban transport system is a powerful tool for improving the efficiency and affordability of the labor market, and providing better access to education and public health services. A key challenge is, therefore, to develop urban transport system with satisfactory conditions of safety for all the genders. By following the shared streets concept, ASI approach, increasing pysical activity in cities the accidents, injuries and road crshes can be decreased by which road safety can be ensured. And also giving importance to gender related issues and providing secured transportation options will encourage women to use the public transpotation.

Addressing gender in urban transportation projects has the following benefits.

- It increases economic rates of return on investment in infrastructure and increasing the profitability of mass transport systems.
- It meets demand for transportation services through a better understanding of the divergent needs, preferences and constraints of end users both women and men.
- It lowers transaction costs by optimising the transport system for all users.
- It increases access to employment, education, and services that ultimately raise productivity.
- It enables women to better meet the needs of the household, for which they have primary responsibility and ultimately strengthens the base economic unit.

Accessibiltiy of transportation

Automobile travel is a form of mobility, which refers to physical travel. Accessibility refers to people's ability to reach desired goods, services and activities. Accessibility is the ultimate goal of most transportation activity. All else being equal, increased mobility (faster or cheaper travel) increases accessibility, and constrains such as traffic congestion and vehicle fees reduce accessibility, but other factors also affect accessibility, including the proximity of services and activities (such as the distance between homes, public

service and worksites), the quality of Transport Options (such as the convenience, comfort and affordability of walking, cycling and public transit), and mobility substitutes. For example, accessibility can be improved by improving walking and cycling conditions, and public transit services.

Accessibility for disabled and elderly people is not only about physical access to vehicles and systems. In order for a system to be accessible, it must provide information in forms that are useable by everyone, and training for transport staff to understand the needs of disabled and elderly people. Streets, parks, and other urban areas must be designed in a way that enables people to move about safely and confidently.

Accessibility also must be accounted for at every stage of a pedestrian's journey. A wheel-chair accessible bus does no good if a disabled person can't make it to the bus stop. The transport chain must be accessible at all points, for an individual can only make the journey if every link in the chain, from their door to their destination, is reliable, accessible, and affordable. Some of the examples of Universal Accessible designs are shown in below Figure **8-32**.

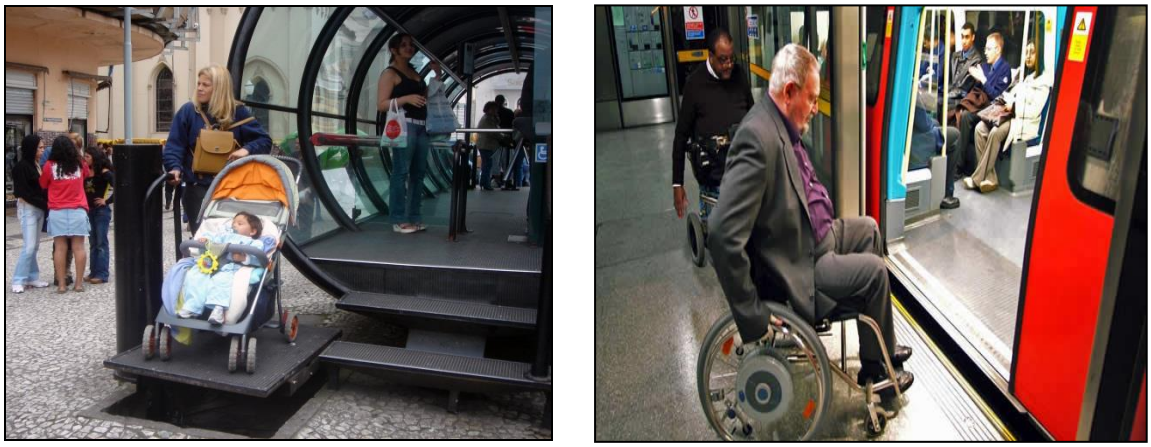


Figure 8-32: Accessibility to Public transport systems

8.5 Non-Motorized Transport Strategy

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

The cycle share in Solapur is about 13% in overall trips, but there is no cycle track facility in the city. Based on the Cyclist opinion survey, about 67% of the respondents feel that it is necessary to have separate cycle tracks.

The proposed measures to develop facilities for pedestrians and bicyclists on the streets include:

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

Construction of Cycle Track, Foot-Paths and Zebra Crossings

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

The proposed cycle track network is presented in the next chapter.

Foot Over Bridges and Walkways

Providing grade separated pedestrian crossing is an efficient way of improving safety for pedestrians, particularly at locations with high traffic volumes or on the corridors with larger widths. Foot over bridge can be provided with well-designed pathways to ensure safety for pedestrian movement at the busy junctions like Saat rasta and Railway station. The details for proposed walkways are presented in the next chapter.

Cycle Rickshaw Management

Solapur has cycle rickshaws as one of the important modes of transport. About 2% of the trips are carried by the cycle rickshaws. However, the cycle rickshaws currently operate in a disorganized fashion. The haphazard movements of these vehicles hamper the traffic flow on the carriageways. In the absence of any organized parking, the cycle rickshaws park on the available carriageways, resulting in reduced roadway capacities and increased potential for hazards for the road users.

It is hence desirable to have a strategy to designate cycle rickshaw stands at appropriate locations in areas that have been served by cycle rickshaws. Besides, they should run on the recommended cycle tracks to ensure an orderly and safe movement.

8.6 Freight Management Strategy

Freight movement in a city is an inevitable process of trade and economy. Traditionally, movement of goods for local consumption and sale generally takes place from a certain location within a city which is closest to the wholesale markets. In other cases where there have been successful planning interventions, the goods terminal is preferred to be located on the outskirts of the city, in order to prevent the entry of heavy vehicles into the congested parts of the city.

Solapur city has a wide catchment area for truck traffic. The city connects major national and state highways. The analysis indicated that there is lack of terminal facilities for trucks and multi-axle vehicles. To reduce the impact of heavy vehicle movement on local traffic, trucks should be banned during 7.00 am to 12 noon and 4.00 pm to 9.00pm. Lighter modes of transport for goods movement almost take place throughout the day in all parts of the city. A definite freight management strategy needs to be devised wherein adequate consideration is given to the economic activity of the region alongside ease of operations and flow of general city traffic. The primary concepts to be used for strategizing a freight strategy would be the following:

- Provision of terminal facility outside outer ring road on major radial corridors
- Classifying primary, secondary and tertiary freight hubs.
- Road network planning for interconnectivity between the freight hubs

- Relocating activity centers for congestion free inner areas

8.7 Parking Strategy

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

The parking strategies that would be considered for Solapur include

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

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

8.8 Traffic Engineering and Management Measures

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

ITS Management

Another important area that will assist and help significantly is the development of electronics in traffic management. The total ITS package however is very intricate and may

not find applicability immediately in true mixed traffic (Indian) conditions. However it will be essential to pursue the following:

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

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

IPT Management

The main IPT in Solapur are the share auto rickshaws. They do not have designated parking places at most of the areas in the city which is causing an unsafe scenario for the road user. Hence it is recommended to have dedicated auto rickshaw parking bays. The RTO must identify these locations for the orderly parking of auto-rickshaws. Besides at all the bus stops, terminals and railway stations, integration with IPT should be achieved for smooth interchange.

It is also important to relook into the auto permits and restrict them on the public transport routes (Mainly on the bus routes) to avoid conflict of interest. To support environmental friendly development, the new auto permits or renewal of auto permits should be restricted to the less emission vehicles.

Hawker Management

There is quite a bit of encroachment of the right-of-way by hawker, as well as by illegal structures in the city. These hawker encroachments are hindrance to the movement of people and also reduce the capacity of roadways. We propose „hawker zones" to be created at decongesting main roads in Solapur, and at the same time, protecting the interests of hawkers

Accordingly, three types of zones are proposed to regularize hawkers;

- Green zone – areas where hawking is allowed all the time
- Amber zone – areas where hawking is allowed at restricted hours
- Red zone – areas where hawking is not allowed anytime.

The municipality and development officials in tandem with the Traffic police should identify such zones in Solapur and ensure safe and efficient hawking management. All the mobility corridors will fall in the red zone category while all the pedestrian zones will fall in green zone category.

Other Traffic Management Measures

- Bus stops should be at least 60 m away from the junctions
- Bus bays should be considered at all possible bus stop locations
- Auto parking should be banned near all junctions and moved at least 50m away from junctions
- On street parking should be banned at critical locations on all major roads. To curb the menace of haphazard and illegal parking on main roads measures like restricted parking, time limit parking and metered parking should be thought of.

8.9 Travel Demand Management

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

- Subsidizing transit costs for employees or residents.
- Car parking controls and pricing
- Flex-time work schedules with employers to reduce congestion at peak times

- Congestion pricing tolls during peak hours.
- Road space rationing by restricting travel at certain times and places.
- Workplace travel plans
- Road space reallocation, aiming to re-balance provision between private cars and other sustainable modes
- Introducing active trip reduction programs
- Public education and awareness programs.

9. Project Proposals and Impacts

9.1 Introduction

The previous chapter described transport strategies and measures for the horizon year. This chapter we will discuss the strategy wise recommended projects. The SMC study has also brought out a comprehensive list of proposals that are important. Hence, proposals given in this chapter (Emerged out of this Study) form a good road map in providing Comprehensive Mobility solutions for Solapur.

9.2 Road Widening / Development Proposals

IRC 106-1990 for Urban Roads recommend Design Service Volumes for different classification of roads at Level of Service C (i.e., Design Service Volume/Capacity = 0.7) and the estimated capacities are presented below. Required number of lanes has been worked out for each road corridor/sections on the basis of lane configuration. It is observed that no. of lane requirements is very high, which is not feasible to provide in the field. Therefore the rationalization of lane requirements is made.

Table 9-1 Classification of Roads

Type of Carriageway	Category of Urban Road		
	Arterial	Sub-arterial	Collector
2 Lane Two way	2143	1714	1286
3 Lane One way	5143	4143	3143
4 Lane Undivided Two way	4286	3429	2571
4 Lane Divided Two way	5143	4143	-
6 Lane Undivided Two Way	6857	5429	-
6 Lane Divided Two Way	7714	6143	-

9.3 Road Improvement Proposals

The travel demand models developed for the Solapur city, showing predominant demand of travel in east-west direction. The list of road widening proposals for different roads in Solapur city is presented in Table 9-2.

Table 9-2: Road Widening Proposals

S. No.	Road Name	Year of implementation	Number of lanes	
			Existing	Proposed
1	Jule Solapur Road	2016	2	4
2	Budhwar Bazar Rd	2021	2	4
3	Joshi Gali	2021	2	4
4	Limayewadi Rd	2021	2	4
5	Mahatma Gandhi Rd	2021	2	4
6	Mumbai Hwy	2021	2	4
7	Murajeta	2021	2	4
8	Rajiv Nagar Road	2021	1.8	4
9	Ramwadi Road	2021	1.8	1.9
10	Ravivar Peth Marg	2021	2	4
11	Outer ring road (Hyderabad Rd to Bangalore Rd)	2021	2	4
12	Akkalkot Road	2026	2	4
13	Model Colony Rd	2026	1.5	2
14	Rupa Bhavani Rd	2026	2	4
15	Kumte Road	2031	2	4
16	New bypass Road	2031	2	4
17	Old Karamba Rd	2031	2	4
18	Rajaswa Nagar Road	2035	2	4

9.4 Bypass Road

In general, by passes are required to avoid the passing of through traffic from the city. It was observed from the field surveys, that the amount of by passable traffic in Solapur city is about 21,622 PCUs in the year 2015 of which major contributors are Solapur-Pune highway road, Mangalore Road, Hyderabad Road, Tulijapur Road and Akkalakot Road. Presently, Solapur City has two bypass roads namely Hyderabad-bijapur bypass, Islampur-Madhavnagar bypass, Bijapur-Pandarpur bypass road and Bhudhgaon-Pandapur road.

Bypass is recommended with 2-lane configuration in phase 1 which would be widened to a 4-lane configuration by 2035. Details are given in below Table 9-3**: Proposed**

Table 9-3: Proposed Bypass Road

S.NO	From	To	Length(KMS)	No. Of Lanes(phase 1)	No. Of Lanes(Phase 2)
1	Mangalore high way	Pune highway	10	2	4

Total existing road network=21 km

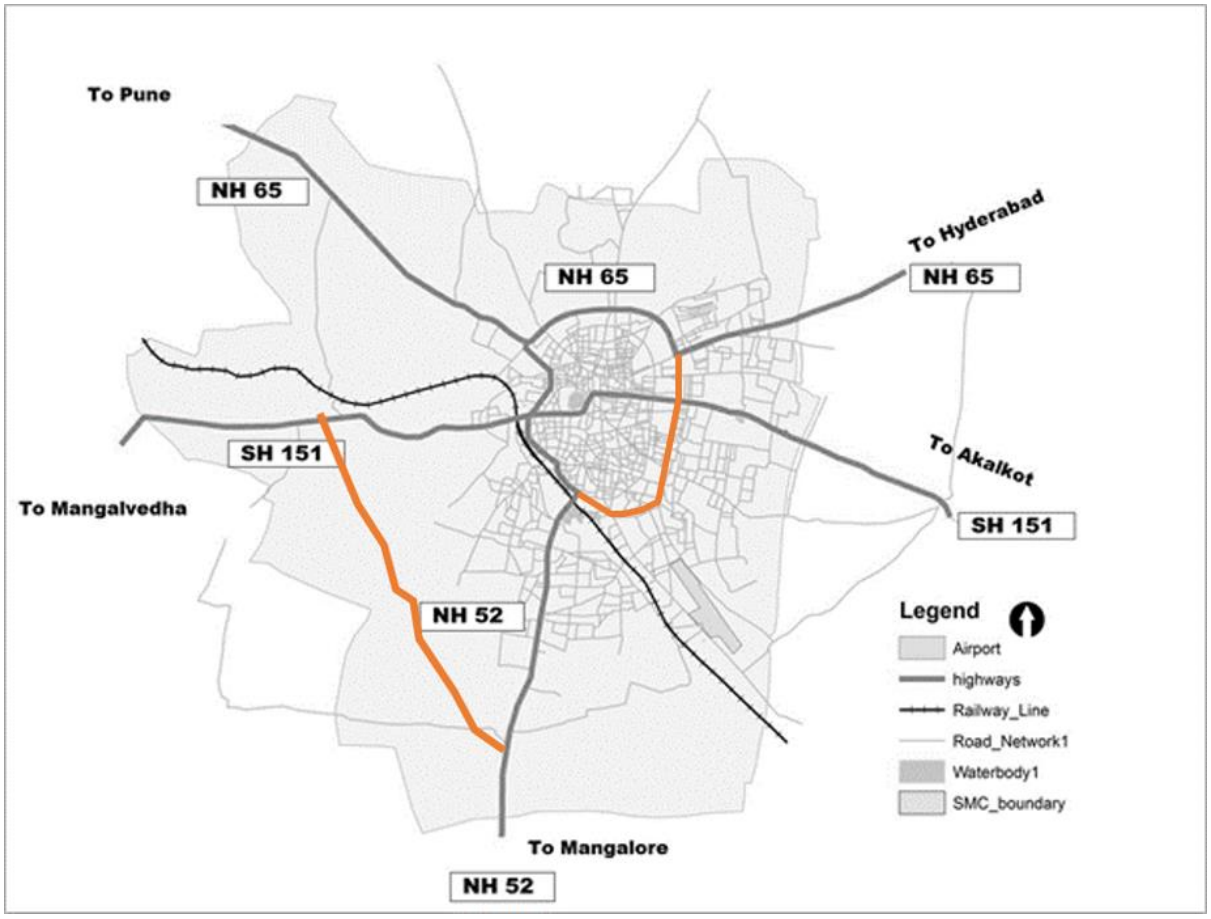


Figure 9-1 Proposed Bypass for the Solapur city

9.5 Improvement of Radial Roads

Improvement of following Radial Roads are recommended for 4-lane configuration from existing 2-lane configuration by **2035**. The below Table 9-4 represents the radial road widening proposals.

Table 9-4: Radial Road Widening Proposals for the Solapur city

S. No.	Road Name	Existing Lane-Configuration	Proposed Lane-Configuration	Year	Length (Kms)
1	Solapur-Mangalore Highway	2-Lane	4-Lane	2026	6.36
2	Hyderabad Highway	2-Lane	4-Lane	2031	7

3	Solapur Beedh Road	2-Lane	4-Lane	2035	5.23

9.6 Public Transport Proposals

9.6.1 Bus augmentation

The proposed bus augmentation structure is presented below.

Table 9-5: Recommended Bus Augmentations

S. No	Year	Additional Fleet Requirement	Scenario Details
1.	2015	**127**	Ideal Existing Situation
2.	2021	**20**	Route Rationalization
3.	2026	**80**	Route Rationalization
4.	2031	**100**	Route Rationalization
5.	2035	**50**	Route Rationalization

9.7 Non-Motorized Transport Proposals

9.7.1 Construction of Footpaths

With careful understanding of availability of footpath on major corridor, it was observed that nearly 31 km stretch comprising national and state highways require pavement improvement. This can be considered as a short term proposal with immediate attention for pedestrian safety. Details are presented in below Table 9-6 and Figure 9-2.

Table 9-6 Proposed Footpaths for Solapur City

S. No	Name of the Road	From	To	Total Length (KM)
1	Saath Rasta	Yashodhara Hospital	Jodabasavanna Chowk	0.93
2	Railway station road	Bhayiya Chowk	Murarji Peth	0.96
3	Mumbai Highway	Pune Naka Flyover	Siddheshwar Society	3.43
4	Beed Bypass	Siddheshwar Society	Tuljapur Beed Junction	1.17
5	Mumbai Hwy	Market Yard	Relience Formulation	2.27

S. No	Name of the Road	From	To	Total Length (KM)
		Chowk	Community Centre	
6	Mumbai Hwy	Market Yard Chowk	Shelgi	1
7	Bijapur Road	Pani Talki chowk	Bhaji Market chowk	1.44
8	Akkalkot Road	Jodbasavanna Chowk	Gandhi Nagar, Rangraj Nagar	1.57
9	Sahara Nagar Road	Asara Chowk	Hatture Vasti	2.48
10	Mangalore Highway	Vijapur Naka	Soregaon	3.35
11	Court Colony Road	Vijapur Naka	Asara chowk	2.46
12	Mangalore Highway	Vijapur Naka	Patrakar Bhavan	1.51
13	Solapur Road	Patrakar Bhavan	Market Yard Bus stop	5.77
14	Padmashali chowk raod	Ranga Bhavan Junction	Rajendra Chowk	1.57
15	Mangalore Highway	Jule	Kamala nagar	0.66
			TOATL	**30.57**

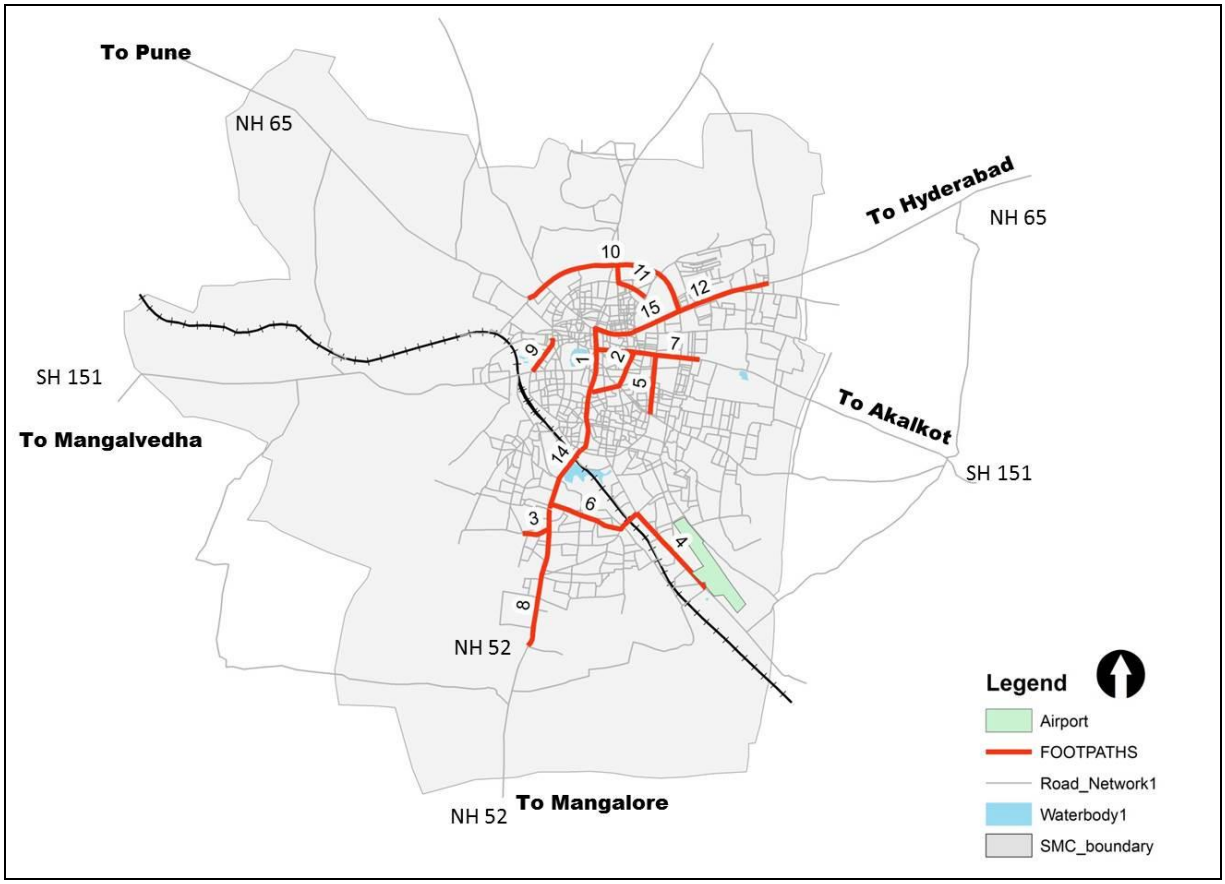


Figure 9-2: Proposed Foot Paths in Solapur City

9.7.2 Construction of cycle tracks

The corridors identified as mobility corridors in Solapur can also be considered for providing cycle track on both side of the road.

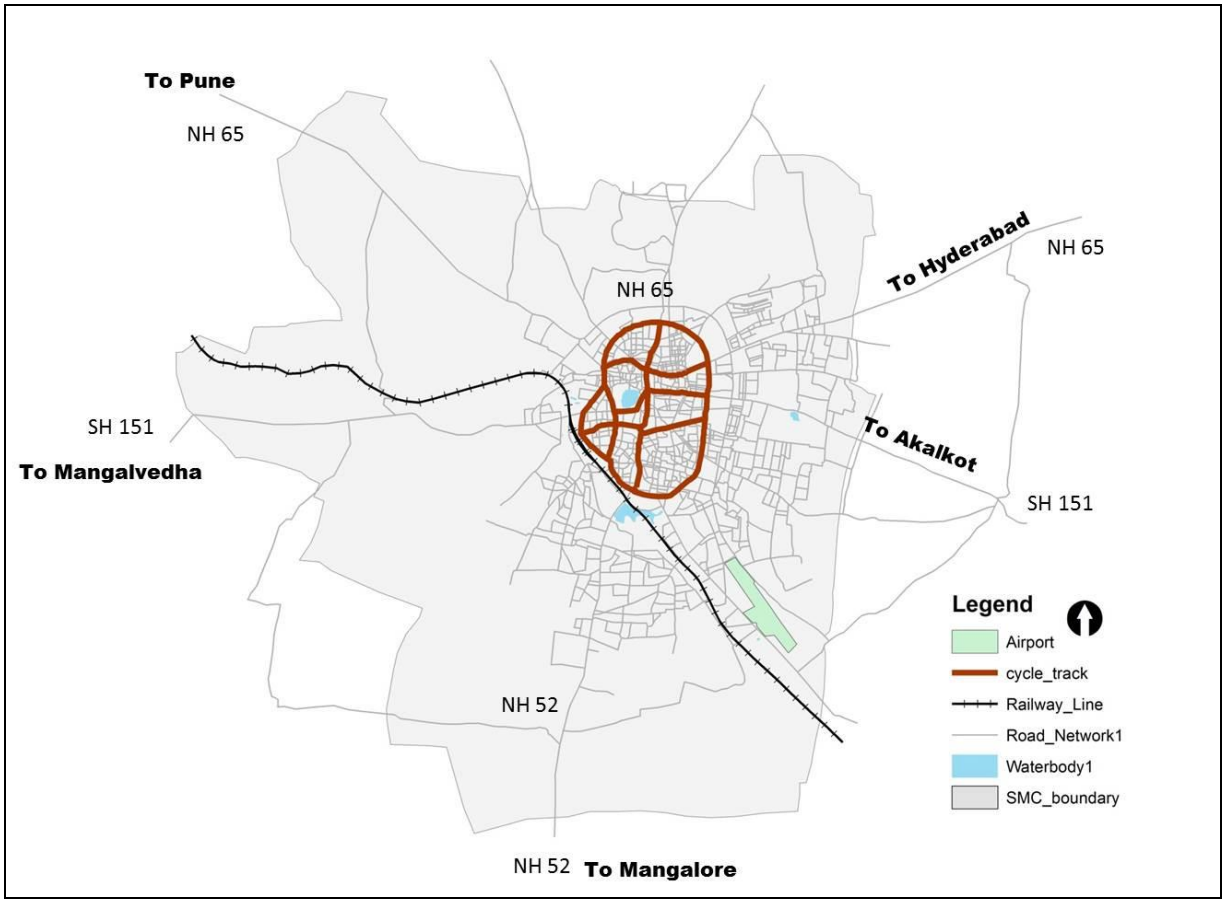


Figure 9-3 Proposed Cycle Tracks for Solapur City

Table 9-7: Corridors eligible for developing cycle track network

No	Road Name	Starting Point	Via	Road Length(in KM)	
				Phase 1	Phase 2
1	Navi Pet	Pani Taki Chowk	Hyderabad To Bijapur Bus Stop	2.26	
2	Navi Pet	Mahesh Nagar	VIP Road	3.35	
3	Siddeswar Pet	Pani Taki Chowk	Nh 211	2.51	
4	Chatrapathi Sivaji Mahara	Bhavani Peth	Solapur Road		2.71
5	Mahesh Nagar	Bhavani Peth	Inner Ring Road		4.4
6	Navipet	Bhavani Peth	Saat Rasta Road		4.23
7	Navipet	Old police line	Railway station road		2.23
8	Railway station	WIT bus stop	Station road	3.16	

About 24 km network length is proposed for cycle track provision.

9.8 Foot Over Bridges and Walkways

The below Figure 9-4 represents the proposed elevated walkway between MSRTC Bus Terminal to Solapur Railway Station. The approximate length is 2.7 km.

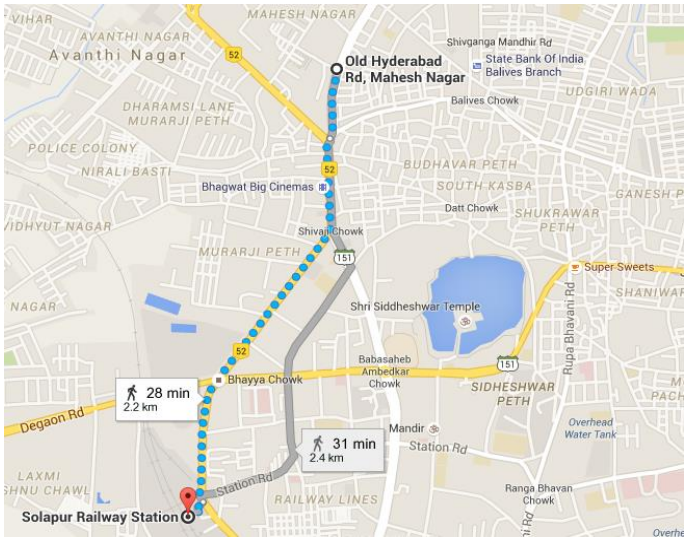


Figure 9-4: Walkway from MSRTC Bus Terminal to Solapur Railway Station

9.9 Proposals for Freight Management

A truck terminal provides interface between intercity and local transportation facilities and which handle the distribution and collection of goods within the city. Such truck terminal will have minimum land area of 2 hectare. Some of the facilities that can part of truck terminals are as follows:

- Circulation Area and Parking Area
- Petrol Pump
- Toilets
- Restaurant /Dhabas
- Shops & STD booths
- Go-down
- Weigh Bridge
- Administrative Office
- Fire Station
- Transport agents offices

- This terminal can be used by commercial vehicles generating from outer cordons before entering into the city. Open land is proposed for truck parking with a capacity of More than 100 trucks.
- Commercial vehicles can park in the terminal during the goods vehicles restriction into the city.
- It can be given as pay and user facility.

There is no truck terminal at entry points to Solapur city (Out skirts at Cordon points). The number of commercial vehicles generated from different goods terminal points obtained from goods focal point survey (on sample basis) is presented in Table 9-8**: Proposed goods terminals in Solapur city.**

Table 9-8: Proposed goods terminals in Solapur city.

S. No	Location	Area required in (Acres)	Total no. of goods vehicles(OC)
1	Solapur-Hyderabad Road (NH-9)	49	3673
2	Solapur-Mangalore Road (NH-13)	27	2022
3	Solapur-Pune Road (NH-9)	82	6123
4	Solapur-Tuljapur Road (NH-204)	1.85	1092
5	Old Vijapur Naka	41	3081

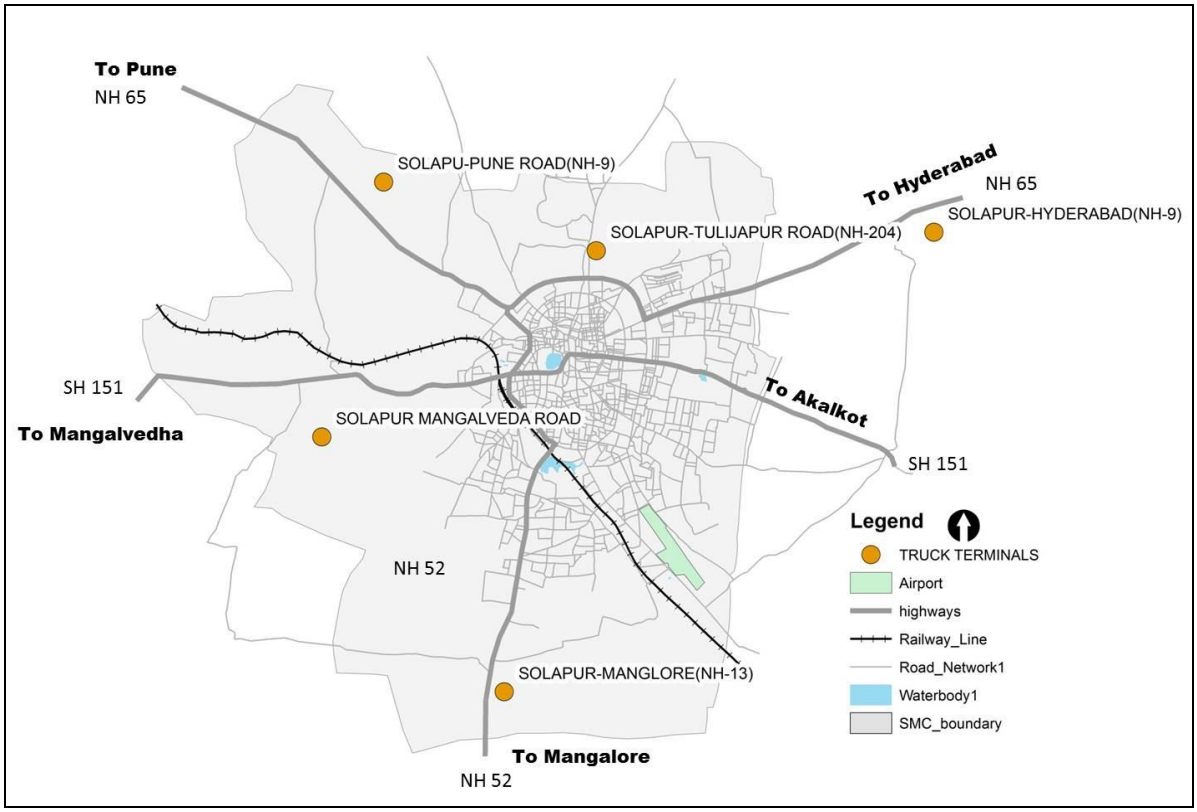


Figure 9-5: Proposed truck terminals for the Solapur city

9.10 Parking Proposals

Following are the sites which may be considered for the off-street parking locations and is presented in Table 9-9. The detail feasibility study should be undertaken for finalizing the locations.

Table 9-9: Proposed off street parking locations

No	Site Location	Approximate Land Area (Acres)
1	District court	1.5
2	Employment chowk	0.5
3	Railway station	1.5
4	Temple	0.5

The available public spaces like gardens can be considered for underground parking so as to serve dual purpose. The potential sites which can be considered for off-street parking are highlighted in the Figure 9-6. Apart from these locations, the off-street parking might be considered at TTMC locations.

Figure 9-6 Proposed Parking Places for the Solapur City

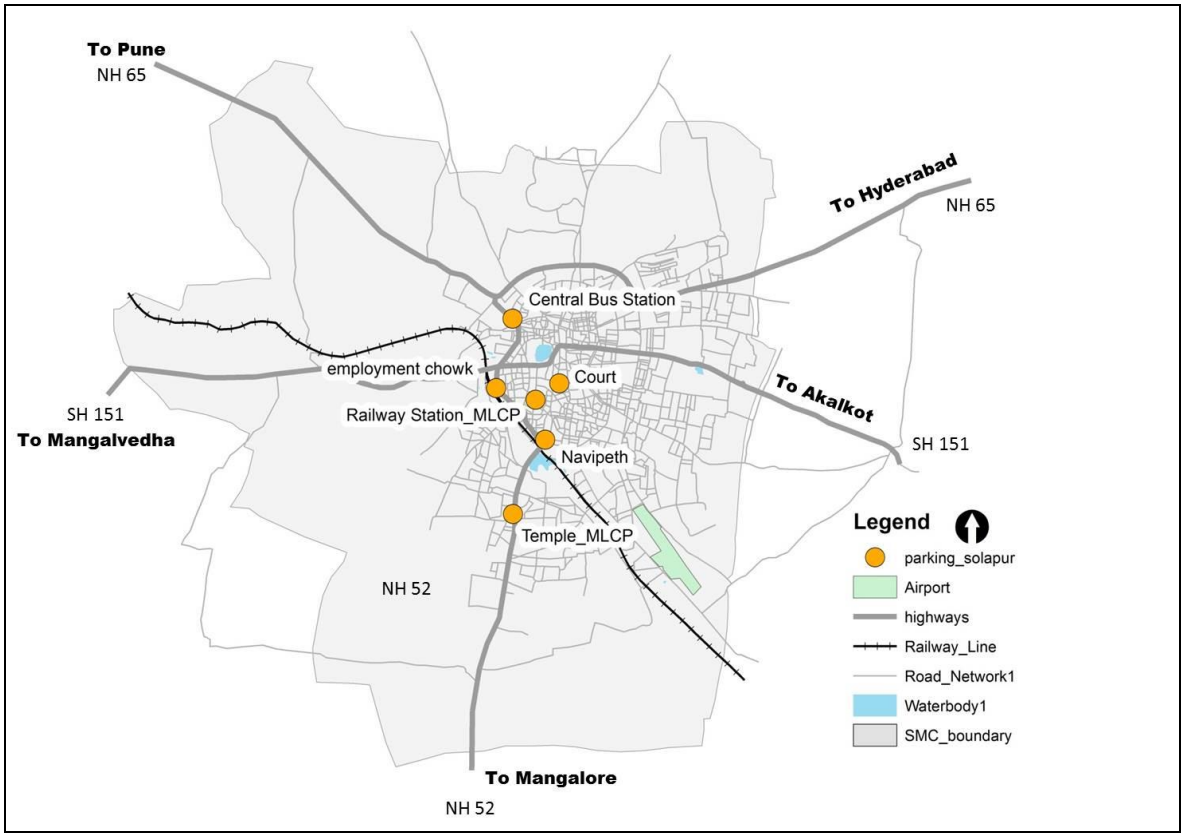


Figure 9-7: Proposed Parking Places in Solapur City

9.11 Traffic Engineering and Management Proposals

9.11.1 Proposed Junctions for Improvement

Traffic level at major junctions has varies between 3000 and 11000 PCU during peak hour. The situation will become more considerable in horizon years. Based on this, grade separation is proposed at the following junctions, presented in Table 9-10.

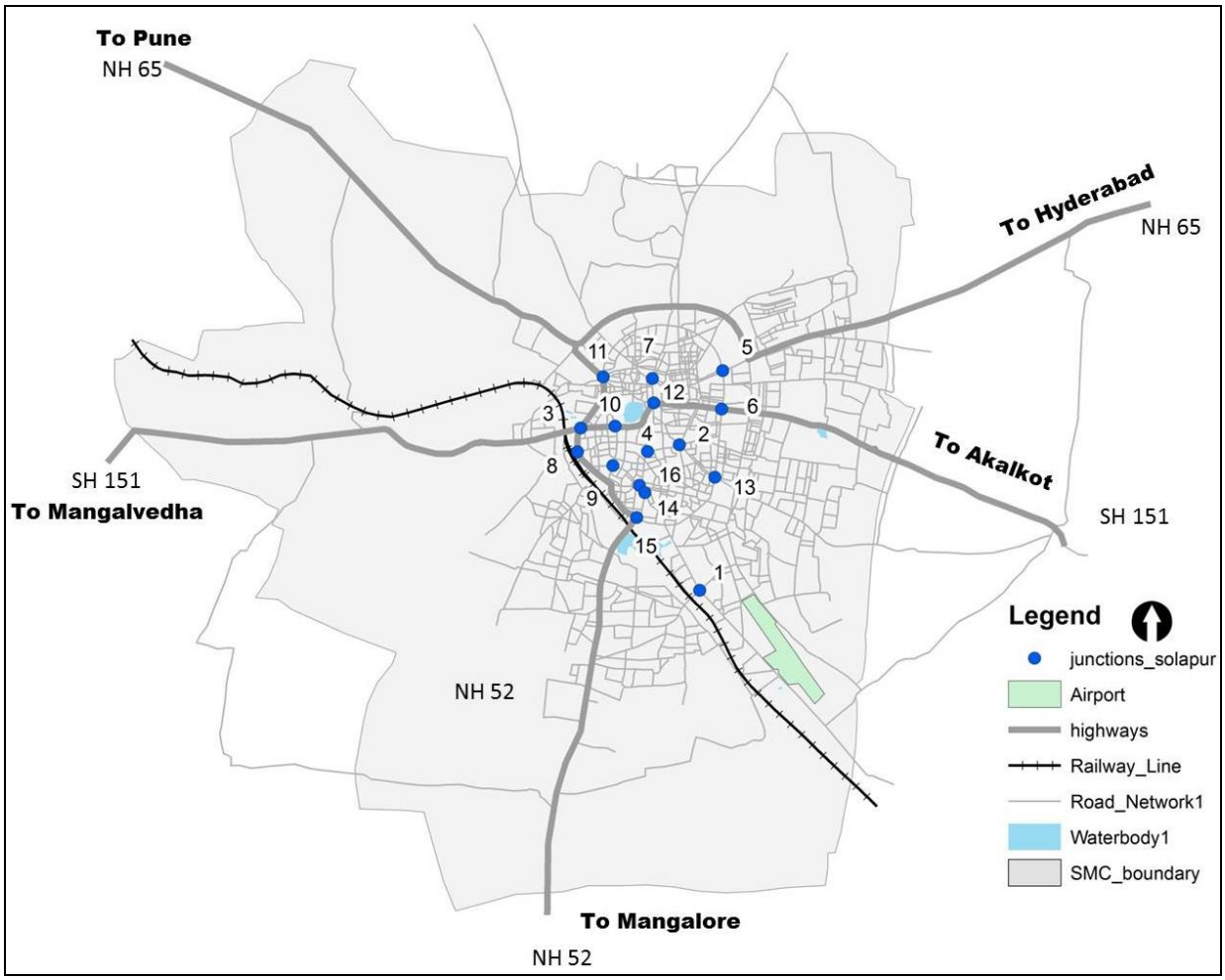


Figure 9-8 Proposed Junction Improvements for the Solapur City

Table 9-10: Proposed Junctions for the Improvement

S. No	Name of the Junction	Year
1	Saat Rasta Junction	2021
2	PatrakarBhawan	2031
3	PatrakaarBhawan	2035
4	Bhaji Market	2035
6	Old Employment Junction	2035
7	Park Chowk Junction	2026
8	Shivaji Chowk	2035

S. No	Name of the Junction	Year
9	Vijapurves junction	2021
11	Shanti Chowk	2031
12	Market Yard	2031
13	Rang Bhawan Junction	2026
14	Civil Hospital Chowk	2026
15	Aasara Chowk	2035
16	Bhayiya Chowk	2031

9.12 Construction of flyovers at following junctions

Traffic level at major junctions has varies between 3000 and 11000 PCU during peak hour. The situation will become more considerable in horizon years. Based on this, flyovers are proposed at the following junctions, presented in Table 9-11.

Table 9-11: Proposed flyovers at the following junctions

Sr No	Name of the location	Flyover
1	Saat Rasta Junction	2021
2	Park Chowk Junction	2026
3	Rang Bhawan Junction	2026
4	Civil Hospital Chowk (Kumta Naka Chowk which is ahead)	2026
5	PatrakarBhawan	2031
6	Shanti Chowk (Govt. Polytechnique Junction)	2031
7	Market Yard (JunaBoramani Naka Bus stop)	2031
8	Bhayiya Chowk	2031
9	PatrakaarBhawan(Hyderabad Bijapur Bypass junction)	2035
10	Bhaji Market (Old Kumbhari road-New Paccapeth)	2035
11	Old Employment Junction	2035
12	Shivaji Chowk	2035
13	Vijapu ves junction (Jodabasvanna Stop Location)	2035
14	Aasara Chowk	2035

9.13 Signage and Marking

The infrastructure improvement like road widening, ROB, construction of new links will be more effective with the provision of proper signage and road markings. This will increase the safety and will bring discipline in driving conditions. As per the inventory analysis, 75% of surveyed network (approx 112 km) requires substantial improvements in providing proper signage and markings.

9.14 Short, Medium and Long Term Improvements

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

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

Accordingly, long term, medium term and short term proposals for Solapur are shown in the Table 9-12.

Table 9-12: Short, Medium and Long Term Improvements

Short Term Improvements	Medium Term Improvements	Long Term Improvements
• Traffic and Pedestrian Management measures - Road Markings/ Signage • Junction Improvements and Management Measures • Construction of Footpaths • Bus Augmentation • Elevated Walkway • Provision of Cycle Track • Road Widening	• Off Street Parking Development • Redevelopment of City Bus Terminus • Rail Over Bridges (ROB) • Truck Terminals • Transport Hub • TTMC • ITS	• Bypass Road

10. Implementation Plan

10.1 Project Costing

The projects identified in the earlier section are divided into three categories based on the urgency and duration of the implementation. The long term projects are came as the output of transportation model built specifically to understand the future demand and system requirement. Some of these evolved projects have potential to enter into Public Private Partnership (PPP); however detail case to case project reports are required for validating feasibility. The total cost of the proposed projects is around 814.3 crores. It is important to highlight that the CMP serves only to identify schemes and once these schemes are detailed for feasibility and engineering purpose, some of these costs may vary. The tentative block cost estimation is done in reference with the district scheduled rates for year 2010-11

The overall short term project cost is estimated to be 375.63 crores. All junction improvement schemes, footpath implementation, cycle track network development, removal of encroachment will fall into this category. While implementation of ROB, developing main and sub docking station for cycle network, TTMC, off-street parking / multistory parking will fall under medium term projects. The approximate cost of medium term projects is 389.39 crores. The long term projects will cost around 66.34 crores. The detail costing is represented in Table 10-1.

The projects proposed are to be implemented in three phases.

Phase 1 - To be implemented between 2015 and 2021

Phase 2 – To be implemented between 2021 and 2026

Phase 3 - To be implemented between 2026 and 2035

Table 10-1: Phase Wise Costing of the Proposed Projects

s.no	Projects	Unit	Quantity	Rates (Crores)	Total Cost (in Crores)	Project Phasing Quantities			Phasing Rs (in Crores)		
						2016-2021	2021-2026	2026-2035	2016-2021	2021-2026	2026-2035
Short term Projects											
1	Traffic and Pedestrian Management measures - Road Markings/ Signage	Km	112.40	0.09	10.23	112.40	0.00	0.00	10.23	0.00	0.00
2	Junction Improvements and Management Measures	Nos	16.00	0.18	2.93	16.00	0.00	0.00	2.93	0.00	0.00
3	Construction of Footpaths	Km	30.57	0.68	20.74	30.57	0.00	0.00	20.74	0.00	0.00
4	Elevated Walkway from Rly Stn - Bus Stand - Transport Hub	Km	2.70	2.08	5.62	2.70	0.00	0.00	5.62	0.00	0.00
5	Provision of cycle track	Km	33.85	1.06	35.88	24.85	9.00	0.00	26.34	9.54	0.00
8	Road Widening	km	140.66	2.13	300.24	56.00	12.13	72.53	119.53	25.89	154.81
	Total Short Term Project Cost (In Crores)				**375.63**				**185.39**	**35.43**	**154.81**
Medium Term Projects											
9	Bus Augmentation	Nos	377.00	0.42	158.34	127.00	100.00	150.00	53.34	42.00	63.00
10	Off Street Parking Locations	Nos	4.00	0.12	0.46	2.00	2.00	0.00	0.23	0.23	0.00
11	ITS (Control room / Passenger Information System and Traffic Information System)	LS	1.00	18.00	18.00	1.00	0.00	0.00	18.00	0.00	0.00
12	Rail Over Bridges	Nos	1.42	0.22	0.32	0.00	0.00	0.00	0.00	0.00	0.00
13	Truck Terminal	Nos	5.00	5.00	25.00	2.00	2.00	1.00	10.00	10.00	5.00
14	Transport Hub	Nos	2.00	14.50	29.00	1.00	1.00	0.00	14.50	14.50	0.00

s.no	Projects	Unit	Quantity	Rates (Crores)	Total Cost (in Crores)	Project Phasing Quantities			Phasing Rs (in Crores)		
						2016-2021	2021-2026	2026-2035	2016-2021	2021-2026	2026-2035
15	Traffic and Transport Mangement Centre (TTMC)	Nos	5.00	9.50	47.50	2.00	3.00	0.00	19.00	28.50	0.00
16	Bus Depot and Workshop	Nos	3.00	21.52	64.55	1.00	2.00	0.00	21.52	43.03	0.00
17	Fly overs	Nos	14.00	2.08	29.16	1.00	3.00	10.00	2.08	6.25	20.83
18	Outer Ring Road (Hyderabad Rd to Bangalore Rd)	km	8	2.13	17.08	8			17.08		
	Total Medium Term Project Cost (In Crores)				**389.39**				**155.74**	**144.51**	**386.83**
Long Term Projects											
19	Bypass	km	10.00	6.63	66.34	10.00			66.34	0.00	0.00
	Total Long Term Project Cost (In Crores)				**66.34**				**66.34**	**0.00**	**0.00**
	Total Cost (In Crores)				**831.37**						

Reference: SoR 2010-11 (The cost does not include land acquisition cost)

10.2 Financing Options

As per the Recommendations of Working Group on Urban Transport for 12th Five Year Plan, the financing of urban transport projects in the country has largely been confined to gross budgetary support from the government and the user charges. Due to heavy investment needs of urban transport and conflicting demands on the general exchequer, the investment in urban transport in past has not kept pace with the rapidly increasing requirement of the sector. The current level of user charges of limited urban transport facilities, do not make the system self-sustainable. At the same time, providing safe, comfortable, speedy and affordable public urban transport to all has to be a necessary goal of the governance. The key funding sources besides GBS and fare box can be dedicated levies, land monetization, recovery from non-user beneficiaries, debt and private investments. The paradigm of financing has to clearly move towards non-users pay principle and the polluters pay principle. There is a need for long-term sustainable dedicating financing mechanism to address fast worsening scenario in the field of urban transport. All the various components in which the investment would be required in the 12th Five Year Plan would need to be funded through a combination of funding from Govt. of India, State Govt./urban local body, development agencies, property development, loan from domestic and financial institutions as well as PPP. Thus, it is imperative to identify projects that are amenable to Government funding or PPP.

10.3 Public Private Partnership (PPP)

Public-Private Partnerships is cooperation between a public authority and private companies, created to carry out a specific project. They can take on a number of forms, and can be a useful method of capturing property value gains generated by transport infrastructure In a PPP for a new transport infrastructure development project, the public authority creates a secure environment for the private sector to carry out the project, and the private partner offers its industry know-how, provides funding and shares in the project's risk. The objectives of the public and private sector partners appear to be quite different. The public sector aims to best serve the interests of taxpayers. The aim is not to use public money to obtain a return on capital investments. The private sector, on the other hand, aims to ensure a return on investment for its shareholders and to be as profitable as possible and yet these two contrasting goals can function perfectly well together in the framework of a PPP. The decision

to undertake a public-private partnership and the choice of the most suitable form of partnership greatly depends on the context and the types of project to be developed are given below:

- The project context may influence the type of PPP to be implemented. The public partner must evaluate the total cost of the project, its importance in terms of public need, the time frame, the number of actors involved and the geographic area in question. Does providing this public service require a major infrastructure? Will it require high levels of human and financial resources to provide this service? Before a decision can be made, it is necessary to fully understand the context of the proposed project.
- The cost of the project is of course a critical factor, which will weigh on the choice. Many PPP concern projects for underground systems, LRT and BRT requiring significant levels of financing which the local authorities would have difficulty assuming alone.
- A well-structured institutional framework and the local authority's experience in developing transport projects are also decisive factors. Urban transport is an industrial and commercial activity, which involves financial risk. Bringing in experienced partners is one way of compensating for a lack of certain skills in this field, though a good PPP should call upon other forms of expertise on the part of the public authority. This can sometimes facilitate obtaining a loan, in particular from international funding agencies.
- The tasks entrusted to the private sector (design, construction, development, operation, maintenance) will influence the type of contract.
- The sharing of responsibilities and risks will determine the degree of involvement of each partner and the type and clauses of the contract. There are many types of contracts but it is primarily the sharing of financial risk, which will determine the key characteristics. There are two categories of risk: commercial risk, related to trends in revenue, and industrial risk, related to the cost of construction and trends in operating and maintenance expenses. If both types of risk are covered by the public partner, then it would be a management contract in which the private partner is merely

performing the work. The private partner must meet the specifications but will not be motivated to improve the service nor propose innovative techniques or management;

- If the project is not self-financing, i.e. if, at the end of the contract, the total revenues and gains do not balance out the total costs, the transit authority may be required to provide compensation, depending on the clauses of the contract.

10.4 Government sources of funding

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

Viability Gap Funding

In a recent initiative, the Government of India has established a special financing facility called "Viability Gap Funding" under the Department of Economic Affairs, Ministry of Finance, to provide support to PPP infrastructure projects that have at least 40% private equity committed to each such project. 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 can take various forms such as capital grants, subordinated loans, O&M support grants and interest subsidies. It will be provided in installments, 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:

- Roads and bridges, railways, seaports, airports, inland waterways
- Power
- Urban transport, water supply, sewerage, solid waste management and other physical infrastructure in urban areas
- Infrastructure projects in Special Economic Zones
- International convention centers and other tourism infrastructure projects

JnNURM Funding

Since cities and towns in India constitute the second largest urban system in the world and contribute over 50% of the country's GDP, they are central to economic growth. For the cities to realise their full potential and become effective engines of growth, it is necessary that focused attention be given to the improvement of infrastructure in an organised manner. As such, the JnNURM was launched in December 2005 with the aim to encourage reforms and fast track planned development of identified cities. Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability of ULBs/Parastatal agencies towards citizens. The period of the Mission is seven years, up to 2012. During this period, funds shall be provided for proposals that would meet the Mission's requirements. Assistance under JnNURM is additional central assistance, which would be provided as Grant (100% Central grant) to the implementing agencies. The funding from JnNURM is supported by counterpart funding in the form of grants from the State and the ULBs, for which the ratio has been fixed by the Mission for different categories of cities.

10.5 Dedicated Urban Transport Fund at city level

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

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

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

Anticipated Purchase of Land

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

- Directly selling the land to private developers including the estimated added value in the sale price, such as was done in Aguas Claras on the periphery of Brasilia, or in Copenhagen;
- Developing the area as part of an urban renewal project and then selling it at market price, as was done in Copenhagen or in Japan, where rail companies were the first to use this method to finance their operations

A city can also levy additional stamp duty (5%) on registration of property.

Betterment Tax

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

This tax must be levied on all areas that benefit from the new transport infrastructure. The land is valued each year based on an optimal use of each site, without taking into account the existing facilities. A tax based on the value of the land is then levied in order to generate funds for the public sector. Thus, if the value of the land increases, the tax collected also increases. This means that a vacant plot of land in the city centre which has been earmarked for building a residential and commercial complex will pay the same tax as an identical site which has already been developed in a similar manner. Unlike construction taxes, no tax reduction is available to landowners who leave the site empty. Likewise, taxes are not increased if the site is built upon. Landowners will therefore to seek to capitalize on the use of their land.

Land Value Tax

Once an area is well connected by public transport and is accessible to the commercial area and also the livability of the area increases it is possible that the price of the land will

increase. Such increase in price can be source revenue for the municipality. Similar to parking, the obtained revenue needs to be utilized for improvement of the area and other areas in the vicinity. A substantial amount of revenue could be generated through cess on turnover, particularly in cities, based on industry, trade and commerce activities. Such cess has already been levied for Bangalore MRTS project. Bangalore has also levied luxury tax and professional tax towards the metro fund.

Advertising

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

Paris, France has used the advertising money in developing a public bike scheme, which is now a well renowned model. Similarly, Transport for London (TfL) has made a deal with the advertising specialist, Clear Channel, for the regular maintenance and design of the street furniture in return for the advertising space on bus shelters.

One important aspect that needs to be considered is that the advertising money needs to be utilized for improving the transport system rather than spending it on building more roads. In the similar way, the advertising should not be overdone to avoid visual pollution. Further, ideally advertising revenue should not be a reason for building of pedestrian overpasses as the greater good for the society from these overpasses is minimal.

10.6 Sources of Finance

Based on the above possible sources of funding and based on broad guidelines as per the Working Group Report for 12th 5 year Plan, the sources of financing for all the projects are presented in Table 10-2 and Figure 10-1.

Table 10-2: Sharing of Funding

GoI	State Govt	ULB	VGF	Private Sector / Loan	Total
232.784	166.274	45.7254	4.15685	382.43	831.37
28%	20%	5.50%	0.50%	46%	

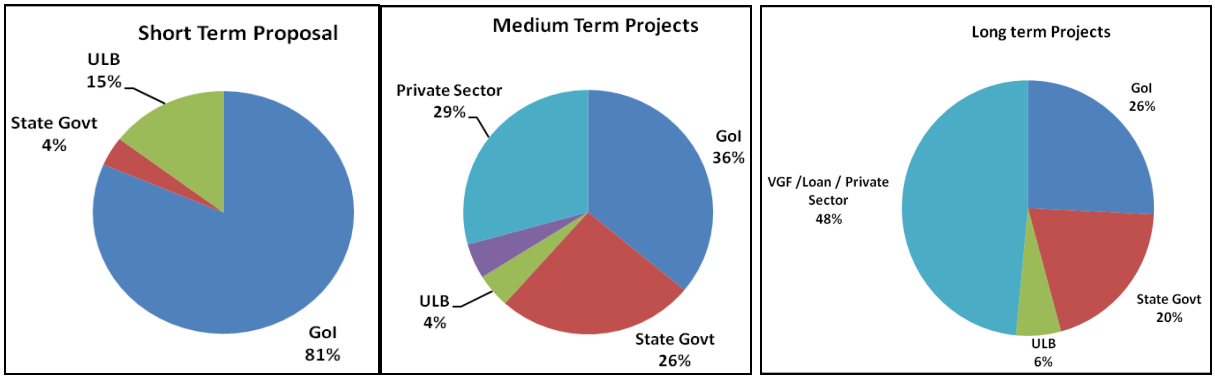


Figure 10-1: Sharing of Funding for Short Term, Medium Term and Long Term Projects

11. Institutional Framework

11.1 Background

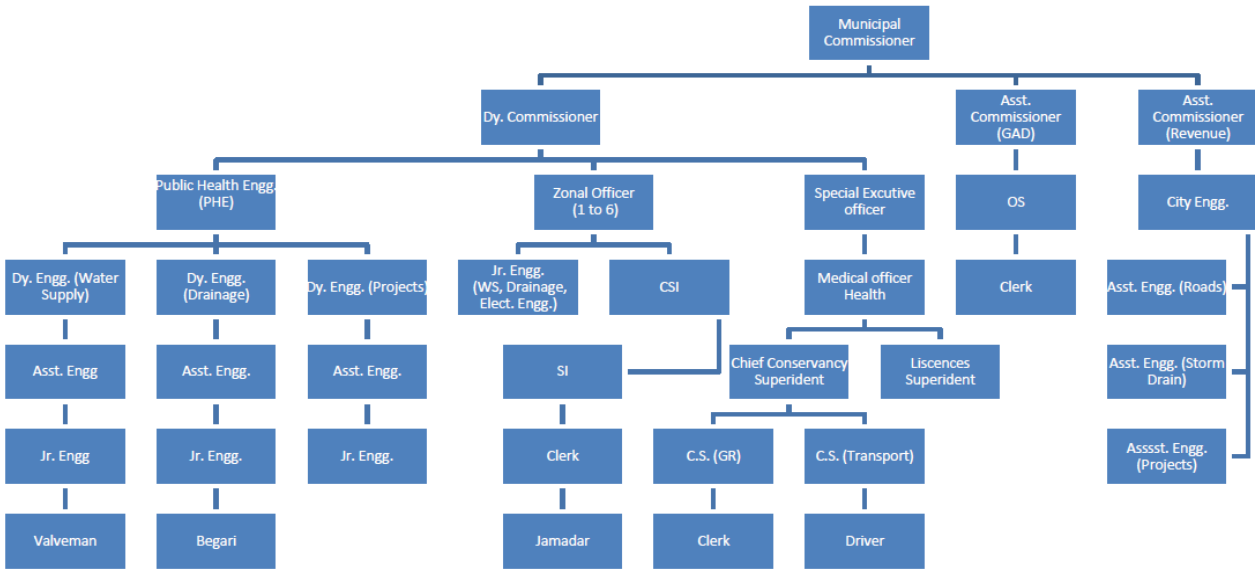
City transport system generally involves several organizations that look after various forms and aspects of the transport system and network and have overlapping functions and areas of work. Therefore to delineate areas and to remove ambiguity of functions the institutional framework has been proposed.

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

Following is the list of departments and Organizations involved in urban affairs and urban transport in Solapur.

- Housing and Urban Planning Department
- State Urban Development Department
- Public Works Department
- National Highway Authority of India (NHAI)
- Superintendent of Police (Traffic), Solapur
- Solapur Development Authority (SDA)
- District Urban Development Agency (DUDA)
- Maharashtra State Road Transport Corporation (MSRTC)
- Railways
- State Pollution Control Board, Solapur
- Regional Transport Office (RTO)
- State Level Unified Metropolitan Transport Authority

The Solapur Municipal Council established in the year 1852 was given the status of Corporation on 1st May 1964. It is governed under "Maharashtra Municipalities Act – 1965". The city specific characteristics which have greater implication on city development process has been identified and on that basis the entire city has been divided into six zones, with total 98 electoral wards. The organogram of the Solapur Municipal Corporation is shown in following figure:



11.2 Suggestions

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

- No clear segregation between the planning and implementing bodies.
- Lack of coordination amongst all the departments in the urban transport sector.
- All departments related to urban transport do not function in coherence.
- Road projects are implemented in isolation with other projects which should otherwise be an integral part of road development like footpath, cycle tracks, pedestrian facilities etc.
- No control over mushrooming IPT modes in the city, which lead to issues of congestion along with contesting with the buses for passengers.
- Operation issues in public transport due to poor route and service planning.

- No dedicated organization that is in charge of long term urban transport planning for the city.

Suggestions

Implementation of a Comprehensive Mobility Plan is an opportunity to identify and strengthen the institutions responsible for planning, development, operation and management of the city transport system and build capacity in them to take up the programmes under the short term and long term plan, policies and programmes through public institutions on/or private sector participation. The existing institutional framework should be improved for the implementation of the urban transport proposals and is discussed below.

1. SMC needs to strengthen professional capacity to undertake planning, design and implementation of large scale transportation projects.
2. The institutional capacity of SMC to implement large projects is constrained and therefore they would invariably need support from other state level organisations such as MSRDC, PWD and MSRTC.
3. SMC should maintain the database related to urban transport and socioeconomic parameters for planning purpose.
4. SMC should appoint one Traffic Engineer who will be responsible for planning, design, implementation and co-ordination with all other organisations such as Traffic Police, MSRTC etc. The responsibilities of Transport Planner/Traffic Engineer are listed below:

- to coordinate the planning and design of traffic and transport plans
- to assist in the development and implementation of local transport policies
- to plan, design and implement public transport and general traffic improvement schemes
- to draw up and implement traffic regulations concerning the utilization of road space by different vehicle types and pedestrians
- to maintain traffic signs, carriageway markings and traffic control devices
- to monitor vehicle and pedestrian movements

- to develop traffic schemes of a temporary or experimental nature

11.3 Urban Transport Fund

Public transport sector in Solapur is running in losses leaving little or no scope for enhanced services to the users. On the physical infrastructure side, vehicle sales generate large revenues, through taxation. Most of the proceeds, however, are treated as general taxes and do not trickle down to the urban area level as a ready pool of resources for urban transport projects.

It is thus suggested that a separate collection of funds be generated locally and so that the same may be spent locally on development and maintenance of urban transport infrastructure. This fund can be managed by a professional fund manager (appointed by the city level Unified Metropolitan Transport Authority) so that the balances in this fund can earn appropriate returns, in accordance with prevailing market potential.

Any local investment proposal that would require funding/part funding from the Local Govt./State Govt. could be posed to the UTF for financial support. Approval could be given by the UMTA, after due appraisal by the Local administrator/Secretariat.

Sources of Funding:

- Taxes - property tax, sales tax on fuel, advertisement tax
- Portion of parking fees
- Collections from congestion tax
- Additional fee on PUC certificate
- Collections from traffic violation fines
- Additional registration fee on vehicles – this could be graded depending on the size of the vehicle
- Proceeds from a “Land Value Tax” or “Betterment Levy”
- Any other fee/tax that may be decided to be used exclusively for investments in improving urban transport infrastructure and services

11.4 Implementing Agencies

Based on roles and responsibilities of various institutions, the agencies responsible for implementing the proposed projects in the CMP are presented in Table 1-1.

Table 11-1: Details of Implementing Agencies

S. No	Projects	Agencies responsible for Implementation	Implementation Options	
			Construction	Operation/Maintain.
1	Construction of Footpaths	SMC/PWD	PWD/ULB	ULB/ PWD
2	Grade Separated Pedestrian Facilities / FOB	SMC/PWD	PWD/ ULB	ULB/ PWD/ Private
3	Road Marking	SMC	PWD/ ULB	ULB/ PWD/NHAI
4	Restoration of Pathways	SMC	GoI/State Govt/ ULB	ULB/ PWD
5	Intersection improvement	PWD/ SMC/NHAI/MIDC	State Govt/ ULB	PWD/NHAI
6	Traffic Management Schemes	SMC / Traffic Police	State Govt/ ULB	PWD
7	City bus service(Bus Augmentation)	SMC / SPV	GoI/ State Govt/ Private	Private
8	Bus Stops	SMC	State Govt./Private	Private
9	ITS on Buses	SMC / SPV	GoI/ State Govt./ ULB	Private
10	ITS on Bus Stops	SMC / SPV		
11	Off street parking facilities	SMC/Traffic Police / Respective land owner / PWD	Private	Private
12	Public Education and Awareness	Directorate of Urban	GoI/ State Govt / ULB	Public Education and Awareness Program

S. No	Projects	Agencies responsible for Implementation	Implementation Options	
			Construction	Operation/Maintain.
	Program	Development/ SMC/ Traffic Police		
14	Development of Freight Terminal	State Govt/Traffic Police	State Govt/Private	Private
15	Network Improvement	PWD/ NHAI/SMC	PWD/ NHAI/Private	PWD/ NHAI/MIDC / Z.P./ Private
19	Street Lights	SMC	State Govt/ ULB	SMC/Private
20	Area Pedestrianisation	SMC / Traffic Police	ULB	Private
21	New Bus Terminals / TTMC	MSRTC / SMC / SPV	GoI / State Govt / ULB / Private	Private

Annexure

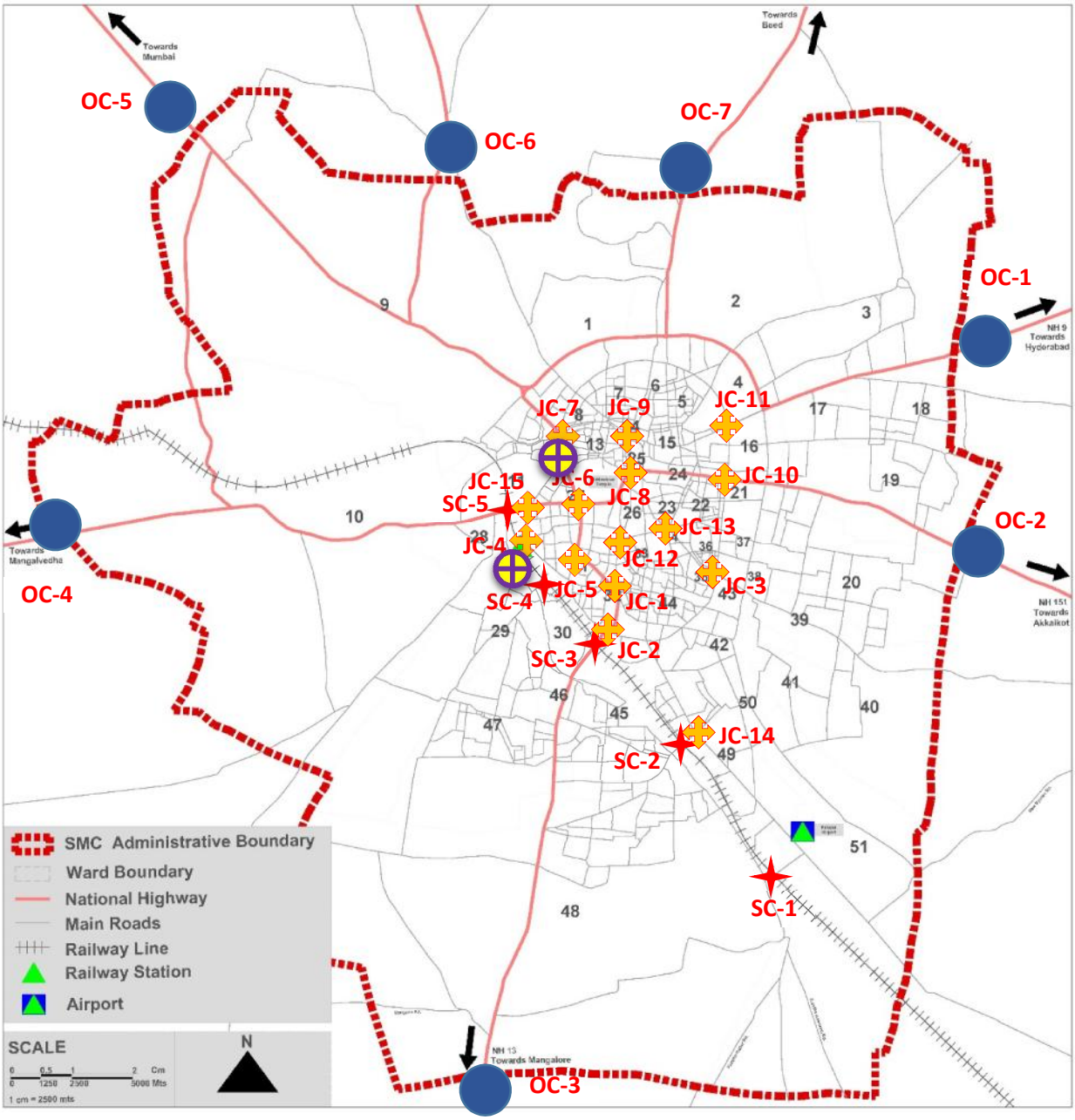
Annexure I: Survey Locations in the Study Area

Annexure II: Summary of Classified Traffic Volume Counts

Annexure III: Landuse Plan

Annexure – I: Survey Locations in Solapur

Annexure – I: Survey Locations in Solapur



Outer Cordon (OC)

Screenline Count (SC)

Turning Movement Count (TMC) & Pedestrian Count (PC)

Terminal Survey

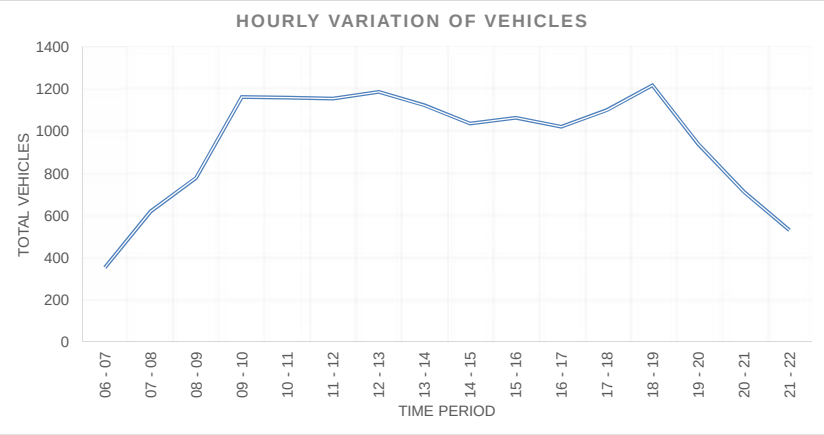
Annexure – II: Summary of Classified Traffic Volume Counts

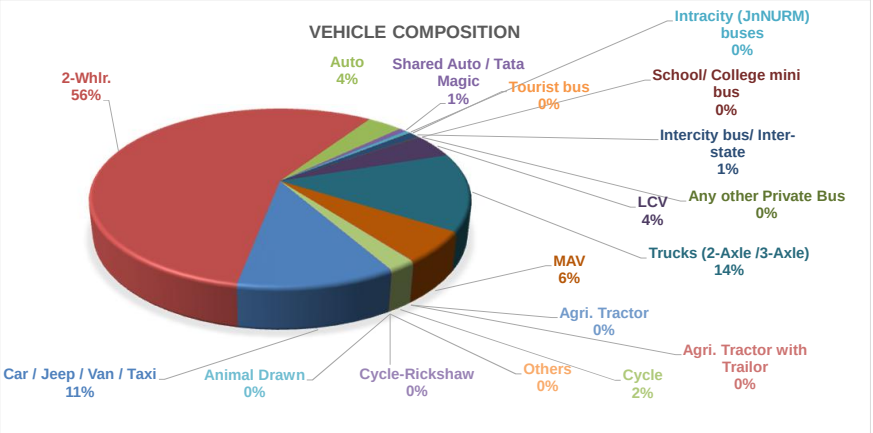
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Hyderabad Road (NH-9)
Day of Survey Thursday
Directions Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	38	135	7	5	1	4	6	0	2	14	91	38	0	0	13	0	0	0	354	856
07 - 08	60	311	23	2	5	1	9	3	3	17	127	41	0	0	18	0	0	0	620	1213
08 - 09	78	418	35	10	5	0	9	0	1	25	112	58	0	0	29	0	0	0	780	1409
09 - 10	71	752	56	8	4	0	10	2	0	55	124	54	0	0	28	0	0	0	1164	1735
10 - 11	141	685	37	11	5	1	13	0	0	43	142	57	0	0	26	0	0	0	1161	1820
11 - 12	144	687	44	9	7	0	14	0	0	41	146	50	0	0	13	0	0	1	1156	1796
12 - 13	152	673	51	11	5	0	13	0	0	57	143	64	0	2	17	0	0	0	1188	1918
13 - 14	115	654	38	13	2	0	13	0	1	71	144	55	0	0	16	0	0	2	1124	1808
14 - 15	119	579	51	4	4	0	14	0	0	46	137	71	0	1	11	0	0	1	1038	1820
15 - 16	131	560	38	8	6	0	13	0	0	53	175	69	0	1	10	0	0	2	1066	1960
16 - 17	129	561	31	9	7	0	13	3	1	48	160	53	0	0	8	0	0	0	1023	1755
17 - 18	127	618	43	10	4	0	10	0	0	46	136	70	0	3	34	0	0	0	1101	1845
18 - 19	132	733	39	9	4	0	12	0	0	56	144	58	1	1	30	0	0	0	1219	1884
19 - 20	105	562	28	4	5	0	9	0	0	41	127	31	1	0	28	0	0	0	941	1407
20 - 21	107	397	14	1	4	0	8	0	0	25	113	34	0	0	10	0	0	0	713	1194
21 - 22	75	227	8	0	3	0	9	0	1	27	122	50	0	0	8	0	0	0	530	1188
Total Veh	**1724**	**8552**	**543**	**114**	**71**	**6**	**175**	**8**	**9**	**665**	**2143**	**853**	**2**	**8**	**299**	**0**	**0**	**6**	**15178**	**25607**



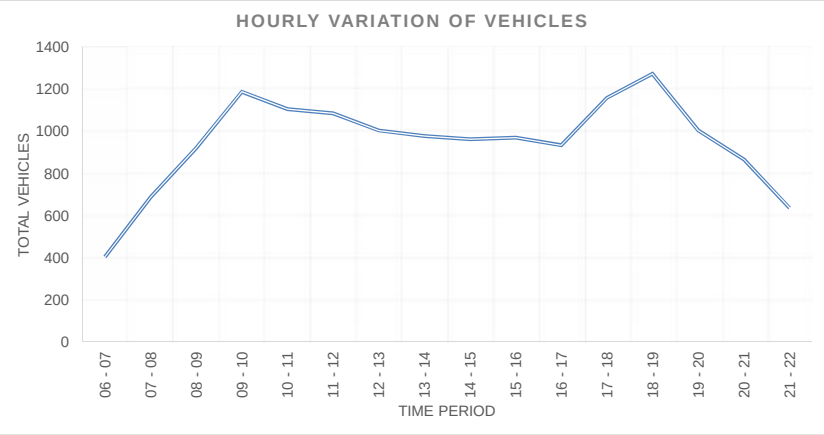


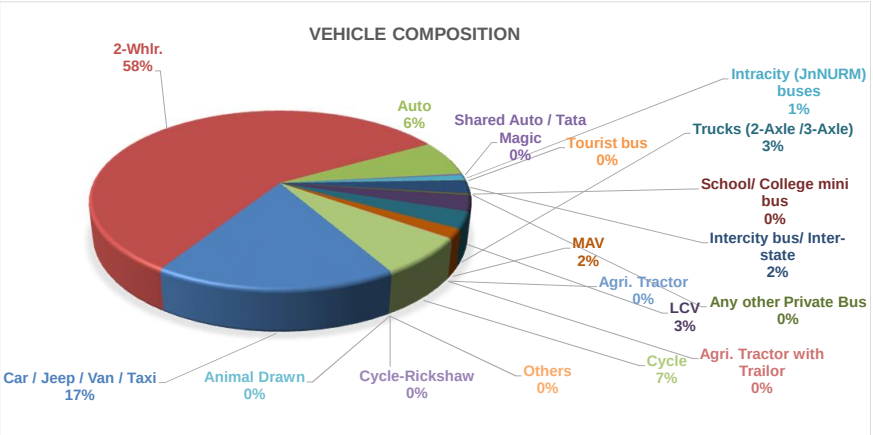
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Akkalkot Road (SH-151)
Day of Survey Thursday
Directions Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	43	186	37	0	3	3	8	0	4	12	24	22	0	0	61	0	1	0	404	501
07 - 08	80	349	68	2	9	0	22	4	3	21	16	7	0	1	106	0	0	0	688	716
08 - 09	105	519	59	0	8	3	22	1	1	18	26	6	0	1	151	0	1	0	921	883
09 - 10	143	768	65	2	7	1	23	0	3	28	37	6	2	1	102	0	0	1	1189	1149
10 - 11	159	702	80	1	9	0	23	0	1	36	21	8	0	3	64	0	0	0	1107	1099
11 - 12	177	660	78	4	7	0	30	0	0	38	28	14	0	0	50	0	0	0	1086	1121
12 - 13	156	603	76	2	12	0	31	0	1	32	30	12	0	0	49	0	0	1	1005	1060
13 - 14	151	584	64	1	8	0	32	0	3	29	36	37	0	2	32	0	0	0	979	1129
14 - 15	172	517	58	1	7	0	32	0	0	39	43	63	0	1	30	0	0	0	963	1221
15 - 16	224	524	49	0	11	0	36	1	1	37	46	15	0	0	27	0	0	0	971	1063
16 - 17	203	529	53	1	11	0	19	2	4	35	28	4	0	1	44	0	0	0	934	944
17 - 18	238	670	82	8	11	0	19	0	1	34	31	7	0	1	58	0	0	0	1160	1168
18 - 19	235	722	77	7	12	1	23	2	2	29	29	17	0	0	118	0	0	0	1274	1270
19 - 20	204	568	57	4	10	0	22	0	3	21	26	12	0	1	76	0	0	0	1004	1013
20 - 21	190	490	56	3	10	0	18	0	1	19	23	10	0	0	46	0	0	0	866	886
21 - 22	160	380	20	0	6	0	8	1	5	13	13	10	0	0	21	0	0	0	637	633
Total Veh	**2640**	**8771**	**979**	**36**	**141**	**8**	**368**	**11**	**33**	**441**	**457**	**250**	**2**	**12**	**1035**	**0**	**2**	**2**	**15188**	**15854**



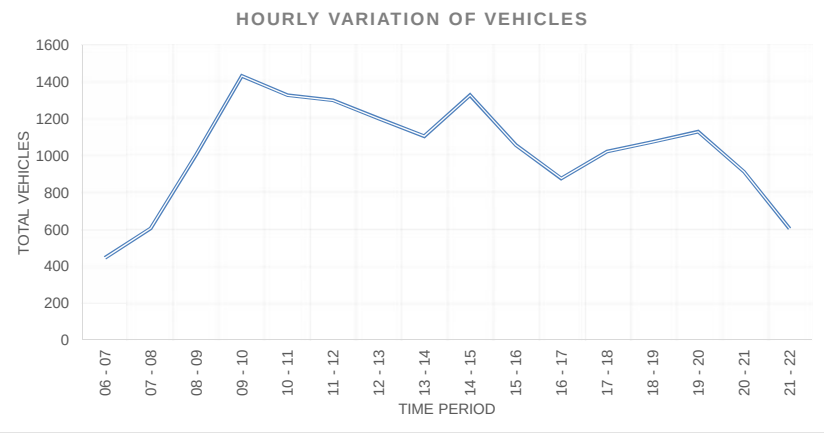


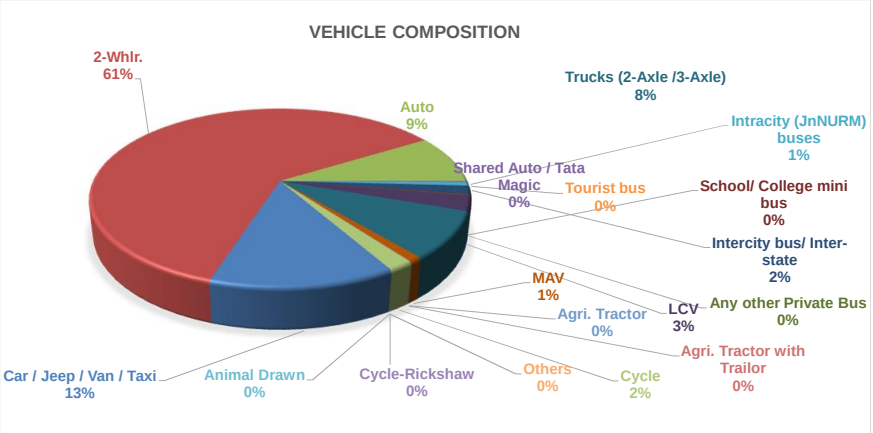
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Mangalore Road (NH-13)
Day of Survey Thursday
Directions Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	61	200	41	3	4	0	7	0	0	18	75	5	0	0	32	0	0	0	446	678
07 - 08	79	360	57	4	4	1	16	5	1	19	44	0	0	0	16	0	0	0	606	730
08 - 09	103	677	85	5	6	0	25	3	0	28	30	0	0	0	45	0	0	1	1008	1041
09 - 10	152	973	143	2	8	0	18	4	0	37	35	2	0	4	54	0	0	1	1433	1476
10 - 11	150	919	127	3	8	0	18	5	0	39	37	0	2	1	19	0	0	1	1329	1388
11 - 12	166	892	112	1	6	0	23	3	1	43	38	0	0	1	15	0	0	0	1301	1351
12 - 13	154	808	109	2	11	0	18	2	2	42	43	0	0	1	10	0	0	0	1202	1288
13 - 14	144	680	102	1	9	0	11	1	1	36	102	13	0	0	7	0	0	0	1107	1422
14 - 15	181	630	96	2	8	0	25	1	0	35	289	53	0	0	8	0	0	0	1328	2357
15 - 16	147	538	105	0	8	0	9	0	2	28	179	31	0	0	11	0	0	0	1058	1694
16 - 17	158	524	87	1	8	0	24	0	1	28	31	7	0	0	8	0	0	0	877	995
17 - 18	144	686	102	2	4	0	18	0	1	28	22	0	1	0	15	0	0	0	1023	1052
18 - 19	149	719	97	2	7	0	21	0	0	19	24	1	1	0	35	0	0	0	1075	1090
19 - 20	163	669	88	2	4	0	9	0	0	24	126	28	1	0	16	0	0	0	1130	1541
20 - 21	120	550	54	0	8	0	4	0	0	16	144	10	0	2	5	0	0	0	913	1315
21 - 22	124	241	33	1	5	0	3	0	3	19	174	0	0	0	0	0	0	1	604	1118
Total Veh	**2195**	**10066**	**1438**	**31**	**108**	**1**	**249**	**24**	**12**	**459**	**1393**	**150**	**5**	**9**	**296**	**0**	**0**	**4**	**16440**	**20538**



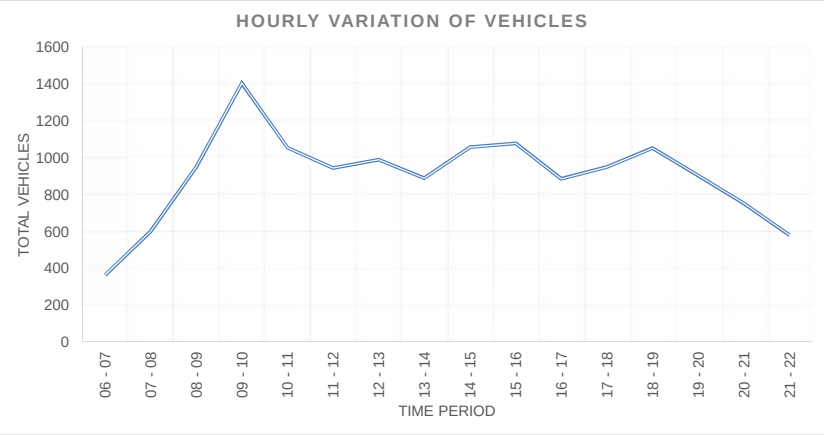


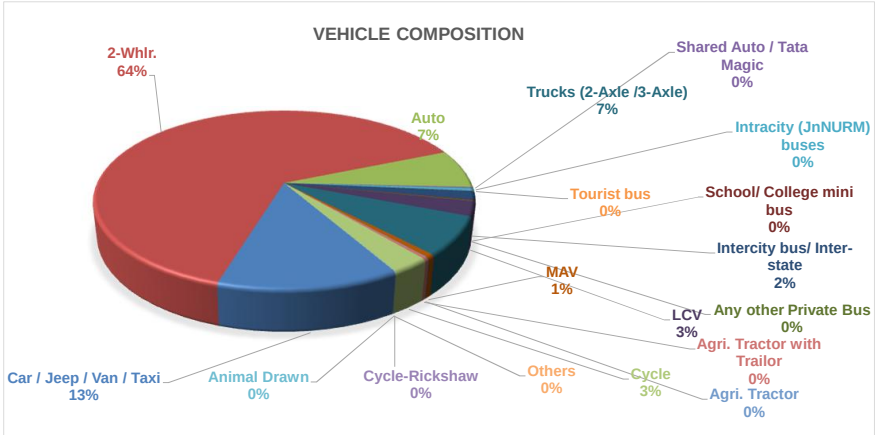
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Mangalwedha Road
Day of Survey Thursday
Directions Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	55	181	19	2	5	0	6	1	1	17	46	6	1	0	21	0	2	0	363	507
07 - 08	82	366	40	2	3	1	17	2	2	20	35	0	0	0	29	0	2	0	601	674
08 - 09	105	656	56	4	4	0	19	4	1	24	30	0	0	0	46	0	0	1	950	949
09 - 10	162	996	89	0	5	0	23	2	0	22	44	2	1	6	51	0	2	0	1405	1417
10 - 11	113	734	81	3	7	0	15	2	0	30	44	1	0	2	21	0	0	2	1055	1129
11 - 12	102	622	94	0	5	0	19	3	1	38	27	0	1	2	30	0	0	0	944	1000
12 - 13	111	665	76	5	3	0	15	1	2	31	49	4	0	4	23	0	1	0	990	1095
13 - 14	112	602	78	1	0	0	17	1	2	25	39	0	1	1	11	0	0	0	890	966
14 - 15	163	643	68	1	5	0	20	0	1	30	95	17	1	3	10	0	1	0	1058	1356
15 - 16	145	589	70	0	5	1	20	0	2	25	171	31	2	0	18	0	0	0	1079	1655
16 - 17	139	570	67	5	5	1	17	0	1	28	37	4	0	0	11	0	0	0	885	967
17 - 18	133	615	68	2	4	1	12	1	1	25	37	0	1	5	45	0	0	0	950	997
18 - 19	149	696	81	3	3	0	18	0	0	22	30	0	2	10	39	0	0	0	1053	1096
19 - 20	105	556	59	0	5	0	6	0	0	19	101	18	1	5	29	0	0	0	904	1207
20 - 21	105	478	35	1	7	0	4	0	1	13	88	3	0	1	16	0	0	0	752	952
21 - 22	109	286	29	1	2	0	1	1	0	14	131	0	0	0	6	0	0	0	580	931
Total Veh	**1890**	**9255**	**1010**	**30**	**68**	**4**	**229**	**18**	**15**	**383**	**1004**	**86**	**11**	**39**	**406**	**0**	**8**	**3**	**14459**	**16899**





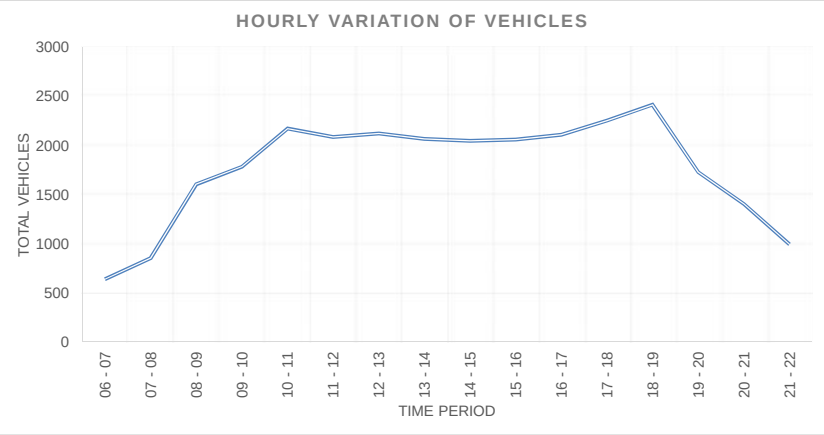
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

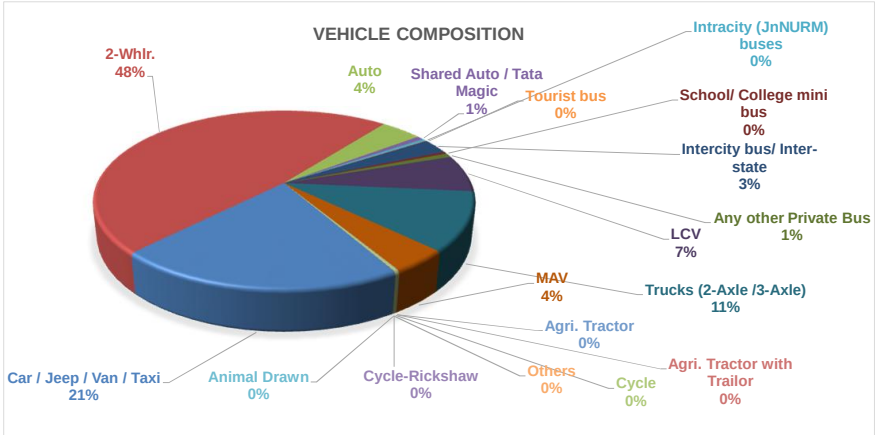
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Pune Road (NH-9) **Directions** Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	118	202	24	5	4	2	21	5	37	30	137	52	0	0	3	0	0	0	640	1290
07 - 08	133	361	47	12	9	2	31	9	41	38	130	34	2	1	3	0	0	0	853	1427
08 - 09	256	877	82	23	8	6	35	33	21	48	153	55	0	0	9	0	0	0	1606	2193
09 - 10	304	967	107	15	13	0	39	2	17	82	178	52	0	3	4	0	0	1	1784	2453
10 - 11	374	1151	131	16	6	0	51	4	6	159	178	81	0	0	12	1	0	1	2171	2958
11 - 12	399	1062	109	14	8	2	43	3	1	168	212	60	0	2	4	0	0	1	2088	2927
12 - 13	457	1035	90	18	6	1	53	7	4	177	199	70	2	0	3	0	0	1	2123	2986
13 - 14	405	1002	90	9	7	0	61	2	4	171	207	109	0	0	1	0	0	1	2069	3095
14 - 15	413	899	79	10	7	4	48	4	18	162	212	186	1	0	2	0	0	2	2047	3386
15 - 16	455	919	67	13	4	1	81	12	8	162	228	105	0	2	3	1	0	0	2061	3174
16 - 17	511	1005	81	7	6	2	49	7	22	143	197	73	0	1	7	0	0	0	2111	2955
17 - 18	462	1140	87	20	11	2	57	21	7	150	227	61	1	1	5	0	0	1	2253	3134
18 - 19	563	1285	77	10	4	1	56	5	12	121	198	71	0	1	10	0	0	0	2414	3152
19 - 20	404	829	59	9	6	1	49	3	6	108	196	54	1	0	5	0	0	0	1730	2489
20 - 21	358	580	38	4	10	1	57	0	5	99	183	67	0	0	2	0	0	0	1404	2229
21 - 22	293	310	25	1	2	0	39	0	1	94	177	50	0	0	0	0	0	0	992	1763
Total Veh	**5905**	**13624**	**1193**	**186**	**111**	**25**	**770**	**117**	**210**	**1912**	**3012**	**1180**	**7**	**11**	**73**	**2**	**0**	**8**	**28346**	**41611**





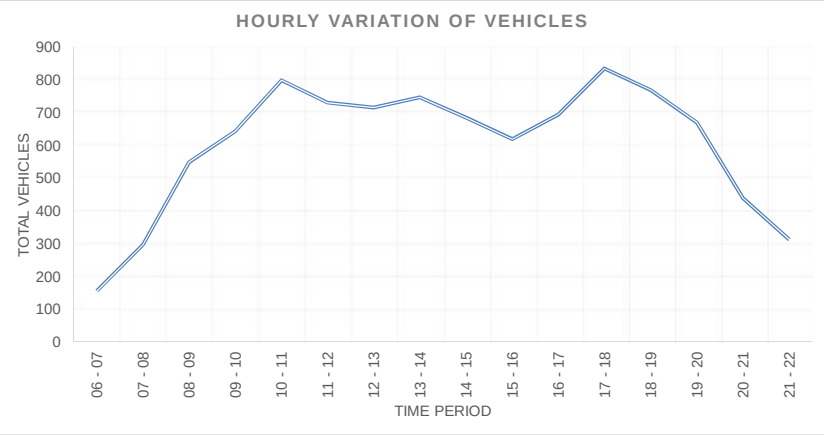
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

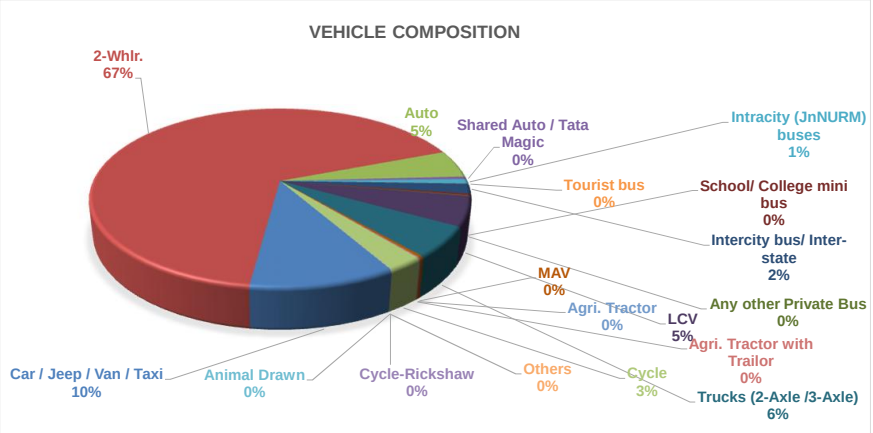
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Barshi Road (To SH-151)

Day of Survey Thursday
Directions Both

Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	17	91	9	3	3	0	5	1	0	0	13	1	0	0	13	0	0	0	156	180
07 - 08	36	188	17	6	4	0	6	0	0	9	5	1	0	1	24	0	0	0	297	283
08 - 09	42	388	32	6	6	0	12	10	1	19	8	1	0	1	22	0	0	1	549	527
09 - 10	58	466	30	2	5	0	16	2	0	22	16	1	0	1	23	0	1	0	643	621
10 - 11	80	561	33	6	6	0	11	1	1	39	31	2	1	2	24	0	1	0	799	821
11 - 12	55	496	33	2	4	3	11	1	2	51	50	2	0	0	20	0	1	0	731	833
12 - 13	75	480	31	1	8	0	12	2	2	49	48	0	0	1	6	0	0	1	716	825
13 - 14	75	484	41	1	1	0	11	0	0	49	65	6	1	3	10	0	0	0	747	917
14 - 15	80	432	42	2	5	0	13	2	0	42	58	2	0	0	7	0	0	0	685	825
15 - 16	85	370	31	1	5	0	18	2	1	41	58	1	0	0	6	0	0	0	619	775
16 - 17	62	462	37	3	6	0	9	7	1	43	48	2	1	0	13	0	0	1	695	802
17 - 18	87	522	43	7	4	0	14	3	2	44	67	2	1	1	38	0	0	0	835	972
18 - 19	78	525	37	8	6	0	12	1	0	41	41	2	0	0	18	0	0	0	769	827
19 - 20	77	492	21	0	6	0	11	0	0	30	15	2	0	0	16	0	0	0	670	643
20 - 21	64	304	28	0	5	0	9	0	0	16	8	0	0	0	6	0	0	0	440	422
21 - 22	41	218	16	0	3	0	4	0	0	21	3	2	0	0	5	0	0	0	313	304
Total Veh	**1012**	**6479**	**481**	**48**	**77**	**3**	**174**	**32**	**10**	**516**	**534**	**27**	**4**	**10**	**251**	**0**	**3**	**3**	**9664**	**10579**



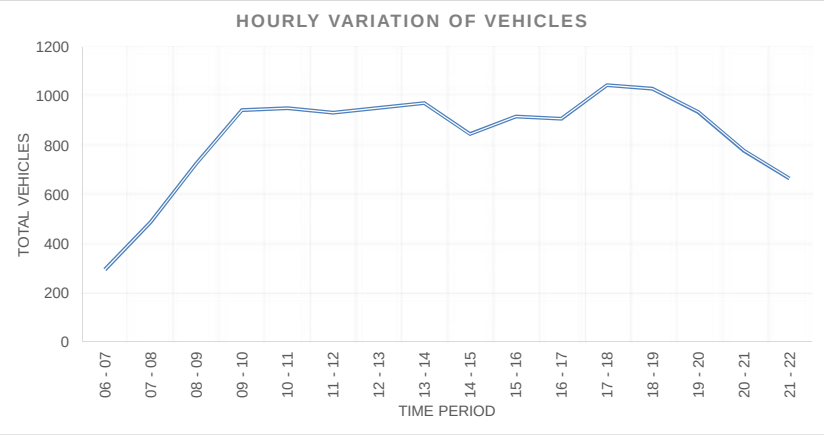


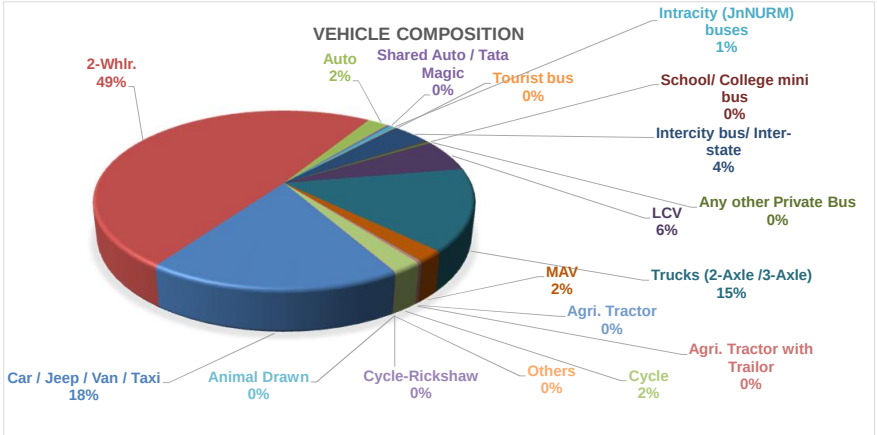
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015
Name of the Road Solapur-Tuljapur Road (NH-204)
Day of Survey Thursday
Directions Both

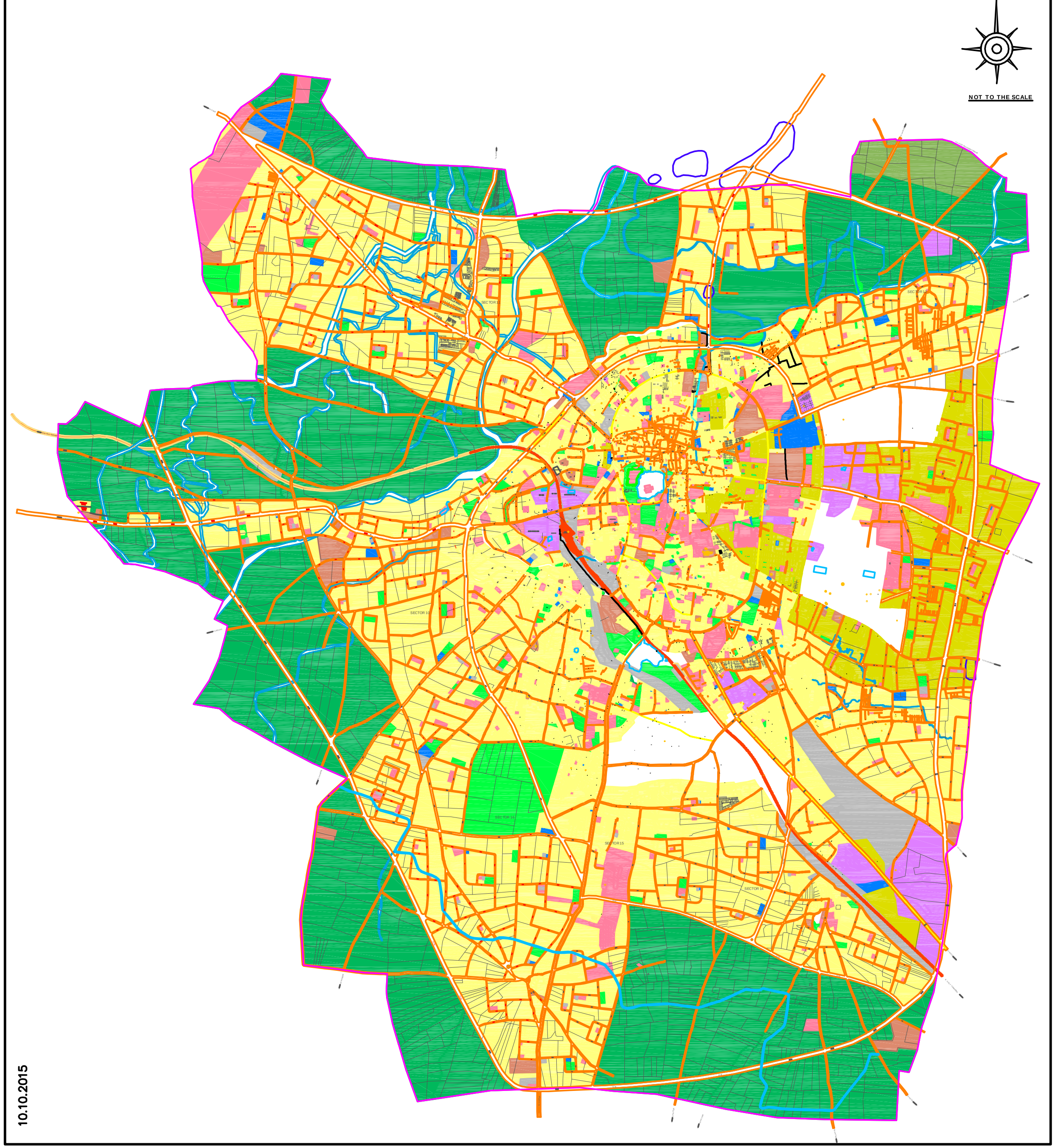
Time Period	Car / Jeep / Van / Taxi	2-Whlr.	Auto	Shared Auto / Tata Magic	Intracity (JnNURM) buses	Tourist bus	Intercity bus/ Inter-state	School/ College mini bus	Any other Private Bus	LCV	Trucks (2-Axle /3-Axle)	MAV	Agri. Tractor	Agri. Tractor with Trailor	Cycle	Cycle-Rickshaw	Animal Drawn	Others	Vehicles	PCUs
06 - 07	40	78	7	3	1	1	18	2	3	25	63	41	0	0	13	0	0	0	295	653
07 - 08	77	230	12	1	5	0	26	0	5	23	75	7	1	0	24	0	0	2	488	744
08 - 09	105	369	11	3	3	0	36	1	4	30	103	8	4	2	46	0	0	0	725	1041
09 - 10	139	528	29	7	7	0	33	0	10	61	98	6	1	1	24	0	0	0	944	1243
10 - 11	137	546	22	5	15	0	28	2	2	58	111	11	0	3	11	0	0	1	952	1308
11 - 12	149	516	20	2	5	3	40	1	2	54	101	21	0	3	15	0	0	2	934	1306
12 - 13	162	494	27	1	5	0	37	2	2	66	121	19	1	1	15	0	0	1	954	1382
13 - 14	170	486	20	3	4	0	36	0	0	70	139	30	0	2	13	0	0	0	973	1489
14 - 15	126	384	15	1	5	0	43	0	6	53	168	31	1	3	11	0	0	0	847	1483
15 - 16	178	349	16	0	3	0	40	1	2	47	232	31	0	4	15	0	0	0	918	1734
16 - 17	177	477	19	3	5	7	35	0	4	49	103	8	1	2	18	0	0	1	909	1240
17 - 18	216	557	29	5	4	3	35	2	3	72	89	10	2	3	15	0	0	0	1045	1344
18 - 19	189	567	22	2	5	1	37	0	1	59	104	12	2	2	27	0	0	1	1031	1356
19 - 20	225	442	17	0	3	0	45	0	3	36	134	15	0	0	14	0	0	2	936	1377
20 - 21	174	323	11	1	4	0	30	0	1	42	166	15	0	0	12	0	0	0	779	1321
21 - 22	175	214	7	1	4	0	29	0	1	40	178	7	0	1	9	0	0	0	666	1244
Total Veh	**2439**	**6560**	**284**	**38**	**78**	**15**	**548**	**11**	**49**	**785**	**1985**	**272**	**13**	**27**	**282**	**0**	**0**	**10**	**13396**	**20266**





Annexure – III: Land-use Plan

Landuse Plan -Solapur Mahanagarpalika



10.10.2015