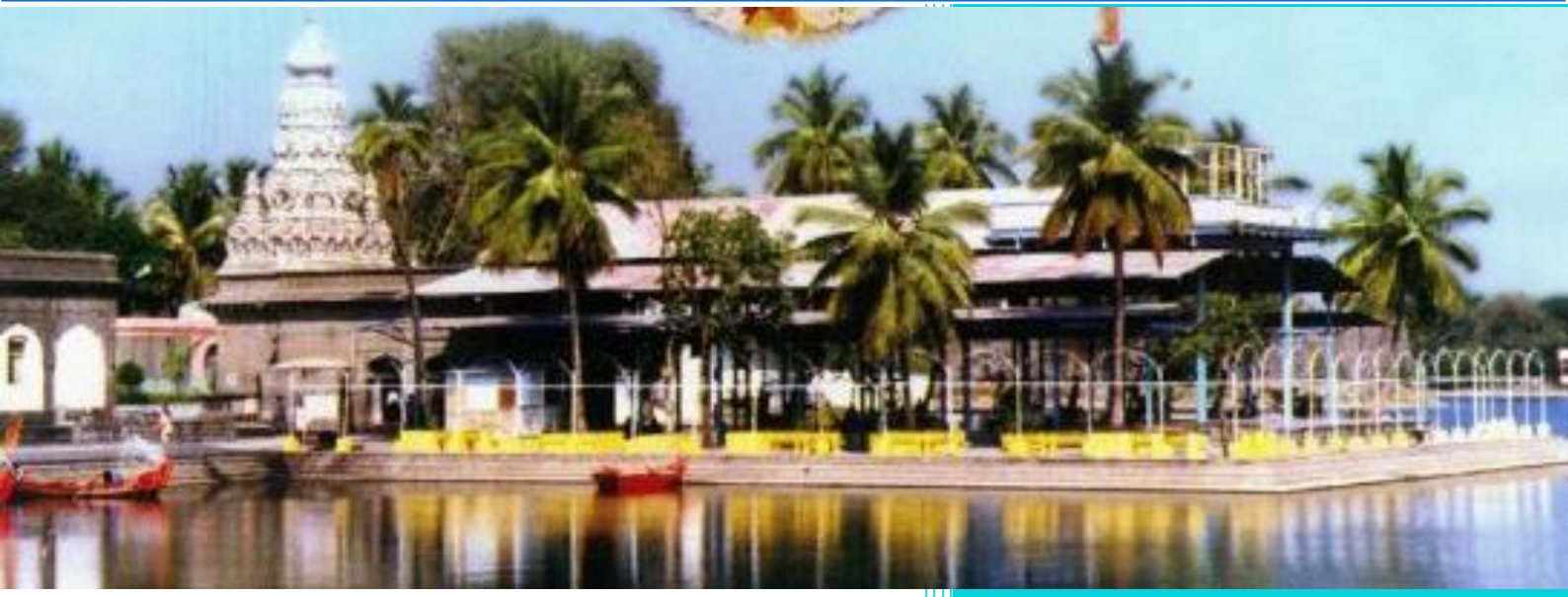
Urban Mass Transit Company Limited

2016

COMPREHENSIVE MOBILITY PLAN - SOLAPUR



Interim Report

Solapur Municipal Corporation

Quality Management

Revision	Date	Report Prepared By	Report Reviewed By	Report Approved By	Description
1	31st March, 2016	Mahesh Kumar Chenna, J Siva Niranjan	S.Ramakrishna	D.B.Srinivas	First Draft
2	1st April, 2016	Mahesh Kumar Chenna, J Siva Niranjan	S.Ramakrishna	D.B.Srinivas	First Draft

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Table of Contents

List of Tables

List of Figures

Chapter 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. ✓ On reducing pollution, greenhouse gas emissions and energy consumption.	✓ 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 in Figure 1-1.

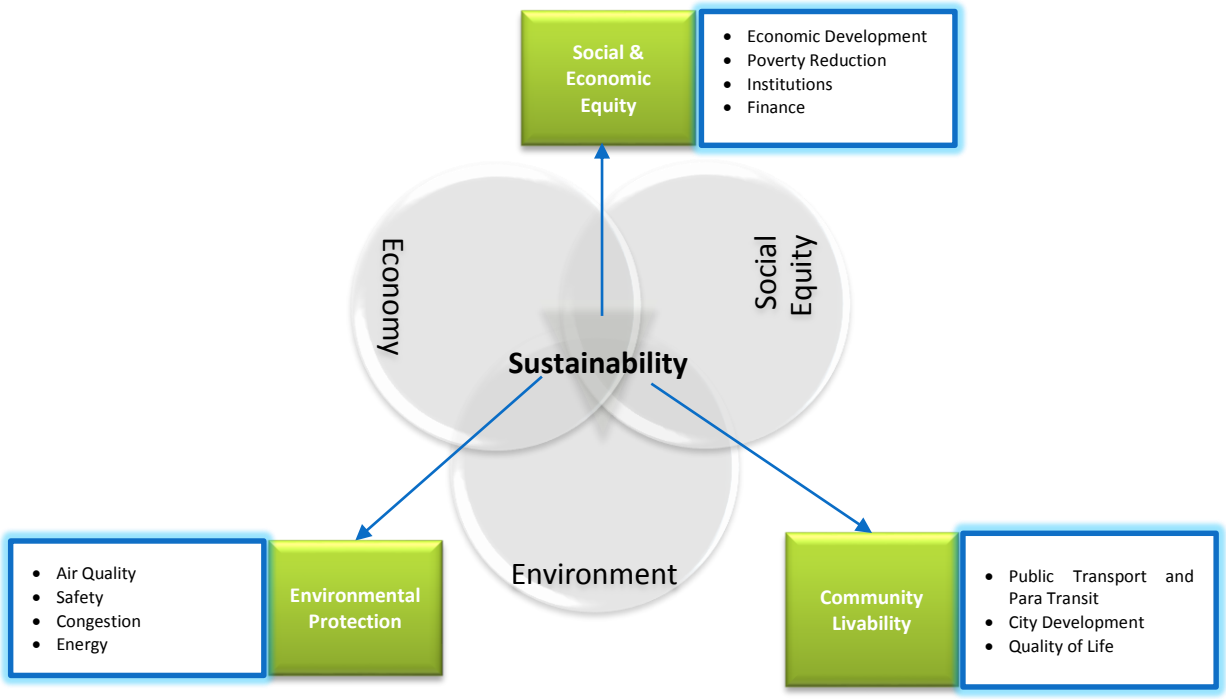


Figure 1-1 Sustainable Mobility Solutions

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

Scope of Work	Detailed tasks involved that address Scope of Work
(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 Task 11: Landuse 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

Scope of Work	Detailed tasks involved that address Scope of Work
	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 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 Environmentally Sustainable Means of Transportation System for 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

Inception report was submitted in May 2015. This Interim 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
- Maharashtra Pollution Control Board (MPCB)

1.8. Structure of the Report

The Interim Report is consists of five 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 way forward

Chapter 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 the Figure 2-1.

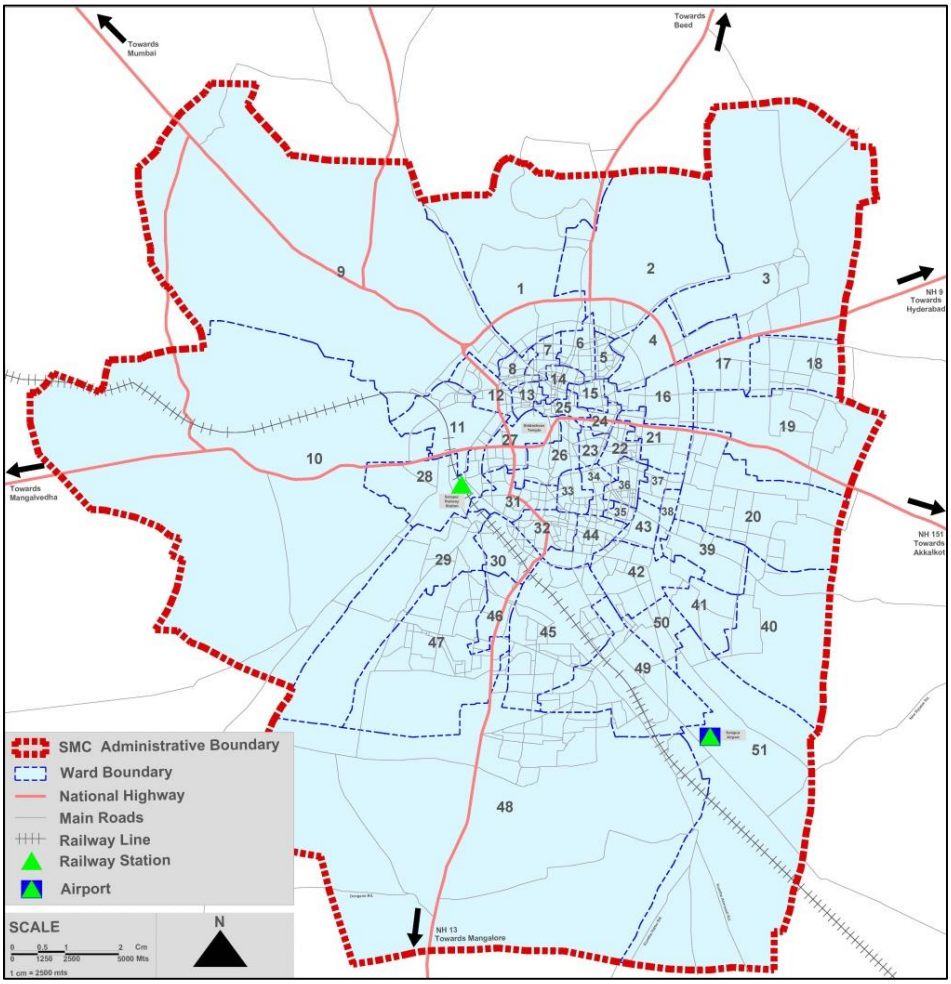


Figure 2-1: Solapur Municipal Corporation Area (Planning Area for CMP)

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**.

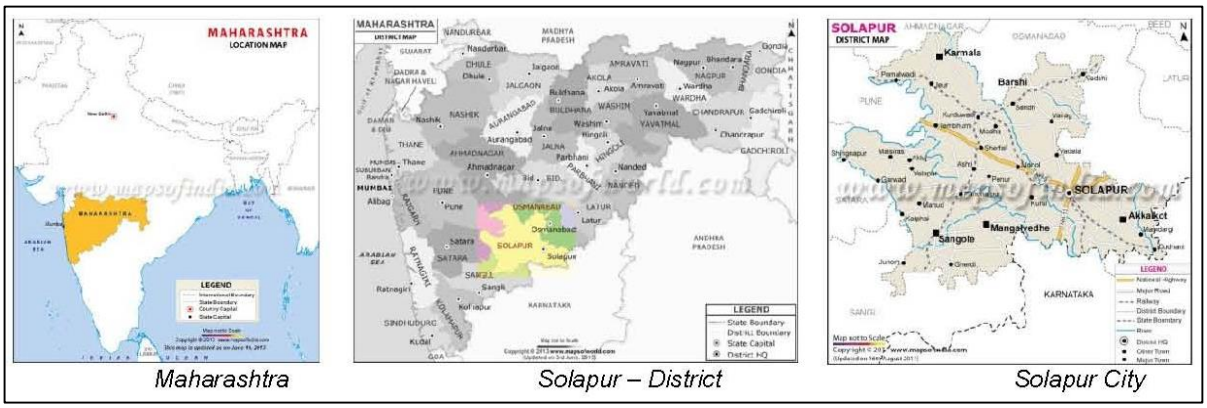
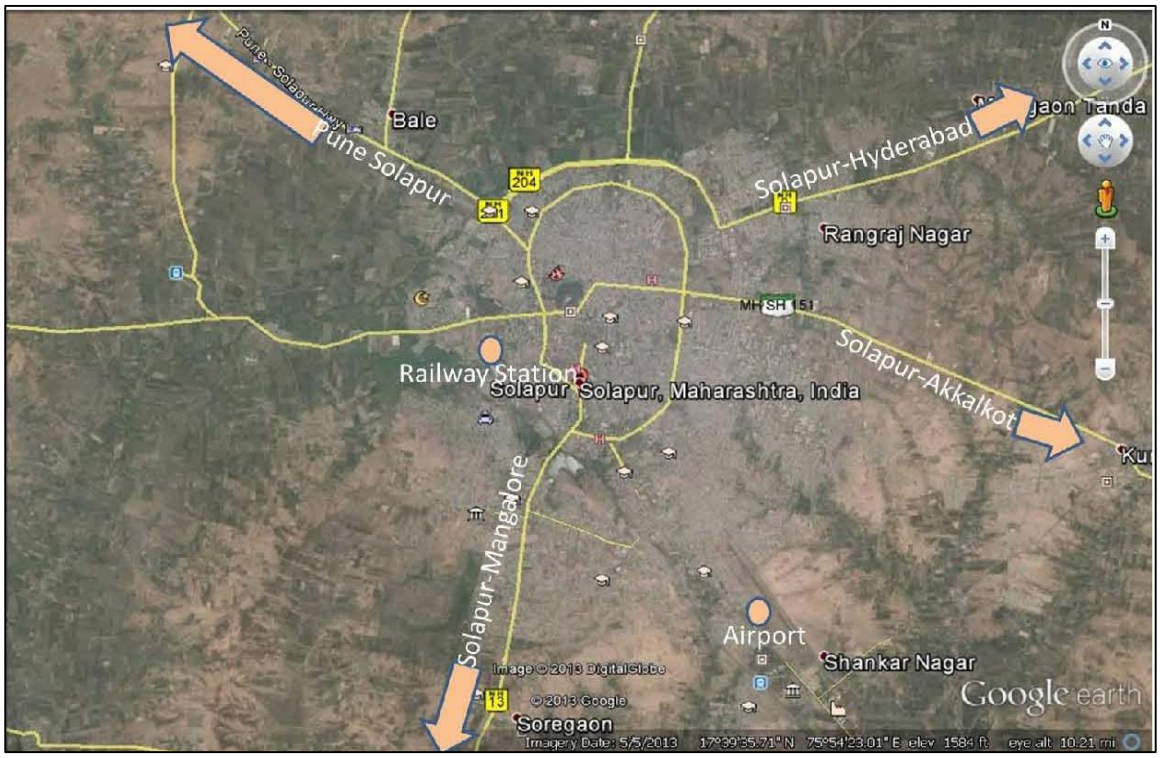


Figure 2-2: Location of Solapur City

Solapur is well connected by roadways and railways to all major cities in Maharashtra and neighboring states. The city is connected with Karnataka by four National Highways –9 via Pune and Vijayawada. NH-13 to Mangalore; NH-211 to Dhule and NH-204 to Ratnagiri and Nagpur. It is also connected with important cities in Maharashtra such as Nagpur, Sangli, Kolhapur, Nanded etc. Busses from Maharashtra and Andhra Pradesh state transport corporation operate from the Solapur bus stand. 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 to increase in population and thus higher growth rate of population. Due to closure of these mills and diminishing industrial growth, the diminishing population growth is observed. In the last decade (2001-11) growth of the population has come down to 9.07% from 44.39% in 1991-2001.

2.5.1.1. Population Density

Overall density of the core city has been high over the years until the increase in city limits in 1992. The city area has been changing over the years in last four decades and hence the density pattern varies. In 1971 the density of the city was 17149 persons per km^2 which increased to 20159 persons per km^2 in 1981. In 1992, 13 villages adjoining to SMC were merged in 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 in 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

2.6. Economic Characteristics

2.6.1. 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% only.

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.

2.6.1.1. 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

2.7. 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%

Land Use Type	Past (1994)			Proposed (2017)		
	Area (Ha)	% of Total Area	% of developed Area	Area (Ha)	% of Total Area	% of Developed Area
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%	
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)

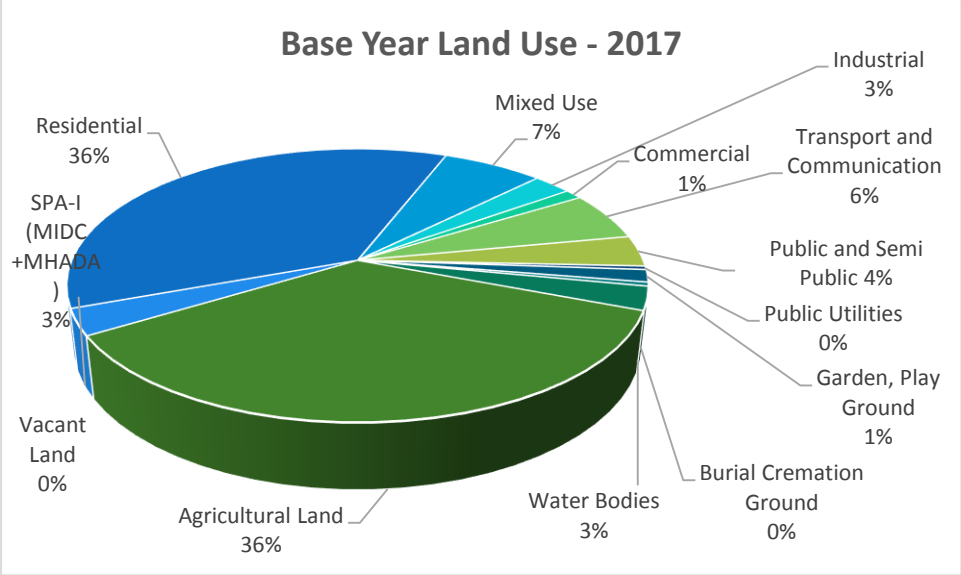


Figure 2-4: Land Use Distribution in Solapur Municipal Corporation

2.7.1. 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 Sq kms
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, Beedi Kamgar Vasahat 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

[1] City Development Plan for Solapur - 2041

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.

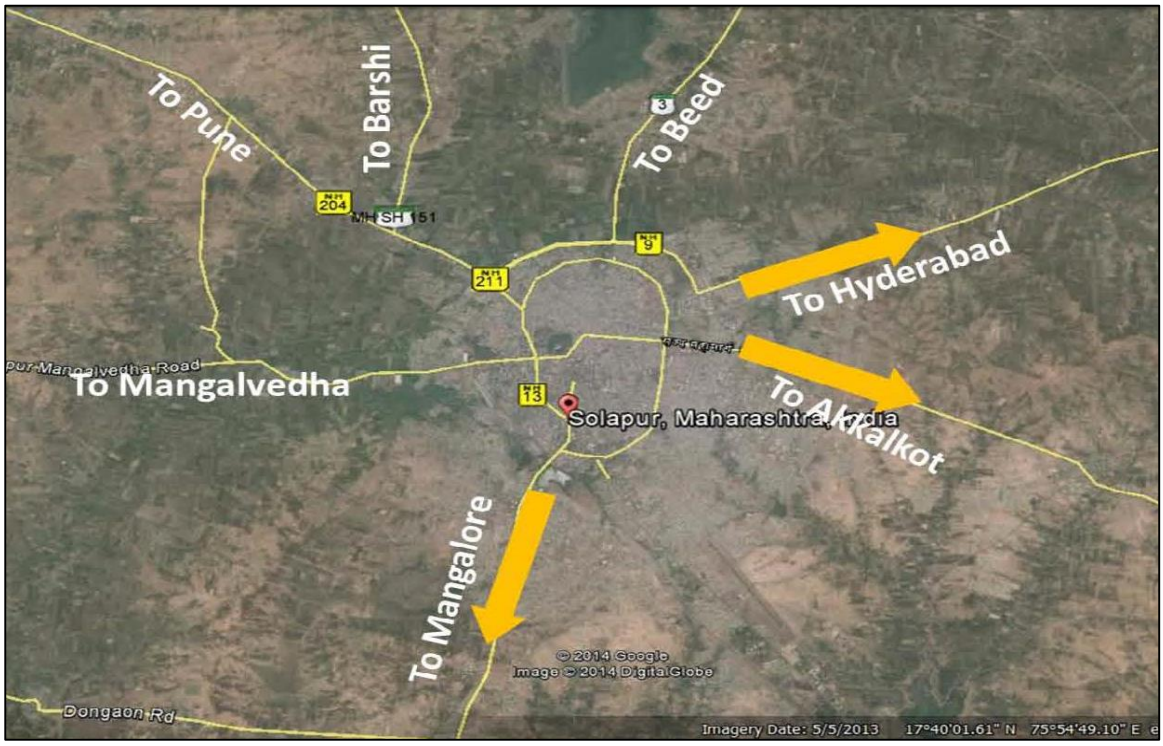


Figure 2-5: Growth Directions of Solapur City.

2.8. Traffic and Transportation System Characteristics

2.6.1. Transport Connectivity

2.6.1.1. 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 Vijaywada via Hyderabad,
- NH-13 connecting Solapur to Mangalore, Karnataka
- NH-211 connecting Solapur to Dhule and;
- NH 204 connecting Ratnagiri-Nagpur passes through city.

Recently, sanctioned National Highways- Solapur - Gulbarga and Ratnagiri-Solapur-Nagpur (Refer to **Figure 2-3***).*

2.6.1.2. 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 Nagpur, Solapur Pune Hutatma Express, Solapur Mumbai, Solapur Jaipur Superfast express and Solapur Goa Express

2.6.1.3. Air Connectivity

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

2.6.2. 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:-

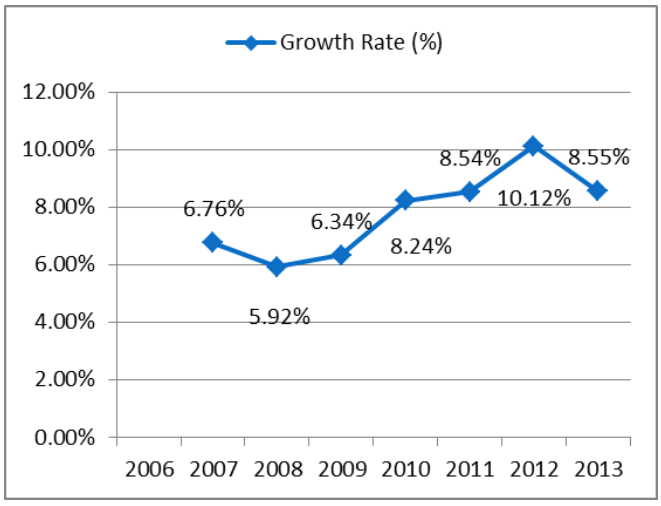
1. Railway Station Area;
2. Panjrapol (Bus Stand Area)
3. Sat Rasta
4. Lucky Chowk

5. Rangbhavan
6. Park Chowk
7. Kontam Chowk
8. Ashok Chowk
9. Shivaji Chowk
10. Chatrapati Sambhaji Chowk

2.6.3. 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. When the same figures for the subsequent year are assessed, it can be seen that the total vehicles in the city has grown to 5,54,731 registering a growth rate of 9.35%. While the share of 2 Wheelers remains at 80%. The **Figure 2-6** *&* **Table 2-7** represents the composition of the 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%



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

Figure 2-6: Growth of Vehicles in Solapur City

Table 2-7: 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%

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
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%**

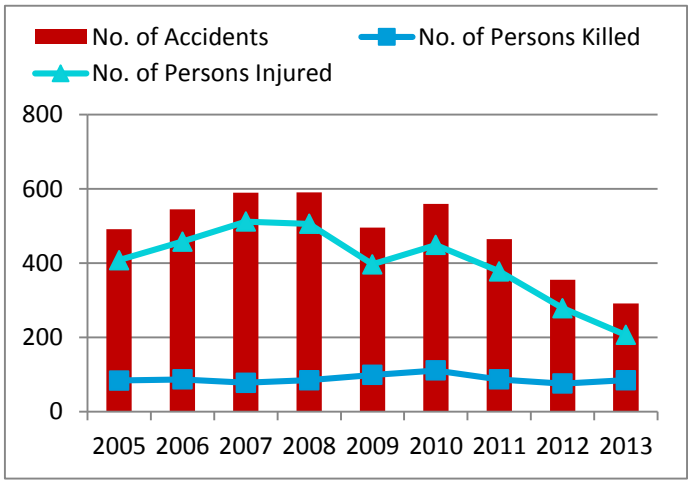
Source: Motor Transport Statistics of Maharashtra 2010 – 2011, 2011-12 and 2012-13

2.6.4. Road Accidents

The trend of motor vehicle accidents in Solapur from 2005 onwards is shown in the **Figure 2-7** below.

Figure 2-7: Accidents Trend 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



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.

2.6.5. 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.

2.6.6. 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, Zhila Parisad Road, Saraf Katta, Kontam Chowk Area, Station Road, Navi Peth are the main areas crowded with unauthorized on-street parking.

2.6.7. 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, Vijapur Raoad 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]

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

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.

2.6.7.1. Public Transportation Ridership

Based on the data shown in **Table 2-8,** 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 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 2-8: 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)

2.6.8. 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.

Chapter 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, Screenline 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.

3.4 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

Below **Figure 3-1** represents the zoning of study area.

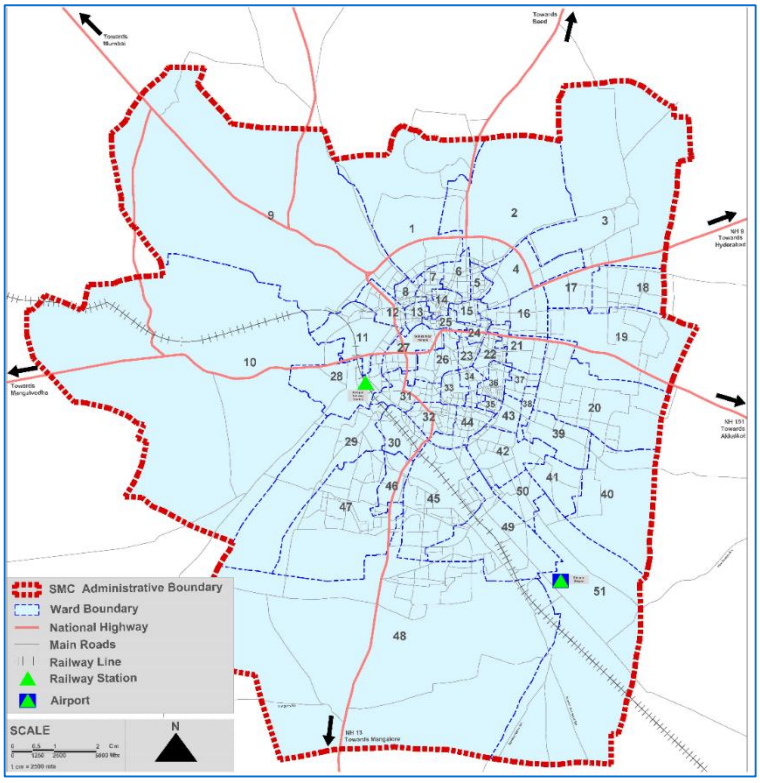


Figure 3-1: Zoning of the Study Area

3.5 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
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

TAZ No	Population	House Holds	Employment	TAZ No	Population	House Holds	Employment
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

3.6 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
  - Screenline 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

3.6.1 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.

3.6.2 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

3.6.3 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**.

3.6.4 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 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 entering/leaving 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 Bijapur 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

3.6.5 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	Patrakaar Bhawan	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 (DadaSaheb Junction)	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	Vijapur ves junction	IC-8	22/07/2015	Wednesday
9	Madhala Maruti Chowk	IC-9	22/07/2015	Wednesday
10	Shanti Chowk (Govt. Polytechnique Junction)	IC-10	23/07/2015	Thursday
11	Market Yard (Juna Boramani 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.

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 16 hrs at 7 outer cordon (OC) locations and 16 hrs at 15 intersections. The analysis of the same is presented in further sections.

3.6.6 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 3-3**.

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	Madhala Maruti Temple	31/07/2015	Friday
6	Mousir Maglee Banu	31/07/2015	Friday
7	Naval Petrol Pump	31/07/2015	Friday
8	Navi Peth	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 3-3: Parking Surveys

3.6.7 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

3.6.8 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 modelling. The Speed and Delay surveys are carried out on all major and important corridors of the study area.

3.6.9 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.

3.6.10 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

3.6.11 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 3-4**.

Figure 3-4: Household Survey Progress

3.6.12 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.

3.6.13 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	Patrakaar Bhawan	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	Vijapur ves junction	PC-8	22/07/2015	Wednesday
9	Madhala Maruti Chowk	PC-9	22/07/2015	Wednesday
10	Shanti Chowk (Govt. Polytechnique Junction)	PC-10	23/07/2015	Thursday
11	Market Yard (Juna Boramani 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

3.6.14 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.

Chapter 4. Primary Survey Data Analysis

3.3. Introduction

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

4.1 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** represents the daily traffic volume at outer cordon and screen line points. Summary of Classified Traffic Volume Counts at Outer Cordon and Screenline 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	Kumthe Aherwadi 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	Sangola Mangalweda 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	Kumthe Aaharwadi 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	Sangola Mangalweda Crossing	SC-5	28260	25640	27451	24757	55,711	50,397

Source: Primary Survey, 2015

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 line Locations								
1	Kumthe Aaharwadi 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

4.2 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.

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	Patrakar Bhawan	IC-1B	3-Arm	84,313	89,094
3	Patrakaar Bhawan (Hyderabad Bijapur Bypass junction)	IC-2	4-Arm	81,377	78,061
4	Bhaji Market (Old Kumbhari road-New Pacca peth)	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	Vijapur ves junction (Jodabasvanna Stop Location)	IC-8	5-Arm	146,196	142,933
10	Madhala Maruti Chowk (Saraf Khatta Shanivar Peth 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 (Juna Boramani 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

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
2	Patrakar Bhawan	84,313	89,094	6936	7.8	6470	7.3
3	Patrakaar Bhawan (Hyderabad Bijapur Bypass junction)	81,377	78,061	6122	7.8	5769	7.4
4	Bhaji Market (Old Kumbhari road-New Pacca peth)	81,571	75,148	6030	8.0	5337	7.1

S. No.	Location	Total Vehicles	Total PCUs	Morning Peak		Evening Peak	
				PCUs	% of Total PCUs	PCUs	% of Total PCUs
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	Vijapur ves junction (Jodabasvanna Stop Location)	146,196	142,933	11321	7.9	10784	7.5
10	Madhala Maruti Chowk (Saraf Khatta Shanivar Peth 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 (Juna Boramani 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

4.3 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
6	Bus	21.4

Source: Primary Survey, 2015

4.4 Household Survey

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

4.4.1 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%
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.

4.4.2 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%

Distance Range (Kms)	Percentage of Households		
	Daily need shop	School	Doctor
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
Auto	10.9
Cycle Rickshaw	11.0
Total	**11.3**

Distribution of Trips by Purpose:

Distribution of trips by purpose for Solapur is given below.

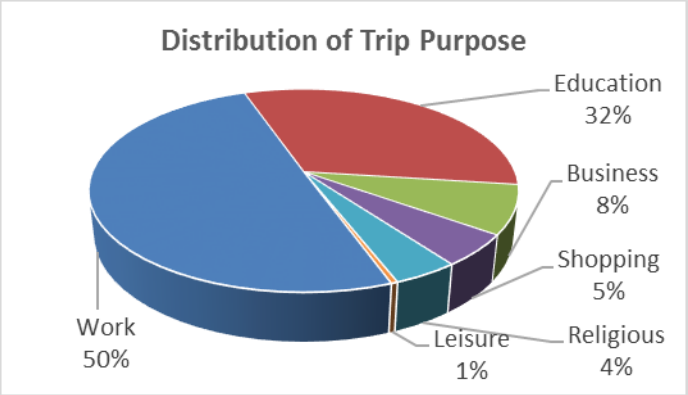


Figure 4-1: Distribution of Trips by Purpose in Solapur

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 Including Walk	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%

Time (Minutes)	Public Bus	Cycle Rickshaw	Shared Auto	Total
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

4.4.3 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 the **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	Solapur	
	Male	Female
0-5	4%	4%

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

4.5 Road Inventory Survey

4.5.1 Right of Way

Right of way of various roads having a total length of 112.4 kms 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

4.5.2 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

4.5.3 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

4.5.4 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 vapour 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%

Lux Level	LHS		RHS		Both	
	Length (Km)	% Road Length	Length (Km)	% Road Length	Length (Km)	% Road Length
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

4.5.5 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

4.5.6 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

4.5.7 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

4.5.8 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.

4.5.9 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 Solpaur are Saat Rasta Junction, Patrakar Bhawan, Patrakaar Bhawan (Hyderabad Bijapur Bypass junction), Bhaji Market (Old Kumbhari road-New Pacca peth), Railway Station Junction, Old Employment Junction, Park Chowk Junction, Shivaji Chowk, Vijapur ves junction (Jodabasvanna Stop Location), Madhala Maruti Chowk (Saraf Khatta Shanivar Peth junction), Shanti Chowk (Govt. Polytechnique Junction), Market Yard (Juna Boramani Naka Bus stop), Rang Bhawan Junction, Civil Hospital Chowk (Kumta Naka Chowk which is ahead), Aasara Chowk and Bhayiya.

4.5.10 Guard rails

There are no pedestrian guard rails within the Solpaur.

4.6 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	Rajendra Ngr to Siddheswa Kaekh	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

4.7 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)

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
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	Madhala Maruti Temple	10:30 - 11:30	190	1221	On-Street
6	Mousir Maglee Banu	10:45 - 11:45	109	256	On-Street
7	Naval Petrol Pump	11:45 - 12:45	64	468	On-Street
8	Navi Peth	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

4.8 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

S. No	Location	Morning Peak Hour		Evening Peak Hour		Along and Across Pedestrians	Road Crossing Pedestrians
		Volume	Time	Volume	Time		
1 (B)	Patrakar Bhawan	478	0845 – 0945	529	1715 - 1815	5934	3107
2	Patrakaar Bhawan (Hyderabad Bijapur Bypass junction)	392	1100 – 1200	256	1815 - 1915	3498	2882
3	Bhaji Market (Old Kumbhari road-New Pacca peth)	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	Vijapur ves junction (Jodabasvanna Stop Location)	1641	1045 – 1145	2016	1745 - 1845	23936	18401
9	Madhala Maruti Chowk (Saraf Khatta Shanivar Peth junction)	1208	1100 – 1200	1659	1745 - 1845	16529	10343
10	Shanti Chowk (Govt. Polytechnique Junction)	782	0900 – 1000	594	1730 - 1830	7674	5617
11	Market Yard (Juna Boramani 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 Vijapur ves junction (Jodabasvanna Stop Location).

Table 4-38 represents the calculations for $PV^2/(2*10^8)$ 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 Ramesh Hospital Junction, Hindu College Junction, Nazz Center, Sitara Junction, Benz Circle, etc.
- It is observed that Ramesh Hospital Junction road and Hindu College Junction Road are having more PV2 values.

Table 4-38: PV^2 Values at Major Important Intersections[3]

S. No	Location	Maximum [(PV^2)/(1* 10^8)] Observed	Warrant for Controlled Measures
1	Saat Rasta Junction	1806	Yes
2	Patrakar Bhawan	114	Yes
3	Patrakaar Bhawan (Hyderabad Bijapur Bypass junction)	80	Yes
4	Bhaji Market (Old Kumbhari road-New Pacca peth)	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	Vijapur ves junction (Jodabasvanna Stop Location)	1352	Yes
10	Madhala Maruti Chowk (Saraf Khatta Shanivar Peth junction)	226	Yes
11	Shanti Chowk (Govt. Polytechnique Junction)	179	Yes
12	Market Yard (Juna Boramani 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

[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 2×10^8 (or $2 = PV^2/10^8$) for a divided road, then there is requirement of pedestrian crossing facility.

4.9 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
- 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

4.10 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	Bhali Ves Auto 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
		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.

4.11 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.

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

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%.

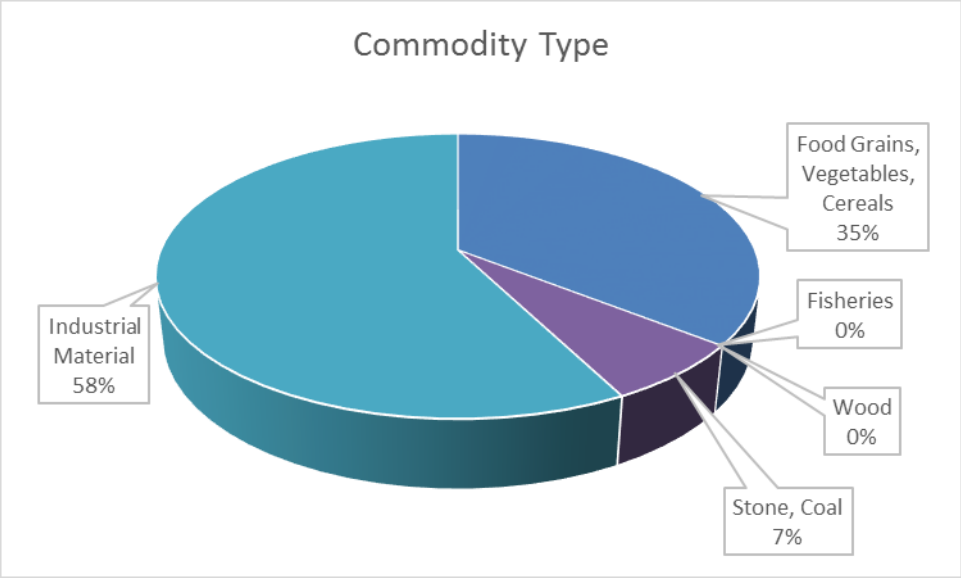


Figure 4-2: Commodity Type

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%

S. No	Operational Difficulties	% Share
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.

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: 16 Tonnes
- 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.

4.11.1 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.

4.11.2 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.

Chapter 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

Los 1	Presence of Organized Public Transport System
1	>= 0.6
2	0.4 – 0.6
3	0.2 – 0.4
4	< 0.2

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 179 sq.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
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 = 28 Kmph

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 =19 Kmph

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 delay 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

Los 1	Fatality rate Per Lakh of Population
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

Los 2	Mixed Land Use Zoning
3	5 – 15
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 = 0 kms

% 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 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 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.

S. No	Bench mark	Overall LoS	LOS calculated	Inference as per MOUD Guidelines
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.

Chapter 6. Way Forward

6.1 Stakeholders workshop

It is proposed to conduct the stakeholder's workshop as part of this study, where the preliminary findings of the study would be shared. The stakeholder views would be taken as one of the inputs and same would be given due consideration during the analysis and forming recommendations.

Subsequently, the draft final CMP report will be finalized and submitted for SMC review. This will include the development of urban transport model for the existing as well as future growth; short, medium and long term transportation strategies.

The final CMP report will be submitted after sharing the recommendations to the stakeholder workshop.

6.2 Short Term Action Programs

Consultant proposes various short term improvement schemes in order to improve the existing chaotic traffic situation. Some of the general short term recommendations are presented below:

- Providing pedestrian facilities
- Junction improvements
- Providing bus bays and shelters
- Commercial vehicle restriction during peak periods
- Segregation of slow and fast traffic
- Planning on street/off street parking facilities
- Removal of Encroachments
- Providing Cycle Lanes
- Removal of bottlenecks

6.3 Development of Transport Model

Transport demand model is one of the key steps evolving medium to long term forecasts and strategies. For this study, the Transport Demand Model will be developed in CUBE software. CUBE is a State-of-Art Software which is widely used both nationally and internationally for

travel demand modeling assignments. The model shall be calibrated & validated for the base year and then used to forecast traffic for the future years. Potential major future network developments such as Bus Rapid Transit System (BRTS) or Rail Transit System shall also be considered and assessed for its impact.

6.4 Transportation Strategies

Better urban planning and modal shift to public transport, making long term transport plans will facilitate the growth of Cities in a way that ensures efficient and convenient public transport. Most urban transport programs will incorporate a combination of these strategies.

Given the existing situation of Solapur and the future growth considerations within the overall Development Area, it is important to devise multi-pronged strategies to deal with the complexities of issues related to the current and future traffic and transport system of the city.

Each of the broad strategies includes sub-strategies of immense importance. The strategies (as shown in Figure 6-1) when implemented through specific projects shall fulfill the goals and objectives of the CMP.

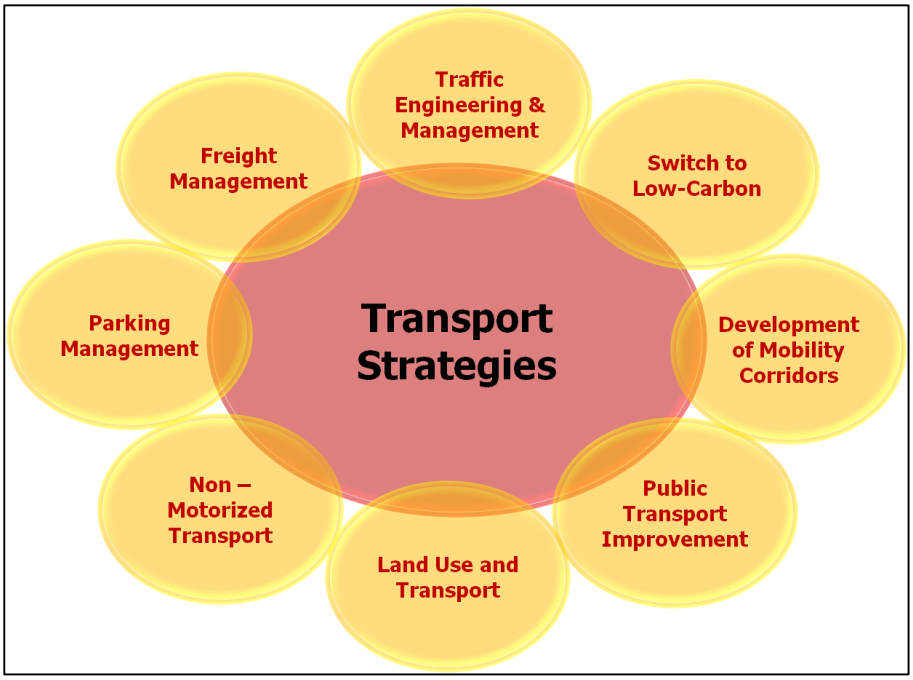


Figure 6-1: Development of Transportation Strategies

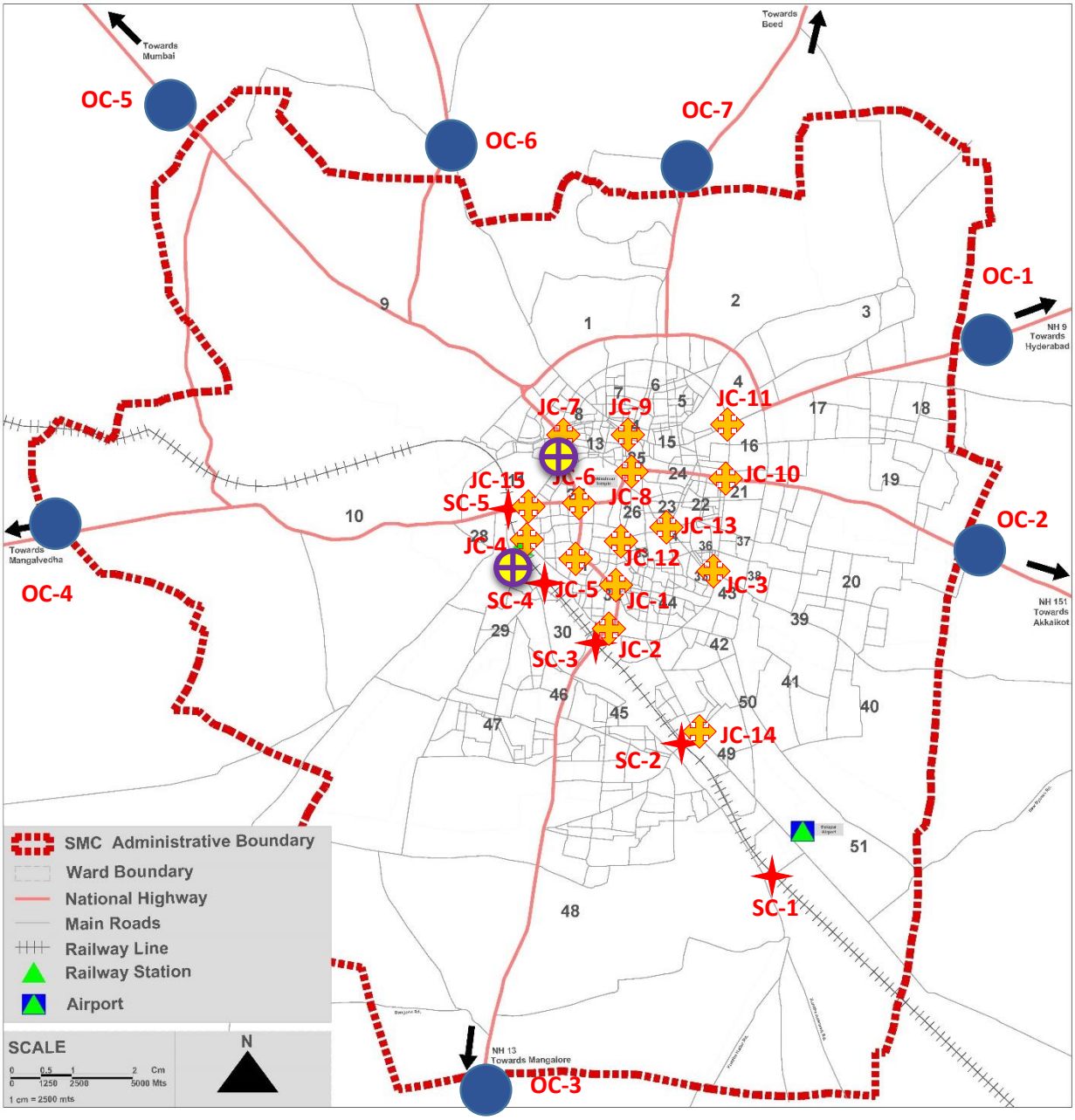
Annexures

Annexure I: Survey Locations in the Study Area

Annexure II: Summary of Classified Traffic Volume Counts

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

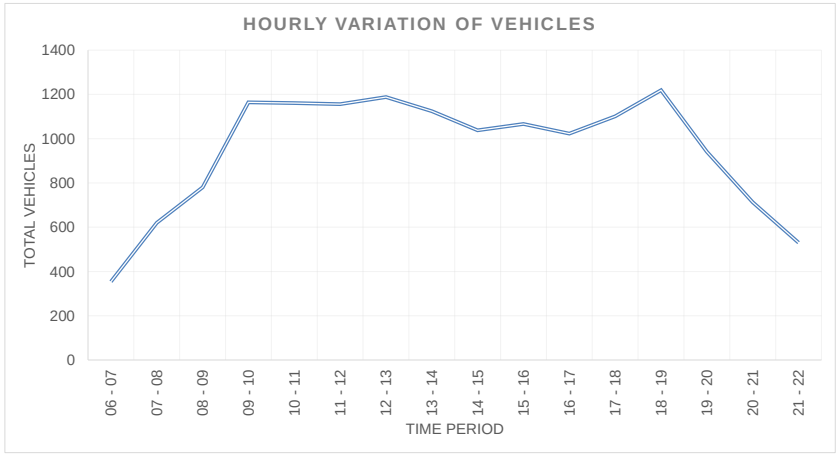
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

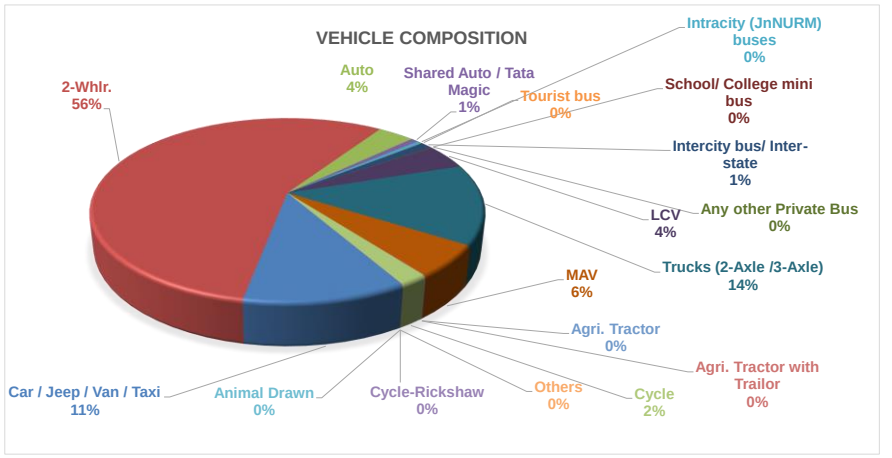
Classified Traffic Volume Count - Outer Cordon

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**





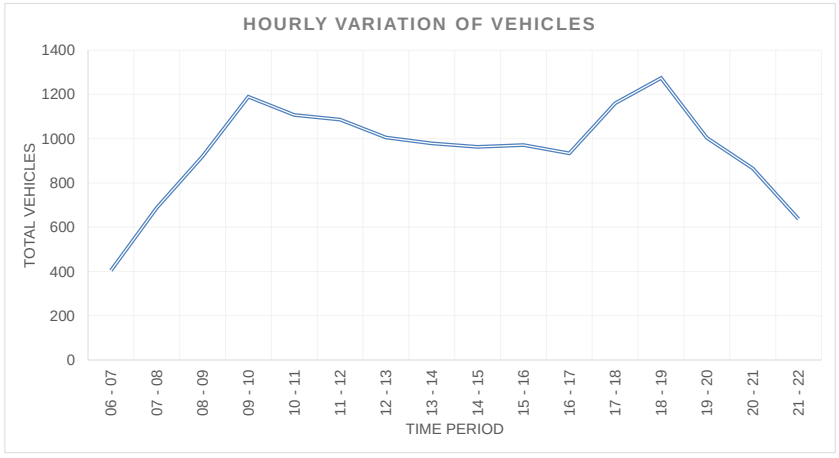
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

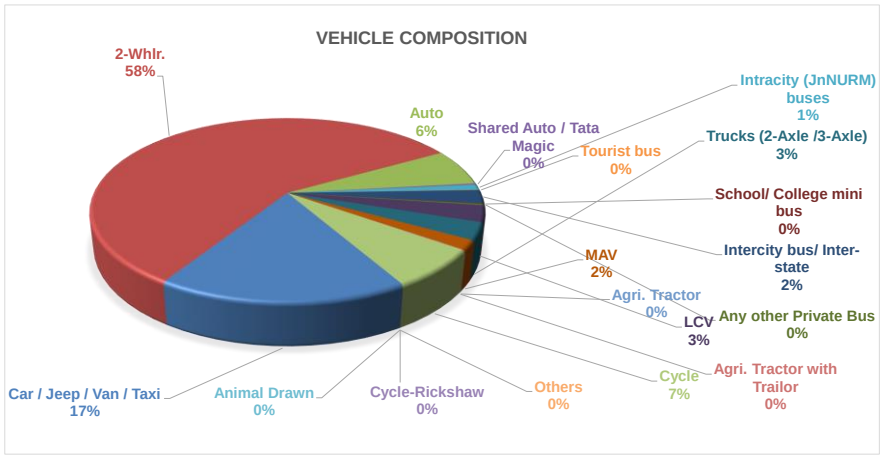
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Akkalkot Road (SH-151) **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**





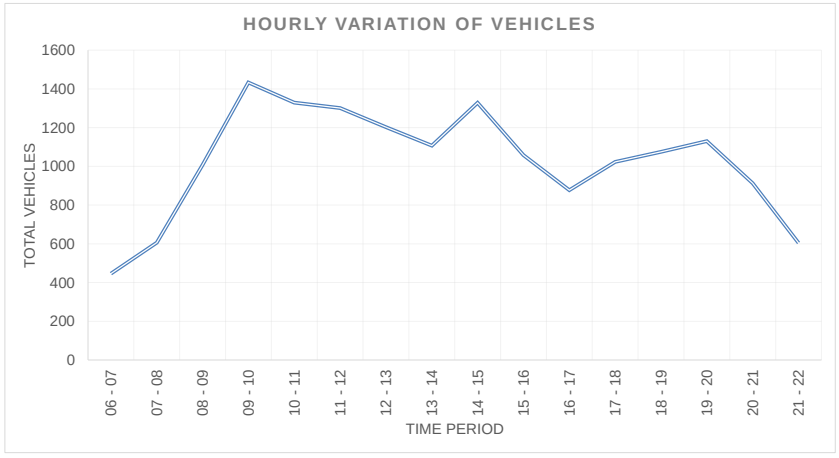
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

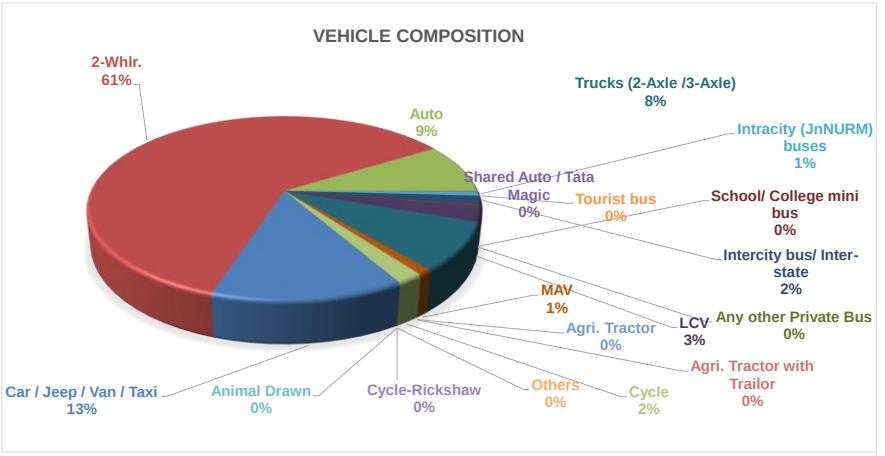
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Mangalore Road (NH-13) **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**





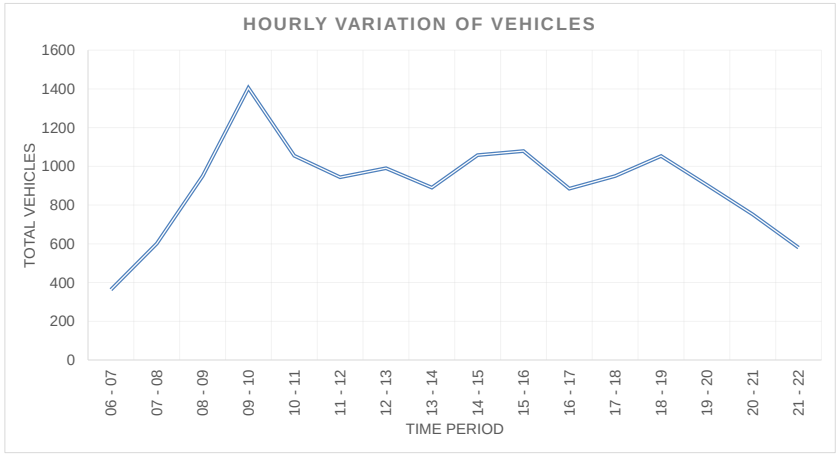
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

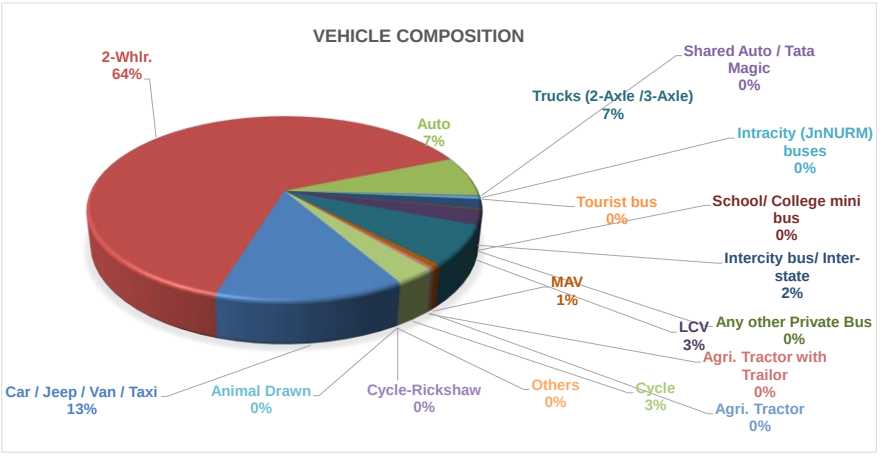
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Mangalwedha Road **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**



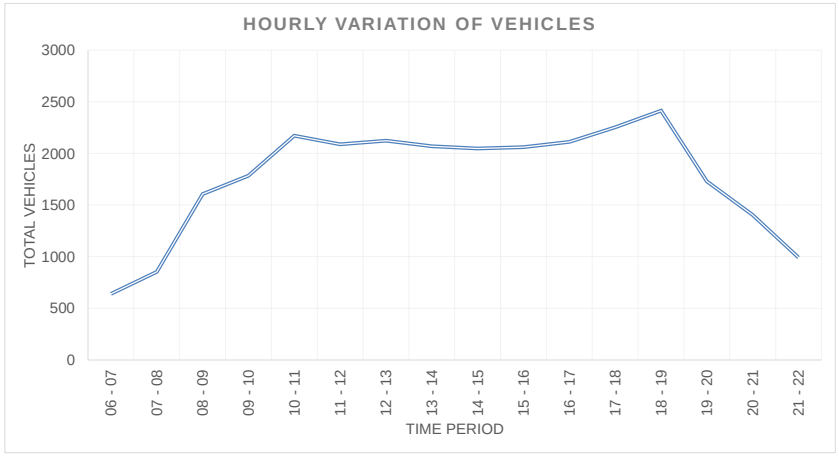


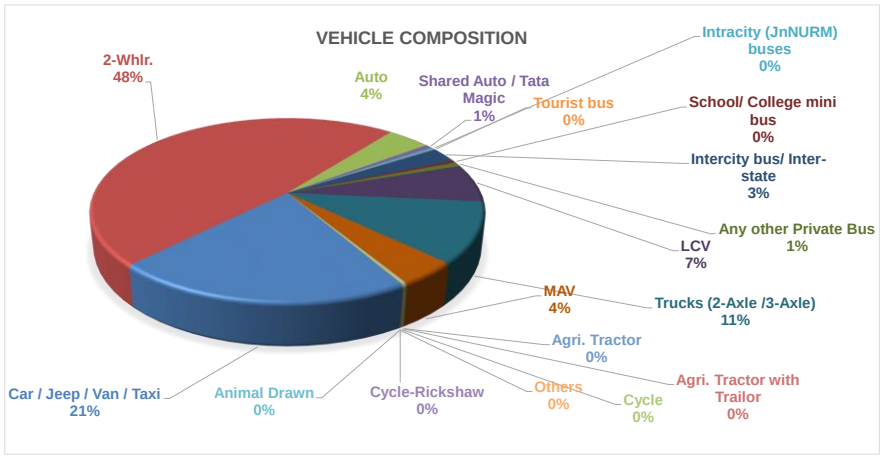
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

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**





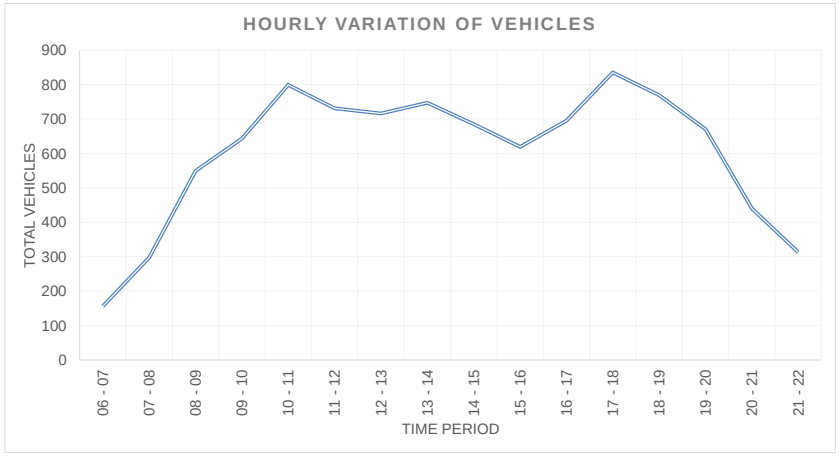
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

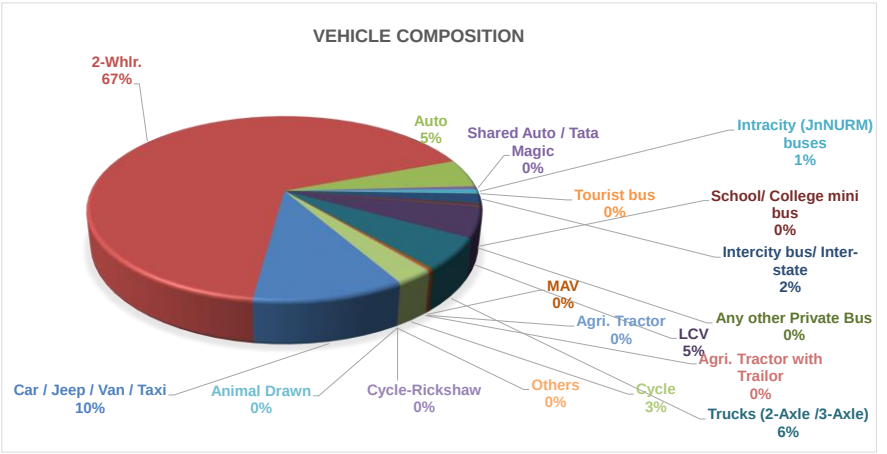
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Barshi Road (To SH-151) **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**





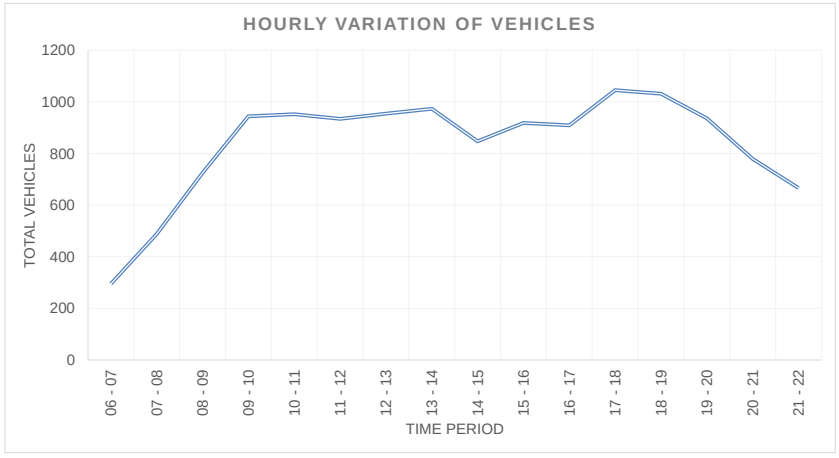
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

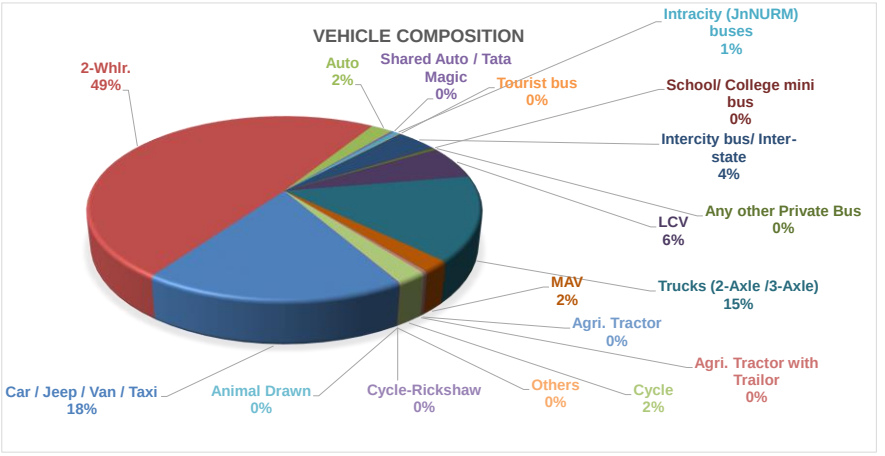
Classified Traffic Volume Count - Outer Cordon

Date of Survey 23/07/2015 **Day of Survey** Thursday

Name of the Road Solapur-Tuljapur Road (NH-204) **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**





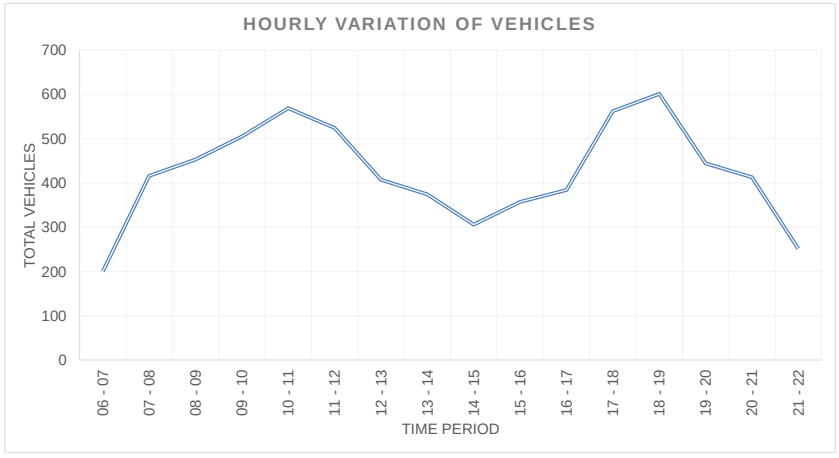
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

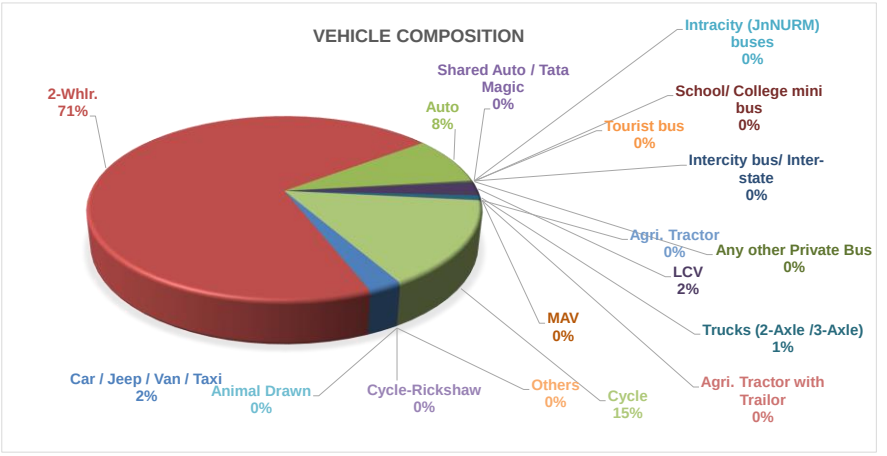
Classified Traffic Volume Count - Screenline

Date of Survey 24/07/2015 **Day of Survey** Friday

Name of the Road Kumthe Aaharwadi Road **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	5	99	12	0	0	0	0	0	0	6	8	0	0	1	69	0	0	0	200	169
07 - 08	7	254	36	0	0	0	0	1	0	4	7	0	0	0	107	0	0	0	416	347
08 - 09	11	288	37	1	0	0	0	0	0	15	5	0	0	0	95	0	0	1	453	389
09 - 10	11	351	33	0	0	0	0	0	0	12	4	0	1	0	93	0	0	0	505	417
10 - 11	18	383	46	2	0	0	0	0	3	11	6	1	1	0	98	0	0	0	569	493
11 - 12	14	402	33	0	0	0	0	0	1	12	2	0	0	0	60	0	0	0	524	435
12 - 13	5	313	37	0	0	0	0	0	0	13	3	0	0	0	36	0	0	0	407	357
13 - 14	8	267	44	0	0	0	0	0	0	8	3	0	0	0	44	0	0	0	374	337
14 - 15	7	208	46	0	1	0	0	0	1	7	3	0	0	0	33	0	0	0	306	293
15 - 16	4	216	32	0	0	0	1	0	3	15	9	0	0	0	77	0	0	0	357	320
16 - 17	13	267	40	0	0	0	1	1	0	13	3	0	0	1	45	0	0	0	384	349
17 - 18	15	429	51	0	0	0	0	0	3	12	0	0	0	0	52	0	0	0	562	488
18 - 19	13	455	42	0	0	0	0	0	0	13	0	0	0	1	77	0	0	0	601	499
19 - 20	14	337	33	0	0	0	1	0	2	7	1	0	0	0	49	0	0	0	444	376
20 - 21	7	323	34	0	0	0	0	0	0	6	1	0	0	0	42	0	0	0	413	349
21 - 22	8	189	12	0	0	0	0	0	0	8	0	0	0	0	34	0	0	0	251	202
Total Veh	**160**	**4781**	**568**	**3**	**1**	**0**	**3**	**2**	**13**	**162**	**55**	**1**	**2**	**3**	**1011**	**0**	**0**	**1**	**6766**	**5818**





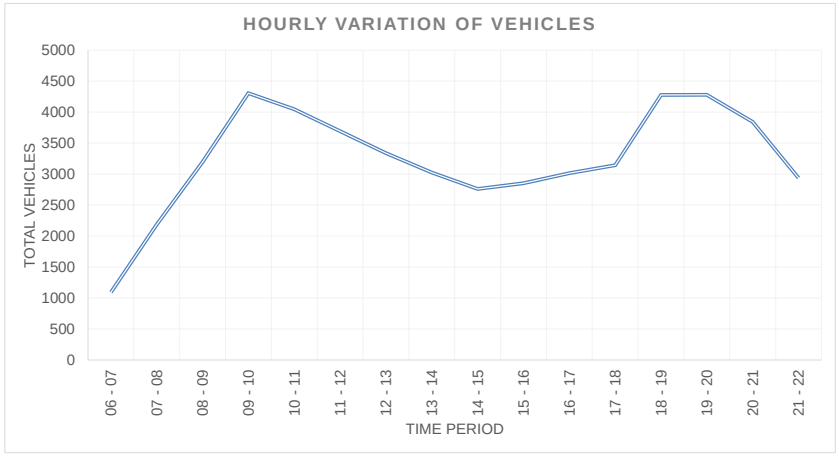
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

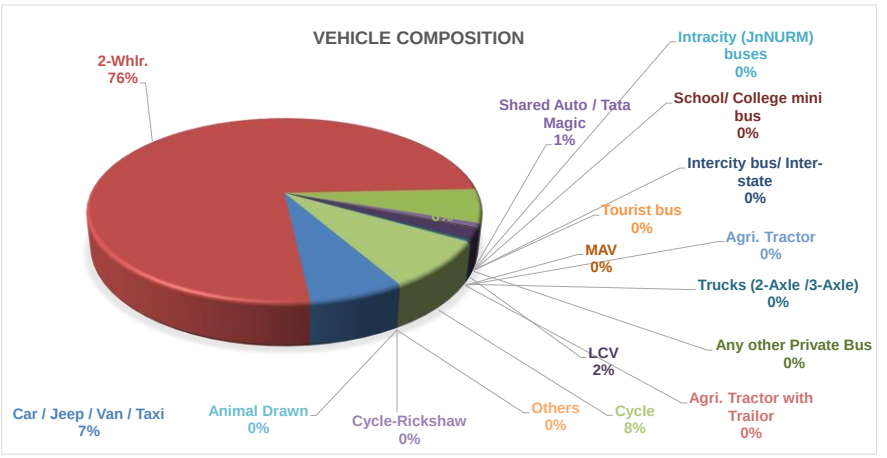
Classified Traffic Volume Count - Screenline

Date of Survey 24/07/2015 **Day of Survey** Friday

Name of the Road Asara bridge, Konark Nagar crossing **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	66	715	51	6	1	0	0	2	3	15	8	0	0	1	225	0	0	0	1093	879
07 - 08	165	1548	129	23	1	0	1	10	6	17	19	0	0	0	268	0	0	0	2187	1846
08 - 09	246	2274	145	43	12	0	0	11	10	40	20	0	0	0	395	0	0	0	3196	2658
09 - 10	275	3165	173	35	2	0	0	9	5	68	21	0	0	0	552	0	0	0	4305	3486
10 - 11	212	3153	201	15	1	0	0	3	1	85	21	0	0	1	351	0	0	2	4046	3365
11 - 12	197	2828	261	19	0	0	0	2	2	103	12	0	0	3	265	0	0	0	3692	3187
12 - 13	194	2605	241	14	0	0	0	0	2	88	16	0	0	0	177	0	0	0	3337	2900
13 - 14	182	2369	205	9	0	0	1	3	3	63	12	0	0	0	176	0	2	0	3025	2600
14 - 15	161	2120	215	15	0	0	1	2	3	56	18	2	0	2	166	0	0	0	2761	2431
15 - 16	194	2079	209	39	1	0	0	8	2	98	7	0	0	0	212	0	3	0	2852	2500
16 - 17	223	2214	224	51	4	0	0	7	3	85	8	1	0	0	194	0	0	0	3014	2657
17 - 18	250	2212	234	52	5	0	0	13	2	78	3	0	0	2	293	0	0	0	3144	2744
18 - 19	298	3246	255	4	0	1	9	1	4	74	5	0	0	1	377	0	0	1	4276	3593
19 - 20	282	3402	231	3	0	0	0	0	0	33	4	0	0	0	324	0	0	0	4279	3517
20 - 21	268	3199	145	2	0	0	0	0	0	26	6	0	0	0	197	0	0	0	3843	3109
21 - 22	213	2402	143	3	0	0	0	0	3	24	4	0	0	0	145	0	0	0	2937	2426
Total Veh	**3426**	**39531**	**3062**	**333**	**27**	**1**	**12**	**71**	**49**	**953**	**184**	**3**	**0**	**10**	**4317**	**0**	**5**	**3**	**51987**	**43899**



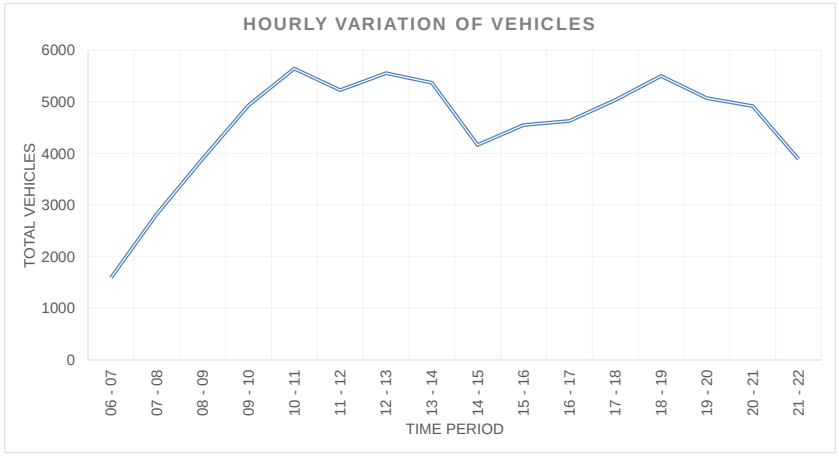


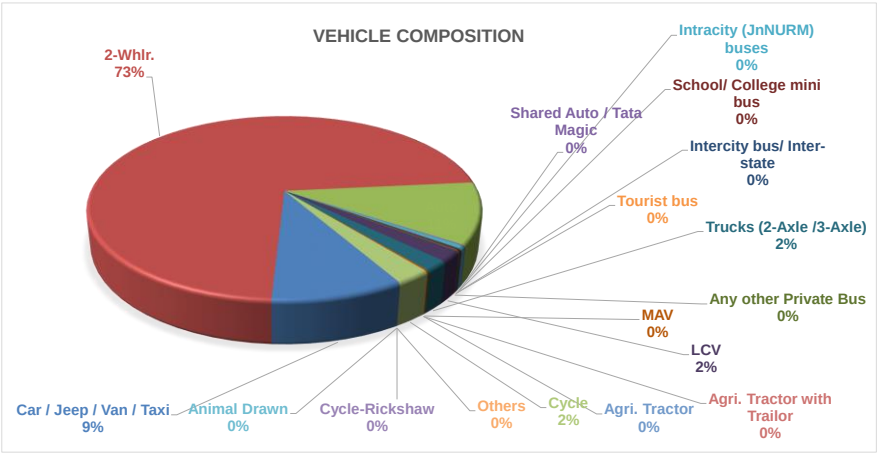
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Screenline

Date of Survey 24/07/2015
Name of the Road Old Bijapur Naka
Day of Survey Friday
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	133	1060	166	2	14	2	1	7	2	26	73	11	0	0	95	0	0	0	1592	1610
07 - 08	254	1896	379	17	27	1	3	16	12	34	41	3	0	0	139	0	0	3	2825	2803
08 - 09	349	2727	431	13	40	2	4	20	4	75	28	0	0	0	204	0	0	0	3897	3663
09 - 10	433	3514	564	6	26	1	5	2	3	79	27	0	0	1	265	0	0	1	4927	4574
10 - 11	472	4082	684	6	30	3	4	4	1	120	36	0	0	2	197	0	0	1	5642	5344
11 - 12	464	3717	713	14	27	0	9	2	1	123	26	0	0	3	124	0	0	2	5225	5086
12 - 13	457	4100	688	9	30	0	7	4	3	130	29	0	0	2	94	0	0	1	5554	5314
13 - 14	467	3945	651	2	28	2	5	5	1	132	27	0	0	0	101	0	0	1	5367	5111
14 - 15	393	2752	450	3	16	1	9	4	0	75	316	64	0	2	80	0	0	0	4165	4602
15 - 16	451	3197	520	4	17	2	19	18	7	93	126	22	0	0	74	0	0	1	4551	4580
16 - 17	516	3314	534	5	16	8	20	14	5	97	26	5	0	0	68	0	0	0	4628	4450
17 - 18	455	3692	563	10	18	2	0	17	26	116	28	0	0	0	104	0	0	1	5032	4763
18 - 19	499	4127	546	3	16	0	12	2	15	83	50	4	0	0	143	0	0	0	5500	5097
19 - 20	539	3831	400	1	7	0	8	0	4	73	152	5	0	0	51	0	0	0	5071	4759
20 - 21	430	3890	336	0	9	0	6	3	0	44	149	8	0	0	43	0	0	0	4918	4523
21 - 22	391	2978	238	0	10	1	6	4	1	41	180	2	0	0	36	0	0	0	3888	3651
Total Veh	**6703**	**52822**	**7863**	**95**	**331**	**25**	**118**	**122**	**85**	**1341**	**1314**	**124**	**0**	**10**	**1818**	**0**	**0**	**11**	**72782**	**69930**



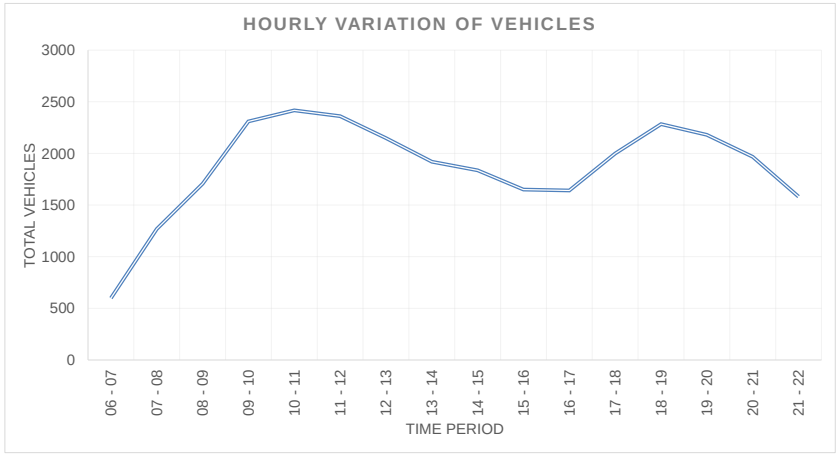


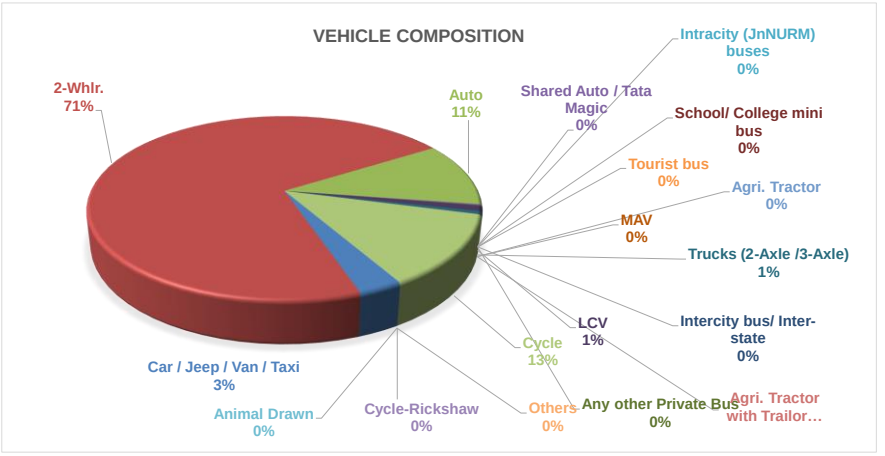
COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Screenline

Date of Survey 24/07/2015
Name of the Road Modi Railway Crossing
Day of Survey Friday
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	12	383	81	2	0	0	0	0	2	8	0	0	0	0	108	0	3	0	599	538
07 - 08	28	831	133	9	1	0	0	4	0	16	3	0	0	0	243	0	0	0	1268	1087
08 - 09	39	1231	153	3	1	0	0	0	0	22	2	0	0	0	256	0	0	0	1707	1438
09 - 10	58	1628	190	2	0	0	0	1	0	23	7	0	0	0	399	0	1	1	2310	1919
10 - 11	71	1747	247	4	0	0	1	5	0	28	22	0	0	0	290	0	2	0	2417	2128
11 - 12	60	1602	337	6	1	0	0	1	0	24	23	0	0	2	302	0	3	0	2361	2198
12 - 13	69	1480	350	0	0	0	0	0	0	23	24	0	0	0	202	0	0	0	2148	2069
13 - 14	74	1336	277	4	1	0	0	1	1	28	7	0	0	0	191	0	0	0	1920	1792
14 - 15	74	1272	254	1	0	0	0	2	0	16	8	1	0	1	206	0	0	1	1836	1699
15 - 16	61	1199	195	6	1	0	0	1	0	17	11	0	0	2	157	0	0	0	1650	1497
16 - 17	68	1161	217	4	1	0	0	2	0	15	9	0	0	3	162	0	0	0	1642	1518
17 - 18	78	1421	237	2	1	0	0	1	3	13	16	0	0	3	225	0	0	0	2000	1811
18 - 19	65	1654	221	2	0	0	0	0	1	17	23	0	0	0	300	0	0	0	2283	1980
19 - 20	63	1622	185	0	1	0	0	0	0	10	2	0	0	0	297	0	0	0	2180	1819
20 - 21	55	1535	151	0	1	0	0	0	0	13	1	0	0	0	212	0	0	0	1968	1637
21 - 22	46	1210	127	1	0	0	0	0	0	5	0	0	0	0	193	0	0	0	1582	1312
Total Veh	**921**	**21312**	**3355**	**46**	**9**	**0**	**1**	**18**	**7**	**278**	**158**	**1**	**0**	**11**	**3743**	**0**	**9**	**2**	**29871**	**26440**





COMPREHENSIVE MOBILITY PLAN FOR SOLAPUR

Classified Traffic Volume Count - Screenline

Date of Survey 24/07/2015 **Day of Survey** Friday

Name of the Road Sangola Mangalweda Crossing **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	67	784	179	2	2	0	3	0	5	18	32	2	0	0	284	0	0	0	1378	1289
07 - 08	123	1698	334	52	7	0	10	10	2	32	16	0	0	3	521	0	4	1	2813	2550
08 - 09	143	2000	242	13	7	0	9	5	11	43	11	0	0	2	456	0	7	0	2949	2542
09 - 10	201	2770	357	18	10	0	10	5	5	84	25	0	0	12	650	0	6	3	4156	3653
10 - 11	236	3023	487	16	9	0	11	2	1	96	35	1	0	11	679	0	9	0	4616	4164
11 - 12	233	2886	538	24	4	0	17	1	3	89	28	0	0	4	665	0	10	0	4502	4111
12 - 13	202	2541	430	10	4	0	17	3	0	89	25	0	1	6	329	0	9	0	3666	3420
13 - 14	193	2277	399	3	3	0	13	7	3	67	20	0	1	5	293	0	8	1	3293	3083
14 - 15	196	2245	398	5	3	0	13	1	5	53	72	5	0	4	359	0	6	0	3365	3200
15 - 16	207	2177	431	19	4	0	7	6	3	52	68	4	0	2	460	0	6	0	3446	3262
16 - 17	216	2202	382	11	3	0	16	6	4	67	46	0	0	5	365	0	7	2	3332	3131
17 - 18	254	2544	424	20	4	0	13	4	11	79	28	0	0	6	502	0	2	1	3892	3562
18 - 19	230	2944	400	11	5	0	9	0	3	47	27	1	0	10	496	0	5	0	4188	3718
19 - 20	217	2999	329	5	3	0	9	0	2	52	19	0	1	4	445	0	1	0	4086	3523
20 - 21	186	2655	267	0	8	0	5	0	5	42	19	0	0	0	344	0	1	0	3532	3028
21 - 22	164	1840	194	0	0	0	0	0	6	39	19	0	0	0	235	0	0	0	2497	2162
Total Veh	**3068**	**37585**	**5791**	**209**	**76**	**0**	**162**	**50**	**69**	**949**	**490**	**13**	**3**	**74**	**7083**	**0**	**81**	**8**	**55711**	**50397**