REPUBLIC OF INDIA
HYDERABAD METROPOLITAN DEVELOPMENT AUTHORITY/
HYDERABAD GROWTH CORRIDOR LIMITED

JICA SPECIAL ASSISTANCE FOR PROJECT IMPLEMENTATION (SAPI) FOR THE ASSISTANCE FOR THE INTRODUCTION OF ITS ON ROAD NETWORK IN HYDERABAD METROPOLITAN AREA IN INDIA

FINAL REPORT

March 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
JICA STUDY TEAM Consisted by

N I P P O N K O E I C O . , L T D .
EAST NIPPON EXPRESSWAY CO., LTD.
METROPOLITAN EXPRESSWAY CO., LTD.

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Abbreviations

Abbreviation	Long Name
24/7	24 hours a day, 7 days a week
ADHA	Automatic Data Historical Archive
AFC	Automatic Fare Collection
AHS	Automated Highway System
AMFRA	Automated Mileage and Fuel Reporting and Auditing
ANPR	Automatic Number Plate Recognition
AP	Andhra Pradesh
APSDPS	Andhra Pradesh State Development Planning Society
APSPCB	Andhra Pradesh State Pollution Control Board
APSRTC	Andhra Pradesh State Road Transport Corporation
ARSI	Automated Roadside Safety Inspection
ATCC	Automatic Traffic Counter-Cum-Classifier
BOOT	Build Own, Operate and Transfer
BOT	Build Operate and Transfer
BRT	Bus Rapid Transit
BSUP	Basic Services to the Urban Poor
CA	Concession Agreement
CALM	Communication Air-Interface Long and Medium Range
CCC	Command & Control Centre
CCTV	Closed Circuit Television
CDA	City Development Authority
C-DAC	Centre for Development of Advanced Computing
CDP	City Development Plan
CDS	City Development Strategy
CFA	Central Financial Assistance
CMC	Common Mobility Card
CMP	Comprehensive Mobility Plan
CMU	Corridor Management Unit
CRIS	Centre for Railway Information Systems
CTCH	Central Toll Clearing House
CTP	Cyberabad Traffic Police
CTS	Comprehensive Transportation Study
CVAP	Commercial Vehicle Administrative Processes
CVEC	Commercial Vehicle Electric Clearance

Abbreviation	Long Name
DBFOT	Design, Build, Finance, Operate and Transfer
DCP	Deputy Commissioner of Police
DIT	Department of Information Technology
DIV	Data Import and Verification
DRM	Digital Road Map
DSRC	Dedicated Short Range Communication
ECB	Emergency Call Box
EMRI	Emergency Management and Research Institute
ENPS	Emergency Notification and Personal Security
ERP	Electronic Road Pricing
ETC	Electronic Toll Collection
EVM	Emergency Vehicle Management
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHMC	Greater Hyderabad Municipal Corporation
GNSS/CN	Global Navigation Satellite System/Cellular Network
GoI	Government of India
GPRS	General Radio Packed Service
GPS	Global Positioning System
HATS	Hyderabad Area Transportation Study
HGCL	Hyderabad Growth Corridor Limited
HIN	HAZMAT Incident Notification
HMDA	Hyderabad Metropolitan Development Authority
HMRL	Hyderabad Metropolitan Railway Limited
HTMS	Highway Traffic Management System
HTP	Hyderabad Traffic Police
H-TRIMS	Hyderabad Traffic Integrated and Management System
HUDA	Hyderabad Urban Development Authority
IBEC	International Border Electronic Clearance
ICT	Information and Communication Technology
IIT	Indian Institute of Technology
IM	Incident Management
IMD	India Metrological Department
IMF	International Monetary Fund
IRC	Indian Roads Congress
IRR	Inner Ring Road

Abbreviation	Long Name
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems
JICA	Japan International Cooperation Agency
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KAREN	Keystone Architecture Required for European Networks
L&T	Larsen & Toubro Co., Ltd
LED	Light-Emitting Diode
LRT	Light Rail Transit
MCH	Municipal Corporation of Hyderabad
MCIT	Ministry of Communication & Information Technology
MDS	Meteorological Data System
MDSS	Maintenance Decisions Support System
MET	Meteorological Station
MGBS	Mahatma Gandhi Bus Station
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MMTS	Multi Modal Transport System
MoRTH	Ministry of Road Transport & Highways
MoUD	Ministry of Urban Development
NCT	National Capital Territory
NH	National Highway
NHAI	National Highway Authority of India
NIC	National Informatics Centre
NIT	National Institute of Technology
NTDPC	National Transport Development Policy Committee
NUTP	National Urban Transport Policy
OBSSM	On-Board Safety and Security Monitoring
OBU	On-Board Unit
OD	Origin-Destination
ODC	Operational Data Control
ORR	Outer Ring Road
OSRT	Off Site Realtime System
PAHS	Partially Automated Highway System
PCU	Passenger Car Unit
PIU	Project Implementation Unit
PPP	Public Private Partnership
PRR	Peripheral Ring Road
PSTI	Protect Sensitive Traveller Information

Abbreviation	Long Name
PTS	Public Travel Security
PTTI	Pre-Trip Travel Information
PUC	Pollution Under Control
R&B	Road and Building Department
RFID	Radio Frequency Identification
RFP	Request for Proposal
RG	Route Guidance
RM	Route Management
RMR	Ride Matching and Reservation
RPV	Route Patrolling Vehicles
RTA	Regional Transport Authority
SAPI	Special Assistance for Project Implementation
SCB	Secunderabad Cantonment Board
SCR	South Central Railway
SCSC	Society for Cyberabad Security Council
SMS	Short Message Service
SPV	Special Purpose Vehicle
SUTP	Sustainable Urban Transport Project
TC	Traffic Control
TCC	Traffic Command Centre
TDM	Travel Demand Management
TIMCC	Traffic Information Management and Control Centre
TMS	Toll Management System
TSI	Traveller Services Information
UIDAI	Unique Identification Authority of India
UMTA	Unified Metropolitan Transport Authority
USA	United States of America
UTI	Unit Trust of India
VIP	Very Important Person
VMS	Variable Message Sign Board
WAA	Wide Area Alert
WIM	Weigh-in-Motion

1 Introduction

1-1 Study Background

Hyderabad is one of six (6) major metropolises in India. It is the capital city of Andhra Pradesh state in South India and located almost in the middle of the country surrounded by Mumbai in west, Bangalore in south and Chennai in southeast.

Hyderabad has been developing as a growth base of international business, represented by the industries of information technology and pharmacy. Traffic has been significantly increasing with rapid urbanisation in recent years. As a result, severe traffic congestion is becoming a social problem, hindering smooth business activities. Thus, there is an urgent need to alleviate traffic congestion.

Under this situation, construction of Outer Ring Road (ORR) is underway to ease congestion by reducing the number of vehicle passing through the city, thereby contributing to regional economic development in suburban area and improvement of the urban environment. Intelligent Transport Systems (ITS) will be developed on ORR by Japanese yen loan project for efficient management of highway and toll collection

In the city of Hyderabad, some governmental bodies and private enterprises recently began developing ITS. However the status of ITS in the city remains in a piecemeal manner, and the systems are planned by individual bodies in an uncoordinated way.

In this background, the state government of Andhra Pradesh requested the government of Japan to carry out a study to prepare a comprehensive ITS Master Plan for Hyderabad Metropolitan Area (HMA).

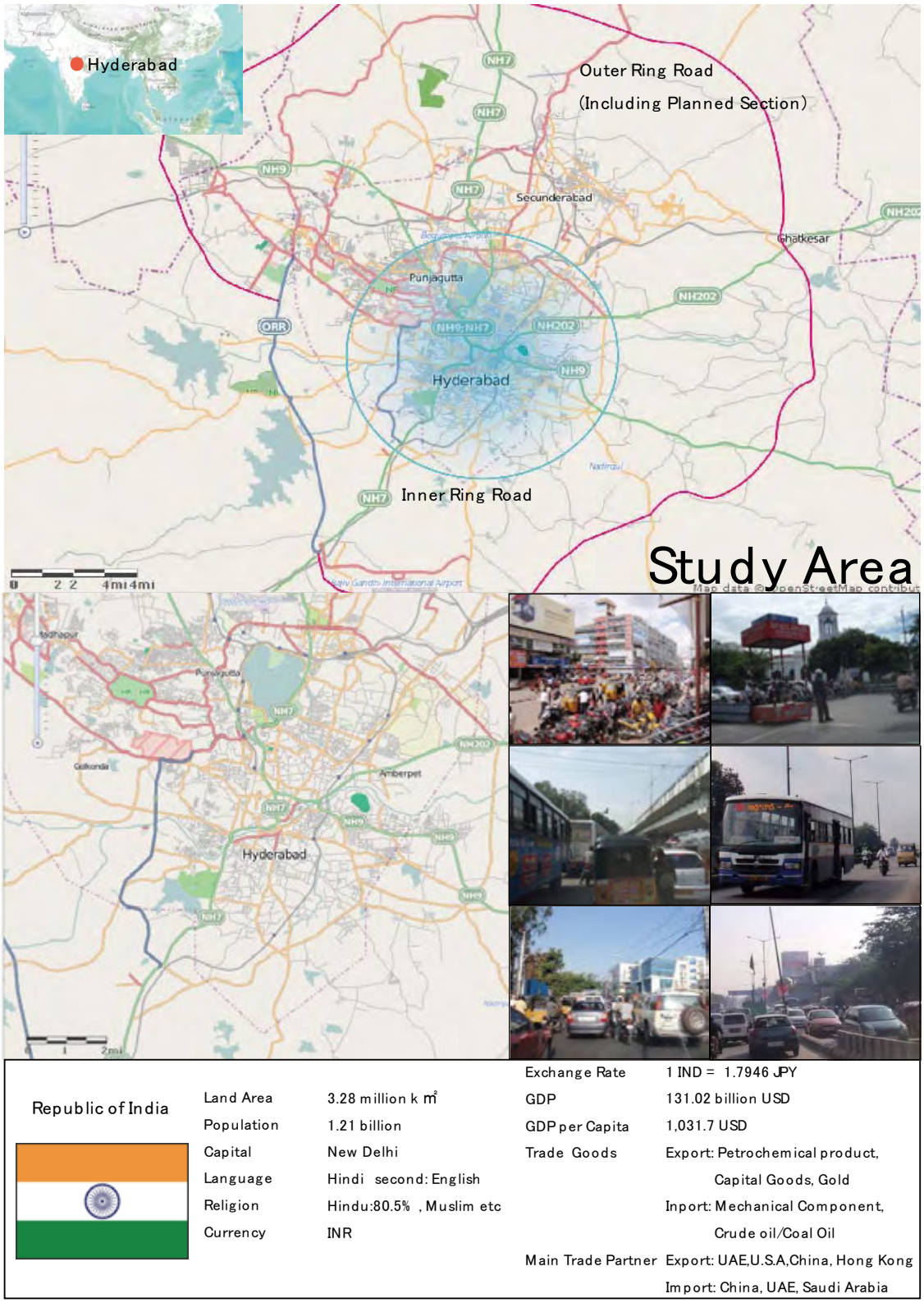
As a result, Hyderabad Growth Corridor Limited (HGCL) under Hyderabad Metropolitan Development Authority (HMDA) and Japan International Cooperation Agency (JICA) agreed that both parties would sincerely cooperate with each other with a view to contributing towards the smooth introduction of ITS in Hyderabad Metropolitan Area by formulating ITS Master Plan and preparing design of pilot prject for the prioritised ITS services.

1-2 Study Objectives

The objectives of the study is to assist Andhra Pradesh State Government and Hyderabad city authority to improve and modernise the traffic and transporation system in Hyderabad through formulating ITS Master Plan and prioritising ITS projects in Hyderabad Metropolitan Area which can be implemented in a phase manner. The study also aims to assist HMDA/HGCL by preparing tender document for the prioritised ITS as a pilot project in Phase-1 of the Master Plan, which will be funded through current JICA loan for Hyderabad Outer Ring Road Phase2.

1-3 Study Area

The study area for this project is shown in the figure below.



Source: JICA Study Team

Figure 1 Location Map of Study Area

1-4 Scope of Works

The scope of works includes (i) formulation of ITS Master Plan for Hyderabad Metropolitan Area, (ii) selection of pilot project(s) for prioritised ITS services, (iii) design of pilot project(s), (iv) preparation of draft tender documents, (v) preparation of operation & maintenance manual, and (vi) preparation of road inventory. The table below lists the scope of works in accordance with terms of reference of JICA.

Table 1 Scope of Works

1 Preparation of ITS Master Plan for Hyderabad Metropolitan Area
1-1 Review of Current Condition in Hyderabad Metropolitan Area, including: - Current Traffic Volume and Traffic Condition - Road Network and Congestion Situation - Traffic Demand and Traffic Assignment - Existing Facilities for Traffic Control - Existing Facilities for Information Provision - Traffic Accident - Public Transport - Existing Related Plans, including Comprehensive Transportation Plan
1-2 Formulation of Policy for ITS Introduction, including: - Clarification of Demarcation between Public and Private Sectors for ITS Introduction and Operation/Maintenance - Evaluation of Needs of ITS and Effect of ITS Introduction
1-3 Conceptual Design of ITS Projects, including: - Outline of System - Rough Cost Estimate - Expected Effect and Conditions for Introduction - Systems to be Considered Traffic Control and Monitoring System utilising CCTV Camera, Traffic Counter and Probe Car System Traffic Information Provision System utilising Media such as VMS Information Exchange Signal System Traffic Demand Control Bus Location System and IC Card
1-4 Assistance for Organisation Setup for ITS, including: - Review of Roles and Responsibilities of Existing Organizations - Proposal of Roles and Responsibilities of New Organisation - Related Existing and Required Laws and Regulations
1-5 Proposal of Funding Scheme and Economic/Financial Evaluation, including: - Cost Estimate for ITS Introduction and Operation - Funding Scheme in Other Countries - Proposal of Funding Scheme including Possibility of Private Sector Involvement - -Economic and Financial Analysis Considering Benefit and Income
1-6 ITS Master Plan Formulation, including:

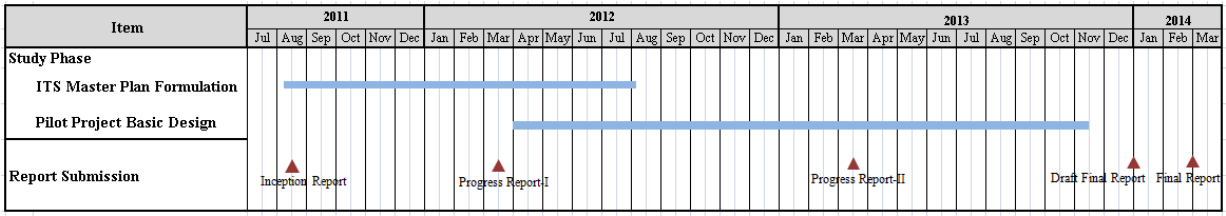
- Preparation of Road Map - Consideration of Latest Technology and Related Laws and Regulations - Lists of Project and Implementation Schedule in Phases and Category
1-7 Assistance for Capacity Building for ITS - Workshops - Participation in ITS World Congress
2 Assistance for Pilot Project
2-1 Selection of Pilot Project for Prioritised ITS Services as follows: - ITS Control Centre and Equipment - Data Collection System by Bus Probe System and Traffic Counter - Information Provision System by VMS, Internet and SMS - Flood Monitoring System and Meteorological Monitoring System - Data Analysis - Road Inventory
2-2 Preparation of Basic Design of Pilot Project, including: - Covered Area - Component and Specification of Equipment - Specification of Operation and Maintenance
2-3 Preparation of Draft Tender Document, including: - Procurement of Equipment - Procurement of Operator
2-4 Preparation of Operation and Maintenance Manual
3 Others
3-1 Supplement Traffic Survey

1-5 Study Schedule

The entire work period of the study is approximately 31 months beginning with the preparatory work in August 2011 and submission of the final report in February 2014.

The study is divided into two stages with the following objectives:

- Phase-1: Formulation of ITS Master Plan
- Phase-2: Basic Design and Preparation of Tender Documents for Pilot Project



Source: JICA Study Team

Figure 2 Study Schedule

1-6 JICA Study Team

The study team includes the following members:

1	Mr. Hiroya TOTANI	Team Leader / Traffic Management Planning
2	Mr. Hideyuki SAKUNAKA	Deputy Team Leader / ITS Planning 2
3	Mr. Noboru KONDO	ITS Planning 1
4	Mr. Koichi NISHIMURA	ITS Design 1
5	Mr. Tomoaki TAKAHASHI/ Mr. Shinichi ANDO	ITS Design 2
6	Mr. Hiroshi WARITA	Public Transportation
7	Mr. Jun OKUNO	Traffic Survey 1 /Economic and Financial Analysis / Funding Planning
8	Mr. Wataru OZONO	Traffic Survey 2 (Support)
9	Mr. Takuma HIRANO	ITS Operation and Management /Institutional Development
10	Mr. Kazuto MATSUZAWA	Construction Planning / Cost Estimate (Facility)
11	Mr. Hisatoshi NAITO/ Mr. Kenji NOMOTO	Tender Document Preparation
12	Mr. Tatsuo TAKANO	Operation Manual for Traffic Control/Information Collection and Provision
13	Mr. Eiji WAKATSUKI	Operation Manual for Equipment/System Maintenance
14	Mr. Toshiki KUROSAWA	Road Inventory
15	Mr. Michio ISEKI	ITS Planning 3
16	Mr. Takayasu OSARA	Project Coordinator / ITS Support

1-7 Counterparts

Counterpart organisation of the project is Hyderabad Growth Corridor Limited (HGCL) /Hyderabad Metropolitan Development Authority (HMDA). HMDA is urban planning agency for the development of Hyderabad metropolitan area. The Government of Andhra Pradesh formed a Special Purpose Vehicle (SPV) for the development of the Outer Ring Road called HGCL. It is a joint venture between HMDA and Infrastructure Corporation of Andhra Pradesh (INCAP). Counterpart staff has been assigned since the beginning of the project. They are Chief Engineer (HMDA), General Manager (Technical, HGCL), Assistant General Manager (Technical, HGCL) and traffic and transportation engineers.

2 Review and Assessment of Current Conditions

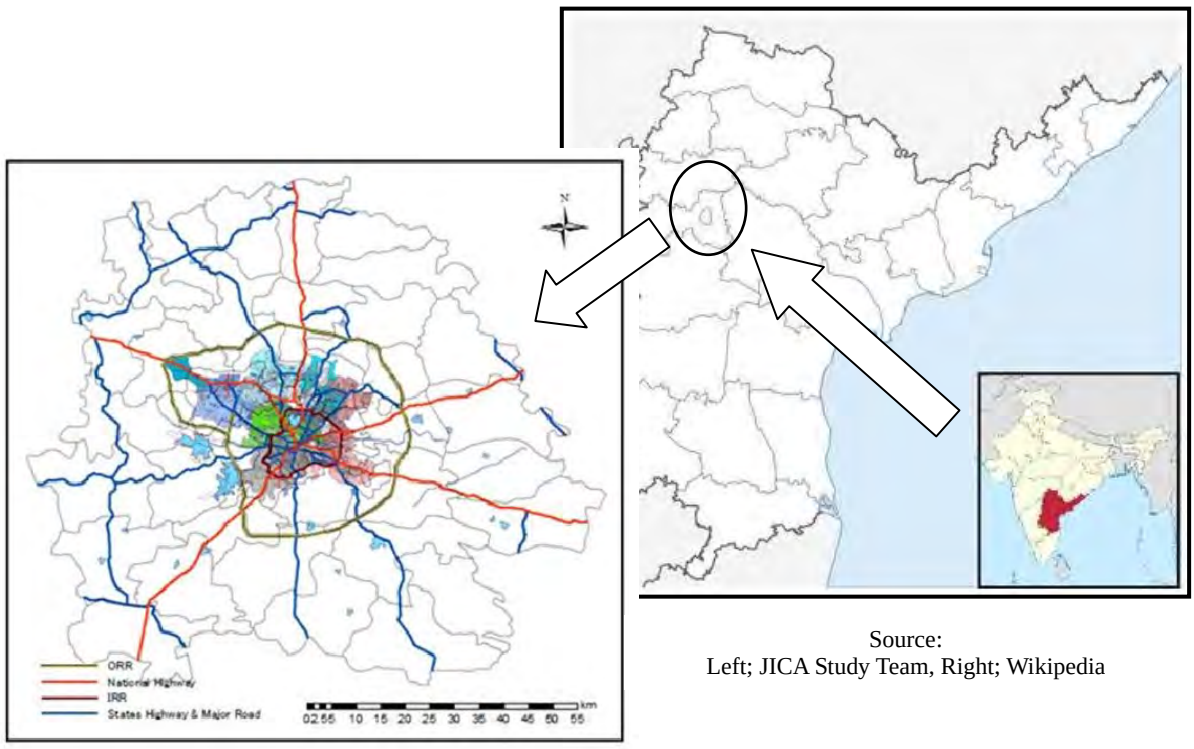
2-1 Regional Basic Information of Hyderabad

2-1-1 Outline of Hyderabad Metropolitan Area

Hyderabad is a capital city of Andhra Pradesh state. Hyderabad Metropolitan Area (HMA) is one of six (6) major metropolises in India and located almost in the middle of Mumbai, Bangalore and Chennai. The total area of HMA is nearly 7,200 sq. km.

It has been a growth base for international business such as information technology, pharmacy, etc. in recent years. The population and number of vehicles have been rapidly growing in the HMA.

The highways connecting to other cities cross in radial pattern in the centre of the city. Severe traffic congestion is commonly seen due to increasing in number of automobiles that pass through the city and run within the city.



Source:
Left; JICA Study Team, Right; Wikipedia

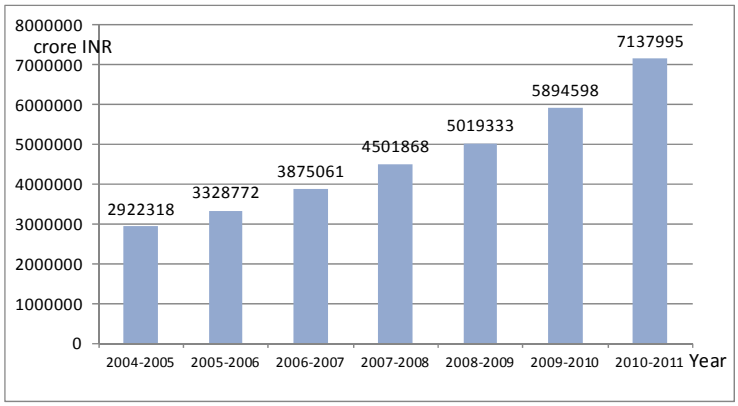
Figure 3 Location of Hyderabad City

2-1-2 Economy

(1) GDP Growth in India

India is an economic superpower in the world after China. But rapidly increasing inflation and other economic issues are major hurdles for further development, in recent years.

The Indian economy in recent years has been consistently showing excellent growth rate with 9.6% in 2006 and 9.2% in 2007. This performance is a result of market restructuring, huge infusions of FDI, increasing foreign exchange reserves, boom in both IT and real estate sectors, and a thriving capital market.



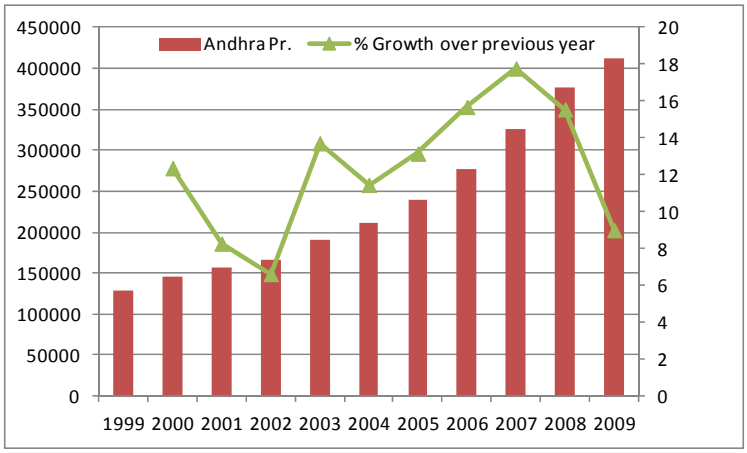
Source: Bank of India website

Figure 4 GDP Growth in India (2004-2005 Price)

(2) GDP Growth in Andhra Pradesh State

Andhra Pradesh GDP is rapidly growing in parallel with Indian national GDP. The economic growth of Andhra Pradesh state is shown in the below figure.

(Unit: Left axis Crore INR, Right axis %)



Source: Ministry of Statistics and Program Implementation

Figure 5 Yearly GDP Growth of Andhra Pradesh State (GDP (99-00 Base))

(3) GDP by State

The GDP growth of Andhra Pradesh has an important role for development of Indian Economy. The Andhra Pradesh GDP generates 10% of the Indian national GDP and occupies 3rd position in the country. The state with highest GDP in India is Maharashtra state which has economic hub Mumbai as its capital city.

Table 2 GDP by State

(Unit: Crore INR)

Sl. No.	State/UT	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	Andhra Pr.	128797	144723	156711	167096	190017	211802	239683	277286	326547	377346	411349
2	Arunachal Pr.	1612	1787	2104	2071	2368	2853	2918	3413	3888	4536	NA
3	Assam	34833	36814	38313	43407	47305	52533	57817	64429	71625	79277	88023
4	Bihar	50174	57242	57657	64965	66174	73654	79382	99579	114616	142504	155051
5	Jharkhand	34323	32093	35069	37967	42449	51323	54879	63229	69253	75711	83078
6	Goa	6330	6757	7097	8100	9301	11482	13262	15248	17215	NA	NA
7	Gujarat	109861	111139	123573	141534	168080	189118	226897	262723	303734	337217	380096
8	Haryana	51375	58183	65505	72528	82862	93561	106393	130236	154231	182588	209510
9	Himachal Pr.	14112	15661	17148	18905	20721	23066	25685	28591	32221	36924	42278
10	J & K	15660	16700	18039	20326	22194	24265	26537	29030	31793	NA	NA
11	Karnataka	101247	108362	112847	120889	130990	156226	183796	205784	240062	270697	298465
12	Kerala	69168	72659	77924	86895	96698	110260	125588	145009	165722	189841	NA
13	Madhya Pr.	80132	79203	86745	86832	102839	106808	117565	133073	149840	171547	194427
14	Chattisgarh	27249	25846	29539	32493	38802	43589	50999	64706	79418	95204	107848
15	Maharashtra	247830	252283	273188	299479	340600	386297	438732	517459	610108	692749	831971
16	Manipur	3260	3112	3369	3506	3979	4568	5066	5403	5848	6344	NA
17	Meghalaya	3578	3961	4478	4763	5280	5805	6445	7330	8472	9611	NA
18	Mizoram	1550	1737	1947	2166	2325	2455	2721	3059	3412	3809	NA
19	Nagaland	2802	3399	3972	4467	4812	5139	5490	5978	NA	NA	NA
20	Orissa	42986	43351	46756	49713	61008	71674	78445	95065	119066	133601	150946
21	Punjab	67162	74677	79611	82249	90089	96660	108653	121209	144309	165804	192364
22	Rajasthan	82720	82435	91771	88550	111606	117274	128644	153344	176420	201675	219769
23	Sikkim	896	1014	1136	1276	1430	1602	1830	2039	2298	2612	NA
24	Tamil Nadu	134185	146796	148861	158155	175371	202374	234837	276917	304989	339212	379503
25	Tripura	4867	5499	6370	6733	7551	8297	9388	10322	10821	NA	NA
26	Uttar Pradesh	175159	181512	190269	206855	226972	248851	277068	312627	357557	412151	491302
27	Uttarakhand	12621	14501	15826	18473	20439	23720	26179	31380	36045	40238	46872
28	West Bengal	135376	143725	157144	168000	189259	209439	229339	264542	307895	353967	NA
29	A & N islands	939	989	1082	1228	1392	1530	1704	2009	2175	NA	NA
30	Chandigarh	4141	4794	5490	6453	7419	8815	10299	12256	14176	16431	19296
31	Delhi	55220	60125	65027	71361	79468	92053	105814	125381	144303	165948	NA
32	Pondicherry	3235	3864	4259	4931	5438	5185	6219	8470	10312	11774	13143

Source: Ministry of Statistics and Program Implementation

(4) GDP Per Capita by State

The Andhra Pradesh State GDP per capita rank in India is in top 10 and is rapidly growing with average growth rate in last five years at 15.01%. The state with the highest growth rate is Delhi.

Table 3 GDP Per Capita by State

(Unit: INR)

SN	StateorUT	2004-2005	2005-2006	% growth	2006-2007	% growth	2007-2008	% growth	2008-2009	% growth	2009-2010	% growth	2010-2011
1	ANDHRA PRADESH	25321	28539	12.7	33135	16.1	39727	19.8	45007	13.2	51025	13.3	60458
2	ARUNACHAL PRADESH	27719	29473	6.3	31840	8	36697	15.2	43445	18.3	51405	18.3	N/A
3	ASSAM	16782	18396	9.6	19737	7.2	21290	7.8	24195	13.6	27197	12.4	30413
4	BIHAR	7914	8341	5.3	10249	22.8	11589	13	14629	26.2	16715	14.2	20069
5	JHARKHAND	18510	18326	0	19789	7.9	24789	25.2	24865	0.3	27132	9.1	29786
6	GOA	76426	85299	11.6	94512	10.8	107311	13.5	119273	11.1	132719	11.2	N/A
7	GUJARAT	32021	37780	17.9	43395	14.8	50016	15.2	55140	10.2	63961	15.9	N/A
8	HARYANA	37842	42133	11.3	49892	18.4	58090	16.4	67757	16.6	78781	16.2	92327
9	HIMACHAL PRADESH	32564	35850	10	38931	8.5	42076	8	46019	9.3	50365	9.4	58493
10	JAMMU & KASHMIR	21314	22813	7	24443	7.1	26285	7.5	28332	7.7	30582	7.9	33056
11	KARNATAKA	26804	31166	16.2	35969	15.4	42345	17.7	47604	12.4	52097	9.4	59763
12	KERALA	31871	36276	13.8	40419	11.4	45700	13	52012	13.8	59179	13.7	N/A
13	MADHYA PRADESH.	15442	16631	7.6	19028	14.4	20935	10	23757	13.4	27250	14.7	N/A
14	CHATTISGARH	18559	20117	8.3	24800	23.2	29385	18.4	34360	16.9	38059	10.7	44097
15	MAHARASHTRA	35915	41624	15.8	49568	19	57218	15.4	62454	9.1	74027	18.5	83471
16	MANIPUR	18640	20395	9.4	21419	5	23093	7.8	24773	7.2	27332	10.3	29684
17	MEGHALAYA	24086	26284	9.1	30952	17.7	34321	10.8	40628	18.3	43555	7.2	48383
18	MIZORAM	24662	26698	8.2	28764	7.7	32488	12.9	38582	18.7	45982	19.1	N/A
19	NAGALAND	30271	33792	11.6	36568	8.2	39985	9.3	45353	13.4	45353	N/A	N/A
20	ORISSA	17380	18618	7.1	21980	18	27560	25.3	30121	9.2	33226	10.3	36923
21	PUNJAB	33103	36142	9.1	41740	15.4	49195	17.8	54633	11	60746	11.1	67473
22	RAJASTHAN	18565	20275	9.2	24055	18.6	26882	11.7	30592	13.8	34042	11.2	39967
23	SIKKIM	26693	30256	13.3	32203	6.4	36452	13.1	46989	28.9	68731	46.2	81159
24	TAMIL NADU	30062	35243	17.2	42288	19.9	47606	12.5	54140	13.7	63547	17.3	72993
25	TRIPURA	24394	26668	9.3	29081	9	31111	6.9	33350	7.1	35799	7.3	38493
26	UTTAR PRADESH	12950	14222	9.8	15998	12.4	17786	11.1	20342	14.3	23395	15	26051
27	UTTARAKHAND	24726	29423	18.9	35111	19.3	42619	21.3	50674	18.9	59584	17.5	68292
28	WEST BENGAL	22649	24720	9.1	27823	12.5	31567	13.4	35513	12.5	41219	16	N/A
29	ANDAMAN & NICOBAR ISLANDS	40921	44754	9.3	53778	20.1	61430	14.2	69186	12.6	74340	7.4	N/A
30	CHANDIGARH	74173	84993	14.5	97568	14.7	102980	5.5	108486	5.3	118136	8.8	128634
31	DELHI	61560	68933	11.9	78741	14.2	89212	13.2	101381	13.6	116886	15.2	135814
32	PONDICHERRY	48302	67205	39.1	68673	2.1	74201	8	79306	6.8	88158	11.1	98719

Source: Economy of India and States of India

(5) GDP Rank of Hyderabad City

Hyderabad, the capital city of Andhra Pradesh state, is the centre of the economic growth of the state. According to the 2011 GDP statistics, Hyderabad is ranked at the 5th amongst the top 10 cities of India.

Table 4 Top 10 Cities of GDP in India in 2011

Rank	City	2011 GDP (in Billion USD)
1	Mumbai	209
2	Delhi	167
3	Kolkata	150
4	Bangalore	83
5	Hyderabad	74
6	Chennai	66
7	Ahmadabad	64
8	Pune	48
9	Surat	40
10	Visakhapatnam	26

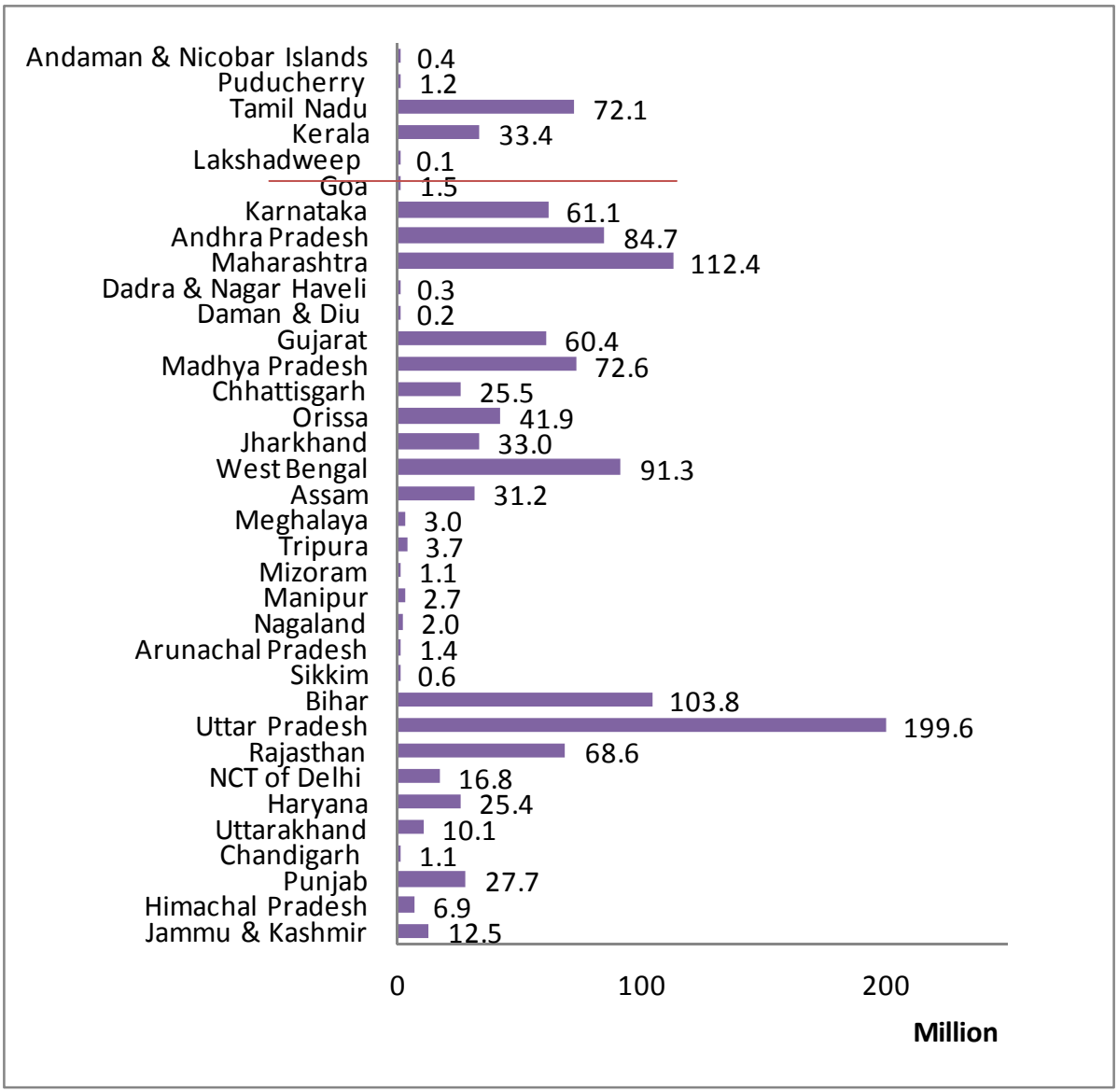
Source: Yahoo Finance Website

2-1-3 Population

(1) Population in India by State

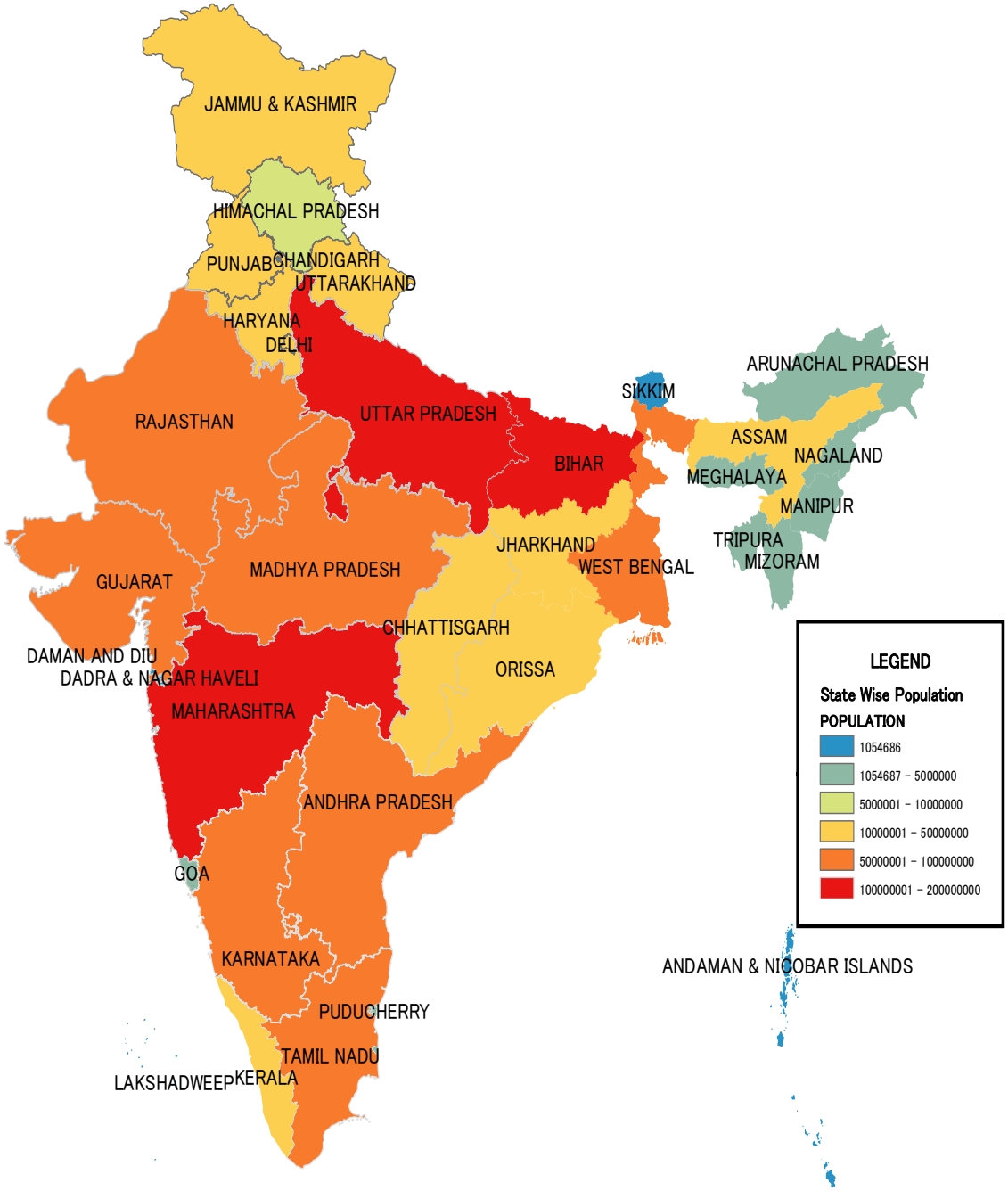
Indian population as per the 2011 census is 1,210,193,422. Uttar Pradesh state has the largest population in India, and Maharashtra is the second largest populated state with Mumbai as its capital. The third and fourth places are occupied by Bihar and West Bengal respectively and Andhra Pradesh occupies fifth place in terms of population.

The Figure 6 below shows population by State and Figure 7 shows the same data on the Indian map.



Source: Ministry of Statistics and Program Implementation

Figure 6 Population by State



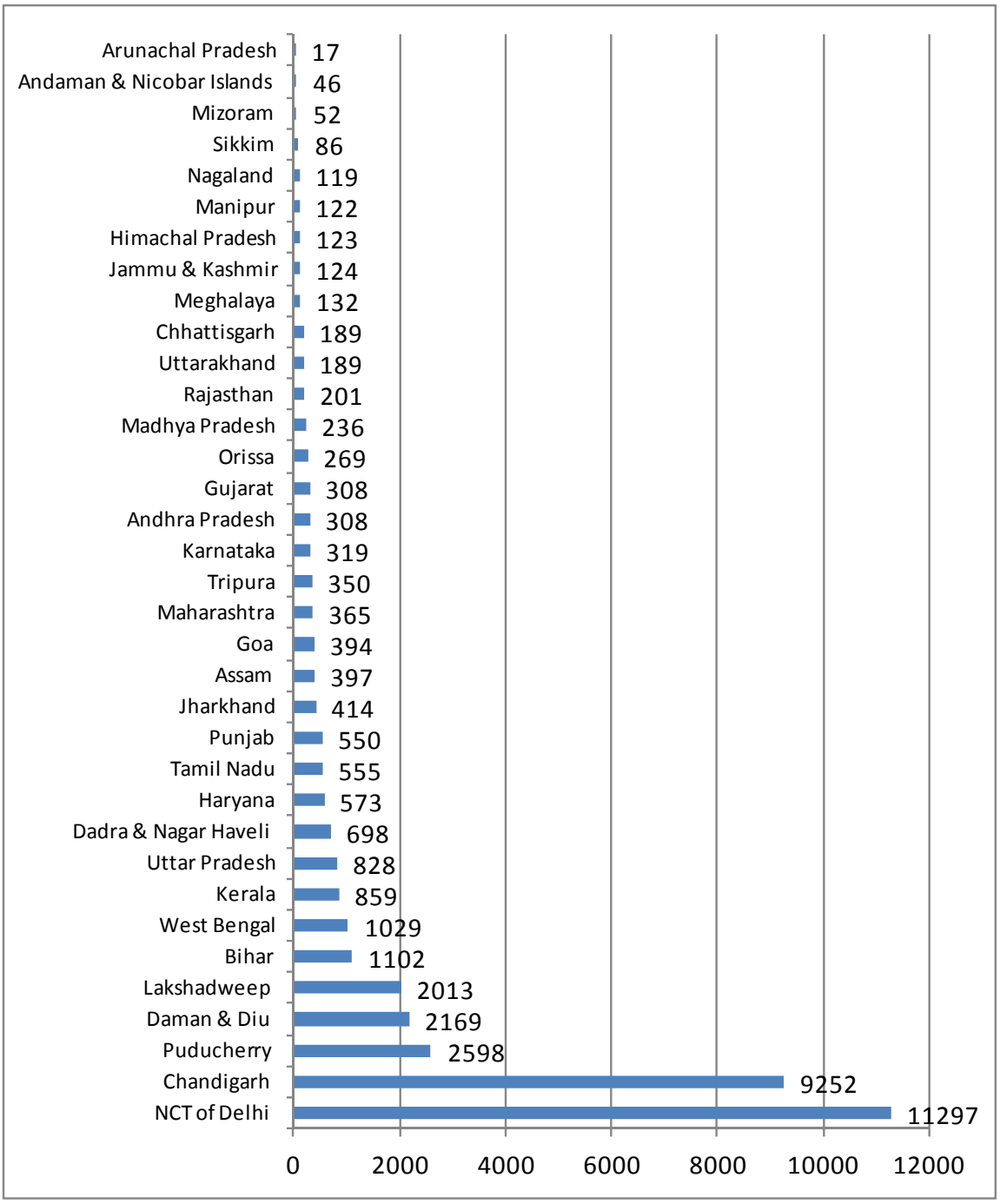
Source: Ministry of Statistics and Program Implementation

Figure 7 Map of Population by State

(2) Population Density by State in India

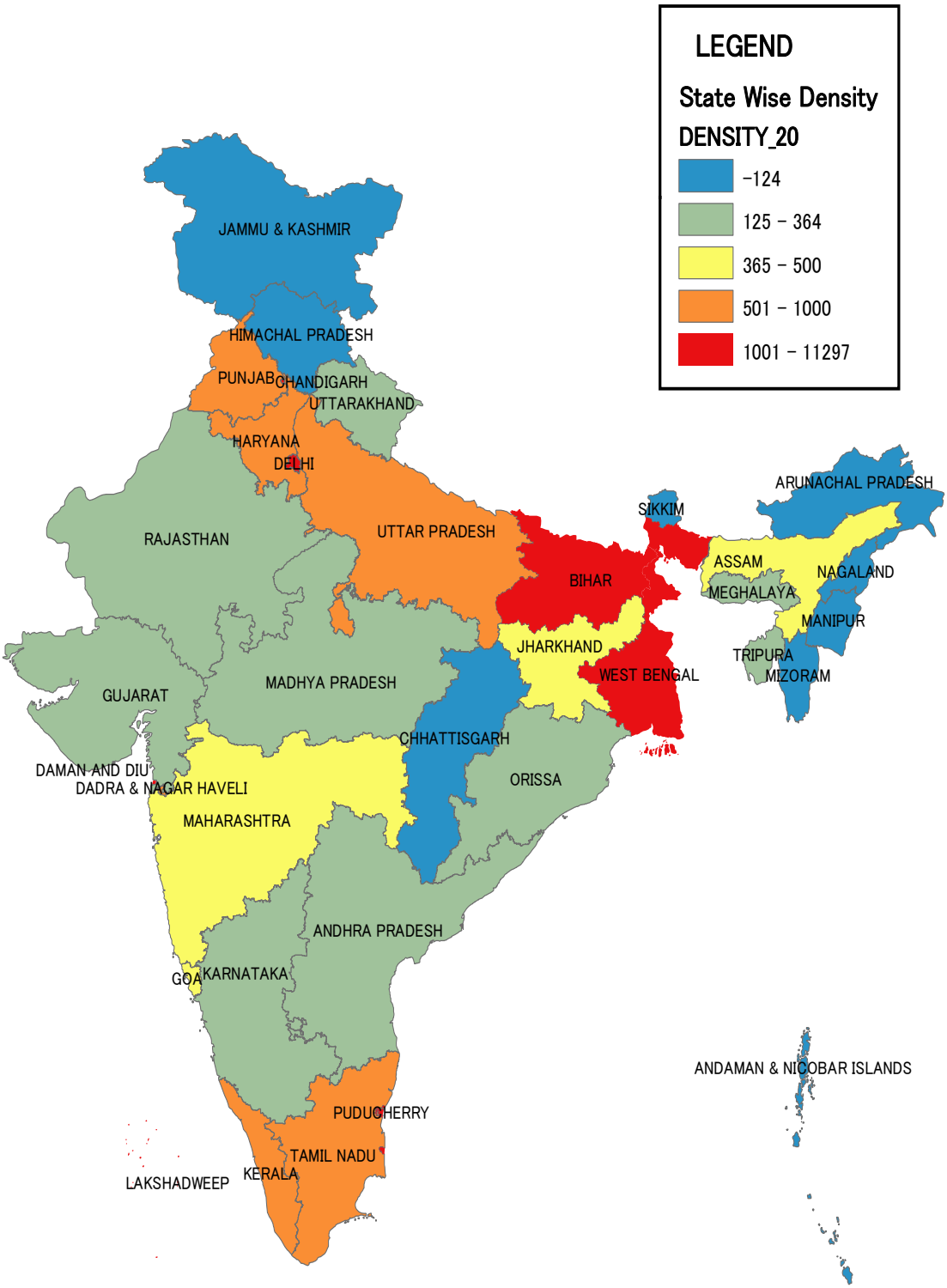
In terms of population density, Andhra Pradesh State is ranked at 20th place in India and is regarded as average state in India. The highest rank is NCT of Delhi and second is Chandigarh.

The Figure 8 below shows population density by State and Figure 9 shows the same data on the Indian map.



Source: Ministry of Statistics and Program Implementation

Figure 8 Population Density by State

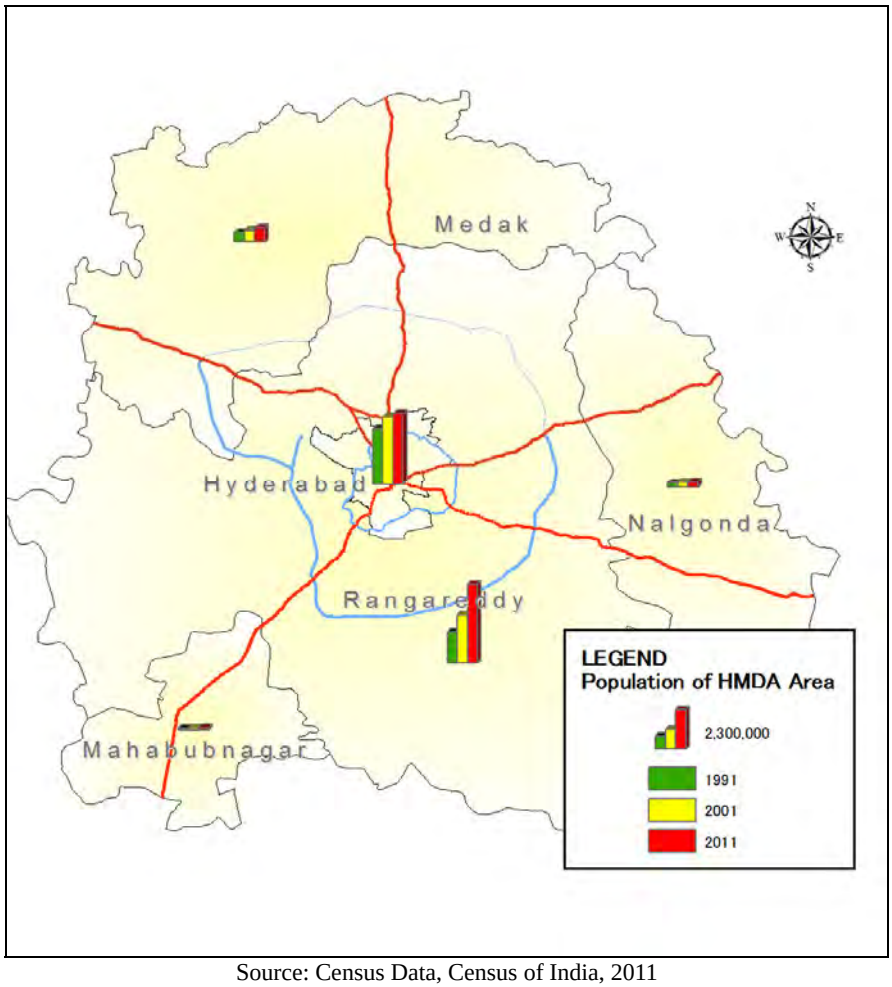


Source: Ministry of Statistics and Program Implementation

Figure 9 Map of Population Density by State

(3) HMDA District Population Transition

The population in HMA is rapidly growing. The core area and Ragareddy district area are mostly populated. According to the population census of Directorate of Census Operations, the population in HMA increased from 5.78 million in 1991 to 7.6 million in 2001 ,32% increase, and to approximately 9.4 million in 2011, 23% increase.



Source: Census Data, Census of India, 2011

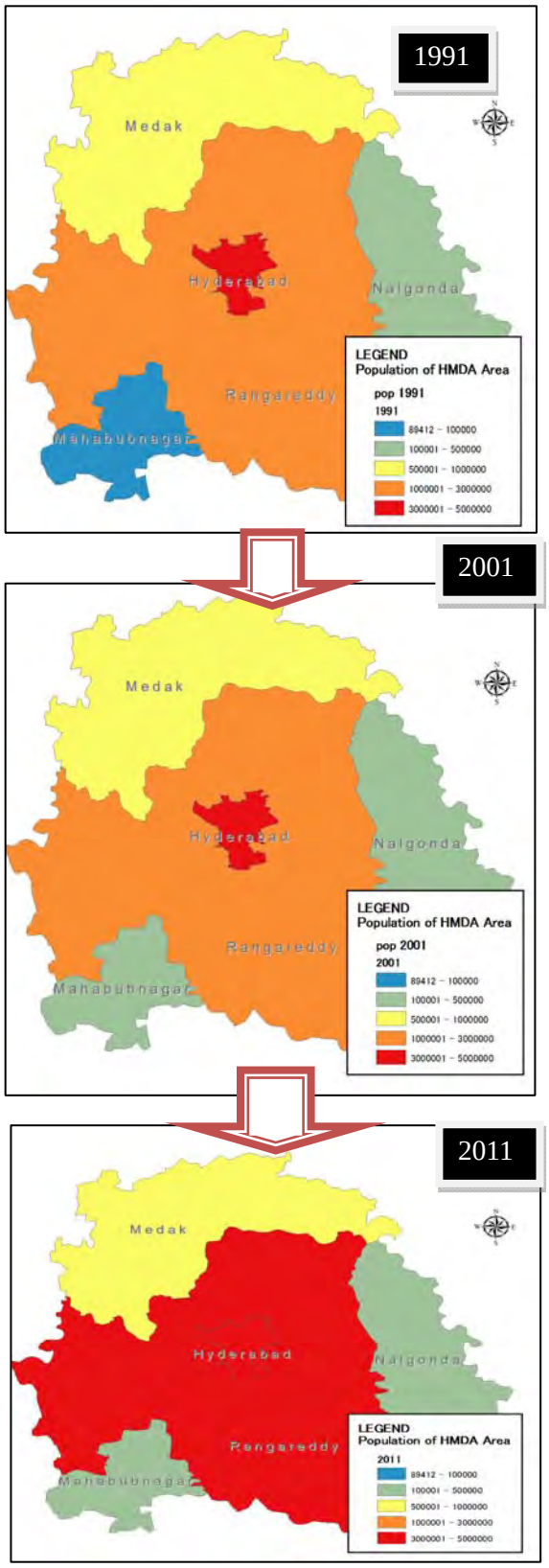
Figure 10 HMDA Population by District 1991-2011

Table 5 HMA Population Data

Year	HMA Population					
	Hyderabad	Rangareddy	Medak	Mahabubnagar	Nalgonda	Total
1991	31,42,214	17,70,965	5,29,117	89,412	2,51,441	57,83,149
2001	38,29,753	27,45,304	6,47,744	1,14,002	2,90,025	76,26,828
2011	39,00,238	43,51,939	7,78,624	1,22,250	3,02,650	94,55,701

(Source: Edited by JICA Study Team based on Census Data, Census of India, 2011)

The Figure below also shows trend of HMDA population by District from 1991 to 2011 on the map. Original data was studied on CTS.

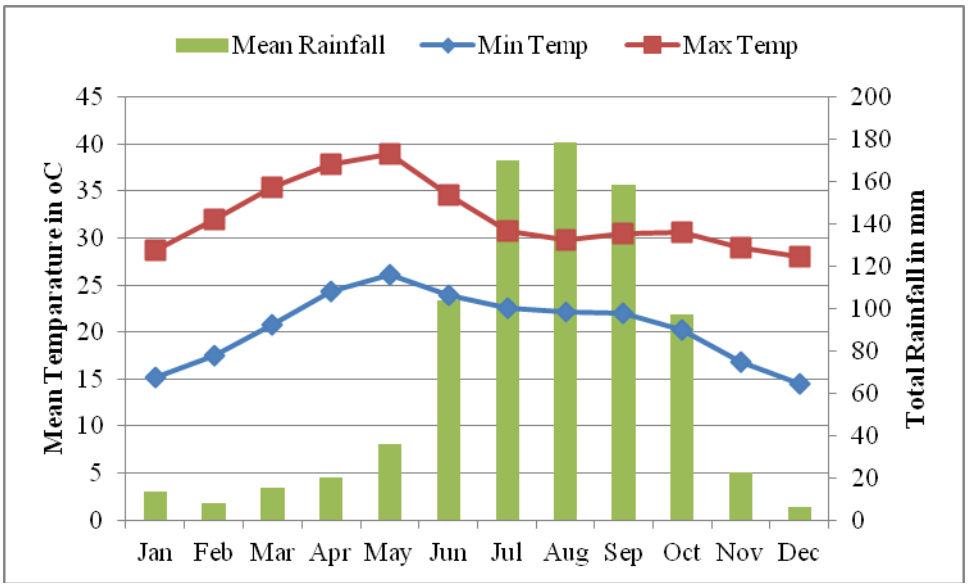


Source: Each Districts Website and CTS First Stage Report

Figure 11 HMDA Population by District from 1991-2011

2-1-4 Climate

The climate in HMA is a combination of tropical and dry weather. The summer is between February and early July and the temperature is between 30 to 40 ºC during this period. The monsoon starts in the middle of July and continues till early October. During the monsoon season, the waterlogged roads are frequently observed in wide areas in Hyderabad due to old and insufficient drainage systems.



Source: IMD Monthly Mean Maximum & Minimum Temperature and Total Rainfall 1901-2000 Data

Figure 12 Average Climate Condition in Hyderabad

The Figure below shows a flooded road near Necklace Road in the monsoon period.

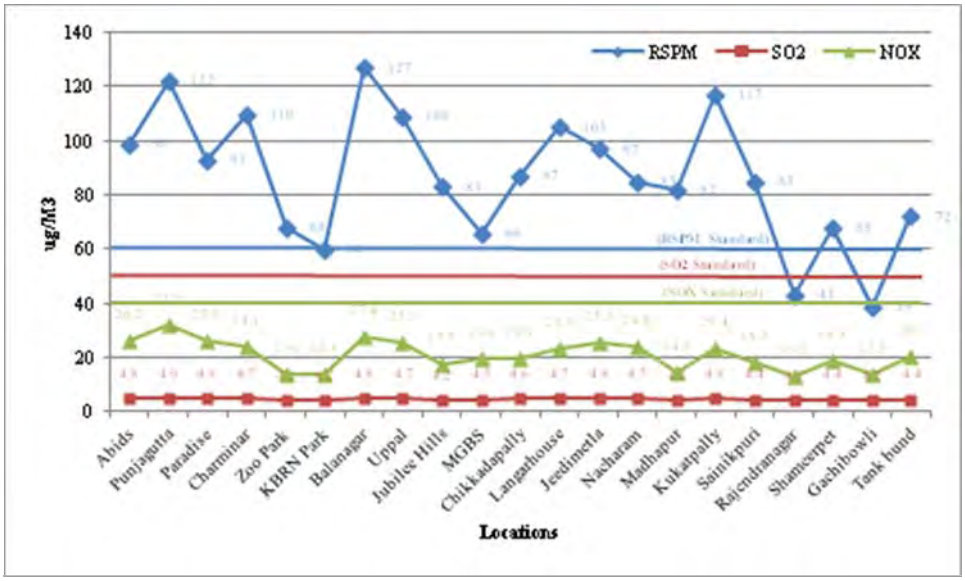
Source: JICA Study Team

Figure 13 Water Flooded Road in Monsoon Period - Near Necklace Road

2-1-5 Environmental Condition

(1) Ambient Air Quality

Air quality in HMA has been seriously deteriorated. Andhra Pradesh Pollution Control Board (APPCB) publishes the annual report on air quality and noise level in HMA and entire Andhra Pradesh. According to the report in 2012, the respirable suspended particulate matter (RSPM) and total suspended particulate matter (TSPM) were exceeding their upper limit whilst sulphur dioxide (SOx) and nitrogen dioxide (NOx) stay within the limits. The yearly average of air quality is shown in the figure below.



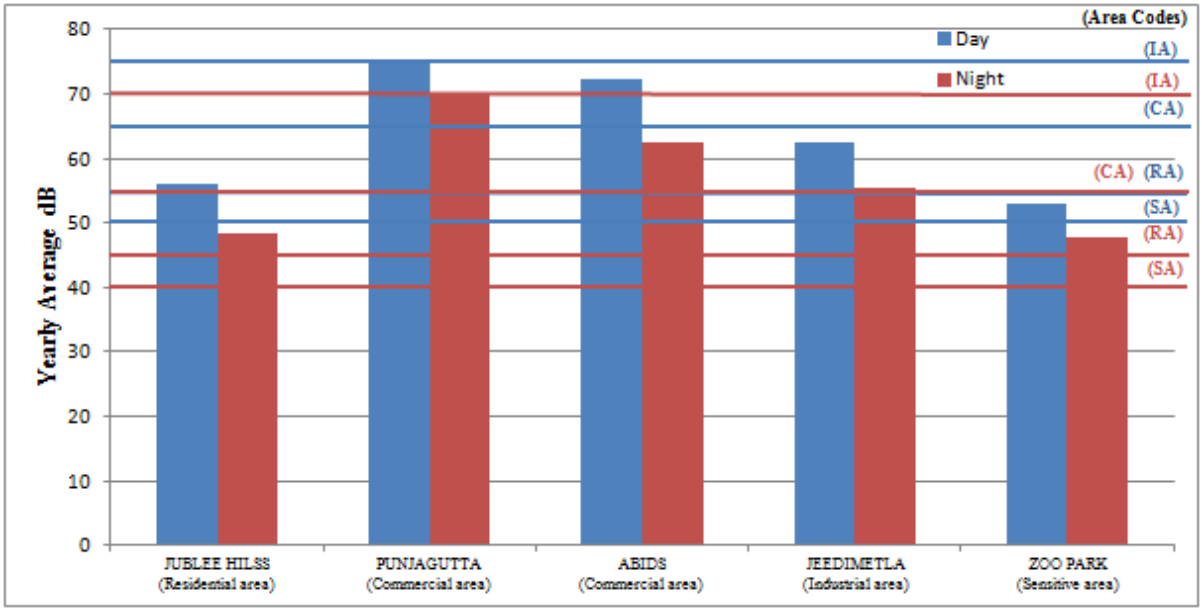
Source: Andhra Pradesh Pollution Control Board, 2012

Figure 14 Yearly Average of Air Quality Level in Hyderabad against NAAQ Standards

(2) Noise Levels

The annual report on the noise in 2012 shows that the noise level in HMA exceeds the upper limit, as summarised below:

- The noise levels are measured at approximately 73 dB in commercial areas.
- Higher noise levels of 52 and 54 dB are measured in noise-sensitive locations, which are Zoo Park and Kasu Brahmananda Reddy National Park (KBRN).



Unit=dB

Area	Noise Level Limit (Standard)		Yearly Average Noise Level (Actual)	
	Day Time	Night Time	Day Time	Night Time
Residential Area (RA)	55	45	56	49
Commercial Area (CA)	65	55	75	70
Industrial Area (IA)	75	70	63	55
Sensitive Area (SA)	50	40	53	48

Source: Andhra Pradesh Pollution Control Board, 2012

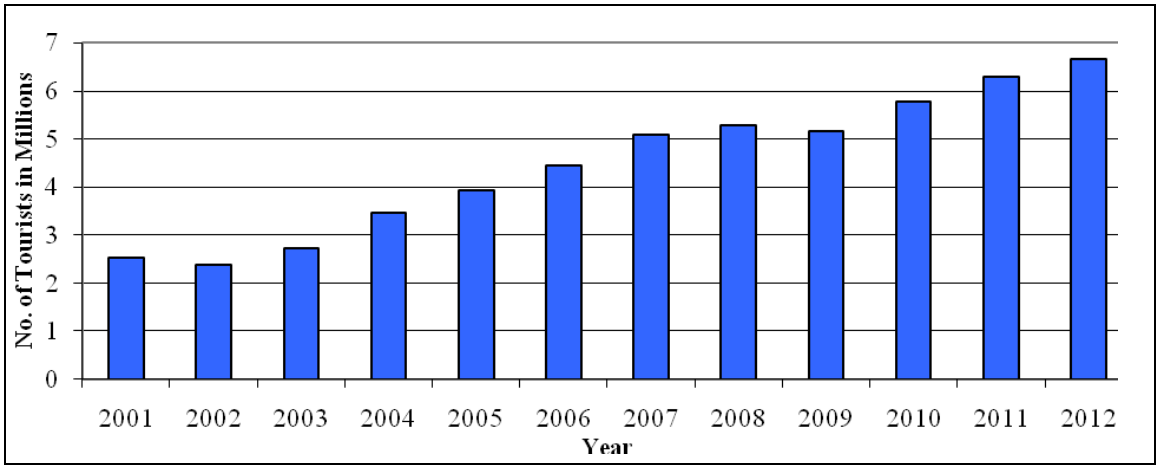
Figure 15 Noise Level Standard and Yearly Average Noise Level in Hyderabad

2-1-6 Tourism

(1) Number of Tourists and Visitors

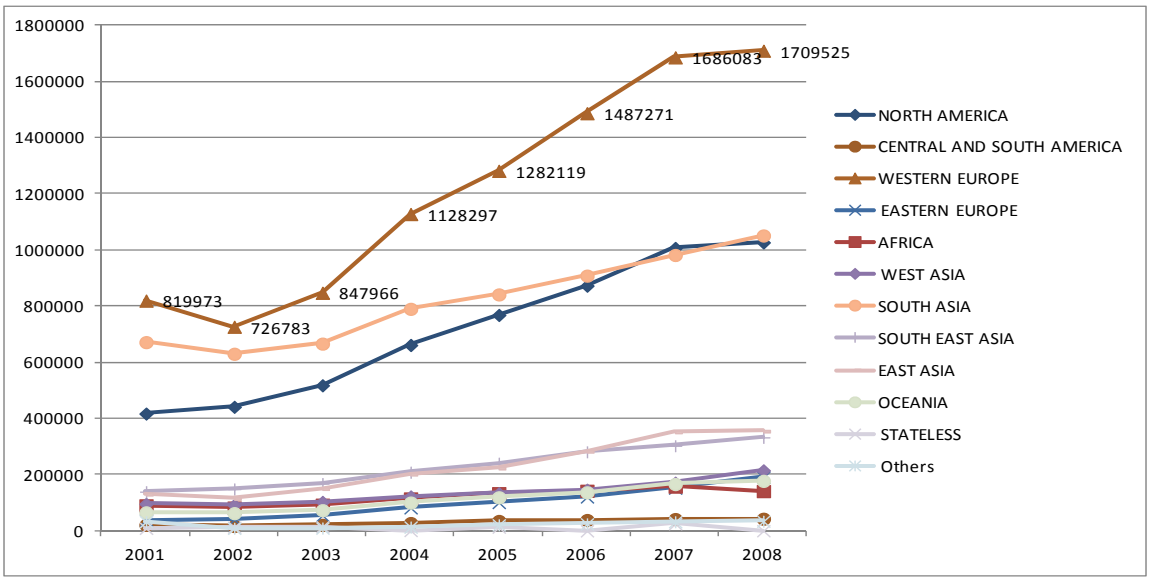
Tourism is an important industry for Indian economy. The number of foreign tourists, called Foreign Touris Arrivals (FTA), has been rapidly growing and it has doubled during the last decade. In 2012, FTA in India was 6.64 million with a growth rate of 5.4% from 2011. Andhra Pradesh state is ranked at the 12th for FTA with 0.292 million visitors in 2012, which is 4.4% of total FTA in India. The number of tourists in Andhra Pradesh state increased in 2012 from 0.268 million in 2011. However it recently decreased in Hyderabad.

There are attractive tourist spots and historical places such as Golkonda Fort, Charminar, etc., in HMA as shown in the figure below. However essential information such as explanation of historical exhibit, guidance for tourists indicating the location of nearest parking, etc. is not sufficiently provided in these places. There is a potential for attracting more tourists if more appropriate information on tourism is provided to visitors.



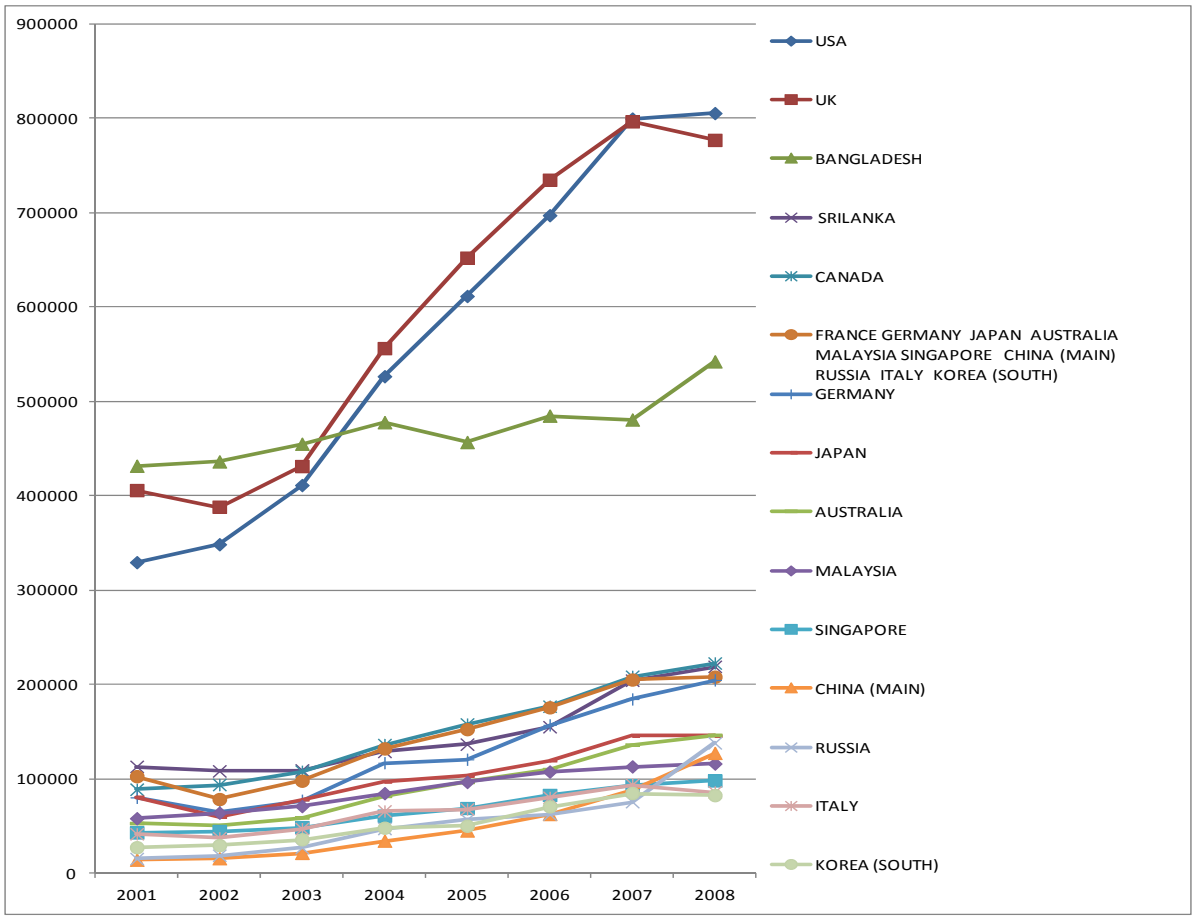
Source: Ministry of Tourism

Figure 16 Number of Foreign Tourists to India 2001-2012



Source: Ministry of Tourism

Figure 17 Regional Number of Foreign Tourists to India 2001-2008



Source: Ministry of Tourism

Figure 18 Number of Foreign Tourists to India by Country: 2001-2008

(2) Tourist Attractions

There are attractive tourist spots and historical places such as Golkonda Fort, Charminar, etc., in Hyderabad Metropolitan Area as shown in the figure below.

However essential information such as explanation of historical exhibit, guidance for tourists indicating the location of nearest parking, etc., is not sufficiently provided at these locations. There exists a potential for attracting more tourists if more appropriate information on tourism is provided to the visitors.

Source: www.clickindia.com

Figure 19 Major Tourism Spots in Hyderabad City

The pictures below show the famous tourist spots in Hyderabad.

(a) Charminar

Charminar, built in 1591, was constructed at the core of the old Hyderabad, standing on the intersection of the two main historical trade routes. The entire city of Hyderabad was designed around Charminar. Charminar has the signature style of Islamic architecture. The structure is made of granite, limestone, and mortar and pulverised marble.

Source: JICA Study Team

Figure 20 Charminar

(b) Salar Jung Museum

The Salar Jung Museum was built in 1951 by the government, from the private collection of Salar Jung III, Prime Minister to the seventh Nizam of Hyderabad. Salar Jung I began collection in the 19th century from three generations, with objects from Egypt, Persia, Southeast Asia and Europe which also includes 3,000 paintings, 47,000 books, 3,000 manuscripts and 9,000 holographs, some of them dating back to the first century. Salar Jung Museum is situated on the Old-city of the Hyderabad central area.

Source: JICA Study Team

Figure 21 Salar Jung Museum

(c) Golkonda Fort

Golkonda fort is one of the most magnificent fortress complexes in India which lies on the western outskirts around 11 km from Hyderabad. The history of Golkonda Fort dates back to early 13th century. The fortress is built on a granite hill 120 meters high, surrounded by massive crenellated ramparts. Golkonda consists of four distinct forts with a 10 km long outer wall with 87 semi circular bastions; some still mounted with cannons, eight gateways, four drawbridges and number of royal apartments & halls, temples, mosques, magazines, stables etc, inside.

Source: JICA Study Team

Figure 22 Golkonda Fort

2-2 Road Networks

(1) Overall Condition

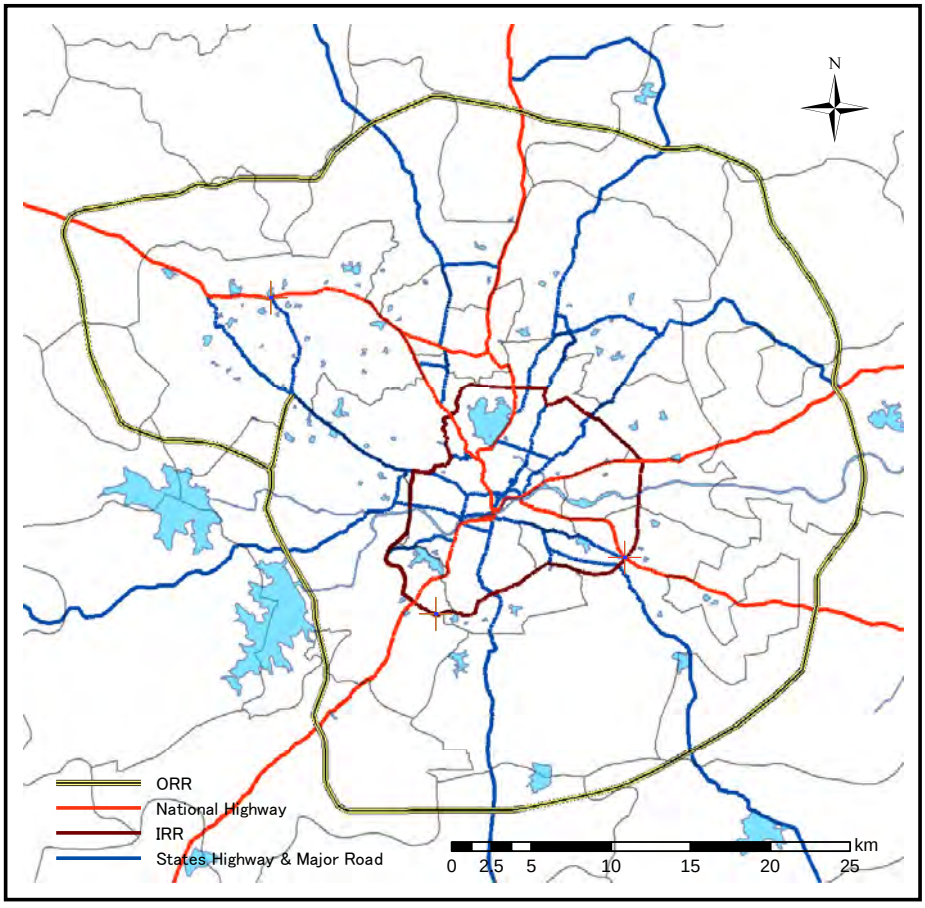
Major national highways (NH) and state highways (SH) pass through Hyderabad. The national highways include NH-44 (old NH-7), NH-65 (old NH-9) and NH-163 (old NH-202), and the state highways include SH-1 (to Karimnagar), SH-2 (to Nagarjunasagar), SH-4 (to Vikarabad), SH-5 (to Srisailam) and SH-6 (to Medak). These highways are 4 or 6 lanes and other roads are basically double-lane.

Inner Ring Road (IRR) passes around the centre of the city and connects with major surrounding areas. Outer Ring Road (ORR) is currently under construction and will pass through the suburban area in HMA.

(2) Road Network

The state road network is developed to link the national highways and major road network of the city. IRR connects with major junctions in the city and accommodates the inner city traffic. ORR is constructed to divert the traffic in the central areas of the city, thereby enhancing economic development in surrounding region.

HMA road network consists of 5,443 km roads including NHs, SHs, HMDA roads, IRR (50 km), and ORR (158 km).



Source: JICA Study Team

Figure 23 Road Network in Hyderabad Metropolitan Area

(3) Traffic Signals

175 signals in total are currently in place in the city, which are 126 in Hyderabad and 49 in Cyberabad region.

Table 6 Existing Traffic Signals

Description	Hyderabad	Cyberabad	Total
3-way	56	31	87
4-way	63	18	81

5-way	7	0	7
Total	126	49	175

Source: RFP for HTRIMS

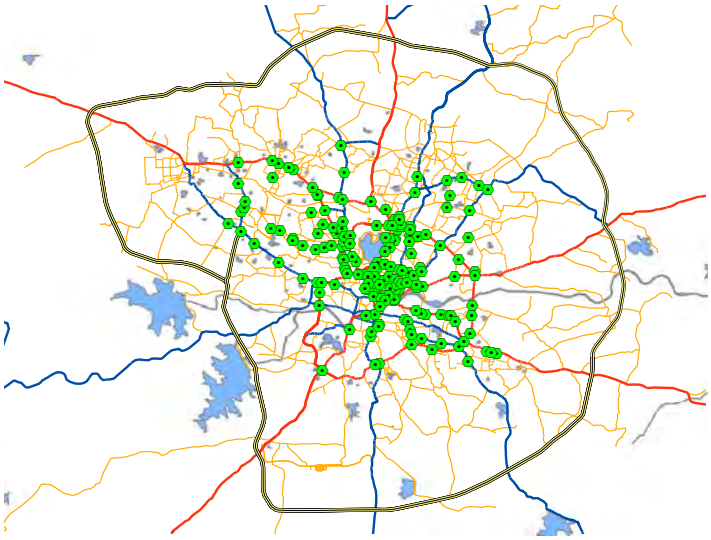


Figure 24 Signal Location Map

The current traffic signals are standalone type and are either the timer based or manually operated by traffic constable. The traffic signals are not adequate in number. Most of the traffic signals are not in operation for a variety of reasons such as power-failure and improper maintenance. GHMC and the Traffic Police recently initiated Hyderabad Traffic Integrated Management System (HTRIMS) project by the state funds. The purpose of the HTRIMS project is to install 221 signals with vehicle actuated controllers, including replacement of the existing signals, in the GHMC area. These traffic signals are powered by solar energy and controlled from Traffic Command Centre (TCC). It is planned to establish TCC which is equipped with a 25 ft x 5 ft video wall in Hyderabad Police Commissioner Office.

Source: JICA Study Team

Figure 25 Examples of Signals at Intersections in Hyderabad City

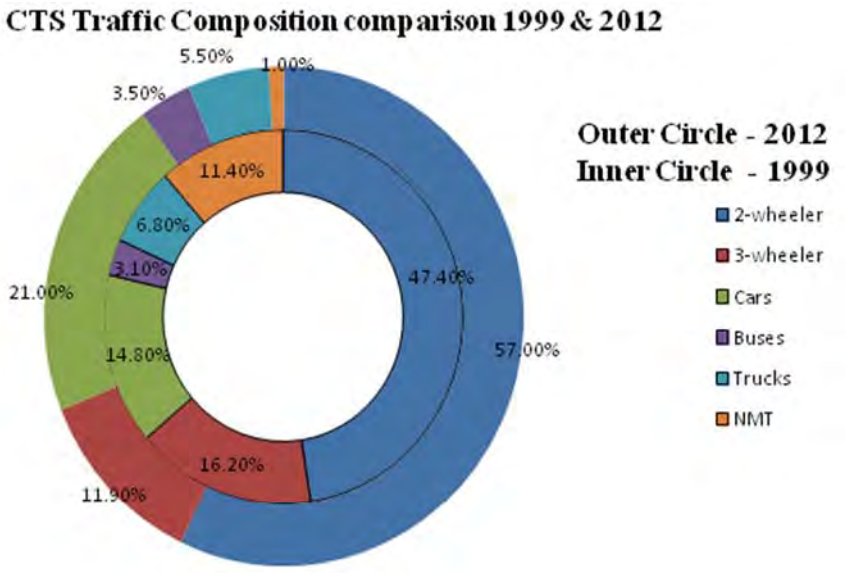
2-3 Current Traffic Volume and condition

(1) Road Traffic Composition

The most noticeable feature of the traffic in Hyderabad is 'heterogeneous traffic' and the dominant mode is 2-wheeler comprising 57% in 2012. The composition of the traffic is:

- 2-wheelers (motorcycle)
- 3-wheelers (auto-rickshaws)
- Buses (APSRTC and private bus)
- Private cars
- Taxi and cabs
- Commercial vehicles

The public transport in the city is heavily dependent on road-based modes such as buses, auto-rickshaws (3-wheelers) and taxies. The rail-based mode is not a major public transport in Hyderabad city yet.



Source: Comprehensive Transport Study

Figure 26 Comparison of Vehicular Composition

(2) Road Traffic Volume

The major traffic studies carried out in HMA are listed in the table below.

Table 7 Major Traffic Studies

No	Report Name	Description
1	Hyderabad Area Traffic Study (HATS) I (1983-1988), HATS II (2000)	Comprehensive traffic study was conducted
2	L&T Ramboll, 2003	Development of Hyderabad Multi Modal Suburban Commuter Transportation System on Commercial Format
3	GHMC, City Development Plan (CDP), 2007	Traffic Volume Data
4	Assistance for the Introduction of ITS Related to the Hyderabad ORR Construction Project, 2010	Traffic survey on 22 cross-sections near outer ring road planned site Origin Destination (OD) survey at roadside
5	Comprehensive Transportation Study (CTS), 2011	Including traffic survey

CTS identified that the largest volume of traffic, in terms of average daily traffic volume, is approximately 2,03,966 PCU at Begumpet ROB. The traffic congestion is especially severe in the areas around IRR.

Table 8 Average Daily Traffic at Various Locations

No	Location	PCUs/Day	No	Location	PCUs/Day
1	Kondapur-HITECH City Rd	68,800	12	Fateh Nagar ROB	64,681
2	Old Mumbai Rd at Raidurgam	60,206	13	Sanath Nagar ROB	1,12,662
3	Attapur Bridge	90,285	14	HITECH City MMTS Stn RUB	71,067
4	Chaderghat Bridge	97,548	15	Old Bombay Rd, Lingampally	32,402
5	Moosarambagh	63,018	16	Alugadda Bhavi	1,19,644
6	Nagole Bridge	95,927	17	On NH-9 near Malakpet	1,77,937
7	Rail Nilayam RUB	1,01,212	18	On NH44 (old NH-7) near Thondapalli	41,633
8	Rashtrapathi Rd	72,688	19	Vidyanagar	42,504
9	Ranigunj	73,367	20	Alwal	36,801
10	Ministers Rd - Necklace Rd,	32,644	21	On NH44 (old NH-7), Medchal Road	62,614
11	Begumpet ROB	2,03,966			

Source: Hyderabad – CTS Report, 2011

The results of the traffic survey conducted in 2009 for the introduction of ITS as part of Hyderabad Outer Ring Road Construction Project shows that the maximum traffic volume is approximately 15,000 PCUs/ day in the areas outside the city of Hyderabad.

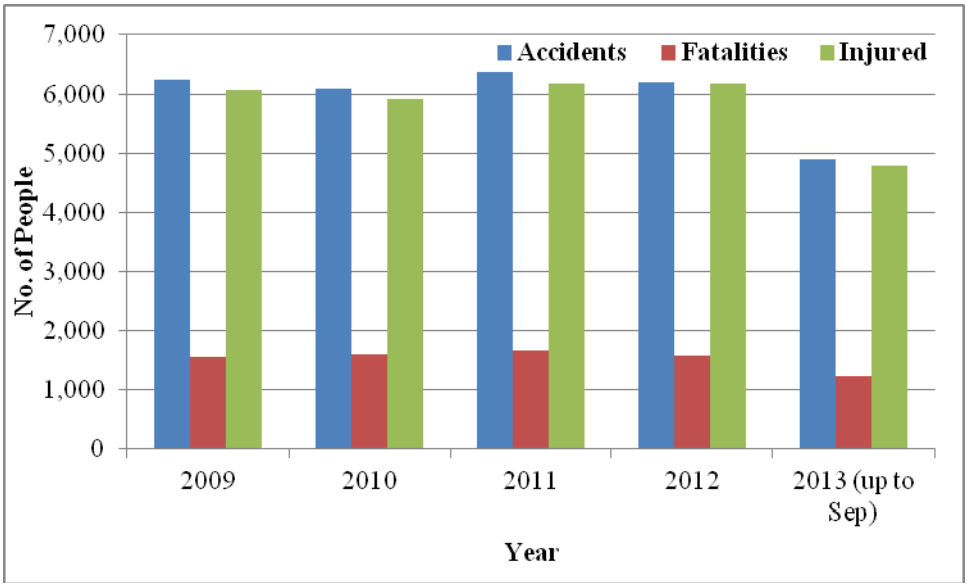
Table 9 Traffic Volume by Location (Daily)

Loc. No.	Location Name	Direction	Motor Cycle	Three Wheeler / Auto Rickshaw	P. Car (Sedan, Jeep, Van)	Mini Bus	Bus	Light Cargo Vehicle	Small Trucks - 2 Axle	Medium Trucks - 3 Axle	Large Truck or Tractor -trailer (Multi Axel)	Others	Total Vehicles
01	Financial District	City to Financial District	1,352	1,227	2,368	343	201	135	109	94	26	3	5,858
01	Financial District	Financial District to City	1,111	961	1,871	158	145	326	46	86	63	22	4,789
02	HCU Depot	City to Lingampalli	1,510	963	1,683	131	506	432	539	201	136	20	6,121
02	HCU Depot	Lingampalli to City	1,679	725	1,850	83	494	518	514	285	66	3	6,217
03	Patancheru	Inbound	1,863	1,643	985	165	722	602	356	222	165	36	6,759
03	Patancheru	Outbound	1,579	1,641	1,225	94	791	452	629	411	128	20	6,970
04	Miyapur	Patancheru to City	944	987	1,963	468	1,015	1,271	892	757	231	22	8,550
04	Miyapur	City to Patancheru	1,182	1,164	1,814	395	1,036	1,384	1,123	1,078	380	5	9,561
05	Dundigal	Inbound	1,279	903	962	109	287	420	569	226	34	53	4,842
05	Dundigal	Outbound	1,101	789	847	168	304	234	542	196	23	108	4,312
06	Medchal Road	Inbound	1,424	718	1,408	103	707	954	822	802	262	43	7,243
06	Medchal Road	Outbound	1,560	917	2,030	78	722	824	807	677	225	28	7,868
07	Shamirpet	Inbound	1,887	792	1,605	150	672	605	606	739	407	105	7,568
07	Shamirpet	Outbound	1,585	659	1,946	177	674	713	943	895	455	253	8,300
08	Keesara	Inbound	774	295	426	18	85	44	382	104	12	0	2,140
08	Keesara	Outbound	641	481	472	34	127	280	182	184	10	23	2,434
09	Ghatkesar	Inbound	1,098	483	711	76	467	272	544	776	173	14	4,614
09	Ghatkesar	Outbound	936	570	790	63	421	353	610	815	112	4	4,674
10	Nagol	Clockwise	2,096	1,652	1,319	304	449	685	631	450	394	6	7,986
10	Nagol	Anti-Clockwise	1,100	1,862	2,091	302	665	393	1,362	746	52	24	8,597
11	Vijayawada Highway	Inbound	849	331	853	48	421	201	785	1,153	201	8	4,850
11	Vijayawada Highway	Outbound	736	362	775	43	469	320	897	818	73	8	4,501
12	Nagarjuna Sagar Highway	Inbound	916	371	680	124	518	418	714	530	28	47	4,346
12	Nagarjuna Sagar Highway	Outbound	1,232	302	794	238	688	625	536	762	50	56	5,283
13	Karmanghat	Clockwise	2,932	963	1,321	213	464	758	943	769	37	15	8,415
13	Karmanghat	Anti-Clockwise	3,277	926	1,183	221	259	662	923	816	81	17	8,365
14	Srisailam Highway	Inbound	1,092	385	901	53	305	333	231	152	110	12	3,574
14	Srisailam Highway	Outbound	1,356	708	827	21	309	595	363	166	20	2	4,367
15	Bangalore Highway - South (Tandepalli)	Inbound	1,233	478	1,164	45	685	609	532	269	196	7	5,218
15	Bangalore Highway - South (Tandepalli)	Outbound	946	515	1,158	30	473	595	521	140	94	16	4,488
16	Bangalore Highway - North (Satamrai)	Samshabad to City	1,723	585	2,054	841	951	1,160	935	742	152	13	9,156
16	Bangalore Highway - North (Satamrai)	City to Samshabad	2,845	823	1,915	139	1,307	996	789	645	35	1	9,495
17	Rajendra Nagar	Rajendra Nagar to City	1,298	183	1,509	122	252	106	182	260	65	25	4,002
17	Rajendra Nagar	City to Rajendra Nagar	905	154	1,362	112	123	751	229	191	12	32	3,871
18	APPA	Inbound	1,511	256	1,359	103	482	587	373	292	160	6	5,129
18	APPA	Outbound	1,519	343	1,174	201	611	441	475	334	57	6	5,161
19	ORR at Gatchibowli	Clockwise	663	37	2,066	10	72	122	98	53	117	5	3,243
19	ORR at Gatchibowli	Anti-Clockwise	696	154	1,664	18	94	166	533	174	36	7	3,542
20	ORR at Samshabad	Clockwise	404	75	1,231	13	90	92	355	257	120	13	2,650
20	ORR at Samshabad	Anti-Clockwise	408	45	1,234	13	177	96	109	379	5	9	2,475
21	LB Nagar	Clockwise	1,523	1,397	2,133	217	328	1,083	772	817	124	0	8,394
21	LB Nagar	Anti-Clockwise	1,516	1,270	1,694	195	439	641	639	834	224	9	7,461
22	Airport Road	City to Airport	804	209	5,692	232	319	187	198	28	72	15	7,756
22	Airport Road	Airport to City	710	190	4,738	165	235	187	83	60	46	5	6,419

Source: Assistance for the Introduction of ITS
Related to the Hyderabad Outer Ring Road Construction Project in India

(3) Traffic Accidents

The number of fatal accidents was 1,565 in 2009 and significant decreases have not been observed since then.



Source: Hyderabad and Cyberabad Traffic Police

Figure 27 Accident Statistics in HMA

(4) Driving Manners

Driving manners is a major issue in HMA. Distinctive manners that adversely affects traffic are frequently observed. A great majority of the drivers ignore the traffic lanes and a number of vehicles are running in parallel without lane discipline.

The major examples are:

- Drivers take right turns at intersections where it is prohibited
- Traffic signals are usually ignored.
- Three or four persons ride on 2-wheelers without helmets.
- Opposite driving on the road is frequently observed.
- Frequent gridlock at roundabout caused by vehicles to enter the roundabout ignoring yielding to the traffic inside the roundabout.

Source: JICA Study Team

Figure 28 Driving Manners in Hyderabad

(5) Overall Condition of Road Infrastructure in Hyderabad

Road infrastructure is not properly developed in Hyderabad. One of the purposes of ITS is to enhance the capacity of road and transport infrastructure but it become possible only if the basic road and transport infrastructure facilities are properly developed.

There are a number of issues of the road infrastructure in Hyderabad such as,

- Unclear lane marking and lane width.
- Unclear demarcation of border between private and public land.
- Frequent delay of land acquisition due to religious and legal issues.
- Insufficient passes for pedestrians and the handicapped.
- Lack of footpaths for pedestrians
- Lack of parking bays

Source: JICA Study Team

Figure 29 Road Conditions in Hyderabad

2-4 Public Transportation

2-4-1 Bus (APSRTC)

(1) Overall Condition

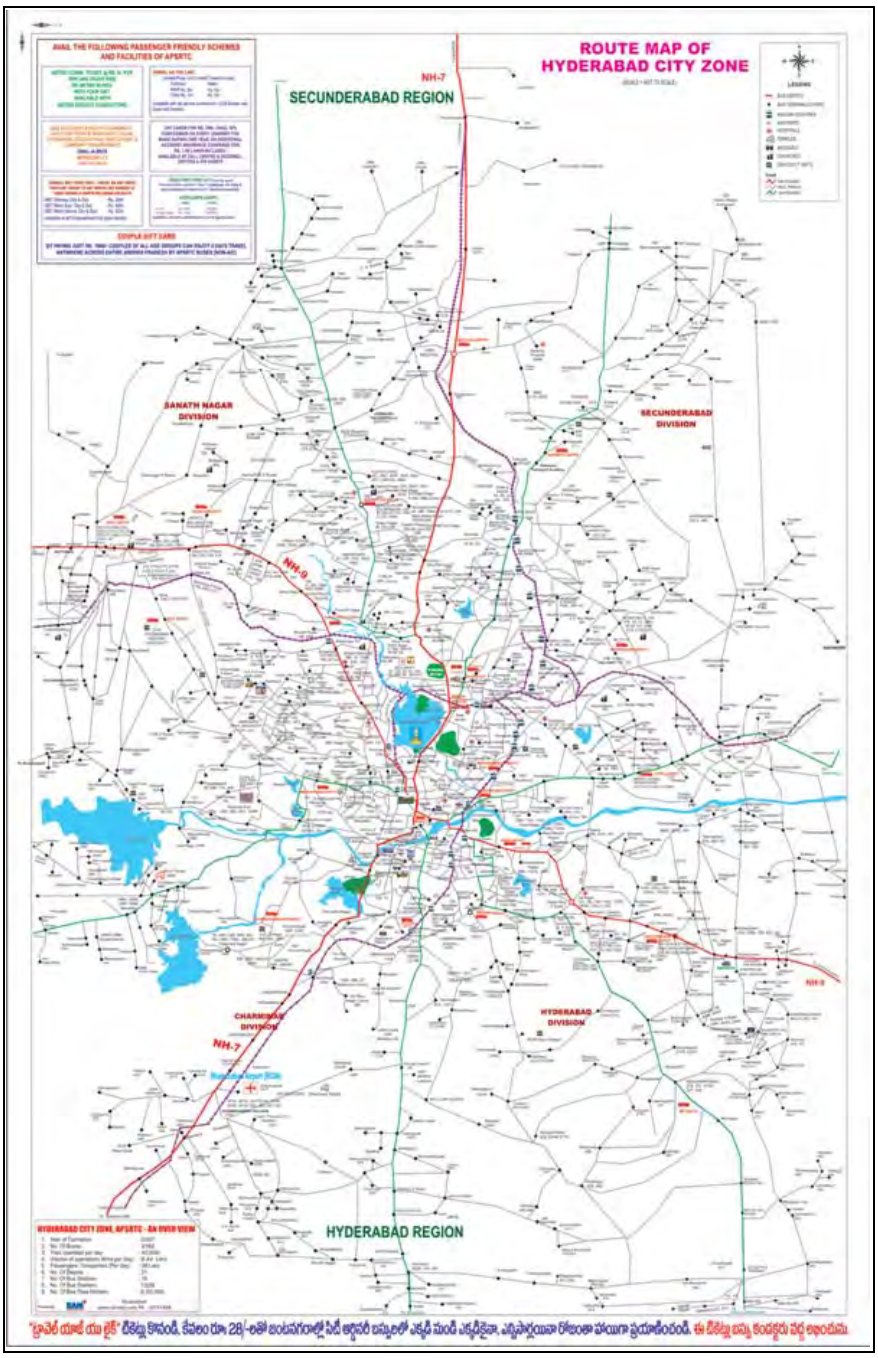
Andhra Pradesh State Road Transport Corporation (APSRTC) is a state bus service operator. They mainly provide inter-city and inter-state bus services in the state. They also offer the city bus services in Hyderabad.

APSRTC operates approximately 22,500 buses in total (19,500 APSRTC owned buses and 3,500 hired buses) on 7,500 routes. They operate approximately 3,800 buses on 865 routes for city bus service in Hyderabad. The daily passengers are approximately 3.4 million. There are 27 bus depots in the city.

The major bus terminal in Hyderabad is Mahatma Gandhi Bus Terminal. It is located in the south region of the city. It functions as a primary origin and destination hub for inter-city and inter-state buses handling approximately 2,800 buses and 80,000 passengers per day.

(2) Route Map

The bus route map in Hyderabad is shown below.



Source: APSRTC Website

Figure 30 Hyderabad City APSRTC Bus Route Map

The bus schedules are shown on static sign boards at the bus stops. Dynamic information such as expected bus arrival time is not provided yet.

(3) Bus Station

The Mahatma Gandhi Bus Station (MGBS) is the biggest bus station in Hyderabad metropolitan area. The MGBS situates in 120,000 m^2 area and the complex is built on 8 ha area. The complex is constructed at a cost of Rs.13 crore. There are 74 platforms for incoming and outgoing buses. Some other facilities at Mahatma Gandhi Bus Station include: a waiting hall of 7,380 sq.m and a shopping complex of 3,455 sq.m besides a 5,000 sq.m area for private parking. The MGBS basically provides long trip bus services to various locations in Chhattisgarh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and others places.

Source: JICA Study Team

Figure 31 Mahatma Gandhi Bus Station

(4) Bus Stops

There are 1928 bus stops and 856 routes in Hyderabad metropolitan area. Some bus stops have roof and benches and others do not. The bus stops are owned by GHMC.

Some bus stops in Hyderabad are located near intersections. This has critical effect on the flow of traffic, generally leading to traffic congestion. The diagram below shows that bus stops located at the centre of intersections.

Source: JICA Study Team

Figure 32 Bus Stop at Middle of Intersection

(5) Fare Systems

The bus fare system is based on distance of travel with basic fare for ordinary city bus at Rs.4/- and Rs.6/- for metro express. The bus fare per day for an adult in normal bus is Rs.28 and is Rs.40 in metro bus. The commuter pass exist and the fare depends on the class of the bus (Ordinary City & Sub: Rs.340/-, Metro Express City & Sub: Rs.440/-, Metro Deluxe City & Sub: Rs.500/-).

Source: APSRTC Home Page

Figure 33 Ride Price of APSRTC Buses

(6) Passengers in Bus and Quality of Service

City buses are generally crowded during peak time and passengers feel uncomfortable to travel during these hours. The passengers need to buy tickets from ticket issuer (called conductor) in the bus.

If smart card system is installed, both the bus operation company and passengers will receive benefits. APSRTC can cut employment cost and ticket printing cost, and passengers can travel with comfort as there is need to be physically buying a ticket.

Source: JICA Study Team

Figure 34 Bus Condition

2-4-2 Railways

(1) South Central Railway

Five states as depicted in the below map come under the jurisdiction of the South Central Railway and it covers 6 routes covering of about 5,810 km track length. The diagram below shows the route map and state wide routes in kilometres.

Figure 35 Route Map of SCR

Table 10 Details of Route Kilometres on 31.03.2011

State	Broad-gauge	Meter-gauge	Total
Andhra Pradesh	4348.440	--	4348.440
Maharashtra	101.070	105.750	1115.820
Karnataka	268.690	--	268.690
Madhya Pradesh	--	70.180	70.180
Tamilnadu	6.860	--	6.860
TOTAL	**5634.060**	**175.930**	**5809.990**

Division	BG	MG	Total
Secunderabad	1315.143	--	1315.143
Vijayawada	958.926	--	958.926
Guntakal	1354.151	--	1354.151
Guntur	617.200	--	617.200
Hyderabad	565.650	--	565.650
Nanded	822.990	175.930	998.920
TOTAL	**5634.060**	**175.930**	**5809.990**

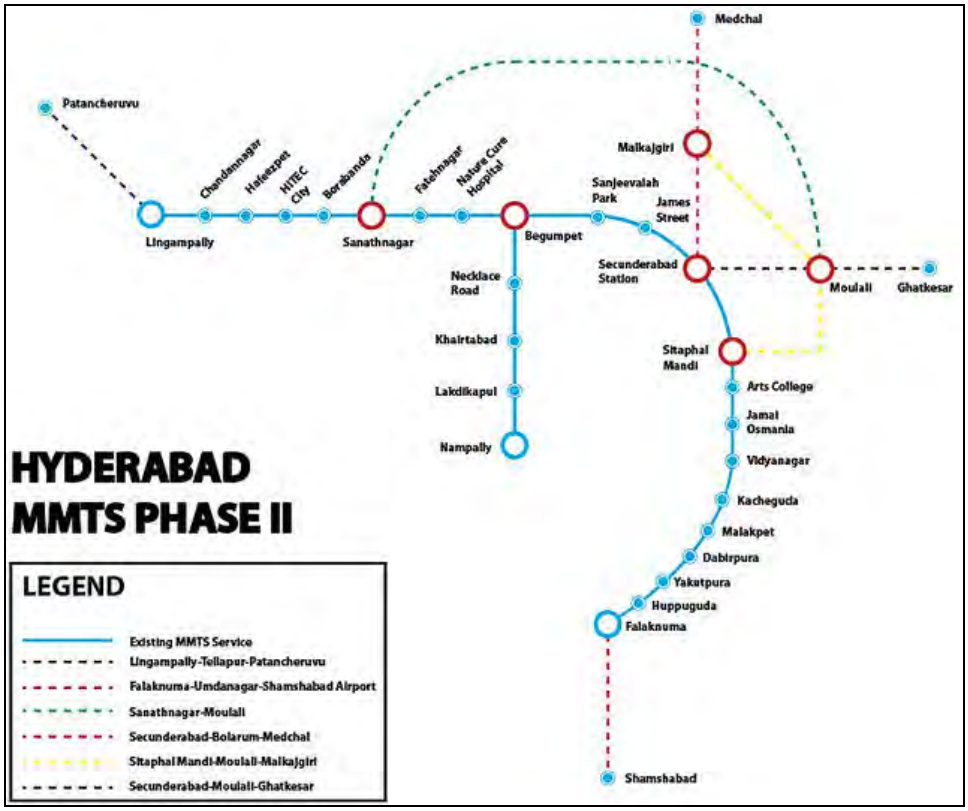
Source: South Central Railway Homepage

(2) Multi-Modal Transportation System (MMTS)

(a) Outline of MMTS

Multi-Modal Transport System (MMTS) is a suburban railway in Hyderabad. It is operated by a joint partnership of state government of Andhra Pradesh and South Central Railway (SCR). The operation in the first phase started in August in 2003. There are 27 stations and MMTS carries approximately 1,500,000 passengers per day. There are first class, general class and special ladies compartments.

Smart card is issued by the SCR. It can be used to purchase these tickets by vending machine at MMTS stations. A combined ticket is also issued jointly by APSRTC and MMTS. It can be used for both bus and train.



Source: Hyderabad MMTS Website

Figure 36 Hyderabad MMTS Map

In May 2010, Indian Railways decided to implement the 107-km Phase-II project for extension of MMTS at the estimated cost of Rs. 641 crore. The railway board cleared Phase-II after the state government agreed to fund two-thirds of the cost. It will carry 300,000 passengers a day. The phase II is comprised of six segments as follows:

- Lingampally-Tellapur-Patancheru (9 km)
- Secunderabad - Bollarum - Medchal (28 km)
- Falaknuma - Umdanagar - Shamshabad Airport (20 km)
- Secunderabad - Moulali - Ghatkesar (19 km)
- Moulali - Sanathnagar chord line (21 km)
- Sitaphalmandi - Moulali - Malkajgiri chord line (10 km)

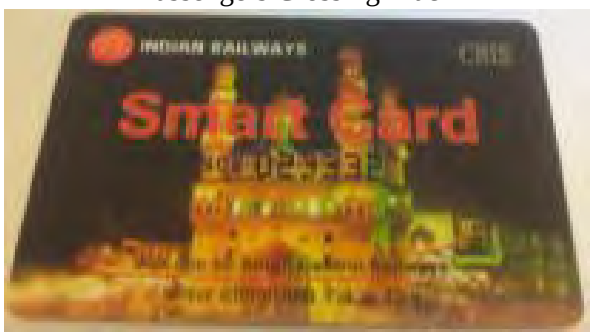
(b) MMTS Stations and Facilities

MMTS stations lack basic facilities so passengers tend to cross tracks without using pedestrian bridges. Such public behaviour may be improved by installing physical blocks using gates.

MMTS has two types of ITS related tools: train approaching information provision system and MMTS smart cards system. To enhance the advantage of smart card system, effective and strategic public information plan is required to control the access at station entrance.

Passengers Crossing Track

Ticket Vending Machine



Smart Card

Train Approaching Provision System

Source: JICA Study Team

Figure 37 Representative Example MMTS Station and its Facilities

(3) Hyderabad Metro Rail

Hyderabad Metro Rail is a mass rapid transit and it is now under construction in Hyderabad. Phase I of the project includes three (3) corridors with total length of approximately 72 km. The stations will be located roughly at every one kilometre. The trains will run every three to five minute in peak hours. The three corridors are as follows:

- Corridor 1: Miyapur – L.B.Nagar (29 km)
- Corridor 2: Jubliee Bus Stand - Falaknuma (15 km)
- Corridor 3: Nagole – Shilparamam (28 km)

The project cost is estimated at INR 141.32 billion. It is expected that there will be 1.5 million passengers per day in 2015. The project is executed on Design, Build, Finance, Operate, Maintain and Transfer basis in Public Private Partnership (PPP) model. The implementing agency is Hyderabad Metro Rail Limited (HMRL) and the concessionaire is Larsen & Tourbo Metro Rail Hyderabad Limited (L&TMRHL). The concession period is 35 years and it includes 5 years of construction. The project began in July 2012 and the construction is scheduled to complete in July 2017.

The table below shows the package by subcontractors under the prime contractor of

L&TMRHL.

Table 11 HMR Sub-Contractor Details

No.	Package	Subcontractor
1	Rolling stock	Hyundai Rotem, Korea
2	Signalling and Communication	Thales Canada / India (French Company)
3a	Track construction	L&T Construction
3b	Rails	Tata Corus, France
3c	Fasteners	Vossloh Germany
3d	Turnouts	Voestalpane, Austria
4	Automatic Fare Collection System	Samsung Data Systems India Pvt. Ltd

Source: Hyderabad Metro Rail Website

Source: HMRL Website

Figure 38 Planned Hyderabad Metro Route

2-4-3 Auto-Rickshaw

The auto-rickshaws are an important mode of transportation for public in Hyderabad. The fare of auto-rickshaw begins with a basic fare of 14.00 RP and increases based on distance. Although it is a common public transport for short length trips, it has adverse affect on traffic. Such affect includes lack of traffic manners, blocking the traffic lanes by the rickshaws waiting on the roads, preventing the smooth traffic flow by its low speed, emitting black smoke affecting the environment, etc. There are 11 to 13 auto-rickshaw unions in Hyderabad. The major unions are:

- IFTU - Indian Progressive Trade Union
- CITU - Central Industrial Trade Union
- BMS - Bharat Majdur Sang
- TADU - Telangana Auto Drivers Union

Source: JICA Study Team

Figure 39 Auto-Rickshaw in Hyderabad

2-4-4 Bicycle

The growing attention has been recently paid to the bicycle as environmentally sustainable transport. However the bicycle has not become a common mode of transport in Hyderabad yet. The preparation of bicycle tracks in Hyderabad is under undeway by GHMC and a few stretches of tracks will be introduced on pilot basis.

Source: JICA Study Team

Figure 40 Bicycles in Hyderabad

2-5 Organizations, Laws and Regulations

2-5-1 Organizations

The organizations related to introduction / implementations of ITS in Hyderabad are listed based on the review and summarised as follows:

Table 12 Related Organizations

1.	**Road Planning Authority**
(1)	Hyderabad Metropolitan Development Authority (HMDA)
2.	**Road Operation and Managing Body**
(1)	Hyderabad Growth Corridor Limited (HGCL)
(2)	Greater Hyderabad Municipal Corporation (GHMC)
(3)	National Highway Authority of India (NHAI)
(4)	Road and Building Department (R&B Department)
3.	**Traffic Management Body**
(1)	Hyderabad Traffic Police
(2)	Cyberabad Traffic Police
4.	**Vehicle Registration Authority**
(1)	Regional Transport Authority (RTA)
5.	**Public Transportation Operator**
(1)	Hyderabad Metropolitan Railway Limited (HMRL)
(2)	South Central Railway(SCR)
(3)	Andhra Pradesh State Road Transport Corporation(APSRTC)
(4)	Taxi Companies (MERU Cab, Easy Cab, Sky Cab, etc.)
6.	**Emergency Response Agency**
(1)	Emergency Management and Research Institute (EMRI)
7.	**IT Related Agency**
(1)	Centre for Development of Advanced Computing (C-DAC)
(2)	National Informatics Centre (NIC)
(3)	National Institute of Technology (NIT)
(4)	Centre for Railway Information Systems (CRIS)
8.	**Environmental Monitoring Agency**
(1)	Andhra Pradesh Pollution Control Board (APPCB)
9.	**Meteorological Monitoring Agency**
(1)	India Meteorological Department (IMD)

The details of the above organizations including roles, tasks, organization charts, jurisdiction areas are described in the subsequent corresponding section.

2-5-2 Laws and Regulations

The laws related to introduction/implementation of ITS in Hyderabad are identified based on the review as follows:

Table 13 Laws / Regulations

1.	**Road/Transport Sector**
(1)	Motor Vehicles Act 1988
(2)	Rules of the Road Regulation 1989
(3)	Pollution Under Control Norms 2004
(4)	Road Transport Corporations Act 1950.
(5)	Andhra Pradesh Motor Vehicles Taxation Act, 1963
(6)	The National .Highways Act, 1956
(7)	The National Highways Authority of India Act, 1988
(8)	Andhra Pradesh Road Development Corporation Act, 1998
2.	**Telecommunications**
(1)	Indian Telegraph Act 1885
(2)	The Indian Wireless Act 1933
(3)	Telecom Regulatory Authority of India Act
3.	**Others**
(1)	Police Act, 1861
(2)	Andhra Pradesh Hyderabad City Police Act 1348 F
(3)	Cyberabad (Metropolitan Area) Police Act, 2004
(4)	HMDA Act, 2008
(5)	GHMC Act, 2007

(1) Motor Vehicles Act

The first enactment of Indian Motor Vehicles Act was in 1914 and it was subsequently replaced by the Motor Vehicles Act, 1939. A Working Group was constituted in 1988 to review all the aspects of provisions of the Motor Vehicles Act, 1939 including pattern of passenger and freight movements, development of the road network in the country and particularly the improved techniques for motor vehicle management. The committee was requested to submit draft proposals for comprehensive legislation to replace the existing Act.

Then, it came into force on the 1st day of July, 1989, as the Motor Vehicles Act, 1988 (59 of 1988) and it was further amended three times in the years of 1994, 2000 and 2001.

The major related sections of the act are:

- Licensing of Drivers of Motor Vehicles
- Registration of Motor Vehicles
- Pollution Control of Transport Vehicles
- Offences, Penalties and Procedure

(2) Rules of the Road Regulation 1989

The Motor Vehicles Act, 1988 (59 of 1988) specifies 32 rules to be followed by the road users and major items are summarized below.

- Caution at Road Junction:
  The driver of a motor vehicle shall slow down when approaching at a road intersection, road junction, pedestrian crossing or a road corner.
- Taking 'U' Turn:
  No driver shall take a 'U' turn where 'U' turn is specially prohibited and on busy traffic road.
- Parking of the Vehicle:
  Every driver of a motor vehicle shall park in such a way that it does not cause or is not likely to cause danger.
- Use of sound horns and silence Zones:
  A driver of a vehicle shall not sound the horn needlessly or continuously or more than necessary to ensure safety.
- Traffic Sign and Traffic Police:
  A driver of a motor vehicle and every person using the road shall obey every direction given whether by signal or otherwise by a police officer for the regulation of traffic

(3) Pollution Under Control (PUC) Norms 2004

The stricter PUC norms for motor vehicles was notified vide Gazette Notification No. G.S.R. 111(E) dated 10.2.2004 and came into force as of the 1st October, 2004. All vehicle owners in India are required to obtain a Pollution Under Control (PUC) certificate as per section 115 (2) of the Central Motor Vehicles Act, 1989. The relevant contents are as follows:

Table 14 The New Norms for Vehicles

Vehicle Type	CO%
2 Wheelers (2/4-stroke)&3 Wheeler (manufactured prior to 31-03-2000)	4.5
4 stroke 2Wheeler and 3 Wheeler vehicles fitted with catalytic converters(manufactured after 31-03-2000)	3.5
4 Wheelers vehicles (manufactured after 31-03-2000) (Petrol/CNG/LPG)	3.0
Bharat Stage complaint Passenger Cars/CNG Buses/LPG (Fitted with 3-way closed catalytic converters)	0.5

(4) Road Transport Corporations Act, 1950

The Act was formed to provide the regulation of Road Transport Corporations. The act stipulates the need of establishment of Road Transportation Corporation in all State of India. The major relevant sections of the act are summarized below.

- Importance of formation of Road Transport Corporation in states in India.
- Organizational Structure of the corporation.
- Responsibilities of Officials appointed at different levels in the corporation.
- Role of government in the corporation.

(5) Andhra Pradesh Motor Vehicle Taxation Act, 1963

The Act consolidates and amends the law relating to levying of tax on motor vehicles in the State of Andhra Pradesh. Some of the major sections in the act are:

- Tax of motor vehicle purchased at any time within the quarter shall be paid in advance by

the registered owner of the motor vehicle.

- Motor vehicle can be checked by the officers of the Commercial Tax Department at any point of time.
- Motor vehicle can be seizure and detained by officers commercial tax and officers of Vigilance and Enforcement Department
- Payment of tax and penalty**:** If the tax due in respect of any motor vehicle has not been paid as specified in Sec. 4 of the Act the registered owner or the person having possession of the motor vehicle shall be liable to pay the arrears of tax along with the penalty imposed.
- Motor vehicle registered in other state is transferred to a person in the Sate and the licensing Officer shall make an entry regarding the amount tax payable in respect of that motor vehicle in the certificate of registration.
- Provisions of this Act not to apply to the motor vehicles designed and used solely for agricultural and mining purposes

(6) The National Highways Act, 1956

An Act was formed for the declaration of certain highways to be national highways. Some of the major directions in the act are:

- The Central Government is responsible for the development and maintenance of all the national highways but by notification in the Official Gazette it may direct that any function regarding development and maintenance of any national highway shall also be exercisable by the Government of the State within which the national highway is situated.
- If any land is acquired under the provisions of this Act then nothing in the Land Acquisition Act, 1894 (1 of 1894) shall apply.
- The Central Government is empowered to levy fees for services or benefits rendered in relation to the use of ferries, temporary bridges and tunnels on national highways and the use of sections of national highways.

(7) The National Highways Authority of India Act, 1988

It was enacted to provide the constitution of the Authority for development, maintenance and management of national highways. The act resulted in constitution of National Highway Authority of India (NHAI), the central government authority to look after the development and maintenance of National Highways in India. Some of the major roles and responsibilities of the authority as specified in the act are:

- Survey, develop, maintain and manage highways entrusted to it
- Construct offices or workshops and establish and maintain hotels, motels, restaurants and rest-rooms at or near the highways.
- Construct residential buildings and townships for its employees
- Regulate and control the plying of vehicles on the Highways.
- Develop and provide consultancy and construction services in India and abroad and carry on research activities in relation to the development, maintenance and management of highways or any facilities thereat
- Provide such facilities and amenities for users of the highways for the smooth flow of traffic.
- Engage, or entrust any of its functions to any corporation owned or controlled by the

Government.

- Assist any State Government in the formulation and implementation of schemes for highway development
- Collect fees on behalf of the Central Government for services or benefits rendered under section 7 of the National Highways Act, 1956.

(8) The Andhra Pradesh Road Development Corporation Act, 1998

It was formed on the 2nd January 1998 for establishment of the Andhra Pradesh Road Development Corporation for development and maintenance of the roads in the state of Andhra Pradesh The major responsibilities of Andhra Pradesh Road Development Corporation as per the act are:

- Survey, develop, maintain and manage the roads.
- Raise resources for such development, maintenance and management of such roads
- Construct, establish and maintain hotels, motels, restaurants and rest-rooms at or near the roads vested in, or entrusted to it
- Regulate and control the use of the roads entrusted to it for the proper management
- Develop and provide consultancy and construction services and carryon research activities in relation to the development, maintenance and management of roads or any facilities
- Provide facilities and amenities for the users of the roads for the smooth flow of traffic on such roads
- Advise the Government on all matters relating to roads and assist the Government in formulation and implementation of schemes for road development
- Collect fees and charges including toll fee for services and benefits rendered in relation to the use of the roads.
- Invite tenders, bids or offers and enter in to contracts
- To undertake works, either jointly with other corporate bodies, or Government, agencies.
- Prepare annual plans and five-year working development plans
- Prepare annual budget

(9) Indian Telegraph Act 1885

The Department of Telecommunications is a responsible authority and major sections of the law are summarized below.

- Privileges and Powers of the Government:
- Exclusive privilege in respect of telegraphs, and power to grant licenses
- Power to make rules for the conduct of telegraphs
- Revocation of licenses
- Power to Place Telegraph Line and Posts
- Power to Place Telegraph authority to place and maintain telegraph lines and posts
- Imposing Penalties

(10) The Indian Wireless Act 1933

It is to regulate the possession of wireless telegraphy apparatus. The major sections of the law are summarized below.

- Prohibition of possession of wireless telegraphy apparatus without license
- Licenses regulations
- Offence and Penalty

- Apparatus confiscated or having no owner to be property of Central Government
- Power of central government to make rules

(11) Telecom Regulatory Authority of India Act

It was constituted in 1997 and was amended in 2000. It was formulated for establishment of the Telecom Regulatory Authority of India to regulate the telecommunication and services at national level in the country. The functions of the authority are stipulated as follows:

- Make recommendations on the following matters:
  - ✓ Need and timing for introduction of new service provider
  - ✓ Terms and conditions of license to a service provider
  - ✓ Measures to facilitate competition and promote efficiency in the operation of telecommunication services so as to facilitate growth in such services.
  - ✓ Technological improvements in the services provided by the service providers.
  - ✓ Type of equipment to be used by the service providers after inspection of equipment used in the network.
  - ✓ Measures for the development of telecommunication technology and any other matter relatable to telecommunication industry in general
  - ✓ Efficient management of available spectrum
- Lay down the standards of quality of service to be provided by the service providers and ensure the quality of service
- Lay down and ensure the time period for providing local and long distance circuits of telecommunication between different service providers.
- Ensure effective compliance of universal service obligations.
- Levy fees and other charges at such rates and in respect of such services as may be determined by regulations

(12) Police Act 1861

The act was formed to re-organize the police and to make it more efficient instrument for prevention and detection of the crime. The act resulted in formation of state government to control the police- force. Some of the roles and responsibilities summarized in the act are:

- The entire police-establishment under a State Government is deemed to be one police force.
- The administration of the police is vested in the Inspector-General of Police in the hierarchy of Deputy Inspectors-General, Assistant Inspectors–General, Superintendents, etc.
- The State Government may impose any limitation on the powers of the Inspector-General of Police.
- It shall be the duty of the police to keep order on the public roads, and in the public streets, and
- to prevent obstruction on the occasions of assemblies and processions on the public roads and in the public streets.
- Regulate and maintain the traffic to make smooth flow of the traffic.
- Regulate the traffic to allow smooth VIP travel movement

(13) Andhra Pradesh Hyderabad City Police Act 1348 F

The act was formed to consolidate the law relating to the Hyderabad Police Act so as to make the Hyderabad City Police an effective means for prevention and detection of crimes, maintenance of peace and investigation into circumstances. Some of the major points in the act for the duties of the police are:

- To obtain intelligence concerning the commission of
- To take action consistent with law and with orders of his superior, to punish the offenders under law
- To prevent as far as possible of public nuisance.
- To apprehend persons whom he is legally authorized to apprehend and for whose apprehension there is sufficient reason.
- To regulate the public traffic in the street to prevent obstructions therein and as far as possible, to prevent the infraction of any rule or order made under this Act or under any other law for the time being in force for observance by the public in or near a street.
- To keep order in the street or at such places of worship, passage,

(14) Cyberabad (Metropolitan Area) Police Act, 2004

The act was formed to establish the Cyberabad Commissionerate for the Metropolitan Area of Cyberabad. Some of the main aspects enclosed in the act are:

- Establishment of Cyberabad police Commissionerate for the metropolitan Area of Cyberabad.
- The act declared that the Police Stations under the sub-divisions of Alwal, Malkajigiri, Saroornagar, Rajendra Nagar, Bala Nagar, Traffic police Stations of Kukatpalli and L.B.Nagar traffic sub-division and the Central Crime Stations of Bala Nagar and Saroornagar crime sub-divisions as Metropolitan Area of Cyberabad.

(15) HMDA Act, 2008

The GO Ms 570 was passed on 25-08-2008 by Government of Andhra Pradesh. This GO is also called as HMDA Act, 2008. The act resulted in formation of Hyderabad Metropolitan Development Authority for the purpose of planning, coordinating, supervising, promoting and securing the development of Hyderabad Metropolitan Region. Some of the major roles and responsibilities of HMDA as specified in the act are:

- To plan, execute and maintain development plans in Hyderabad metropolitan region.
- To undertake by itself or through any agency, the implementation of the area level plans, execution works relating to infrastructure development, public amenities and conservation of the environment.
- To enter into contracts, agreements or arrangements with any person, body or organization as the committee may deem necessary for the performance of its functions.
- To acquire any movable or immovable property by purchase, exchange, gift, lease, mortgage, negotiated settlement or by any means permissible under any law.
- To maintain and manage the Hyderabad Metropolitan Development Fund and allocate finances based on the plans and programmes of the local bodies for undertaking development of amenities and infrastructure facilities and to monitor and exercise financial control over the budgetary allocations concerning development works made through it to various public agencies, local bodies and other agencies.
- To co-ordinate the development activities of the Municipal Corporation, Municipal and

other local authorities are connected with development activities in the Hyderabad Metropolitan Region.

- To acquire any movable or immovable property by purchase, exchange, gift, lease, mortgage, negotiated settlement or by any means permissible under any law.
- To create and manage the Hyderabad Metropolitan Development Bank and take up acquisition every year as may be necessary for various public uses, township development infrastructure development, etc., allocation of land to local bodies and public agencies upon such terms and conditions for undertaking development of amenities and infrastructure facilities.
- To approve the land acquisition programs/proposals of the local authorities, other departments and functional agencies in the metropolitan region.

(16) GHMC Act, 2007 (Andhra Pradesh Government Order 261)

The Government Order 261 was passed on 16th April 2007 by the Government of Andhra Pradesh resulting in formulation of the authority for urban planning for the city of Hyderabad. The corporation was named as Greater Hyderabad Municipal Corporation. Some of the major points in the act are:

- Establishment of GHMC merging 12 municipalities and 8 grampanchayats.
- Some of the major roles of GHMC include:
  - ✓ Improved and higher standards of civic services
  - ✓ Providing better civic administrative mechanism
  - ✓ Ensure better planning and focused development of the city
  - ✓ Ensure uniform enforcement and to make the city internationally competitive with world class infrastructure.

2-6 Existing National Development Plans

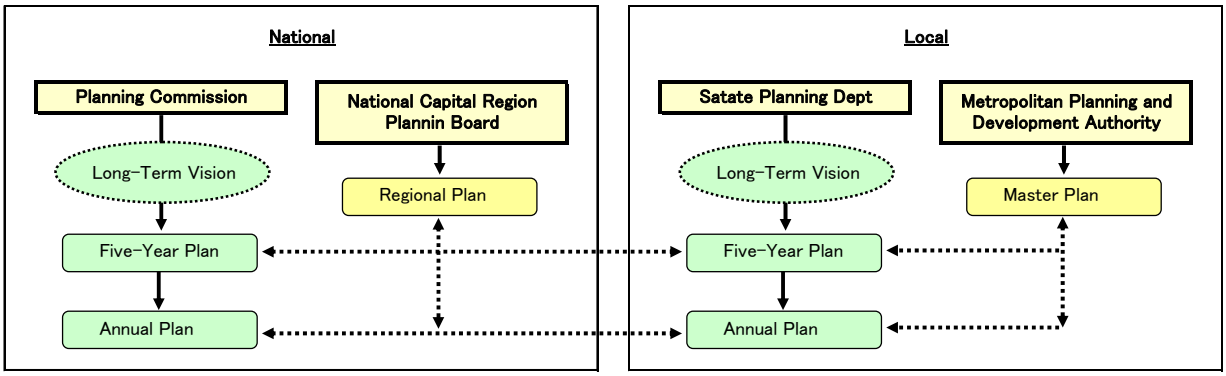
Based on the current review, the existing major national development plans which shall be taken into account are summarized as follows:

Table 15 Existing Development Plans

1.	**Socio Economic Development**
(1)	11th Five-Year Plan (2007-2012)
(2)	12th Five-Year Plan (2013-2017)
(3)	Jawaharlal Nehru National Urban Renewal Mission (JNNURM)
2.	**National ITS Plans**
(1)	Recommendation of Passive RFID for ETC on National Highway
(2)	Common Mobility Card (CMC)
(3)	Go-India Smart Card for Railway
(4)	ICT Implementation Proposed by National Transport Development Policy Committee
3.	**Road Transportation Plans**
(1)	Sustainable Urban Transport Project (SUTP)
(2)	National Urban Transport Policy (NUTP)

2-6-1 Socio Economic Development

The economic policy in India is formulated through Five-Year Plans as stipulated in the Constitution. The plan sets forth a national strategic goals and projects in the form of the five-year plans and covers wide range of sectors including economy, finance, employment, education, social security services, environment, industry, agriculture, transportation, energy, etc. The planning commission of the government of India, chaired by the Prime Minister, formulates a five-year plan by consolidating the plans proposed by the central and ministries as well as the state governments. The working group in each sector consisted by the representatives from the concerned central agencies, ministries, state government and academic personnel are set up and the coordination/collaboration between the central and state governments are ensured. The planning commission monitors the achievement in the previous fiscal year to clarify the issues which need to be addressed to accomplish the planned goals and prepare the annual plan based on the assessment. The budget allocations to the central and state government are affected by this annual plan. The flow of the major national and regional planning for socio-economic development is shown in the Figure below.



Source: Referring Overview of Spatial Policy in India, MLIT, Japan, Sept 2010
Edited by JICA Study Team

Figure 41 National and Regional Planning Flow

(1) 11th Five-Year Plan (2007-2012)

India has been working under the 11th Five-Year Plan (2007-2012) for the last five years. The major theme is “Inclusive Growth” and the goals are to achieve 9% growth in GDP and improve the quality of life of the people especially the poor. The emphasis is placed on mutually related elements including (i) rapid growth and reduction of poverty, (ii) issue of employment, (iii) the right to essential services, (iv) social justice and rights, (v) environmental protection, (vi) gender equality, and (vii) governance. In June 2010, the medium term appraisal on the 11th Five-Year Plan (2007-2012) was reported. The goal to achieve 9% growth in GDP was downwardly revised to 8.1%. However, it marked the highest appraisal on the achievement on overall evaluation among the previous Five-Year Plans and significant investment to the infrastructure development has been made. In particular, the infrastructure sector of electricity and telecommunication has seen the strong growth whilst partial downward adjustments were made in investment to the road and railway sectors of USD 67-76 billion in road sector and USD 48-63 billion in railways respectively. However, the infrastructure in these sectors still holds the significant importance under the situation where the economic growth is expected to surpass China in 2015. The Prime Minister, Manmohan Singh, stresses the emphasis on the infrastructure development of road, railway, port and airport and calls for active participation of the private capital. Thus, the overall goals and growth in these sectors on USD basis at the end of the 11th Five-Year Plan is expected to be achieved. The goals and medium-term achievement on the major infrastructure sectors are shown in

Table below.

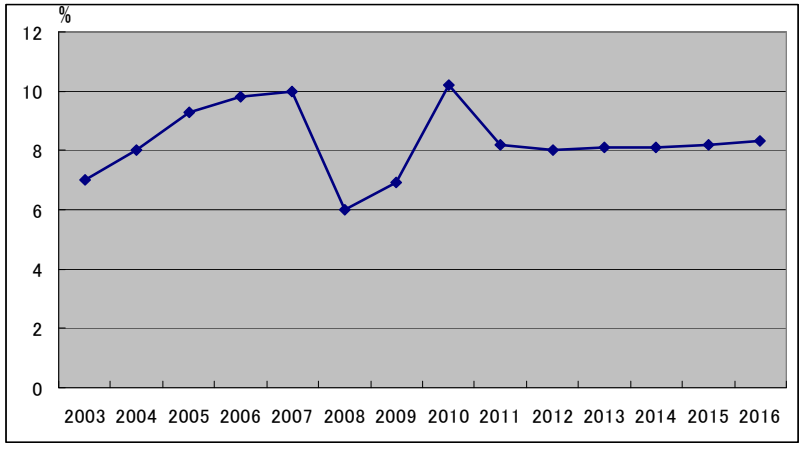
Table 16 Goals and Medium Term Achievement: 11th Five-Year Plan

	Goals (Original)	Achievement	Goals (Adjusted)
Electricity (MW)	78,700	19,092	62,374
Road/Highway (km)	9,570	7,579	-
Telecommunication (million subscribers)	-	671	600
Railway (km)	1,107	671	2,000

Source: Medium Term Appraisal of 11th Five-Year Plan, June 2010

(2) 12th Five-Year Plan (2013-2017)

The 12th Five-Year Plan is under the preparation by the Planning Commission as of December 2012. On the Commission Meeting held in April 2011, the Prime Minister, Manmohan Singh, announced that the goal of annual average growth in GDP in the 12th Five-Year Plan would be set out at 9 – 9.5%. The Government of India expects that the growth rate will be at 8.2% at the end of the 11th Five-Year Plan. However it is considered that this may be difficult to achieve due to the global economic downturn after the year of 2008 and reduction of crop yields in agricultural sectors caused by the drought in India. In the 12th Five-Year Plan, the infrastructure development in transport sector will be significant although the emphasis will be placed on the manufacturing and agriculture sectors. GDP growth rate record and forecast are shown below. (Note: Forecast is after the year 2011.)



Source: Edited by JICA Study Team based on World Economic Forecast IMF, 2011

Figure 42 GDP Growth Rate in India

(3) JNNURM

Jawaharlal Nehru National Urban Renewal Mission, named after the first prime minister of independent India, Jawaharlal Nehru, is a city modernization scheme launched by the Ministry of Urban Development under the Government of India. The mission was officially inaugurated by the Prime Minister, Manmohan Singh on the 3rd December 2005. The objectives of the mission are improvement of quality of life and infrastructure in the cities together with urban sector reforms to strengthen the municipal governance in accordance with the 74th Constitutional Amendment Act, 1992. The features of the JNNRUM are:

- A reform based mission for Central Financial Assistance (CFA) to urban local bodies
- Reforms such as abolition of rent act, urban land ceiling act, reduction of stamp duty etc
- Reforms for better urban transport planning and management

JNNURM consists of the two sub-missions as follows:

- Sub-Mission for Urban Infrastructure and Governance (Administered by the Ministry of Urban Development with a focus on road network, urban transport, water supply and sanitation, solid waste management, and redevelopment of old city areas)
- Sub-Mission for Basic Services to the Urban Poor (BSUP) (Administered by the Ministry of Housing and Urban Poverty Alleviation with a focus on integrated development of slums)

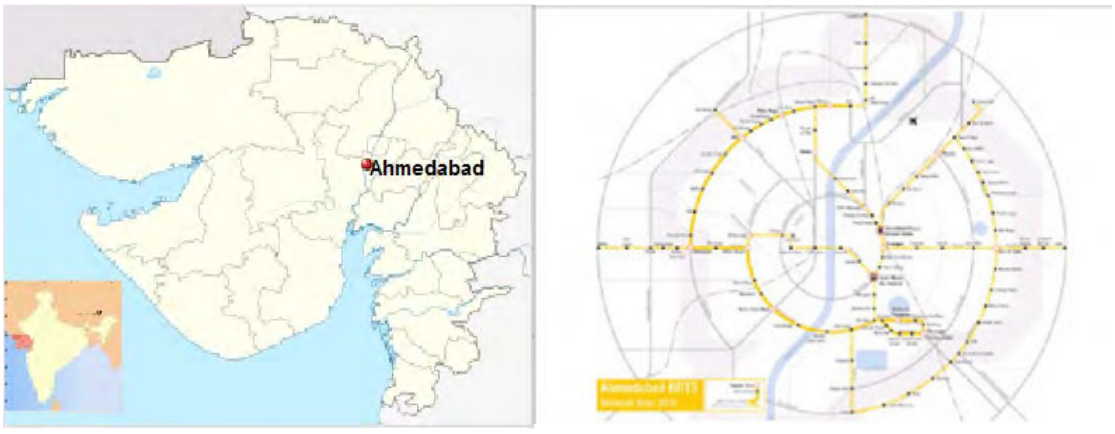
The major policy establishments under JNNURM include:

- Comprehensive Mobility Plan (CMP)
- Setting up of Unified Mass Transit Authority (UMTA)
- Setting up of Dedicated Urban Transport Fund at state and city level
- Transit Oriented Development Policy, Parking Policy and Advertisement Policy
- Setting up of City Specific Special Purpose Vehicle for public transport management
- Setting up of Traffic Information and Management Control Centre etc
- Mechanism for periodic revision of public transport fares

Source: UNTP JNNURM GOI Initiative to Strengthen Public Transport, MOUD, 2006

The funds are channelled through state-level agencies, where the grants from the Central and State Governments are pooled and passed on as grants or soft loans to the cities. The mission emphasizes transparency and accountability. Therefore, the funds are provided to the cities where the city development strategies are prepared and identified that they fit within the policy of the mission. The share of the grant funded by the Central Government varies from approx. 35% in large cities to up to 90% in cities in the Northeast. The projects currently covered by the JNNURM funds include the development of road network, bus rapid transit and related system, water supply, solid waste management, sewage treatment, river and lake improvement and rehabilitation.

Ahmedabad is a metropolitan city in Gujarat State with population of 7.2 million. In order to cater the growing demand of commutation, the City and State Governments initiated a plan for integrated public transit system in which Bus Rapid Transit System (BRTS) is one of the components. The control centre monitors the bus operations and all the buses are equipped with GPS.

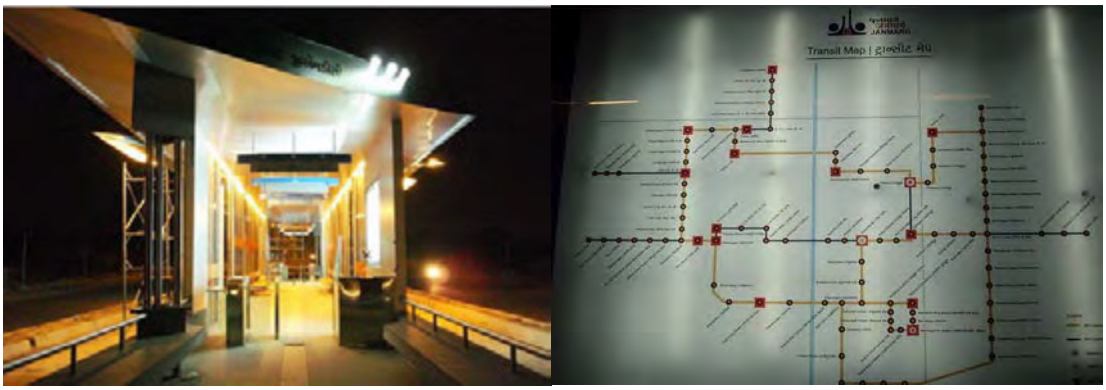


Source: Edited by JICA Study Team based on Wikipedia, Ahmedabad BRT, 2011

Figure 43 Location of Ahmedabad and BRT Routes

Source: Edited by JICA Study Team based on Wikipedia, Ahmedabad BRT, 2011

Figure 44 Snapshot of BRT in Ahmedabad (1)



Source: Edited by JICA Study Team based on Wikipedia, Ahmedabad BRT, 2011

Figure 45 Snapshot of BRT in Ahmedabad (2)

2-6-2 Related National Plans

The major cities in India are the growth engines of the future and transport sector is going to play a major role. The increasing urban population coupled with increased city sizes resulted in the increased travel demand. It has created a lot of pressure on urban transport system and more and more travellers opting for private mode of transport. This has resulted in serious costs in the form of severe delays and loss of productivity. There have also problems of deteriorating air quality and increasing road accidents. The planners identified that increasing in travel demands are closely linked to the economic growth and proactive measures are immediately required to address future demand.

(1) National 11th Five-Year Plan

In this context, the Indian National Government announced the Urban Transport Policy in 2006 with a vision to address these challenges and plan for future demand on Urban Transport. The effective usages of Intelligent Transportation Systems were mentioned and highlighted in the 11th Five-Year Plan published by the Indian Planning Commission.

The 11th Five-Year Plan mentions that “ITS” shall be effectively utilised for setting up traffic information centres that shall help in performing multiple functions. They would include the facilitating of smooth traffic movement and the handling of emergencies and temporary traffic tie–ups in an effective manner. Another function includes collecting data on a continuous basis and thereby providing actual basis for future policies and plan. Such initiatives would be taken in 4 or 5 pilot cities and replicated in all million plus cities in the country. Appropriate ITS infrastructure should be put in use and

model regulators be established.

(2) National Urban Transport Plan 2006

As per the report published by Ministry of Urban Transport of India, while the population in major metropolises increased by 1.9 times from for last two decades, motor vehicles have increased by 7.75 times and the fuel demand in the transport sector grown by 5 to 8% per annum. The projected number of vehicles in India by this study is shown in the table below.

Table 17 Vehicle Growth in India

(million Vehicles)

Vehicles by Type	2005	2008	2015	2025	2035
2-W	35.8	46.1	87.1	174.1	236.4
3-W	2.3	3.0	5.3	8.8	13.1
HCV	2.4	2.9	4.6	9.1	16.2
LCV	2.4	3.2	5.7	12.5	26.9
Car, SUV	6.2	8.8	18.0	41.6	80.1
Total vehicles	49.1	63.9	121.3	246.1	327.7

Source: Urban Transport in India presentation by Ministry of Urban Transport

The above table indicates that the expected increase of cars and SUVs will be approximately 35 times by the year 2035.

The National Urban Transport Plan 2006 emphasises that the focus should be on moving people and not on vehicles as follows:

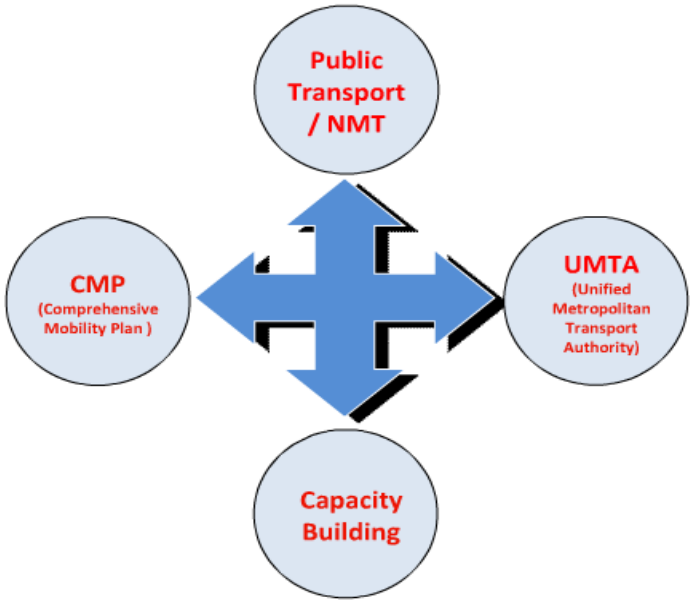
- Incorporating Urban Transport as an important parameter at the planning stage rather than being a consequential requirement
- Reduced travel demand-better integration of land use & transport planning
- Equitable Allocation of Road Space
- Improved public transport
- Introducing ITS
- Facilities for use of non motorized vehicles
- Use of cleaner technology
- Innovative financing mechanism
- Greater involvement of private sector
- Better awareness of transport conditions

(3) Focus of Ministry of Urban Development

The Ministry of Urban Transport laid its focus on establishing as follows:

- Comprehensive Mobility Plan - Integrates the plan’s direction into work activities including Strategic planning, city transportation & land use planning, Project evaluation, Prioritization & coordination among modes with a focus on developing a strategy built around improved mobility
- Public Transport & NMT (Non Motorized Transport) – Encourage and provide opportunity for the travellers to use Public Transport and avoid using personal transport. Also encourage usage of non motorized transport like green vehicles.
- Capacity building – Providing training in ITS technology and develop COE (centre of excellence)

The major domain of emphasis of the Ministry of Urban Transport is depicted in the Figure below.



Source: Urban Transport in India presentation by Ministry of Urban Transport

Figure 46 Focus of Ministry of Urban Development

(4) Unified Metropolitan Transport Authority (UMTA)

The Unified Metropolitan Transport Authority (UMTA) was proposed under the National Urban Transport Policy (NUTP) for all cities with population above 1 million for high level decision and coordination for transport-related planning. The Urban Development Authorities, currently involved in city planning, is supposed to serve as technical secretariats to MPCs/DPCs (Metropolitan Planning Committee and District Planning Committee) and assist for the regional planning. The regional plans prepared by the MPCs/DPCs shall be incorporated into the spatial and socio-economic plans of the state government.

(5) ITS in the 11th Five-Year Plan (2007-2012)

The 11th Five-Year Plan mentions that 'The Intelligent Transportation Systems (ITS) encompasses a broad range of wireless and wired communications and electronic technologies. When integrated into the transportation systems infrastructure and vehicles, the technologies work to relieve congestion, improve safety and enhance productivity. Applied effectively, ITS would help save lives, time and money as well as reduce threats to the environment and generate business opportunities.

2-6-3 National Level Initiatives Related to ITS

(1) Initiatives at National level in India

The central government of India recently started the initiative for deployment of ITS. ITS for Indian cities has been initiated with collaborative projects between the department and research and academic institutions having requisite expertise. Some projects are under implementation. As part of this program, 8 sub-projects were identified by identifying CDAC Thiruvananthapuram as nodal agency and IITs (Chennai and Mumbai), IIM Kolkata as the other participating agencies. In addition, the Embedded Centre of Excellence on ITS was set up at CDAC, Thiruvananthapuram, which will function as a national resource centre in the country. The given below lists the major related initiatives:

- Research by academic institute and relevant department.
- Sub projects initiated by CDAC and under JNNURM
- Introduction of Common Mobility Card
- Establishment of ITS India

The 11th Five-Year Plan (2007-2012) in October 2006 stresses the importance of implementation of ITS in India as well.

(2) Major Initiatives in the Cities

The major Indian cities including Bangalore, Delhi, Chennai, and Ahmadabad are introducing the intelligent/automation systems:

- Delhi - DIMS (Delhi Integrated Multi Modal Transit system)
- Bangalore - BTIS (Bangalore Traffic Information System)
- Chennai - Bus Operation system with GPS/GPRS
- Ahmadabad - BRTS (Bus Rapid Transport System)

(3) Recommendation of Passive RFID for ETC on National Highway

The Ministry of Road Transport & Highways Order No. NH-12037/33/2010-PIC dated 20.04.2010, constituted a Committee on Electronic Toll Collection (ETC) Technology for use on National Highways to examine the technologies available for ETC and concluded the recommendation, on the 28th June 2010, that the appropriate ETC technology would be passive RFID conforming to ISO 18000-6C, to be applied to National Highway in India. The committee was constituted under chairman, Shri Nandan Nilekani, Unique Identification Authority of India (UIDAI), with members of Ministry of Road Transport & Highways (MRTH) and National Highways Authority of India (NHAI) and outside experts from Institute of Information and Technology (IIIT) and Indian Institute of Technology (IIT). The committee examined the appropriateness and feasibility among the available technologies including Dedicated Short Range Communications (DSRC) active as well as passive, Radio Frequency Identification (RFID) active as well as passive, Communication Air-Interface Long and Medium Range (CALM), Global Navigation Satellite System/Cellular Network (GNSS/CN), Automatic Number Plate Recognition (ANPR). It then recommends the passive RFID ISO 18000-6C standard to be adopted for ETC in India and stresses the necessity of preparation of legal framework and establishment of central toll clearing house (CTCH).

(4) Common Mobility Card (CMC)

The introduction of Common Mobility Card (CMC), a contact-less smart card, to be applied as multi-modal usage across different mode of transport has been initiated by the Ministry of Urban Development as national program. On 30th August 2011, the Minister of State for Urban Development, Shri Saugata Roy, announced that the Government would roll out the Common Mobility Card (CMC) to facilitate the commuters to travel by different modes of public transport in the country. The proposed Common Mobility Card (CMC) will be a Smart Card providing for a Common Fare Collection System across the different modes of public transport including buses, metro and railways and will further applied to toll collection and parking fees. It will be progressively extended to all the cities across all the states and union territories. The preparation of Automatic Fare Collection (AFC) Systems for urban buses/city buses is a part of Jawaharlal Nehru National Urban Renewal Mission. The Central Government is providing the additional central financial assistance as per the scheme guidelines of the mission, as well as the financial assistance for AFC Systems of the Metro Railways. The Ministry of

Urban Development has engaged Unit Trust of India (UTI) Infrastructure Technology and Services Ltd. for preparation and implementation of CMC which includes the preparation of design and specification including central clearing house and interfaces, issuance of the card and operation & maintenance of the system on behalf of the public transportation operators. The UTI Infrastructure Technology and Services Ltd. is a 100% owned public sector undertaking, specialized in IT sector, of the Ministry of Finance, of which headquarters is located at Mumbai with its branch offices in sixty (60) cities across the country.

Source: PPT, Introduction to Common Mobility Card (CMC), UTI, Dec 2010

Figure 47 Sample of CMC

(5) "Go India" Smart Card for Railway

In February 2011, the Mamata Banerjee, the Minister of Railway, announced that a pan-India, multi-purpose "Go-India" smart card would be introduced on a pilot basis. It will be a single-window package for passengers for seamless payment applied for long-distance, sub-urban and metro journeys. The card will be available at booking counters, vending machines and internet.

(6) ICT Implementation Proposed by National Transport Development Policy Committee

The National Transport Development Policy Committee (NTDPC) was formulated by the Government of India on 11th February 2010 for the purpose of recommending a long-term National Transport Policy to provide an integrated and sustainable transport system. The ICT sub-working group of Urban Transport Working Group under NTDPC engages in identifying Information and Communication Technology (ICT) Roadmap for Urban Transport up to 2030. The sub-working group on the 9th May 2011 compiled the services to be provided as a proposal of the ITC Roadmap as listed hereunder.

The below is the extract from the recommendation published by NTDPC where "Policy Approval Date" means the date of approval of the policy recommendation.

(a) Policy Approval Date + Five (5) Years

- Vehicle Tracking System
- Realtime Traffic Control and Adaptive Signals
- Realtime Passenger Information System

  Purpose: To increase efficiency in transport management, achieve optimum utilization of assets and increase utilization of public transportation system

(b) Policy Approval Date + Ten (10) Years

- Fare Integration through Common Mobility Card
- Integrated Information Across Mode
- Cashless Toll Collection

  Purpose: To lead better passenger satisfaction, better management of the transport system and help move towards a totally integrated multi modal transport system

(c) Policy Approval Date + Fifteen (15) Years

- Fare Integration through UID
- Intelligent Traffic Management Systems
- Predictive Traffic Management

  Purpose: To enhance passenger satisfaction, help management and reduce congestion

(d) Policy Approval Date + Twenty (20) Years

- Advanced Vehicle Safety System
- Seamless Intelligent Transportation System
- High Level Analysis

  Purpose: To improve predictability of transport network for better operation and maintenance management thereby reducing emissions, improve safety and security of system which will reduce accidents and help respond efficiency for emergency.

2-6-4 Transportation Plan

(1) Sustainable Urban Transport Project (SUTP) by Government of India

The National Urban Transport Policy (NUTP) was launched in 2006 by the Ministry of Urban Development. Its emphasis is to motivate building of people-centric urban transport solutions by promoting public transportation shifting from motorized transportation mode. For effective implementation of the NUTP, the Sustainable Urban Transport Project (SUTP) has been initiated by the Government of India in partnership with the World Bank, United Nations Development Programme (UNDP) and Global Environment Facility (GEF), a multi-national grant mechanism for the increment cost for the project which contributes to environmental protection in the developing countries. The project is implemented by the Ministry of Urban Development and it consists of the following three (3) components in the field of urban transport:

- Component-1: National Capacity Development Initiative
- Component-2: Implementation of Demonstration Projects in Selected Cities
- Component-3: Project Management

The Component-2 aims to catalyze high profile demonstration projects in the selected cities to create the models of sustainable transport solutions to be replicated in other cities in India. The major focuses are:

- Development of Bus Rapid Transit System (BRTS)
- Development of Non-Motorized Transport
- Application of Intelligent Transportation Systems
- Integrated Land-use, Transport Planning and Transit-Oriented Development

The currently selected cities for the demonstration projects as part of the Component-2 are:

- Indore in Madhya Pradesh State,
- Mysore in Karnataka State,
- Naya Raipur in Chhattisgarh State,
- Pimpri-Chinchwad in Maharashtra State, and
- Pune in Maharashtra State

(2) Indore BRT (Example)

The BRT development project in Indore was implemented under the JNNURM funded jointly by the central government of India, along with World Bank and GEF SUTP program. The major components of the project are:

- Establishment of Special Purpose Vehicle (SPV) for development and operation of BRTS
- Development of BRTS corridor
- Advanced Signal Systems with Emergency and Transit Priority Signal
- Automated Fare Collection System[1]
- Network Surveillance with CCTV Cameras
- Traveller Information through VMS Signs
- Traffic Management Centre for Centralized Operations Control

2-7 Existing Regional Development Plans and Related Studies in Hyderabad

Based on the current review, the existing regional development plans in Hyderabad which shall be taken into account are summarized below:

1.	**Urban Development Plans**
(1)	Revised Master Plan for Core Area
(2)	Master Plan for Extension Area of Hyderabad
(3)	City Development Plan
2.	**Road Transportation Plans**
(1)	Comprehensive Transportation Action Plan for Hyderabad
(2)	Development of Hyderabad Multi Modal Suburban Commuter Transportation System (Phase II)
(3)	Hyderabad Metro Development Plan
(4)	Outer Ring Road
3.	**ITS Related Plans**
(1)	Outer Ring Road (ITS Components)
(2)	Integrated Traffic Signal System in Hyderabad
4.	**Related Major Studies**
(1)	Comprehensive Transport Study
(2)	Hyderabad Area Transportation Study – HATS (1986)
(3)	Data Base of Hyderabad Area Transportation Study – HATS II (1986)

2-7-1 Urban Development Plans

(1) Revised Master Plan for Core Area

Several regional development plans were consolidated by the different regional authorities. However these plans remained confined to original municipal areas. Upon merger of the surrounding administrative jurisdictions into Greater Hyderabad Metropolitan Region in 2008, the previous individual plans need to be integrated into the urban planning framework for the region. Thus the preparation of the master plan of the regions is reflected by the Hyderabad Metropolitan Development Agency (HMDA).

[1]

One of the major items is the Revised Master Plan for Core Area, which was drafted in January 2010. The erstwhile area of the former Municipal Corporation of Hyderabad (MCH) is termed as the 'core city area' in the current Hyderabad Metropolitan Development Area. On the presumption that this area will remain to be a vibrant heart of the metropolitan region, the Revised Master Plan for Core Area up to the year of 2013 was drafted by incorporating the framework/considerations prepared.

The major regional development plans/master plans which were consolidated and incorporated are as follows:

- Development Plan for Erstwhile Municipal Corporation of Hyderabad (1975),
- Master Plan of Non Municipal Areas of Hyderabad Urban Development Authority (1980),
- Master Plan of Cyberabad Development Authority (2001),
- Master Plan for Hyderabad Airport Development Authority (2008),
- Master Plan for Outer Ring Road Growth Corridor (2008), and
- Master Plan for Bhongiri and Sangareddy (1988-89)

The adopted basic principles for the Master Plans are:

- Redevelopment and Renewal of Identified Areas and Regulations,
- Efficient Traffic Circulation Network,
- Flexible and Effective Land Use,
- Simplified and Rationalized Regulations,
- Emphasis on Infrastructure Planning and Development,
- Optimization of Existing Lands and Land Usage, and
- Conservation of Heritage and Ecology

The major emphasis is laid on the City Renewal, Revitalization and Redevelopment Strategy (RRR) in terms of:

- Identification of two city centres as multipurpose use nodes to cater to the needs of the city as well as the region as a whole,
- Identification of infrastructure facility nodes (InFANs) to decentralize the activity and movement pattern,
- Preparation of special area development plans and projects (SADPP) to translate the revised master plan into the realistic development,
- Transit oriented development in the form of the mass rapid transit system by identifying the multipurpose zones and incorporating traffic needs,
- Slum re-development by preparation of detailed projects and their implementation, and
- Formulation of special policy on the use of public and semi-public/government lands

In particular, the concepts for the efficient traffic circulation network were emphasized in terms of:

- Optimization of Transportation and Circulation Network Pattern,
- Identification of Activity Centres
- Assurance of Open Spaces, and
- Formulation of Urban Administration and Management/Institutional Framework

The covered areas by the Revised Master Plan are shown in the figure below:

Source: Revised Master Plan for Core Area, HMDA, July 2011

Figure 48 Covered Area of the Revised Master Plan for Core Area

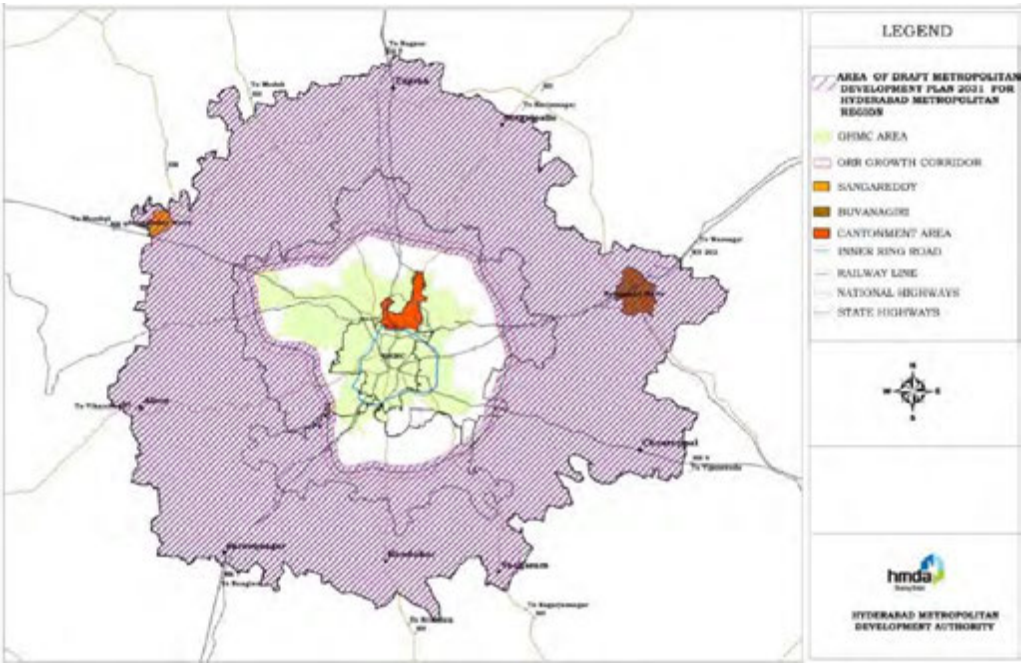
(2) Master Plan for Extended Area of Hyderabad

The other major development plan is the Master Plan for Extension Area of Hyderabad. Upon merger in 2008, the jurisdiction areas of HMDA were extended from 1,692 sq.km to 7,228 sq.km merging five (5) districts including Ragna Reddy, Medak, Nalgonda and 635 villages. The surrounding regional authorities were dissolved. They include Hyderabad Urban Development Authority, Hyderabad Airport Development Authority and Cyberabad Development Authority. Under such condition, the HMDA has undertaken preparation of the Master Plan for Extension Area of Hyderabad, covering the areas of 4,920 sq.km with its target year of 2031. The master plan is still under consideration, reflecting the opinions of stakeholders and public.

The Master Plan is expected to include the following key proposals:

- Development of Peripheral Ring Road (PRR), covering approximately 250 km in surrounding areas
- Development of connecting roads of such areas as Chevella, Sankarpally, Sangareddy, Medak, Mahbubnagar and Nalgonda districts
- Identification of urban centres of the urban settlements with potential growth
- Proposal of multi-modal transport hubs around the newly proposed stations and integrated freight terminals along with the South Central Railways
- Incorporation of new passenger terminals of the railway station in such areas as Shamshabad, Medchal and Hitec city.

The covered areas by Master Plan for Extension Area of Hyderabad are shown in the figure below.



Source: HMDA, July 2011

Figure 49 Covered Area of the Master Plan for Extension Area of Hyderabad

(3) City Development Plan

The government of India has launched Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for promoting reforms and investments for the selected sixty-three (63) cities. Hyderabad is one of the eligible cities under the scheme. It is mandatory for the eligible cities to prepare the City Development Plan (CDP) and implement a set of reforms.

Under the condition where the Hyderabad remained deficient in service delivery with the lowest rating among other major cities in India in terms of such parameters as GDP growth, literacy rate, child mortality rate, sewerage, transportation etc, the Municipal Corporation of Hyderabad (MCH), the former agency of Greater Hyderabad Municipal Corporation (GHMC), prepared a City Development Strategy (CDS) in 2003 to address the gaps. The City Development Plan (CDP) was prepared in 2005 based on the CDS under this condition by the MCH and surrounding municipalities.

The objectives of the CDP are to have a planned growth of the city based on the basic polity and framework for adopting the prioritized local concerns for liveability and requirement in terms of:

- Enhancement of City Productivity,
- Reduction of Poverty,
- Improvement of Urban Governance, and
- Enhancement of Financial Sustainability

The CDP comprises sector plans in 20 years by outlining the policy framework and investment interventions to achieve the vision in terms of the following viewpoints:

- Governance,
- Poverty Alleviation,
- Economic Development,
- Environment,
- Water and Sanitation,
- Solid Waste Management,

- Traffic and Transportation,
- Health and Education, and
- Municipal Finance

Under the framework of above issues, the prioritized sectors and indicators are identified as follows:

- Water Supply,
- Sewerage and Solid Waste Management,
- Transportation Development,
- Water Drainage, and
- Urban Poverty

2-7-2 Road Transportation Plans

(1) Comprehensive Transportation Action Plan for Hyderabad

In order to tackle the issues in transport sector in Hyderabad, the Government of Andhra Pradesh consolidated the Comprehensive Transportation Action Plan in 2005. The State Government appointed the committee headed by the Special Chief Secretary to the Government and convened by the Additional Commissioner of Traffic Police, Hyderabad, of which members consist of:

- Special Chief Secretary to the Government (Chairman),
- Commissioner of Police, Hyderabad (Member),
- Commissioner of Municipal Corporation of Hyderabad (Member),
- Commissioner of Transport, Hyderabad (Member),
- Commissioner of School Education, Hyderabad (Member),
- Chief Engineer of Public Works, Hyderabad (Member), and
- Additional Commissioner of Traffic Police (Convener)

The Committees were held several times with major stakeholder afterwards and the action plans were taken up. The action plans for the issues in transport sector were consolidated in line with the National Urban Transport Policy (NUTP), prepared by the Ministry of Urban Development of India.

The major problems that need to be addressed and improved are identified as below:

- Public Transportation Systems
- Institutional Coordination
- Reinforcement of National and State Highways
- Functional Classifications of Roadways
- Storm Water Drainage System
- Engineering
- Reasonable Planning Process for Town and Transport
- Proper Construction and Maintenance
- Enforcement and Emergency Management

The action plans formulated are:

- Transportation and Planning Policy Measures, including:
  - ✓ Establishment of Unified Metropolitan Transportation Authority (UMTA)
  - ✓ Preparation of Urban Transportation Development Fund
  - ✓ Budget Allocation to Traffic Police

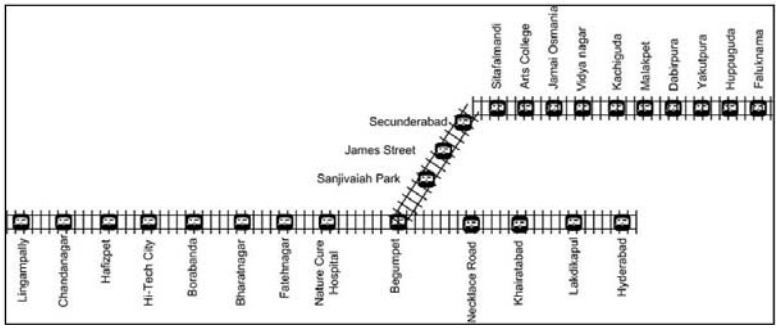
- ✓ Preparation of Zoning Laws
- ✓ Preparation of Sufficient Parking Spaces
- ✓ Reinforcement of Traffic Impact Analysis
- ✓ Enhancement of Pedestrianization
- ✓ Preparation of Functional Road Classification
- ✓ Relocation of Religious Structures and Graveyards
- ✓ Formulation of Regulations on Hawkers
- ✓ Amendment of Motor Vehicles Act
- ✓ Promotion of Staggering Times of Commute for Schools, Offices and Commercials

• Public Transportation System, including:

- ✓ Restructuring of Operations of APSRTC services
- ✓ Increasing Fleet Size of City Buses
- ✓ Preparation of Sufficient Number of Bus-bays and Shelters
- ✓ Introduction of Fleet Management and Information Services
- ✓ Improvement of MMTS Rail Services
- ✓ Expansion of MMTS Railways
- ✓ Preparation of Mass Rapid Transit System

(2) Development of Hyderabad Multi Modal Suburban Commuter Transportation System on Commercial Format Phase II

The Government of Andhra Pradesh entered into a memorandum of understanding with the Ministry of Railways for the development of a rail-based public transit system for the twin cities in two (2) phases (Phase-I and Phase-II) to meet the increasing demand because of rapid growth in population. Phase-I of the project includes the development of existing suburban links, upgrading signalling system and improving the existing and new stations. Phase-II is planned with the extension of the MMTS prepared in Phase-I. It consists of two (2) corridors spanning 43 km, Secunderabad-Hyderabad-Lingampally (28 km) opened in August 2003 and Secunderabad-Falaknuma (15 km) opened in February 2004 respectively. Twenty six (26) stations were developed in combination with preparation of approach roads, circulation areas, parking spaces and some bus bays. The project is planned to be implemented with 50:50 joint venture of Indian Railways and Government of Andhra Pradesh and run & managed by Indian Railways.



Source: Development of Hyderabad MMTS Phase-II, 2008

Figure 50 Hyderabad MMTS Phase-I: Existing Corridors

The development of MMTS Phase-II is currently under planning by the Government of Andhra Pradesh and the South Central Railway. The following three corridors were selected for immediate implementation as MMTS Phase-II. The construction period is planned over five years (2012-2017) and

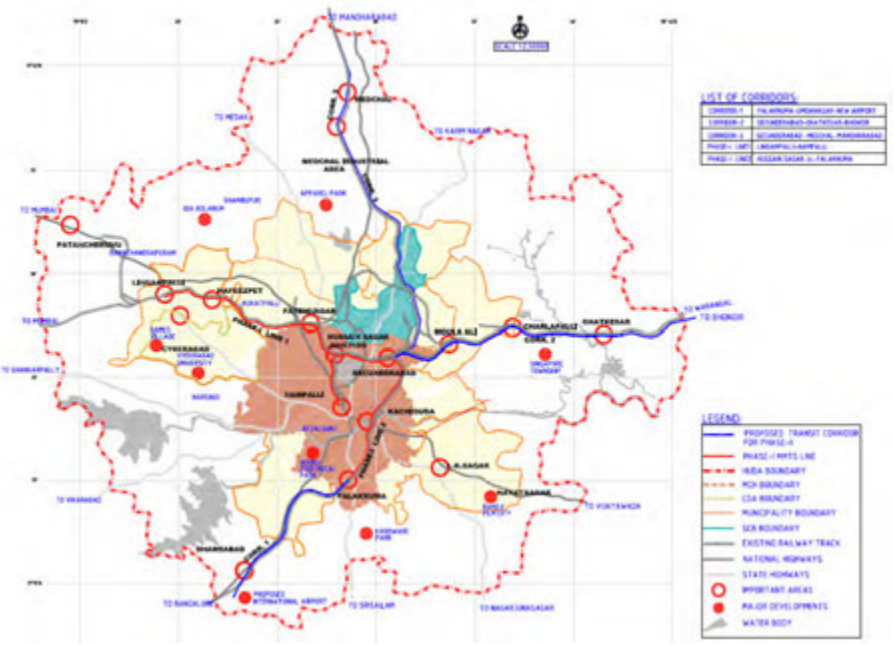
the cost in total is estimated in 632 crore Indian rupees. The following corridors will be developed basically along with the existing railway lines:

Secunderabad – Madchal – Manoharabad (43 km): It will extend MMTS operations in the northern side of the core area of the Hyderabad city. The major locations which will be covered include Secunderabad Cantonment Board (SCB) area, Alwal, Bolaram, Gundlapochampalli Apparel Park, Jeedimetla, Kompalli and Medchal.

Falaknuma – Umadnagar (20 km): it will extend the existing Secundrabad – Faluknuma corridors down to Umdanagar in the south. The route will be prepared to cater the demand in the area by connecting the core area of the Hyderabad and suburban settlement area in Shamsabad, of which development potential is considered high, and the international airport.

Secunderabad – Ghatkesar – Bhongir (46 km): it will be prepared to meet the growing travel demand of the major areas in eastern side of Hyderabad, including Lalaguda, Moula Ali, Charlapalli, Ghatkesar, Bibinagar, and Pagidipalli.

The planned corridors in MMTS Phase-II are shown in Figure below.



Source: Development of Hyderabad MMTS Phase-II, 2008

Figure 51 Hyderabad MMTS Phase-II: Planned Corridors

(3) Hyderabad Metro Development Plan

The Hyderabad Metro is a mass rapid transit system to be developed in the city of Hyderabad. Phase-1 was approved by the Government of India in April 2008 of which entire cost is estimated at INR 12,132 crore, and the project is being implemented under the Public-Private Partnership (PPP).

The required legal framework for construction, operation and maintenance was prepared in the form of adoption of the Andhra Pradesh Municipal Tramways Ordinance 2008. The Government of Andhra Pradesh established a Special Purpose Vehicle (SPV), Hyderabad Metro Rail Ltd, (HMRL), for the purpose of providing a single point of nodal agency to coordinate among different agencies including public and private sectors and facilitating implementation of the project by the concessionaire.

In July 2010, the concessionaire was awarded to Larsen & Toubro (L&T) for the project. The ground work started in January 2011 and the entire project is expected to be completed in five (5) years.

Source: JICA Study Team

Figure 52 Site Work for Preparation of Hyderabad Metro

Phase-1 includes three (3) corridors which cover the distance of approximately 71 km in total. It is planned to be in operation by 2015 with opening of the 12 km-length stretch which connects Miyapur to Khairatabad. The three (3) corridors includes (1) Miyapur-LB Nagar (28.87 km – 27 stations), (2) JBS-Falaknuma (14.78 km – 16 stations), (3) Nagole-Shilparamam (27.51 km - 23 stations). All corridors will be constructed by the elevated structure and generally run in the central median of the road.

Table 18 Length and Stations by Corridors

Corridor	No. of Stations	Length (km)
Corridor I	27	29 (Miyapur – LB Nagar)
Corridor II	16	15 (JBS-Falaknuma)
Corridor III	23	28 (Nagole-Shilparamam)
Total	66	72

Source: Hyderabad Metro Rail Homepage

The planned corridors in phase-1 are shown in the figure below.

Source: Hyderabad Metro Rail Homepage

Figure 53 Planned Corridors of Hyderabad Metro Rail

(4) Outer Ring Road

Hyderabad Urban Development Authority (HUDA), transformed into Hyderabad Metropolitan Development Agency (HMDA) in 2008, planned to develop the outer ring road (ORR) around the Hyderabad Metropolitan area to relieve congestion within the city and to act as a catalyst for dispersal of urban growth. It is envisaged to give a boost to the road cum area development and to connect the urban settlements around the Hyderabad Metropolitan area.

A Special Purpose Vehicle (SPV), named as Hyderabad Growth Corridor Limited (HGCL), was formed under companies' act 1956 on the 26th December 2005 with the registration No. 01-48580 for the purpose of development of the ORR by the Government of Andhra Pradesh.

The ORR is a 158 kilometres, 8-lane ring road expressway built at a cost of INR 6,696 Crores, with assistance of INR 3,123 Crores from Japan International Cooperation Agency (JICA). The design speed is 120 km/h with full access control of two-lane service roads on either side in parallel. It provides the connectivity between NH9, NH7 and state highways leading to Vikarabad, Srisailam and Nagarjunasagar.

The construction of ORR is divided into two (2) phases, phase-I and phase-II. Phase-I has been constructed by the finance of the state government of Andhra Pradesh. The section starts from Rajiv Gandhi International Airport in Shamshabad and ends at IT corridor in Gachibowli with total length of 22 kilometres. It came into service on 14th November 2008.

Phase-II is further divided into phase-II A and phase-II B. Phase-II A is implemented under the scheme of Public-Private Partnership (PPP), with its total length of 62.30 km. Phase-II B is financed by the Government of Japan, through Japan International Cooperation Agency (JICA) with its total length of 71.30 km which is currently under construction.

The state-run APSRTC is planning to construct twenty two (22) terminals-cum-depots (TCD) along the ORR.

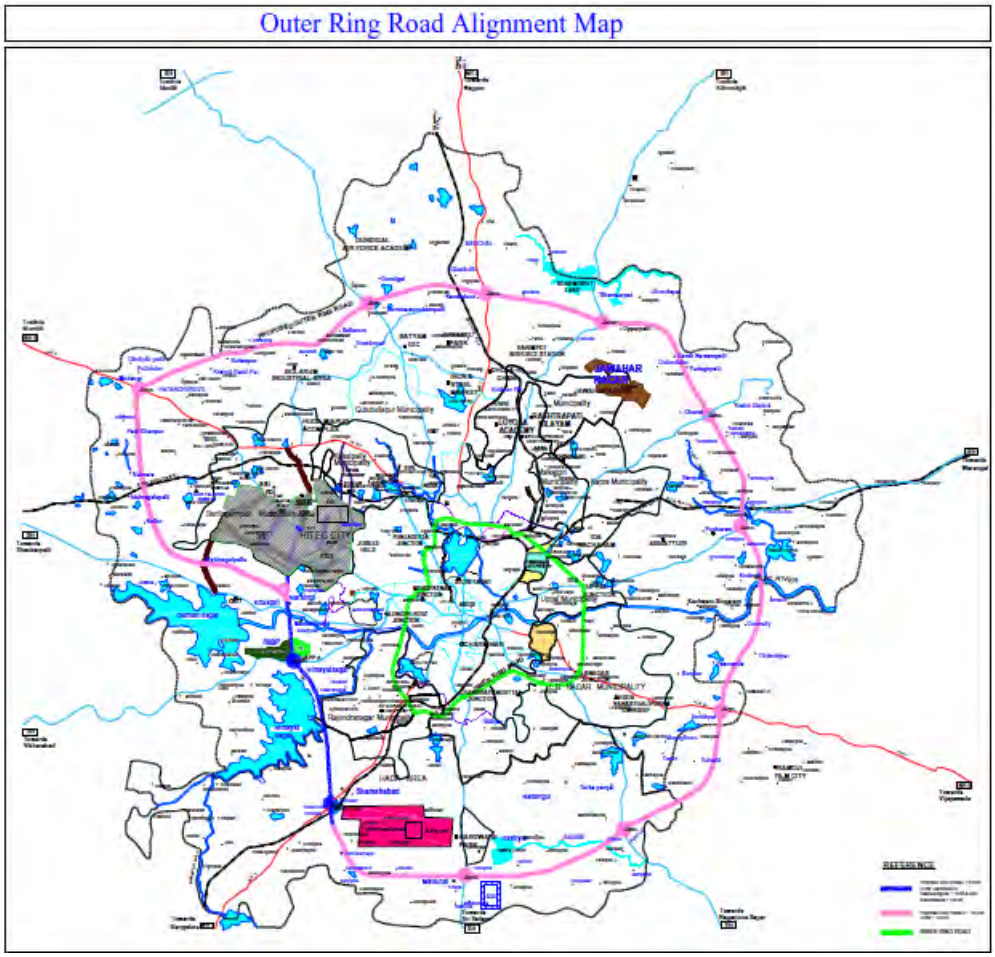
The ORR includes twenty (20) interchanges and one (1) junction.

Table 19 Outline of ORR Project

Phase	Length	Financed by	Section	Status
Phase-I	24.38 km	Andhra Pradesh State Government	Shamshabad – Gachibowli	In Service
Phase-II A	62.30 km	PPP (BOT Annuity)	Pedda Amberpet – Patancheru	Under Construction
Phase-II B	71.30 km	Japanese ODA Loan (JICA Phase 1, Phase 2)	Patancheru – Pedda Amberpet	Under Construction

Source: Hyderabad Metro Rail Homepage

The alignment of the ORR is shown in the figure below.



Source: Hyderabad Growth Corridor Limited, 2011

Figure 54 Alignment of Outer Ring Road

2-7-3 ITS Related Plans

(1) Outer Ring Road (ITS Component)

Under the JICA loan of phase-II B of ORR, ITS introduction and implementation is included. A loan agreement to finance Phase-II B was signed in November 2008 between the government of Japan, through Japan International Cooperation Agency (JICA), and the government of India through Hyderabad Growth Corridor Limited (HGCL) as an executing agency. In order to support the implementation of the ITS component, JICA carried out a special assistance for project implementation (SAPI) from September 2008 to May 2009 and formulated the implementation plan and proposed an institutional setup for management of ITS. Thereafter, JICA through its Technical Cooperation, an Assistance Project for the Introduction of ITS over the ORR is in progress from February, 2011.

(a) Highway Traffic Management System:

The components of HTMS include 1) Traffic Control Centre, 2) Automatic Traffic Counting and Classification, 3) Closed Circuit Television, 4) Emergency Call Box, 5) Meteorological Stations, and 6) Variable Message Signboards.

The major facilities of HTMS are as follows:

- Traffic monitoring and control by the centre and roadside equipment,

- Road and traffic information provision by VMS and Internet,
- Voice communication with patrol team and road users by wireless terminal, emergency call box, mobile phone and land line,
- Roadside equipment monitoring by the centre, and
- System management, database management and fault management.

(b) Toll Management System:

A total of 157 manual and touch & go lanes and 23 ETC lanes are planned at 19 interchanges on Hyderabad ORR. The main traffic control centre is proposed at Nanakramguda interchange and sub-traffic control centre as data backup centre at Ghatkesar interchange.

The TMS will include the following components:

- Manual and Touch & Go lane equipment,
- ETC lane equipment,
- POS system at toll plaza office for issuance and re-charge of smart card,
- Plaza server system, and
- Toll management centre.

(2) Integrated Traffic Signal System in Hyderabad

As of April in 2011, there exist 175 signals in total with 126 signals in Hyderabad and 49 signals in Cyberabad and they are manually operated by Hyderabad Traffic Police personnel.

The Hyderabad Traffic Police and Greater Hyderabad Municipal Corporation took up the replacement of all the existing signals with additional locations and integration of the signal system, called H-TRIMS, Hyderabad Traffic Integrated and Management System. The request for proposal, RFP, was published in April in 2011 by the Hyderabad Traffic Police and Greater Hyderabad Municipal Corporation. It is planned that the installation and preparation of all components described below will be completed in 10 months after award of the project to the contractor. The project will be carried out by Build-Own-Operate-Transfer, BOOT scheme for the period of five (5) years of operation.

Table 20 Outline of H-TRIMS Project

Ordering Party	GHMC and Hyderabad Traffic Police
Installation Period	10 Months
Project Form	BOOT (Build-Own-Operate-Transfer)
Operation Period	5 Years

Source: RFP for Hyderabad Traffic Integrated Management System, April 2011

The components include the replacement of existing 175 signals in Hyderabad and Cyberabad area, installation of additional 45 signals, tentatively 20 Variable Message Sign Board , preparation of control centre called Traffic Command Centre, TCC. The TCC will be prepared in the headquarters of Hyderabad Traffic Police. The equipment will be connected by either wired or GPRS wireless communication.

The equipment of the signals at intersection comprises of the out-station unit of GPRS-based/vehicle actuated traffic signal controller and loop-coil vehicle detectors. The site works include the preparation of lane marking and zebra crossing. The VMS will be prepared by the following conditions:

- GSM/GPRS connection with the TCC
- Communication cost to be covered by the contractor during the contract period

- Used for traffic live update and display messages on traffic conditions controlled by the TCC

Table 21 Existing Traffic Signals

Description	Hyderabad	Cyberabad	Total
3 way	56	31	87
4 way	63	18	81
5 way	7	0	7
Total	126	49	175

Source: RFP for Hyderabad Traffic Integrated Management System, April 2011

Table 22 Installation and Replacement of Signals

No	Traffic Signals	3-Way	4-Way	5-Way	Total
1	Hyderabad				
	Existing	56	63	7	126
	New	20	17	1	38
2	Cyberabad				
	Existing	31	18	-	49
	New	4	3	-	7
Grand Total		111	101	8	220

Source: RFP for Hyderabad Traffic Integrated Management System, April 2011

Table 23 Outline of Total Equipment

Items	Description
Traffic Command Centre	At Headquarters of Hyderabad Traffic Police with Servers
Traffic Signals	220 in total in Hyderabad and Cyberabad
VMS	20 units (tentative)

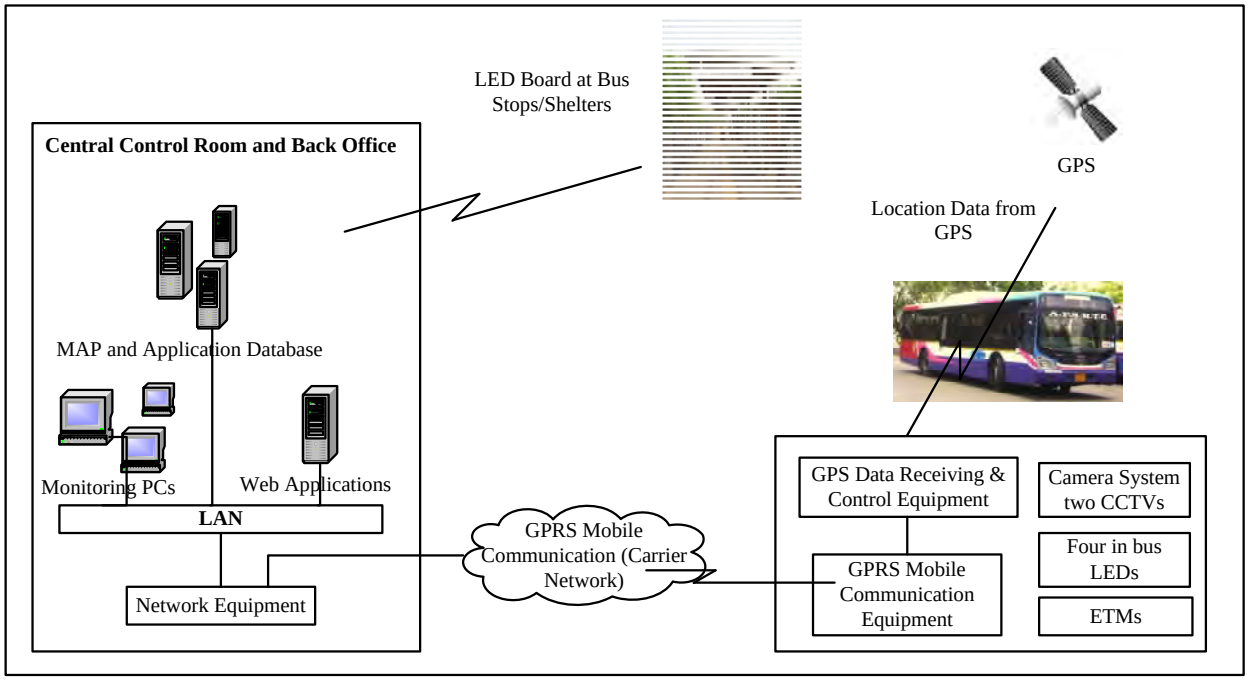
Source: RFP for Hyderabad Traffic Integrated Management System, April 2011

(3) Bus Information System by APSRTC

The Andhra Pradesh State Road Transport Corporation (APSRTC), a road transport corporation owns 22,500 buses in total and operates around 3,800 buses within Hyderabad as city service.

It was originally planned to implement Vehicle Tracking System installing GPS on approximately 12,000 buses. Subsequently the number was reduced to 3,502 buses. The project awarded to M/s CMC Ltd. And it covers 3,502 buses. This includes 1,347 city buses in Hyderabad. Further, the buses to be procured under JNNURM phase-2 will also be covered under the project, in the future. Approximately 100 LED displays are proposed to be installed at important locations in Hyderabad for displaying information of estimated time of arrival of buses.

The figure below shows the configuration of GPS/GPRS enabled system planned by APSRTC. The in-bus GPS device transmits GPS location of bus and route data to back office. In-bus and bus stop display devices receive messages from the back office through GPRS connection. The bus equipped with LED boards located at front and back and display route information. The LED board at bus stop will display messages such as the expected arrival/ departure time, bus scheduling, etc., to passengers.



Source: JICA Study Team

Figure 55 Bus Location System as Planned by APSRTC

Vehicle Tracking and Passenger Information System:

- APSRTC is implementing Vehicle Tracking and Passenger Information System for 3,502 buses, out of which 1,616 are special type buses for long distance. 1,347 city buses (937 JNNURM buses and 410 conventional buses) in Hyderabad are also covered under the project. Remaining 539 buses are procured by JNnURM which are operated in Vijayawada (239 buses), Visakapanam (250 buses) and Thirupathi (50 buses).
- The project has been awarded to M/s CMC Ltd. GPS will be used for tracking the buses and GPRS communication will be used for data transmission.
- A Vehicle Tracking Unit will be installed in all buses covered under the project. An onboard camera with recording unit (for recording up to 48 hours) and, an in-bus LED display with voice announcement for information about expected time of next bus stops will be installed in the buses procured under JNNURM.
- Approximately 100 LED displays are proposed to be installed at important locations in Hyderabad for displaying information of the estimated time of arrival of buses. The city bus in Hyderabad will be monitored from control centre established in Jubilee Bus Station location.
- The APSRTC data centre equipment is hosted in the AP state data centre facility.

2-7-4 Transport Related Studies and Plans in Hyderabad

(1) Major Transport Related Studies

A number of the traffic and transport related studies were conducted earlier in Hyderabad for planning purposes. The major studies are:

- Traffic Studies by the REC (currently NIT) Warangal in 1983-88
- HATS – II in 2000
- DMRC Study for Metrorail in 2003

- L&T Ramboll Study for MMTS Phase- II in 2003
- Comprehensive Transportation Study (CTS), 2011
- HMDA Master Plan 2031

(2) Hyderabad Area Transportation Study -HATS (1986)

The regional Engineering College in Warangal carried out a study of the Hyderabad Urban Area on the request of Government of Andhra Pradesh in 1986. The study recommended a wide range of solutions in respect of roads, bus services, traffic management, reasonable transportation system, land use, railways and mass transit systems. Some major outcomes of the study are as follows:

- Possibility of preparation of a circular railway through Secunderabad, Nampalli, and Malakpet/Kachiguda by connecting Nampalli railway station to Kachiguda,
- Physical improvement of sixty six (66) major intersections, one hundred eleven (111) traffic signals on seven (7) major corridors,
- Recommendation of Light Rail Transit System (LRT) for the following corridors:
  - ✓ L.B. Nagar to Kukatpalli via Dilsukhnagar, Malakpet, Mozamjahi Market, Nampalli, Secretariat, Khairatabad, Ameerpet, Sanathnagar, Kukatpalli
  - ✓ Falaknuma to Rangmahal Junction via Charminar
  - ✓ Mozamjahi Market to Airport via Abids, Basheerbagh, Tankbund, Ranigunj
  - ✓ Khairatabad to Toli Chowke via Masab Tank, Mehidipatnam

(3) Database of Hyderabad Area Transportation Study - HATSII (1986)

This is basic research result data base of Hyderabad Area Transportation Study. The data base contents are:

- Traffic survey location, cross section survey result, modal split, directional splits, 24 hours conversion data and peak hours survey result data, and
- 8 hours parking survey data and 24 hours converted data.

(4) Comprehensive Transport Study (CTS), 2011

The Comprehensive Transportation Study (CTS) is being carried out by HMDA with the approval of UMTA. It covers HMA and is funded in part by Ministry of Urban Development (MoUD). The LEA Group is the study consultant. The objectives of the study are:

- To assess the long-term (up to 2041), medium-term (up to 2031) and short-term (up to 2016 and 2021) transport infrastructure requirement in HMA,
- To propose institutional framework,
- To propose optimum mobilisation of required resources for the transport infrastructure development,
- To develop scenarios of transport and land use for the target year in 2041, and
- To assess the above scenario and alternatives.

The long-term transportation strategies are proposed by the study as follows:

- Integrated land use transport plan and transport driven development,
- Transportation corridor - right of way protection,
- Promotion of transit oriented development,
- Implementation of Non-Motorised Transport (NMT) policy and improve road safety,
- Implementation of parking policy,
- Institutional reforms and capacity building, and

- Efforts on alternative funding sources with focussed approach on development charges.

The improvement and development of public transport for the short, medium and long terms for 2021, 2031 and 2041 are proposed as follows:

Table 24 Proposed Metro, MMTS and BRTS for 2021, 2031 and 2041

No.	System	2021	2031	2041	Total
1	Metro network in km	98	175	48	321
2	MMTS network in km	147	116	165	428
3	BRTS network in km	67	53	273	393

It is also proposed for the improvement and development of highway network in 16,900 km and partially/fully access controlled highway network in 790 km by 2041.

The required costs to cater for the transport network requirement in HMA for the period up to the target year in 2041 are preliminarily estimated at approximately INR 1.25 trillion.

(5) HMDA Master Plan 2031

The Master Plan for HMA 2031 was prepared by the HMDA. It was officially approved in January 2013 by the Municipal Administration and Urban Development Department (MA&UD), Government of Andhra Pradesh. Primary considerations were cover transit oriented development, multi nuclei concept developing alternative centres, and public transport and road development for urban development of the HMA.

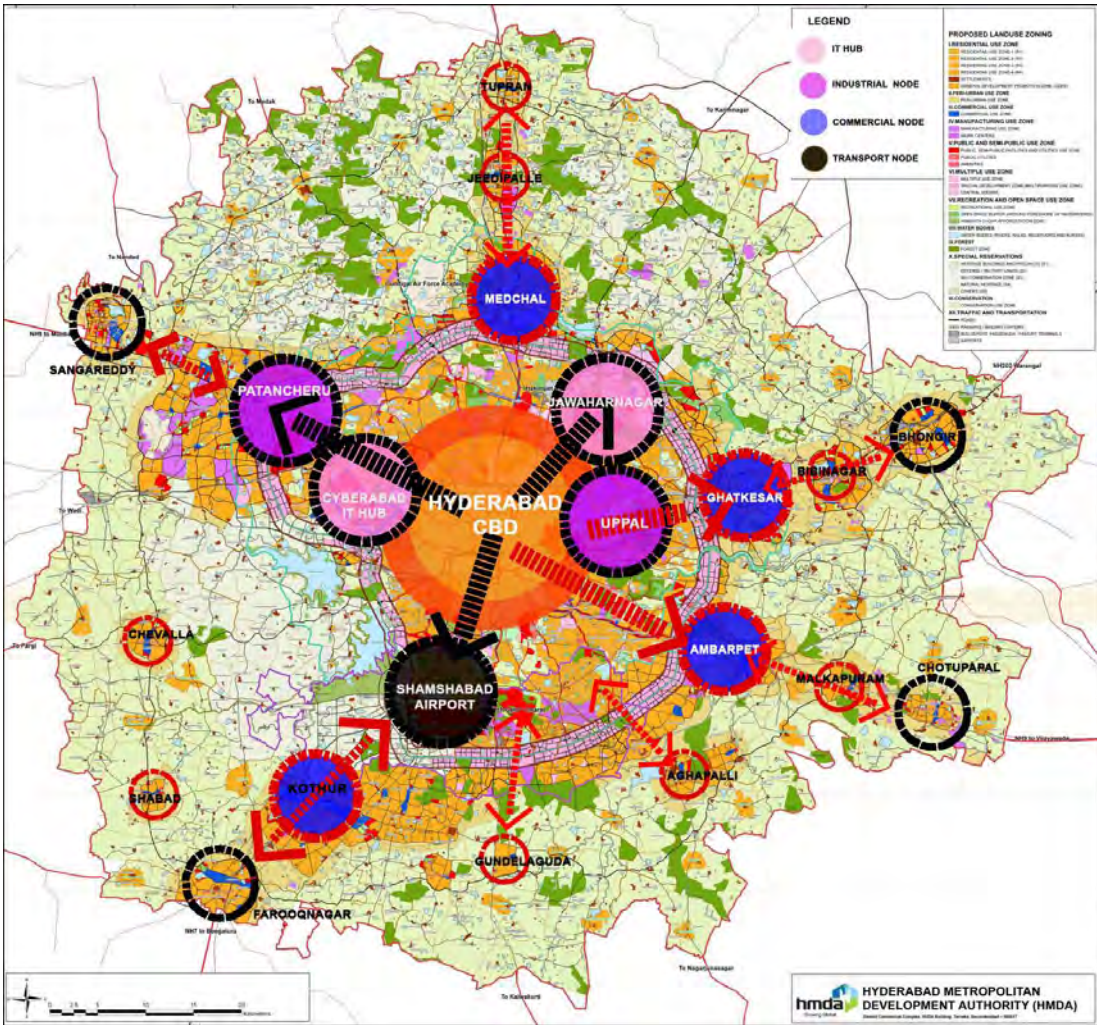
(a) Major Development in Recent Years Including Transit Oriented Development (TOD):

The major developments in recent years such as Rajiv Gandhi international airport, Nehru outer ring road, radial roads, PVNR expressway which connects the centre area of the city and the airport, MMTS, metro rail, software development park (HITEC city), hardware development park, will affect people’s travel patterns in the city.

Several economic hubs, called ‘multiple nuclei centres’ are planned to disperse the economic activities under such situation, and Transit Oriented Development (TOD) which facilitates better connectivity in the city incorporating all above aspects is included in the master plan.

(b) Multiple Nuclei Development:

It is projected that the urban population in the Hyderabad metropolitan region will grow at 15 million by 2031. It is critical to properly disperse the growing economic and commercial activities in the urban area. Multiple nuclei centres/sub centres which are distributed economic/commercial hubs are planned as shown in the figure below.

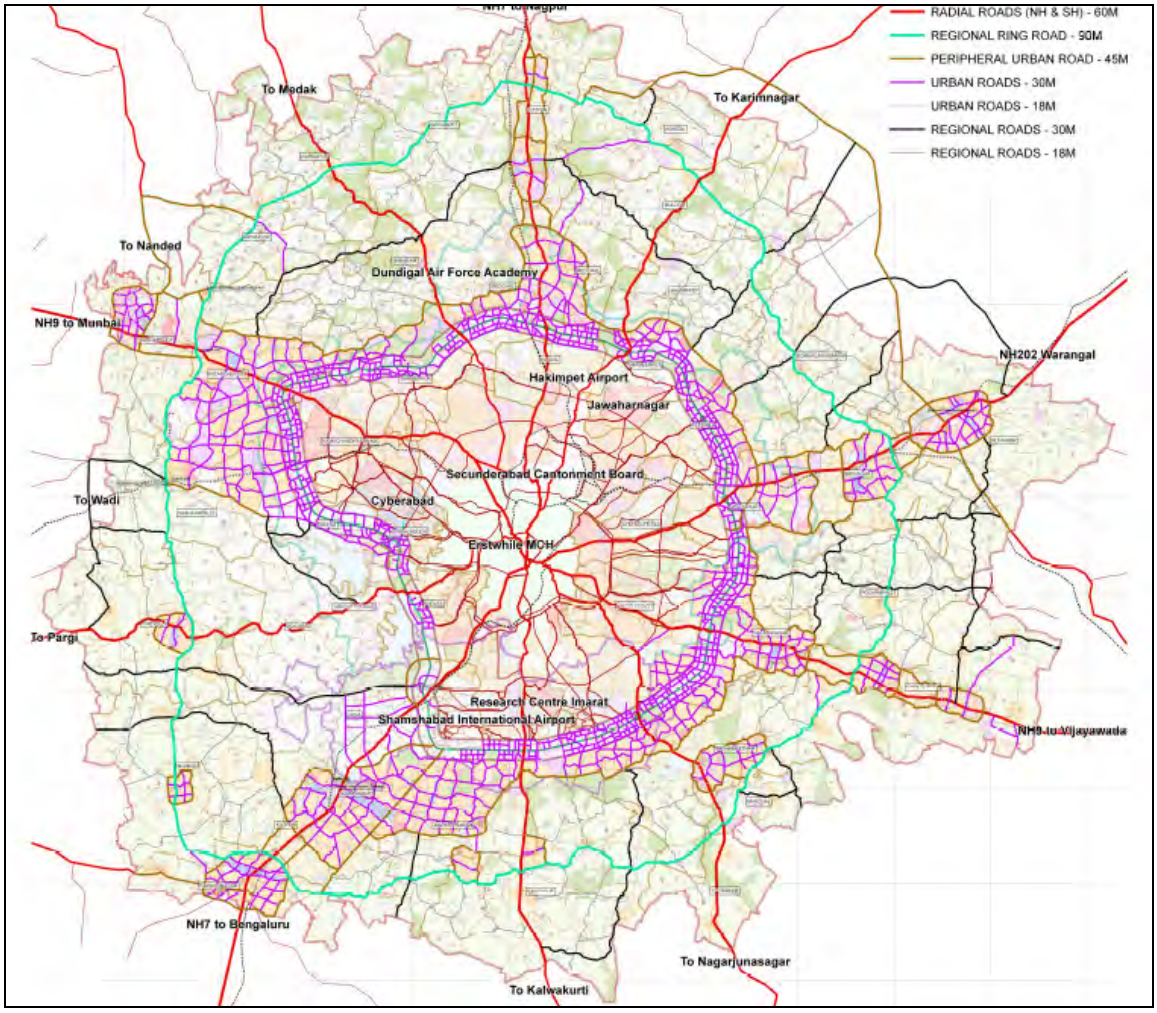


Source: HMDA Master Plan - 2031

Figure 56 Multiple Nuclei Concept for Alternative Centres and Sub Centres

(c) Proposed Road Network Improvement and Development:

The figure below shows the major road network plan proposed by the master plan. It includes the development and improvement of radial roads, regional ring road, peripheral urban road, regional roads, etc.

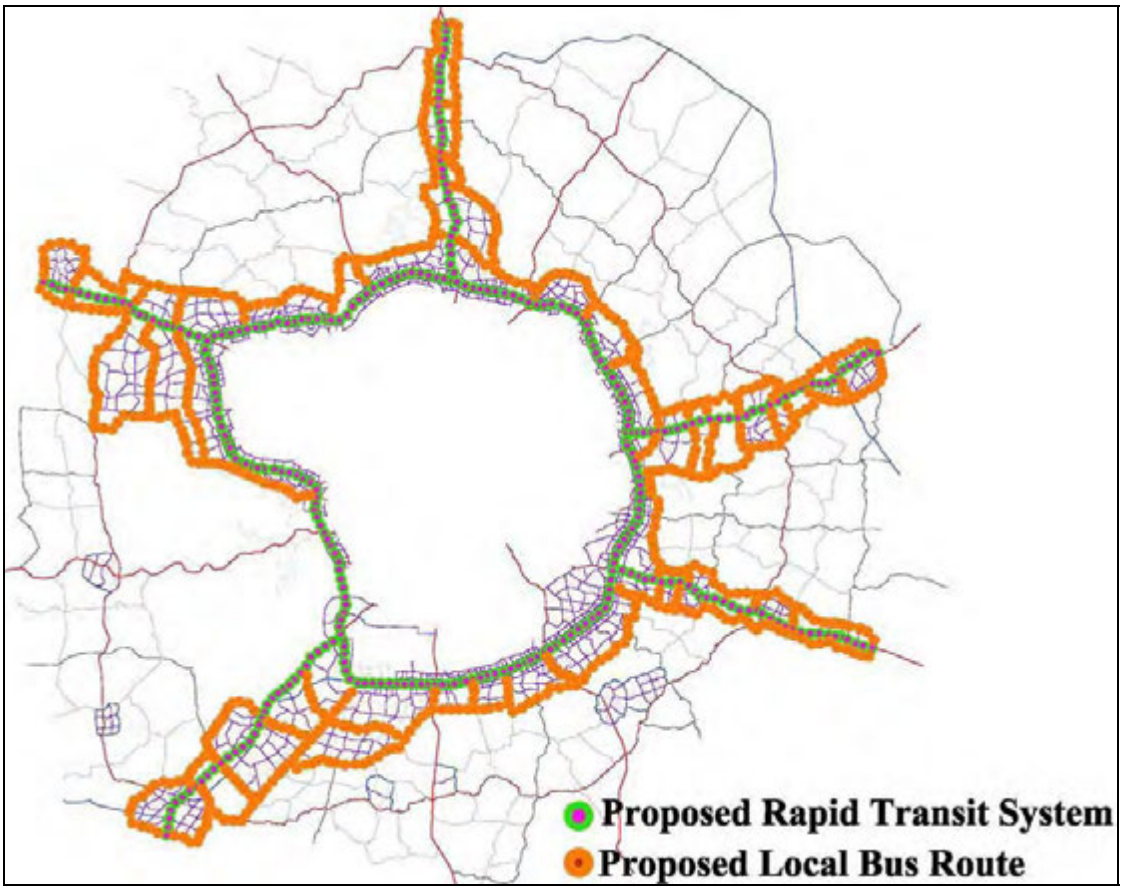


Source: HMDA Master Plan - 2031

Figure 57 Proposed Major Road Network

(d) Proposed Public Transport Development:

The figure below shows the major public transport development proposed by the master plan. It is planned that BRTS with the dedicated lane along the national highway, which passes through the locations of growing economic activities around the city, will be developed. The local bus routes which cover these areas are planned as well.



Source: HMDA Master Plan - 2031

Figure 58 Proposed Public Transport Development

2-8 Existing ITS in Hyderabad

2-8-1 Highway Traffic Management System (HTMS) on National Highway

(1) System Outline

The Highway Traffic Management System (HTMS) is an integrated system for highway control and supervision. It is a realtime decision support system for traffic operators and records/solves contingency situations. The HTMS facilitates the control and operation of traffic management systems including Automatic Traffic Counting and Classification (ATCC), Closed Circuit Television (CCTV), Emergency Call Box (ECB), Meteorological Stations (METs), Variable Message Signs (VMS), etc. from a centralized Traffic Control Centre.

(2) System Configuration

The HTMS servers are centrally managed to which operators located in control room is connected through their computers and communications systems. It collects and provides realtime data of traffic systems like VMS, MET, ATCC, CCTV, ECB, etc. HTMS provides all functionality needed to process data coming from different HTMS subsystems from the field as follows

(a) Emergency Call Box (ECB)

- Pair of ECBs placed on the highway section for every two kilometres.
- All these are connected to control centre, operators attend emergency calls on 24/7 basis.

(b) Closed Circuit Television (CCTV)

- These are installed at five critical locations for traffic monitoring and security.
- Based on analysis of collected data they will identify potential hot spots.
- These cameras zoom up to 2 km.
- All these are connected to control centre and videos stored on storage systems.

(c) Variable Message Signs (VMS)

- Six VMS installed for display of information to road users.
- Operators configure information/message for VMS from control centre.
- There is no information exchange among BOT operators for VMS systems.

(d) Automatic Traffic Counting and Classification (ATCC)

- Two ATCCs are installed for traffic counting, one before toll plaza and other after toll plaza.
- Provides information on traffic volume and vehicle class using loop systems planted below the road surface and other software systems.

(e) Metrological Stations (MET)

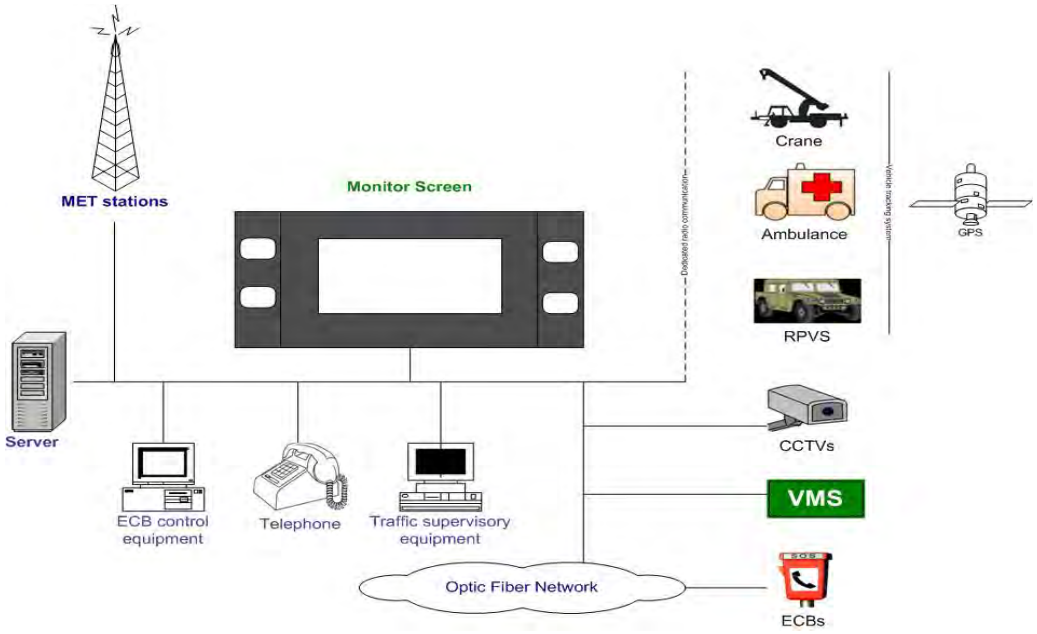
- Installed two meteorological stations to measure climatic conditions.
- Used to advise road users about climatic changes in advance.
- The weather sensors used to collect ambient temperature, Wind Speed & Direction information.

(f) Ambulance, Crane, Route Patrolling Vehicles (RPV)

(g) Low speed weigh in motion (WIM)

- Installed low speed weigh in motion (WIM) system (EFKON). Used to know weight of

vehicles and not using as enforcement system.



Source: JICA Study Team

Figure 59 L&T HTMS System Configuration

(3) Location Map

The Larsen and Toubro (L&T) Western Andhra Tollways Limited (L&T-WATL) installed the HTMS for 56 km from Jadcherla to Kothakota section of NH-7 in Andhra Pradesh on BOT basis.

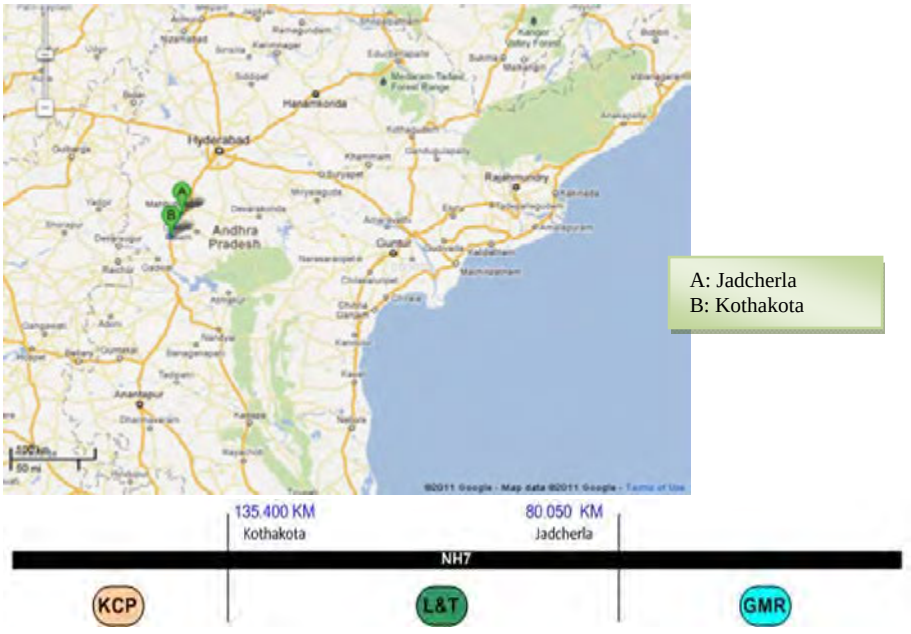


Figure 60 L&T Jurisdiction Map

(4) Technical Features and Specifications

(a) HTMS Control Centre

- Fibre optic for HTMS network.
- CCTVs cameras zoom to 2 km and videos stored in control centre database.
- Identification of critical locations is based on analysis of collected data.
- ECBs are installed on both directions for every 2 km stretch.
- RPVs, crane, ambulance having GPS based vehicle tracking system.
- They have dedicated radio communication.
- Having two meteorological stations to monitor weather conditions.
- Six VMS installed for information display to road users.
- Two ATCCs for traffic counting. One installed before toll plaza and other installed after toll plaza.
- Solar blinkers, low mast solar lights used for safety.
- L&T have their own software module to manage HTMS and other subsystems.
- Ambulances are owned by L&T.
- Followed international standards for all systems.
- L&T is not having any relationship with other BOT operators like KCP and GMR.
- Barricading for road maintenance activities.
- L&T calls 108 services and also sends their own ambulance for incidents on their route.

(b) Toll Plaza

- 12 lanes with manual and touch and go (RFID) system.
- The touch and go (RFID) system has been independently introduced by L&T.
- The card for the touch and go (RFID) can be purchased only at the toll plaza.
- There are no specific plans for extending the touch and go (RFID) system.
- Monthly passes for toll payments (Rs. 500) available at L&T toll centre.
- L&T is having toll based system for revenue collection.
- Revision of toll prices based on whole sale price index and is revised yearly.
- Minimal service level is prescribed by NHAI such as maximum allowed hours of lane closures.
- In case of failure of fulfilment of the minimal service level, the Concessionaire is to be penalized.
- The fulfilment of the service level is audited by the independent agency appointed by the government.
- Government and L&T should equally share inspection charges.
- Followed international standards for toll plaza setup.
- Installed low speed weigh in motion (WIM) system (EFKON) to know weight of vehicles, currently it is not used as enforcement system.

L&T Toll Gate

L&T Toll Booth

RFID Touch & Go

L&T Smart Card

Source: JICA Study Team

Figure 61 L&T Toll Facilities

(5) Current Operational and Technical Issues of the System

- Road user ignorance is one of the causes for accidents.
- The concessioner does not have authority for enforcement, including traffic violence, toll collection and over-weight vehicles.
- Users travel through shortcuts creating incidents.
- Most of the accidents occur between 10PM - 11PM and 12PM - 4PM.
- All toll prices have to pay at single location by integrating the toll plazas.
- No information exchange between the toll plazas and VMS.
- No communication among road operators.
- Each BOT operator has their own network.
- ECB does not require a boundary.
- Online toll payment/monthly cards are required.
- No specific pre-established/agreed coordination with hospitals nearby.

(6) ITS Facilities on Outer Ring Road

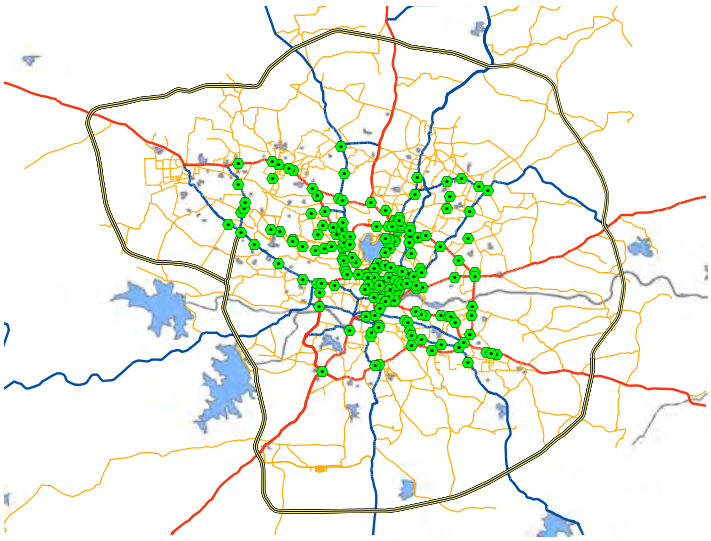
The ITS facilities will be prepared on the entire stretch on the ORR. It includes the Toll Management System (TMS) for automatic toll collection, and Highway Traffic Management System (HTMS) for monitoring traffic conditions and operation of the ITS equipment. The components of the HTMS include Traffic Control Centre (TCC), Automatic Traffic Counting and Classification (ATCC), Closed Circuit Television (CCTV), Emergency Call Box (ECB), Meteorological Stations (METs) and Variable Message Signs (VMS).

(7) Hyderabad Traffic Integrated Management System (HTRIMS)

The Hyderabad Traffic Police together with the GHMC is planning to introduce the Hyderabad

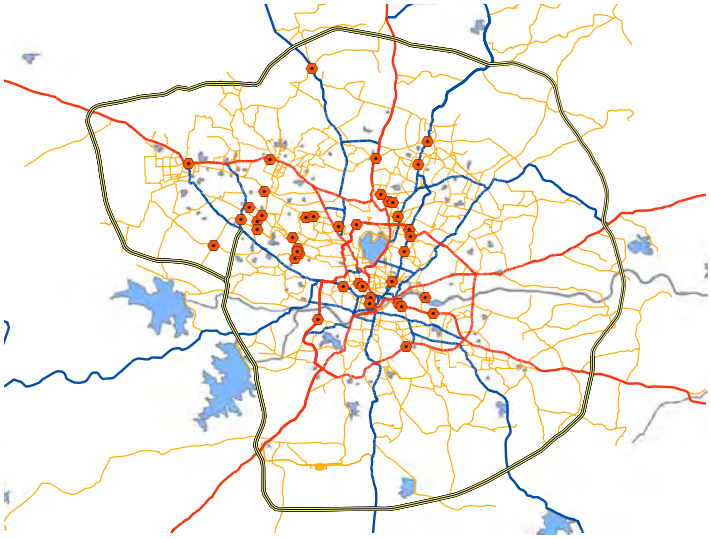
Traffic Integrated Management Systems (HTRIMS) for the purpose of improvement of traffic management and enforcement. The major features are as follows:

- To prepare the Traffic Command Centre (TCC) at the location of the existing headquarters of the Hyderabad Traffic Police, and backup centre at the Cyberabad Traffic Police.
- To prepare the signals without any break at 221 Junctions (180 existing + 41 new) including 15 Secunderabad Cantonment Board Junctions.
- To demonstrate the virtual loops for management of the traffic flow at two junctions as a pilot basis and is managed from the TCC.
- To remotely operate the signalling parameters from the TCC / or at site of the signals based on the existing traffic.
- To monitor the health of the signal facilities from the TCC.
- To create a Management Information System (MIS) for decision making in traffic emergency such as heavy rainfall, accidents, terrorist attack, VIP movements, etc



Source: JICA Study Team

Figure 62 Location of Existing Traffic Signals to Be Replaced by HTRIMS Project



Source: JICA Study Team

Figure 63 Location of New Traffic Signals to Be Installed by HTRIMS Project

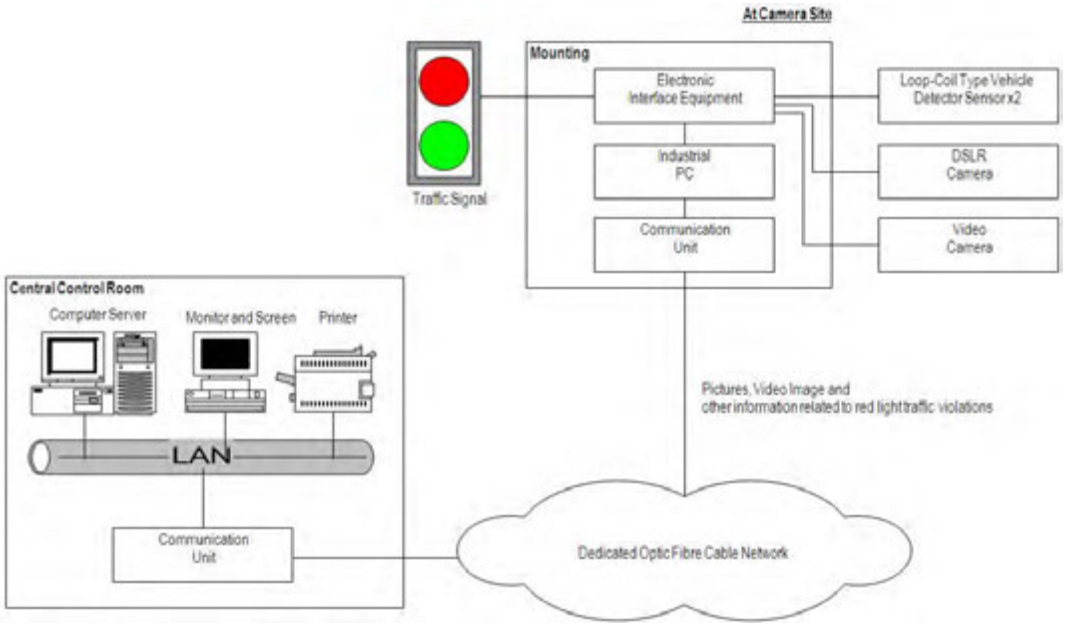
2-8-2 E-Challan System

(1) System Outline

As part of efficient traffic management, the Cyberabad Traffic Police (CTP) introduced a system of e-challans for red light violation offences. It was prepared as Build Operate Transfer (BOT) by Matrix Security and Surveillance Pvt Ltd, Hyderabad and introduced with 23 cameras at 10 locations in Cyberabad area.

(2) System Configuration

The figure below shows the configuration of red light violation enforcement system prepared by Cyberabad Traffic Police. The Video Camera starts recording the violation and the Digital Camera simultaneously captures the photographs of the violating vehicle at intersection loop when red signal is displayed. The captured images are sent to the central server located at Cyberabad Traffic Police office through a dedicated communication channel.

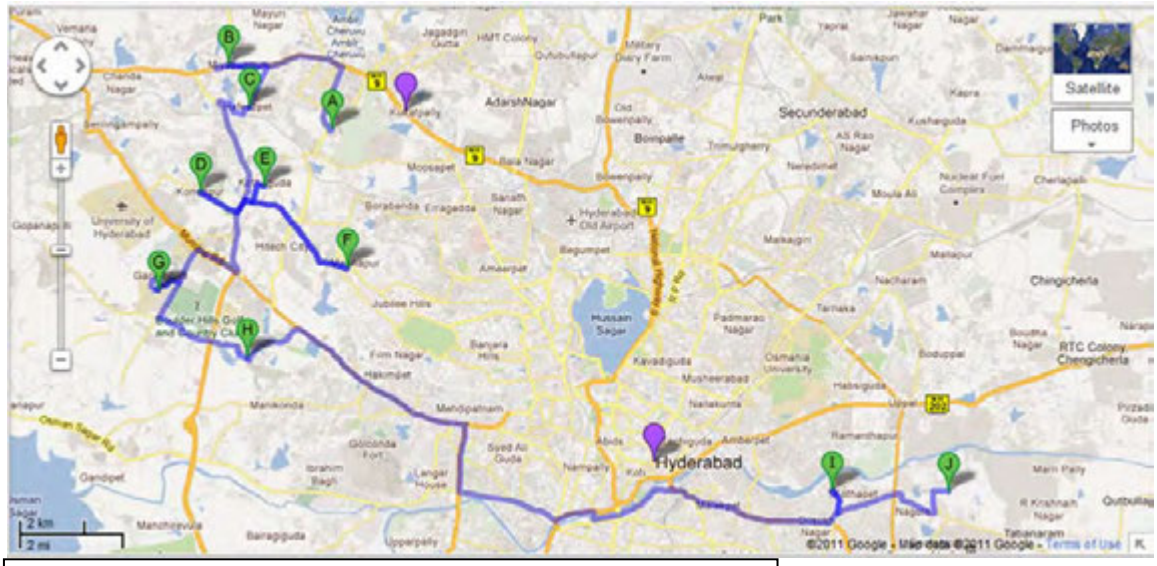


Source: JICA Study Team

Figure 64 Automated Traffic Red Light Violation Enforcement System Configuration

(3) Location Map

The system is configured at 10 different locations in Cyberabad area. The below Google map shows the locations of camera, video installations.



A. Malaysian Township	B. Miyapur
C. Hafeezpet	D. Kondapur
E. Kothaguda	F. Madhapur PS
G. ISB, Gachibowli	H. Khajaguda
I. Chaitanyapuri	J. Nagole X Road

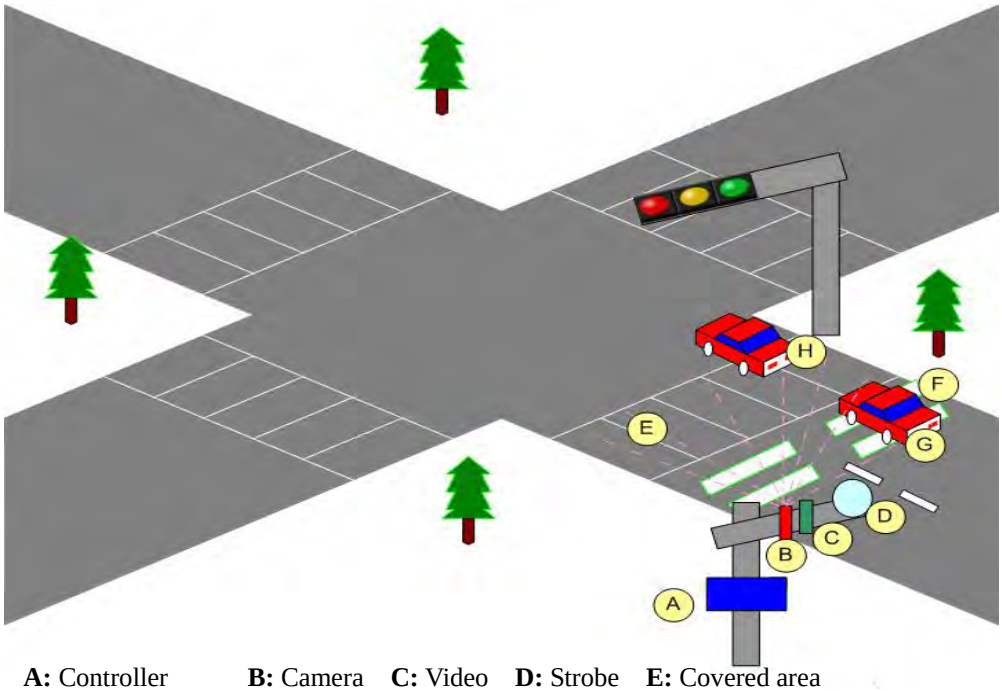
Source: Edited by JICA Study Team

Figure 65 Location Map of Red Light Violation Enforcement System Installed in Cyberabad

(4) Functions of Red Light Violation Enforcement System

The automated red light violation system comprises of Electro-Magnetic loops buried in the road, which are integrated with the Video Camera, Digital Camera with Flash, and an Industrial PC mounted on a pole

- When the signal turns RED, the system becomes active and detects the violating vehicle. In the process, the Video Camera starts recording the violation and simultaneously the Digital Camera captures the photographs of the violating vehicle as a proof of violation
- The cameras operates 24 hours a day and capture video as well as still photographs of every vehicle that violates the traffic signal at the junctions
- All such recorded violations are transmitted to the control room established at the Cyberabad Commissionerate's Office
- Each set of images of red light violations are reviewed, processed (operators key in the vehicle number in application) and approved by the DCP Traffic, Cyberabad Police Department at the control room
- This system collects vehicle database from RTA as .dump file on weekly basis
- The violation data is processed and a traffic challan is generated along with the image of registration plate and sent to the owner of the vehicle by post
- The registered owner who receives the notice can pay the fine at Centres, or at AP Online website or online (through internet)



A: Controller **B:** Camera **C:** Video **D:** Strobe **E:** Covered area
F: Detection zone (Loop coil sensors) **G:** First image before violation
H: Second image after violation

Source: JICA Study Team

Figure 66 Automated Traffic Red Light Violation Enforcement System Functions

The technical features and specifications are:

- Fibre Optic/Copper wire, WIMAX and Radio Frequency are available to be used for communication network.
- Two sets of loop coil type sensor are installed to identify the red light violation vehicles in each lane.
- H.264 standard is used for digital moving image compressed method
- Gigabit Ethernet is employed as digital data transmission protocol.

2-8-3 City Surveillance System

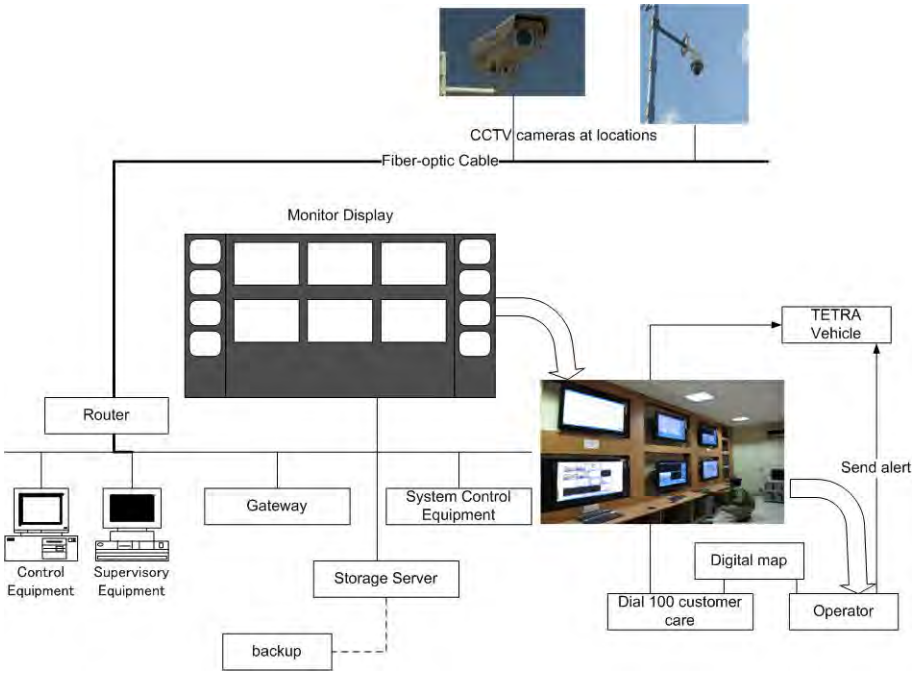
(1) System Outline

The Hyderabad and Cyberabad police are using CCTV (Closed Circuit Television) cameras for the purpose of public safety & security and to protect citizens & public property, traffic regulation, investigation and to maintain law & order.

In Hyderabad currently there are around 350 CCTV outdoor cameras in Hyderabad Police limits while there are 70 CCTV outdoor cameras in Cyberabad Police Jurisdiction. All these cameras are procured, installed, maintained by Hyderabad and Cyberabad police in their limits.

(2) System Configuration

CCTV cameras are installed at various locations to monitor traffic, crime, law and order and are placed at traffic junctions, critical and sensitive locations. CCTV cameras are connected with a dedicated fibre optic cable to the central command centre. Video stream monitored at command centre and the Data is stored in server and also regular backup would be maintained on HDD & Optical disks to retrieve the data as and when required.



Source: JICA Study Team

Figure 67 System Configuration of City Surveillance System

(3) Operational Procedure of the System

- Operated by Hyderabad and Cyberabad Police to monitor the traffic and emergency conditions on roads.
- 250 tetra systems (Walkie-Talkie) are in operation to reach to emergency locations.
- Traffic monitoring using GIS maps.
- When operator notifies any emergency situation he/she calls the nearest TETRA vehicle to alert them to reach the emergency location.
- Fibre-optic cable for the connection of CCTV cameras to the central command control centre.
- All videos are stored in server and regular backups are taken.
- Emergency calls received on 100 police emergency service are processed through call centre and informed to the nearest TETRA vehicle.

(4) Current Operational and Technical Issues on the System

- 40 percent of CCTV cameras in Hyderabad and 50 percent in Cyberabad are not functioning.
- Required funding to maintain these systems is a burden to police department.
- Required more number of CCTV cameras with high quality to cover the important locations across Hyderabad and Cyberabad limits.

2-8-4 TETRA System

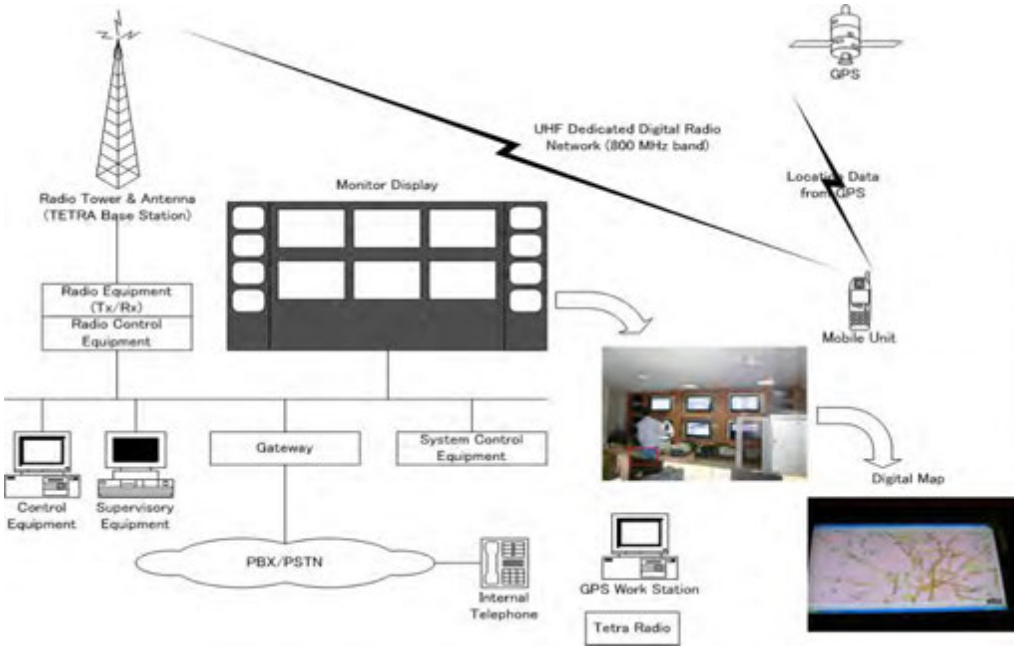
(1) System Outline

The Cyberabad Police are using a secure Terrestrial Trunked Radio (TETRA) communication network. This communication system will enable the Cyberabad Police to better coordinate their resources in the event of any emergency or law and order situation within the Cyberabad Police Commissionerate.

The system operates in 800 MHz band with nine base stations covering 3600 Sq.km area. It can accommodate about 500 users. The TETRA also includes an Automatic Vehicle Location (AVL) system. The TETRA network will provide the Cyberabad Police with a reliable, flexible and efficient communication with clear voice and data/image transmission.

The TETRA network is supplied by EADS (now CASSIDIAN) & Sanchar Telesystems Ltd., New Delhi, India.

(2) System Configuration



Source: JICA Study Team

Figure 68 System Configuration of TETRA Network

(3) Technical Features and Specifications

- TETRA system is a digital radio network operated in 800 MHz band.
- Full duplex communication system.
- Highly secure encryption for transmission.
- Modulation used is TDMA.
- Built-in GPS for GIS & AVLS application.
- Data transmission speed is 19.2 to 152 kbps.
- Simultaneous transmission of voice, data and radio.
- Direct Mode Operation without a base station between radio terminals.
- Base Stations connected in Star and Mesh topology.
- Leased Lines/Fibre optic cable, Microwave links used for network.

2-8-5 Cyberabad Video Surveillance System (HITECH City)

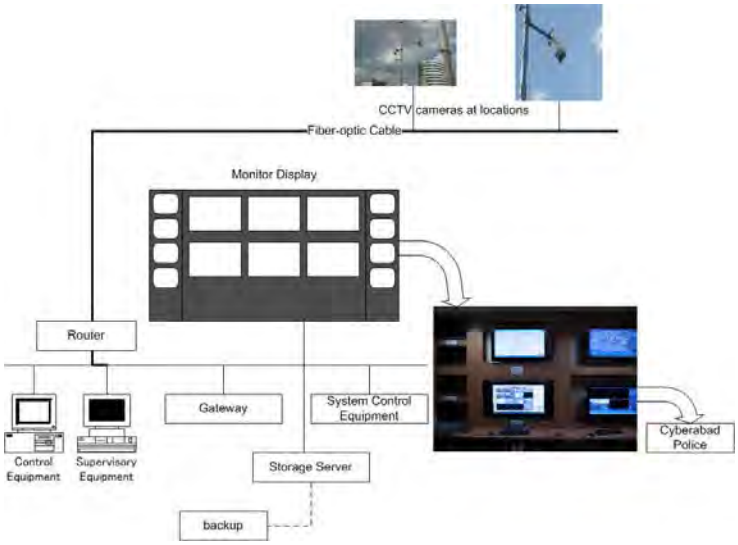
(1) System Outline

Cyberabad Video surveillance system was installed for IT companies around Cyberabad and it was funded by Society for Cyberabad Security Council (SCSC). The system was designed, developed and operated by Ahmadabad based System Integrator M/s. Checkmate Facility & Electronic Solutions. The Command & Control Centre (CCC) is located in Cyberabad Police Commissionerate premises.

The primary objective of the system is to increase the security surveillance covering all sensitive & critical areas for public safety & security, acts as deterrence, efficiently protect citizens & public property, protecting major IT installations, and quick incidents detection through recognition of images with high degree of certainty.

(2) System Configuration

Around 17 HDTV network of 1.3 MP cameras are installed at various locations. These cameras are placed at traffic junctions, critical & sensitive locations and the CCTV cameras are connected with a dedicated fibre optic cable to central command centre. Video streams are monitored by Cyberabad Police for 24x7 at command centre. Data is stored in server and also regular backup would be maintained on HDD & Optical disks to retrieve the data as and when required.



Source: JICA Study Team

Figure 69 Cyberabad Video Surveillance System

(3) Technical Features and Specifications

- 17 HDTV network 1.3 MP cameras, four 360-degree cameras
- Cyberabad Police monitors on a 24x7 basis.
- Videos are stored into server.
- Server backup available for 90 days and after that data would be stored on tape drives.

2-8-6 Weather Monitoring System by Meteorological Department

(1) System Outline

The Meteorological Centre, Hyderabad is a state meteorological centre for the state of Andhra Pradesh and works under Indian Meteorological Department (IMD). The data collected is shared with National Weather Forecasting Centre (NWFC) and updated at regular intervals The collected

information is also provided through various provision systems such as media, websites, etc., It is responsible for carrying out the following weather forecasting activities:

- Synoptic Observation: Round the clock observation of weather on surface.
- Pilot Balloon Observation: Upper air Winds observation at 0600 UTC and 1800 UTC.
- Radios ode Observation: GPS based upper air observation for Atmospheric Pressure, Temperature, humidity, wind Speed and direction at 0000 and 1200 UTC.
- Doppler Radar Observation: 24 Hrs automatic observations with updates every 10 minutes on Websites.
- Radiation Observation: Automatic and Manual observation of Global, Diffused, Terrestrial, direct, UV radiation.
- Automatic Weather Station observation.

(2) Services

Apart from the above mentioned services, some of the daily services include:

(a) Weather Forecasting

A daily bulletin is issued at 12 noon based on 03 GMT data which contains forecast for entire state for next 2 days, Cyclone warning, Heavy Rainfall warnings, position of the weather system if any, local forecast for Hyderabad, Visakhapatnam and Vijayawada Cities along with Outlook for subsequent 2 days along with the summary of weather phenomena occurred (Daily weather report). A weekly bulletin (Weekly Weather Report) is also issued on every Thursday which contains summary of previous week (Thursday to Wednesday).

(b) Aviation

The weather information is provided to ATC and all Airlines at Rajiv Gandhi International Aerodrome, Shamshabad and at Begumpet aerodrome catering to the need of about 250 flights daily, which include upper air winds, temperatures, significant weather (SIG Wx) charts, Aerodrome Warnings, TAFs, METARs and SIGMETs. Met. Support is also provided at Tirupati, Gannavaram and Rajahmundry Airports.

(c) Flood Meteorological Forecast

The flood meteorological office at Hyderabad was established in 1977 and this office issues Daily bulletins for Godavari & Krishna river basins covering six states and of 5, 73, 858 sq Km. basin area during flood season (June to October) including synoptic situations, spatial distribution of rainfall forecast for each sub-basin, Heavy Rainfall Warnings along with realized rainfall. Forecasts issued to Central Water Commission, Hyderabad. Quantitative Precipitation Forecasts are also issued for the sub-basins under flood situation / Heavy Rainfall events. Weekly Weather Summary and Annual Flood Reports are also prepared.

(d) Doppler Weather Radar

The state of the art S-band Doppler Weather Radar of M/s Metstar make commissioned in July 2010 is capable of weather surveillance up to 250 km (maximum up to 500 km) around Hyderabad. It provides imageries derived from volume scan depicting location and intensities of clouds, expected rainfall from these clouds, horizontal winds, wind shear etc. The imageries are a very good tool for weather analysis and forecasting. The Radar products are automatically updated to IMD’s website at 10 minutes interval.

(e) Agricultural Advisory Bulletins

Agro meteorological Advisory Unit was established in 1987 to extend meteorological services to the farming community in the state. Agro meteorological Advisory Unit is regularly issuing Bi-weekly Agromet Advisory Bulletins on every Tuesday and Friday in co-ordination with the State Agricultural University and State Agricultural Dept., Govt. of Andhra Pradesh for the benefit of the farming community in the state.

The unit issues Bi-weekly District forecast valid for succeeding five days for the 9 Agro-Climatic Zones covering all the 23 districts in the state in co-ordination with Acharya N.G. Ranga Agricultural University, Rajendra Nagar, and Hyderabad. This Unit also issues Bi-weekly Bi-Lingual Agro meteorological and Agriculture Bulletins on Tuesday and Friday in collaboration with the State Agriculture Department. Bulletin reflects the Significant past Weather phenomena prevailed and the forecast. The department of Agriculture, Andhra Pradesh provides the inputs regarding Crop condition along with the Pets & Diseases and remedies to be followed to prevent them. The 7 Agro Met Field Units of ANGRAU provides the weather based Agro-advisories. These bulletins are transmitted to media viz. AIR, Doordarshan for broadcast in local language for use of farmers and other user agencies.

2-8-7 Bus Information System by APSRTC

(1) System Outline

The Andhra Pradesh State Road Transport Corporation (APSRTC), a road transport corporation owns 22,500 buses in total and operates around 3,800 buses within Hyderabad as city service.

It was originally planned to implement Vehicle Tracking System for about 12,000 buses. Subsequently the number was reduced to 3,502 buses and the project allotted to M/s CMC Ltd. covers 3,502 buses. This includes 1,347 buses operating in Hyderabad City. Further, buses which will be procured under JNNURM phase-2 will also be covered under the project, subsequently. About 100 LED displays are proposed to be installed in important locations in Hyderabad for displaying information about the estimated time of arrival of buses.

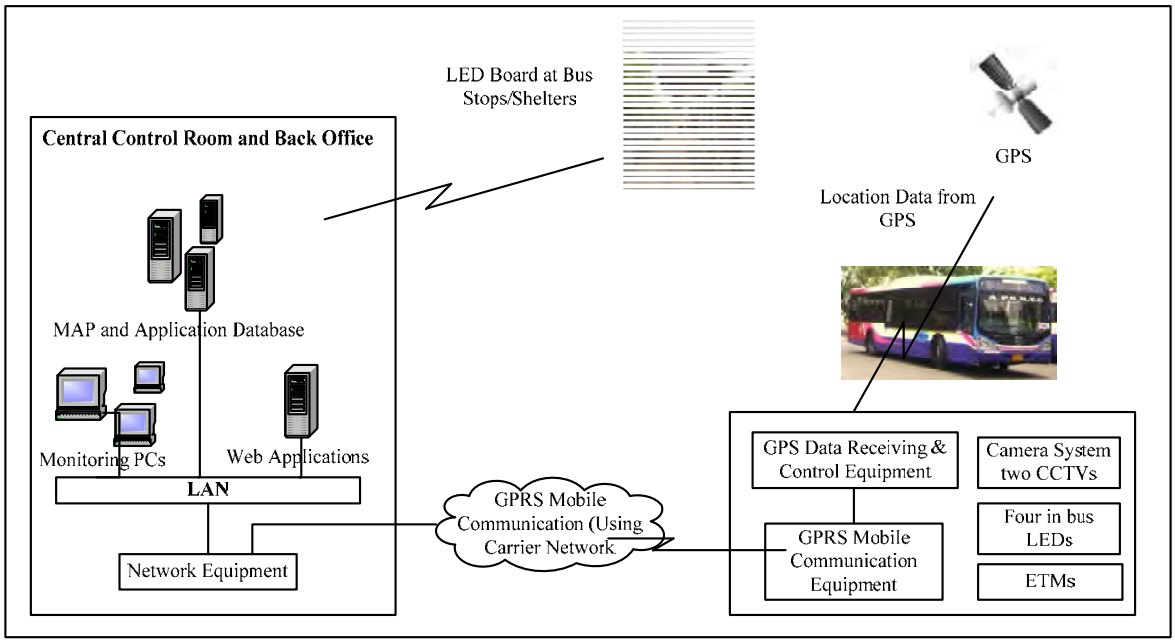
The planned ITS majorly focused on areas such as in-bus, bus stops and passenger information. In-BUS ITS with three LEDs (Front, Back and Side) for bus route information, one LED in bus for visual display of next bus stop, audio for announcing the next bus stop, two CCTV cameras, at bus stops one more LED to know the bus estimated time of arrival, departure, route numbers, etc., SMS system for information to passengers.

(2) System Configuration

The figure below shows the configuration of GPS/GPRS enabled system implemented by APSRTC. The GPS device in-bus transmits GPS location of bus and route data to back office. In-bus and bus stop display devices receive messages from the back office through GPRS connection. The bus equipped with four LED boards located at front, back, side and internal displays. Front, back and side LED boards to display route information and internal LED used for visual display and announcement of stop & next stop. It also comprises of a set of two CCTV cameras one in front and other on rear for recording. These recordings can be available as and when required. The LED board at bus stop used to display messages like expected time of arrival, departure, bus schedule, etc., to passengers. Electronic Ticketing Machines (ETMs) used for ticketing and also bus information sent through SMS to passengers.

(3) Particular Technical Features and Specifications

- Multiplex wiring system
- Communication with central server over GPRS
- 72 hour recording backup for CCTV cameras
- In-bus GPS device receives GPS data from GPS satellites
- Geo-fencing for bus routes



Source: JICA Study Team

Figure 70 Bus Location System as Planned APSRTC

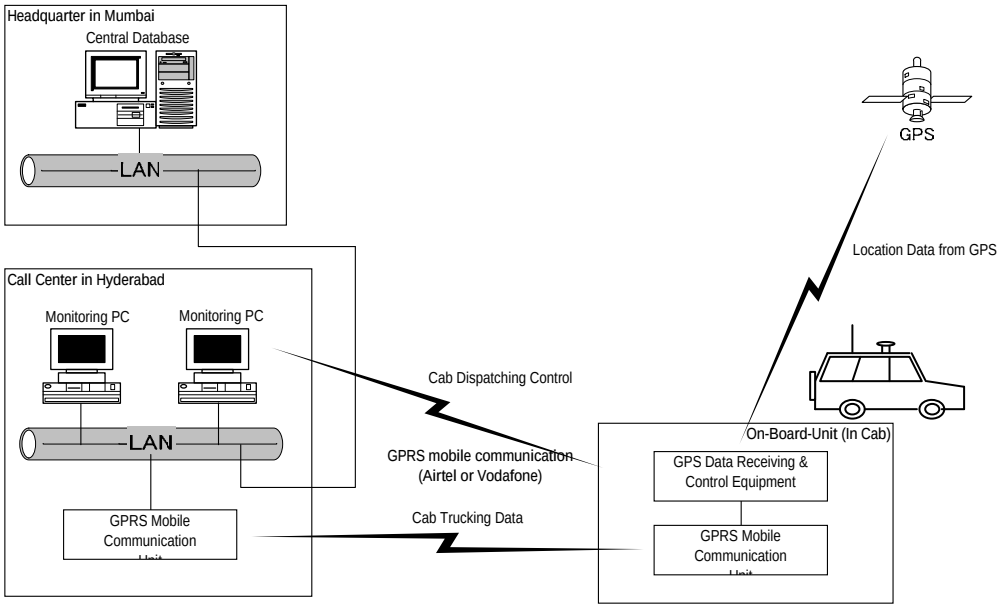
2-8-8 GPS Tracking System by MERU Cab

(1) System Outline

MERU Cab is one of taxi companies headquartered at Mumbai and it provides a radio taxi service in for key metros of India, i.e. Mumbai, Delhi, Bengaluru and Hyderabad. In Hyderabad, the operating area of MERU Cab is only limited to GHMC jurisdiction. MERU Cab has developed and operated GPS tracking system for the taxi dispatching control services since year of 2007. Total of 5000 On-Board Units (OBUs) with 800 OBUs are in Hyderabad are currently being introduced in the system. The system identifies the location of taxis equipped with OBU and automatically indicates it on a digital map installed in monitoring PCs at Call Centre. When the operator working in the Call Centre receives the call from customer, the operator checks the availability of nearest cab by monitoring PC. If any cab is available, the operator sends detailed messages such as customer's address, contact number to the cab OBU through GPRS (General Packet Radio Service) provided by communication carriers.

(2) System Configuration

The figure below shows the configuration of GPS tracking system developed by MERU Cab. The OBU identifies the current location of taxi by receiving the signals from GPS satellites and sends the cab tucking data to call centre with an interval of every 1 minute. The monitoring PCs in Call Centre shows the all of taxi locations on digital map named MapmyIndia. A central database is installed in the MERU Cab headquarters at Mumbai.

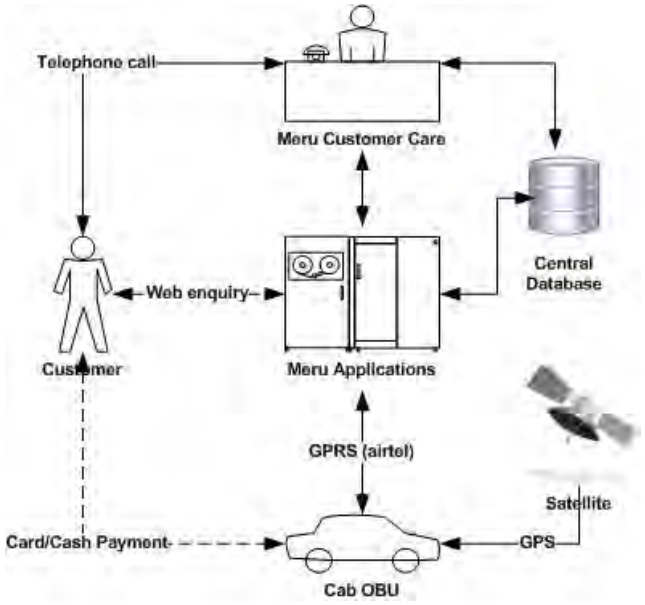


Source: JICA Study Team

Figure 71 System Configuration of MERU Cab GPS Tracking System

(3) Operational Procedure by using GPS Tracking System

- Operators in the Call Centre receive calls from travellers,
- They check the availability of the nearest taxi, i.e. within 8 km from the requested pickup point,
- If it is available, they book the travel and send message to the taxi OBU with the details of the passenger such as address, contact number, etc.
- Driver starts the meter from the pickup point and stops it at the destination,
- The OBU will display the fare amount and gives the print of the required payment, and
- Passengers have the option to pay through credit/debit card where the swipe is available with OBU and also pay cash to the driver.



Source: JICA Study Team

Figure 72 MERU Cab Operational Procedure

(4) Particular Technical Features and Specifications

- MapmyIndia application is utilized for mapping and also their own software applications are built for booking, tracking of cab in the system,
- Tracking of taxi using MapmyIndia application with below indicators on application,

Table 25 Colour Coding on Map Applications in MERU Cab GPS Tracking System

Colour Indicator	Purpose
Red	Cab is hired
Green	Cab is available
Orange	On call
Black	Logged out

- The OBU device is made by Digitax, Italy,
- Airtel/Idea and Vodafone GPRS networks are utilized for the communication links between the OBU in taxi and the Call Centre,
- 1 minute GPS logging interval with the cab,
- OBU comes with Windows CE Operating System,
- Data centre & servers are resided at Mumbai (single location),
- Operation and maintenance of the system are carried out by MERU Cab only,
- The devices installed in cab are the OBU with swipe, meter and printer,
- The meter and printer are connected to the OBU serial port,
- There are around 5,000 OBUs owned by MERU
- OBU with external swipe comes with the price of 50,000 INR, while OBU with inbuilt swipe comes with the price of 100, 000 INR

OBU with external swipe

OBU with inbuilt swipe

Figure 73 MERU Cab System

2-9 Supplementary Traffic Survey

The supplementary traffic survey was carried out for the following purposes:

- To comprehend the traffic volume inside the Inner Ring Road
- To comprehend the travel speed in the city
- To update OD (Origin-Destination) inside the Inner Ring Road

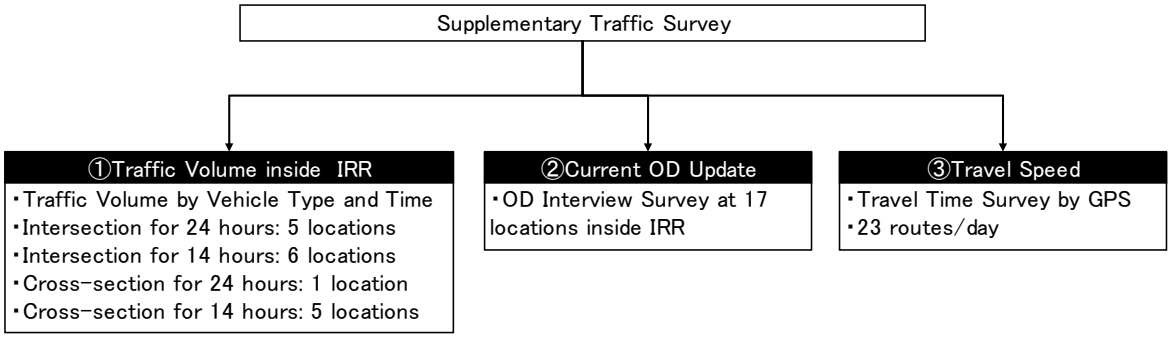
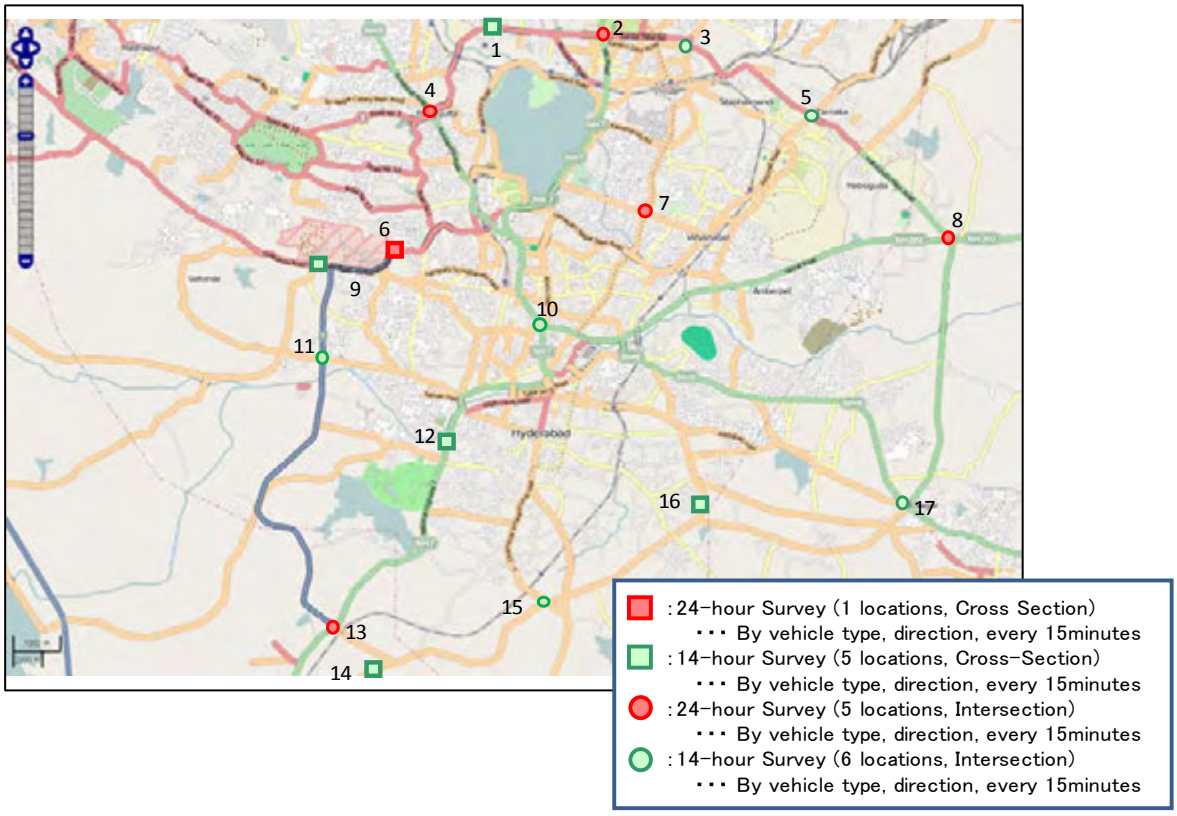


Figure 74 Methodology of Supplementary Traffic Survey

2-9-1 Traffic Count and OD Interview Survey

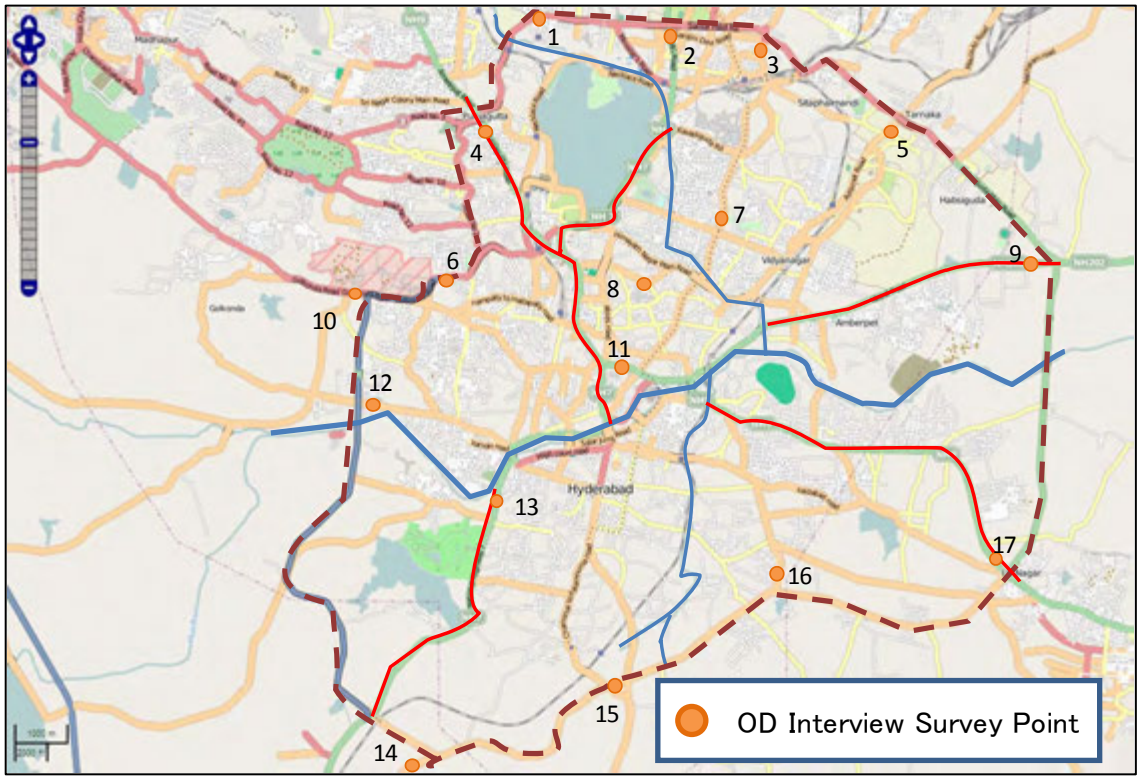
(1) Overall Condition

To identify existing traffic condition of inside Inner Ring Road, traffic count and OD interview survey was carried out. The survey locations were selected by JICA Study Team to figure out incoming traffic to inside IRR and outgoing traffic from IRR and traffic movement of Hyderabad city central. For OD interview survey also same locations were selected to efficiently carrying out the survey.



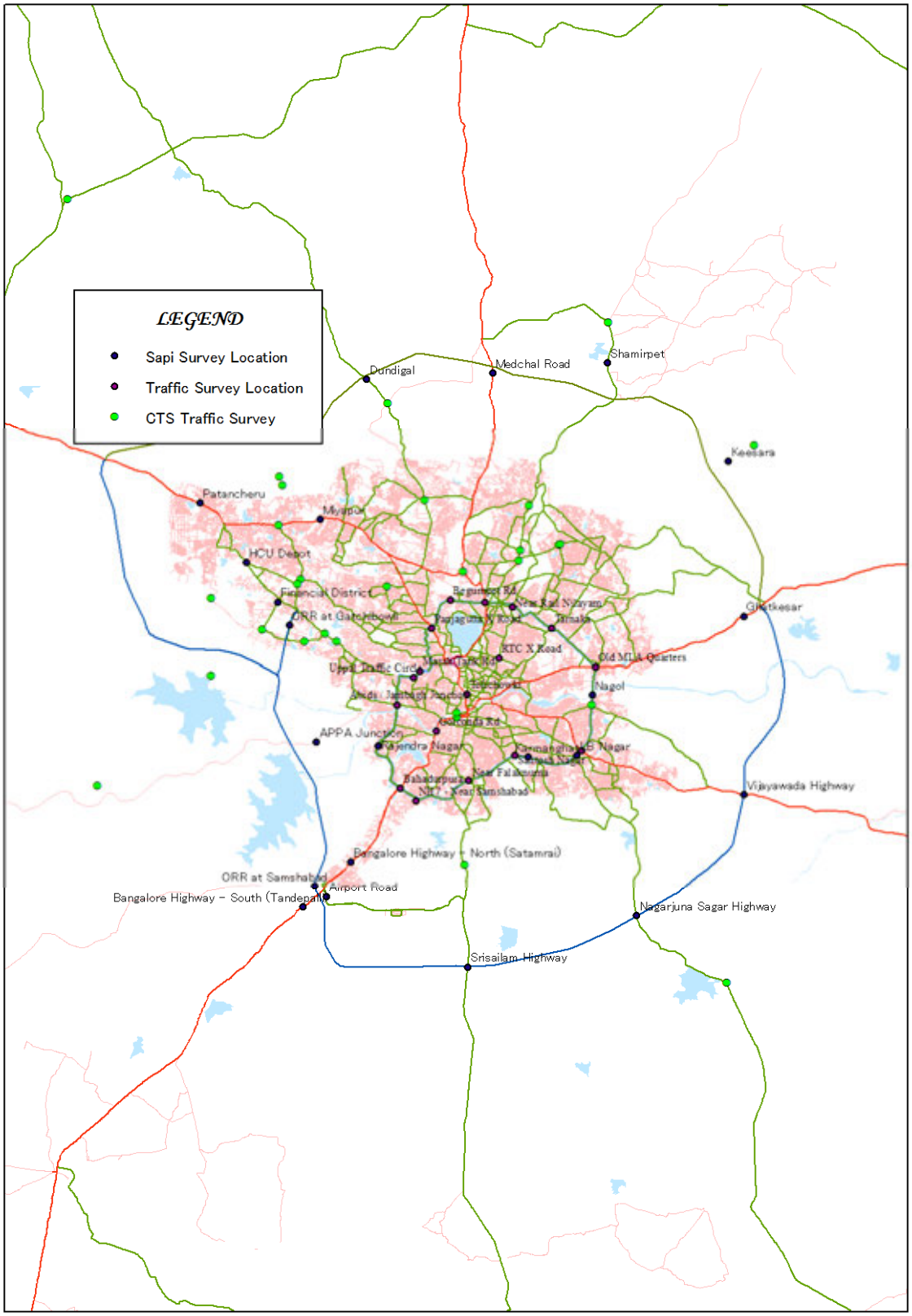
Source: JICA Study Team

Figure 75 Traffic Count Survey Locations



Source: JICA Study Team

Figure 76 OD Interview Survey Locations



Source: JICA Study Team

Figure 77 Comparison of Traffic Count Survey Location

(2) Traffic Count Survey Method

The volume count survey was conducted for both directions by vehicle type with the manually count method, and then recorded for every 15 minutes interval. The vehicles were classified as follows:

Table 26 Vehicle Classifications

No	Classification	No	Classification
1	Motorcycle	6	Light Cargo Vehicle
2	Three Wheeler / Auto-Rickshaw	7	Small Trucks – 2 Axle
3	Passenger Car (Sedan, Jeep, Van)	8	Medium Trucks – 3 Axle
4	Mini Bus	9	Large Truck or Tractor – trailer (Multi-Axle)
5	Bus	10	Others

(3) OD Interview Survey Method

The drivers were interviewed and their answerers were recorded in the interview sheets. The same vehicle classifications as above were applied.

2-9-2 Traffic Survey Results

(1) Traffic volume survey results

The tables below show that the heavy traffic volume on a number of intersections and that some of intersections are saturated.

It shows that the traffic volume on Begumpet Road is highest with approximately 200,000 PCU/14 hours. The details of the survey are described on the survey report on the attachment, ‘Supplementary Traffic Survey’.

Table 27 Result of Intersection Traffic Counting

No.	Location Name	Total (PCU)
14-Hours		
3	Near Rail Nilayam	**301,171**
5	Tarnaka*	**160,880**
17	L.B Nagar Traffic Cir	**85,790**
15	Near Falaknuma	**69,467**
11	Golconda Rd	**162,224**
10	Abids / Jambagh Junction	**170,733**
24-Hours		
2	Mahatma Gandhi Rd / Near Paradise	**287,923**
8	Uppal Traffic Circle	**459,792**
13	NH7 - Near Samshabad	**270,677**
	NH7 - Near Samshabad - Underpass	**44,402**
4	Panjagutta X Road	**373,741**
7	RTC X Road	**262,534**

Source: JICA Study Team

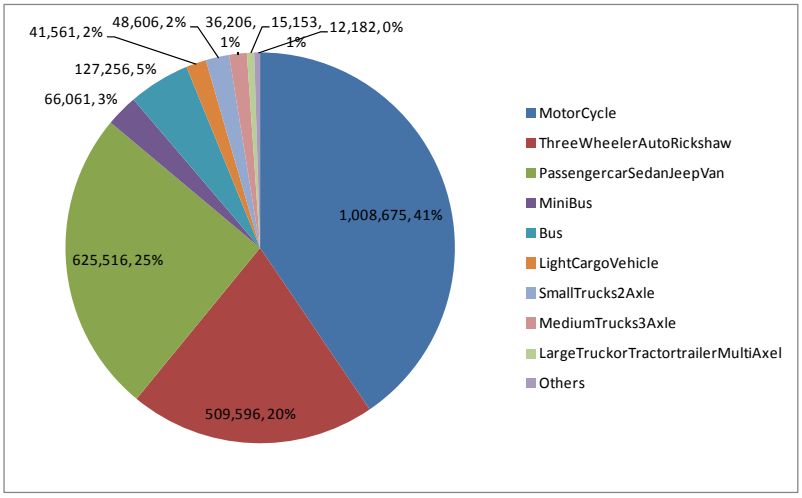
Table 28 Result of Roadside Traffic Counting

No.	Location Name	No. of Hours	Direction	PCU
1	Begumpet Rd	14-hours	Two-way road	117,170
			Two-way flyover	78,752
16	Santosh Nagar	14-hours	Two-way	48,686
14	Mohan Reddy Nagar	14-hours	Two-way	37,873
9	Tolichowki	14-hours	Two-way	118,621
6	Masab Tank Rd	24-hours	Two-way road	43,739
			Two-way flyover	3,147
12	Bahadurpura	14-hours	Two-way	64,596

Source: JICA Study Team

(2) Vehicle Proportions

When proportion of vehicles is considered, the motorcycles are highest proportion and are about 41%. The second largest proportion of vehicle population is car jeep/van and is 25% of the total population. The buses are 5% and mini buses constitute 3%. From the above results, it is clear that Hyderabad's main transportation mode is motorcycle.



Source: JICA Study Team

Figure 78 Vehicle Proportions of Inclusive Sum Survey Locations

(3) PCU Factor

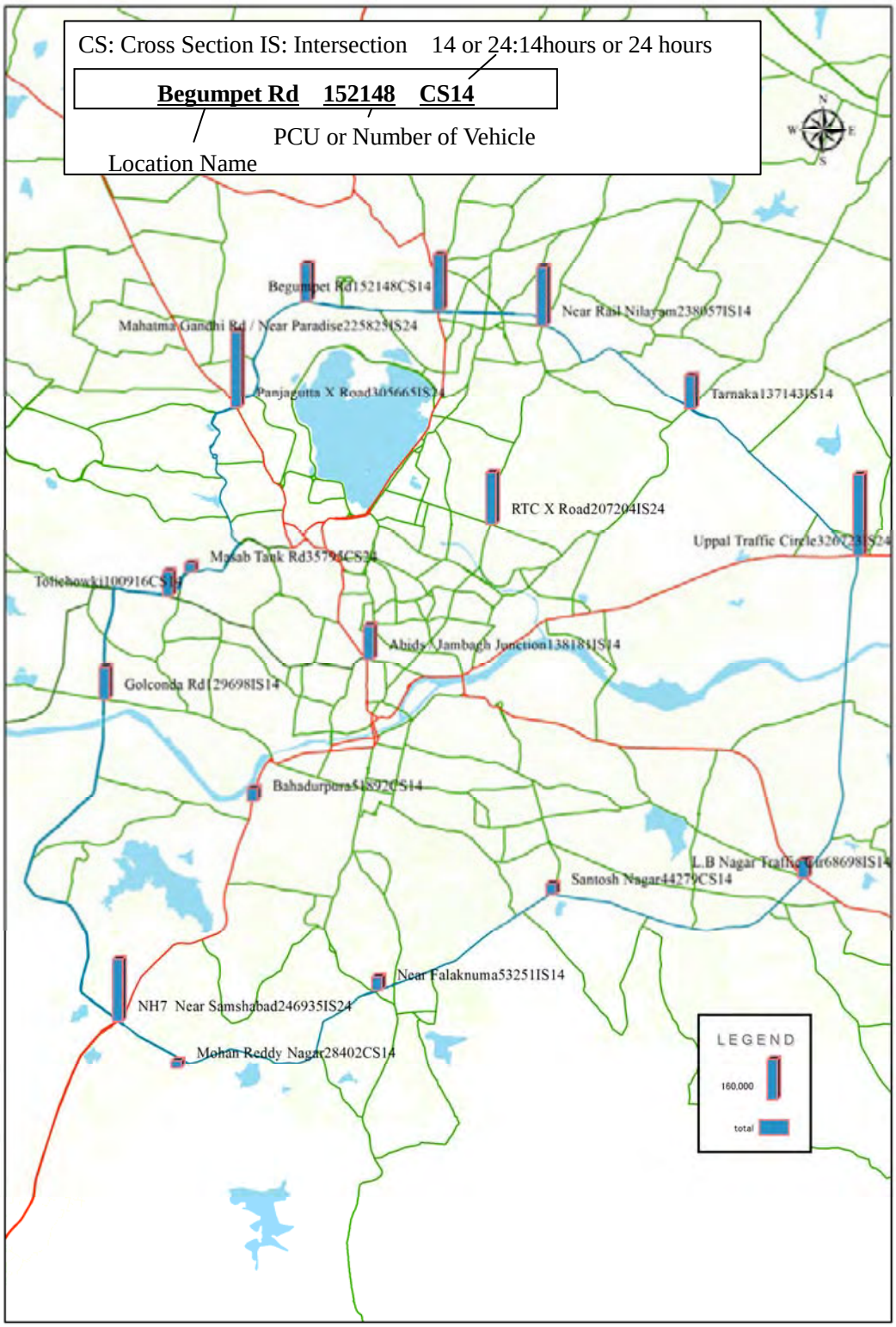
To analyze the traffic volume, the different modes of traffic were converted to equivalent Passenger Car Units (PCU). The PCU factors were obtained from the Indian Roads Congress (IRC) publication 106-1990 "Guidelines for Capacity of Urban Roads in Plain Areas" and are shown table below.

Table 29 Recommended PCU Factors for Various Types of Vehicles on Urban Roads

Vehicle Type		Equivalent PCU Factors	
		Percentage composition of Vehicle type in traffic stream	
		5%	**10% and above**
Fast Vehicles			
1	Two wheelers, Motor Cycle or Scooter, etc.	0.50	0.75
2	Passenger car, pick-up van	1.00	1.00
3	Auto-rickshaw	1.20	2.00
4	Light Commercial Vehicle	1.40	2.00
5	Truck or Bus	2.20	3.70
6	Agricultural Tractor Trailer	4.00	5.00
Slow Vehicles			
7	Cycle	0.40	0.50
8	Cycle Rickshaw	1.50	2.00
9	Tonga (Horse drawn vehicle)	1.50	2.00
10	Hand cart	2.00	3.00

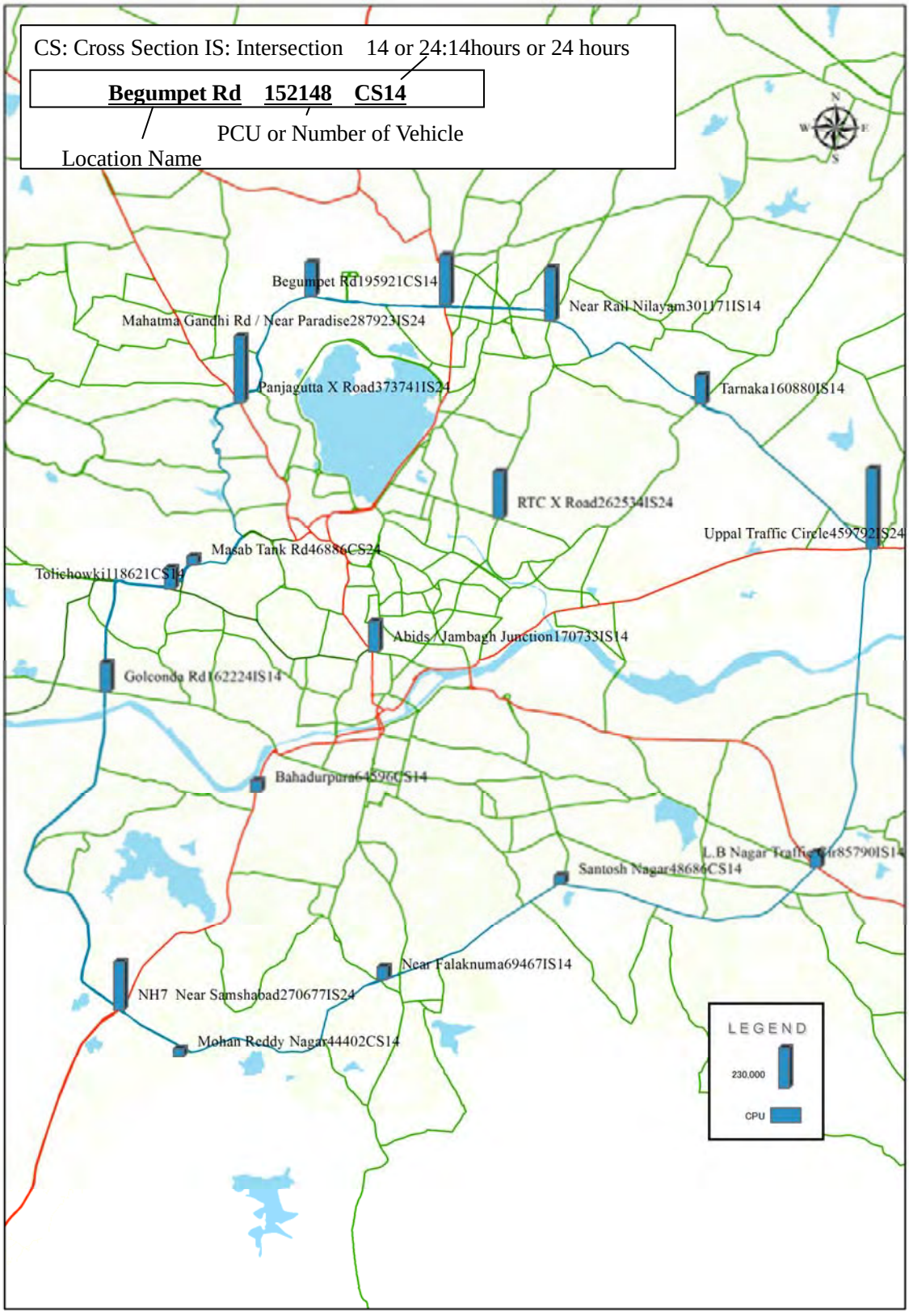
Extract from: IRC: 106-1990, Guidelines for Capacity of Urban Roads in Plain Areas

Source: Guidelines for Capacity of Urban Roads in Plain Area



Source: JICA Study Team

Figure 79 Traffic Volume Survey Result Simple Summation



Source: JICA Study Team

Figure 80 Traffic Volume Survey Result as of PCU

Table 30 Traffic Survey Result Summary

ID	MID	SM	LocationName	MotorCycle	ThreeWheelerAutoRickshaw	PassengercarSedanJeepVan	MiniBus	Bus	LightCargoVehicle	SmallTrucks2Axle	MediumTrucks3Axle	LargeTruckorTractortrailerMultiAxel	Others	total
1	23	CS14	Begumpet Rd	82,473	27,221	32,516	3,136	3,983	537	1,335	634	174	139	152,148
2	24	IS24	Mahatma Gandhi Rd / Near Paradise	90,786	44,342	60,434	8,576	11,782	3,057	2,397	1,786	746	1,919	225,825
3	25	IS14	Near Rail Nilayam	90,227	50,180	66,506	6,348	13,576	3,826	2,610	1,308	963	2,513	238,057
4	36	IS24	Panjagutta X Road	108,509	76,472	103,973	3,255	8,224	1,077	1,498	1,466	1,005	186	305,665
5	26	IS14	Tarnaka	70,412	30,331	25,668	2,218	5,023	1,511	928	433	130	489	137,143
6	35	CS24	Masab Tank Rd	9,936	5,162	11,907	2,687	3,474	897	811	514	225	182	35,795
7	37	IS24	RTC X Road	75,689	50,145	57,857	5,721	11,398	2,157	1,792	1,226	970	249	207,204
8	27	IS24	Uppal Traffic Circle	111,569	55,917	70,678	13,067	22,676	11,680	16,350	14,469	6,577	3,740	326,723
9	34	CS14	Tolichowki	47,206	18,675	22,078	2,938	6,015	2,112	1,363	368	128	33	100,916
10	39	IS14	Abids / Jambagh Junction	62,516	36,810	27,534	1,954	7,910	814	521	122	0	0	138,181
11	33	IS14	Golconda Rd	62,356	30,084	20,806	2,789	3,560	3,562	3,511	1,158	558	1,314	129,698
12	40	CS14	Bahadurpura	26,660	12,352	5,388	762	3,277	1,510	1,311	475	4	153	51,892
13	32	IS24	NH7 Near Samshabad	87,751	31,284	76,840	7,341	17,700	4,706	9,015	8,319	3,055	924	246,935
14	31	CS14	Mohan Reddy Nagar	10,677	6,321	4,688	505	414	1,942	2,143	1,631	75	6	28,402
15	30	IS14	Near Falaknuma	21,758	15,087	9,257	2,412	2,455	720	934	353	137	138	53,251
16	29	CS14	Santosh Nagar	22,561	7,573	11,320	770	1,493	201	253	23	0	85	44,279
17	28	IS14	L.B Nagar Traffic Cir	27,589	11,640	18,066	1,582	4,296	1,252	1,834	1,921	406	112	68,698

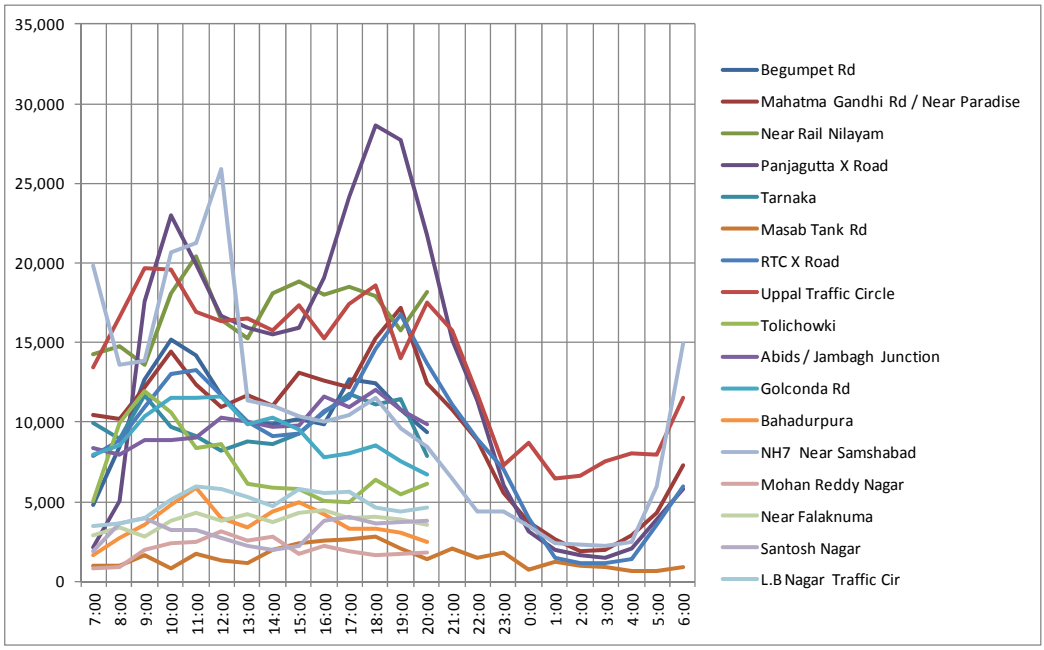
CS14: Cross Section 14hours survey CS24: Cross Section 24hours survey, IS14: Inter Section 14hours, IS24: Inter Section 24hours

(4) Peak-Time Traffic Volume

To identify traffic volume and traffic during the peak-time, the JICA Study Team analyzed the result of the traffic survey. As the diagrams below shows, it indicates that peak-time in Hyderabad is consist of 3 periods of time.

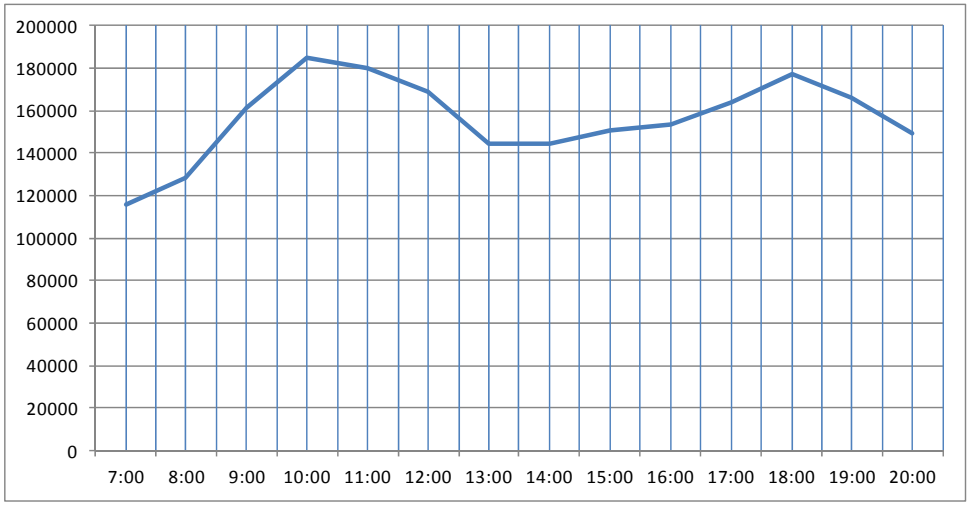
- First Peak: 9:00 to 10:00
- Second Peak: 10:00 to 12:00
- Third Peak: 18:00 to 19:00

The second peak from 10:00 to 12:00 is a typical traffic behaviour observed in Hyderabad.



Source: JICA Study Team

Figure 81 Time-Trend of Each Traffic Survey Locations



Source: JICA Study Team

Figure 82 Time of Day Traffic Volume Trend of Inclusive Sum all Survey Locations

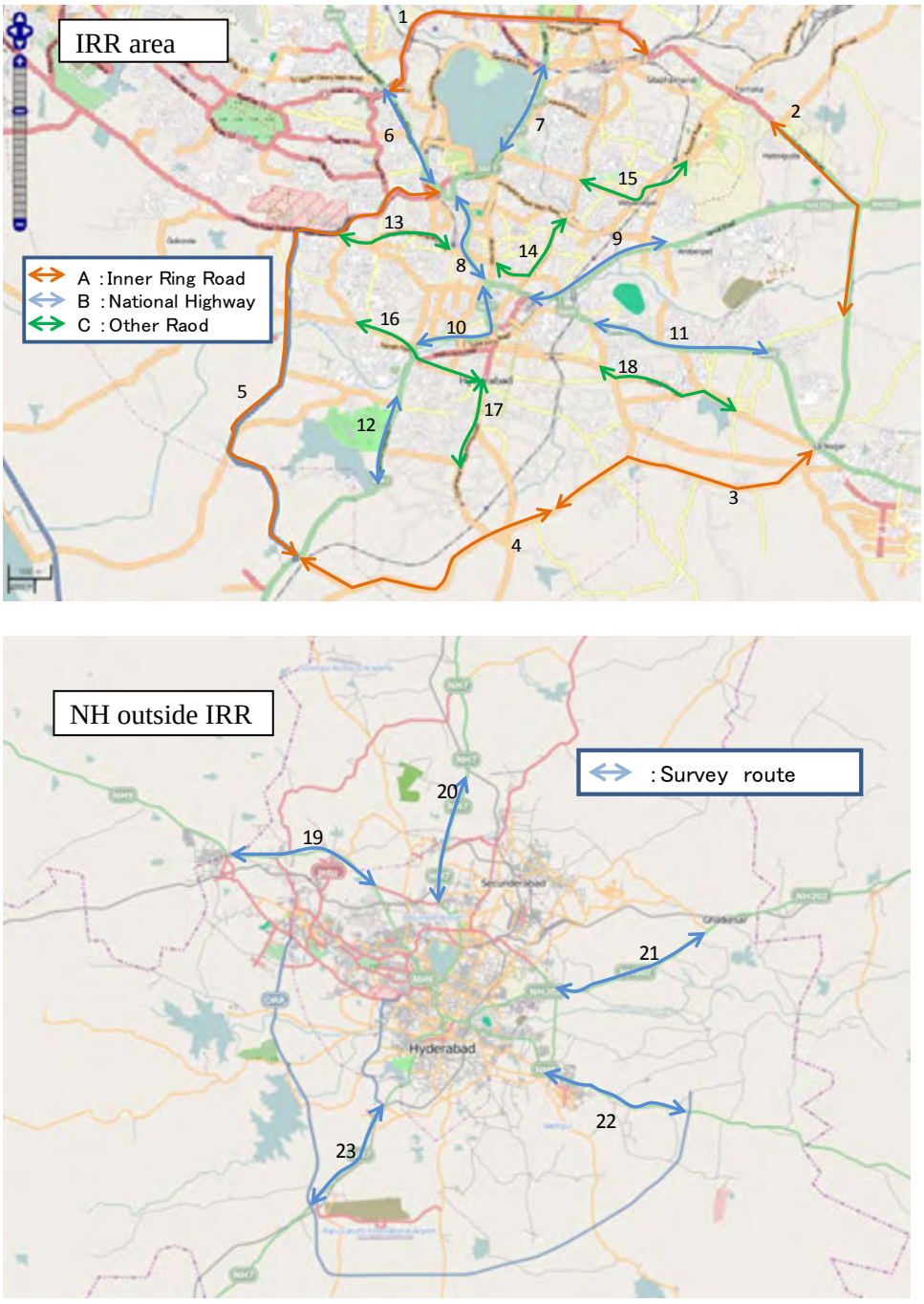
(5) OD Survey Results

Methodology and results of OD servey are described on the survey report on the attachment, 'Supplementary Traffic Survey'.

2-9-3 Travel Time Survey

(1) Overall Condition

To identify current travel speed inside of ORR, especially inside IRR, the travel time survey was conducted. The routes were selected inside IRR and national highway which access to ORR. The figure below shows the travel time survey routes.



Source: JICA Study Team

Figure 83 Travel Time Survey Routes

(2) Survey Method

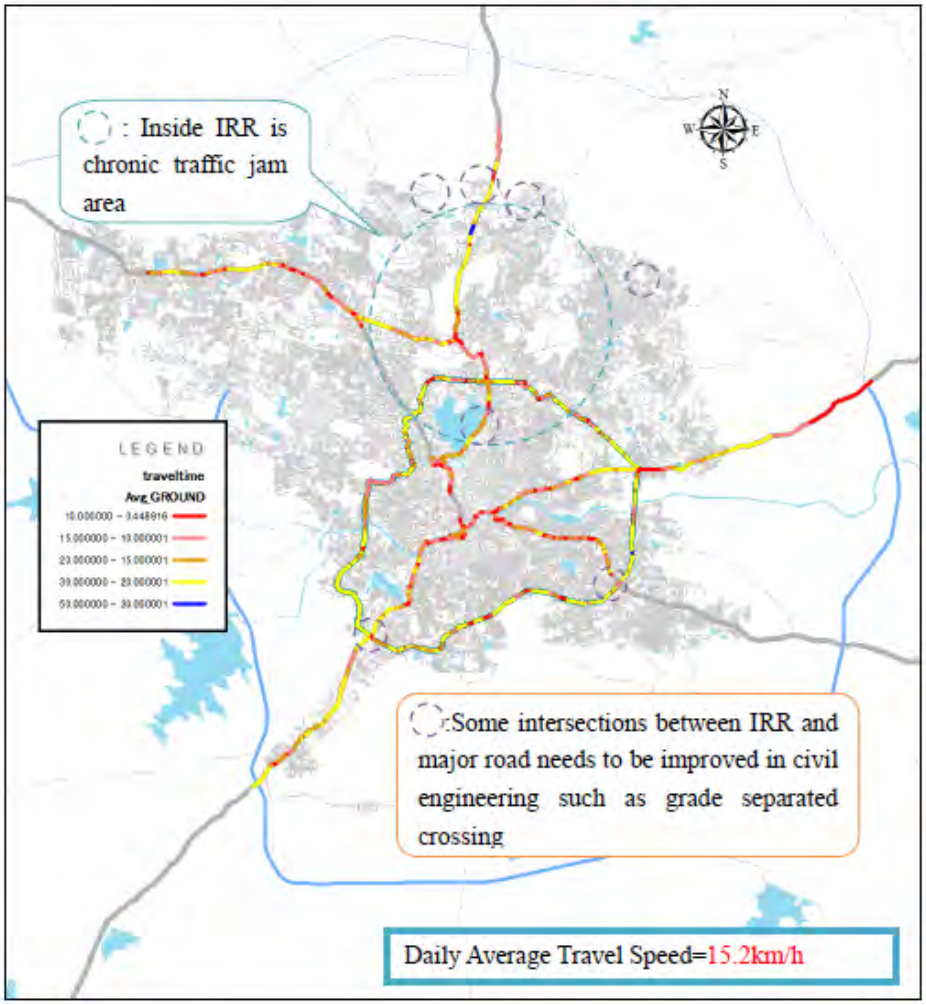
The travel time survey was conducted based on vehicle's trip time on survey routes with GPS.

Recording was obtained 3 times per hour in survey routes.

2-9-4 Travel Time Survey Results

(1) Overall Conditions

To identify overall conditions of Hyderabad with respect to travel time, the JICA Study Team conducted GPS data matching using the GPS data collected in one-day. Although all the data was not collected using the same method all obtained GPS data was utilized to describe the current traffic condition in Hyderabad. The diagram below shows that daily average travel speed on major road network in Hyderabad and from the data collected it was observed that the daily average speed is 15.2 km/h. This result indicates that Hyderabad metropolitan area has shortage of road infrastructure.

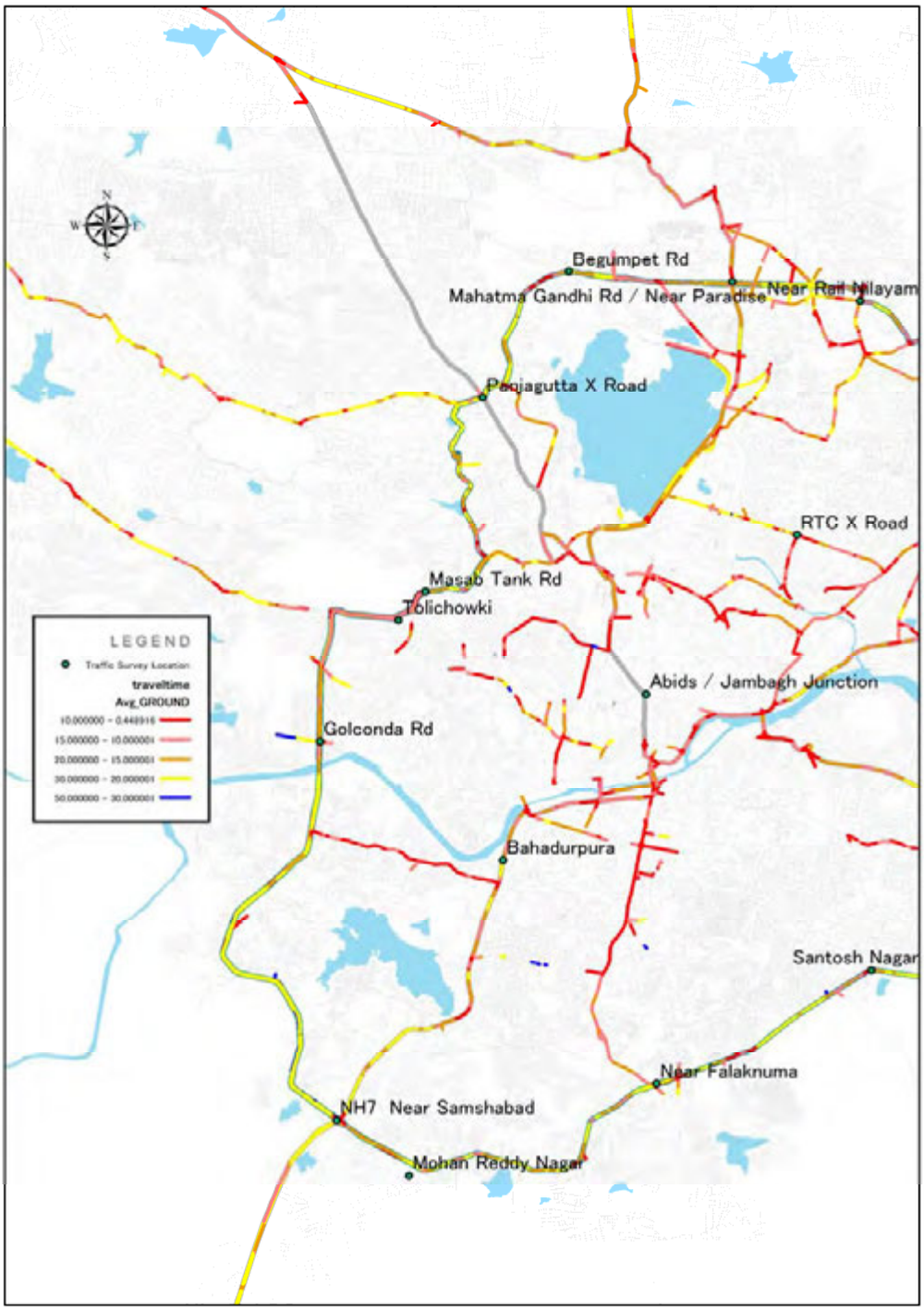


Source: JICA Study Team

Figure 84 Travel Speed Survey Result - Daily Average Data

(2) Western Part of Hyderabad

Daily travel speed in Western part of Hyderabad is low. However on IRR, there is no critical and cut-out congestion point like eastern part. The speed inside IRR is also very slow and requires radical solutions.

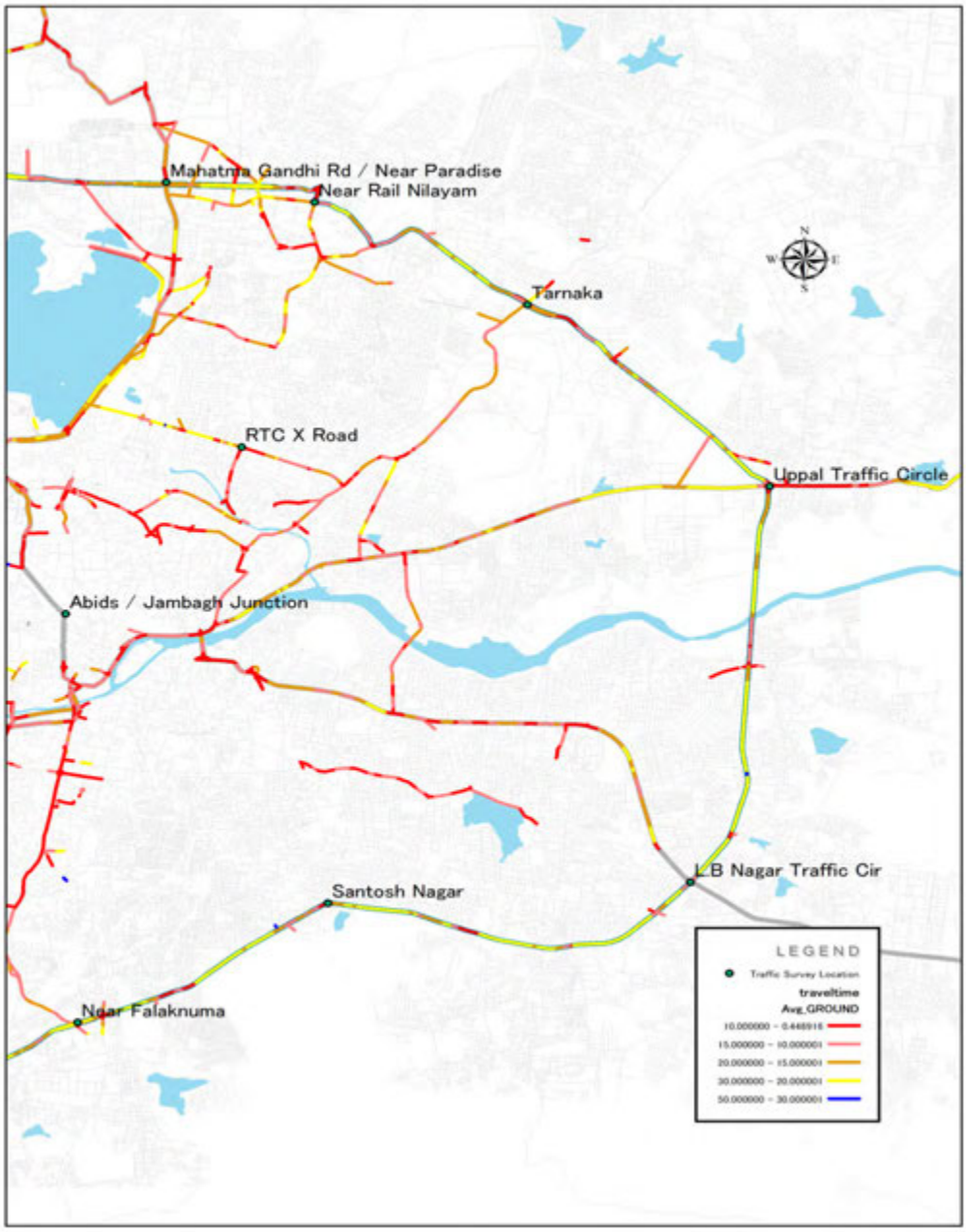


Source: JICA Study Team

Figure 85 Western Part of Hyderabad Travel Speed Survey Result - Daily Average Data

(3) Eastern Part of Hyderabad

In eastern part of Hyderabad, Uppal traffic circle and RTC X road intersection are among the most congested points. These major intersections should be improved with grade separation because there is not only bi-directionally important traffic but also heavy traffic. At the same time, area near Rail Nilayam, also needs improvement with crossing over pass or an underpass.



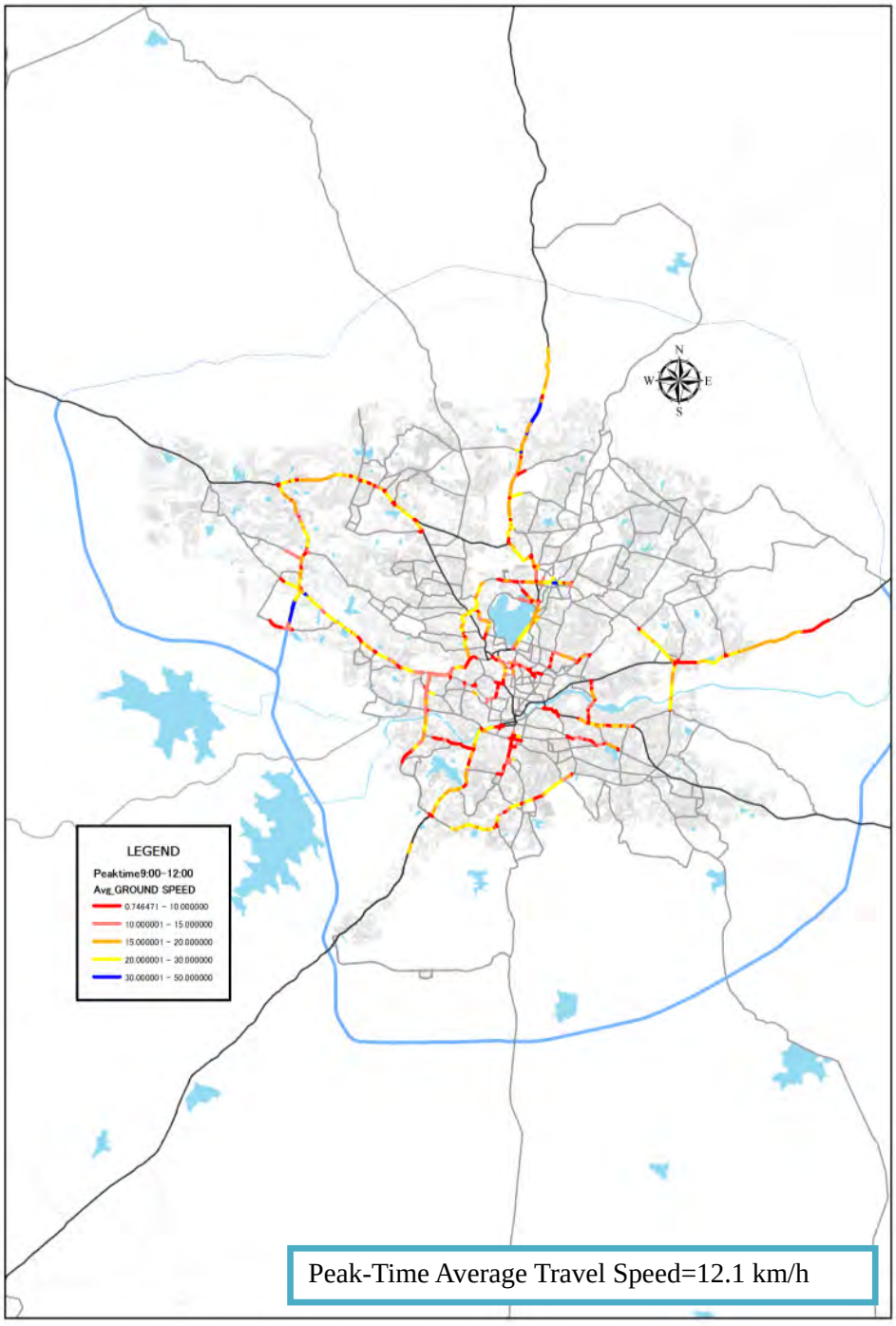
Source: JICA Study Team

Figure 86 Eastern Part of Hyderabad Travel Speed Survey Result - Daily Average Data

(4) Peak-Time Analysis

From the traffic survey result traffic peak-time was presumed between 9:00 to 12:00 because high demand of traffic volume was identified during time period.

The GPS matching result shows that peak-time average travel speed is worse than daily average travel speed and is 12.1 km/h.

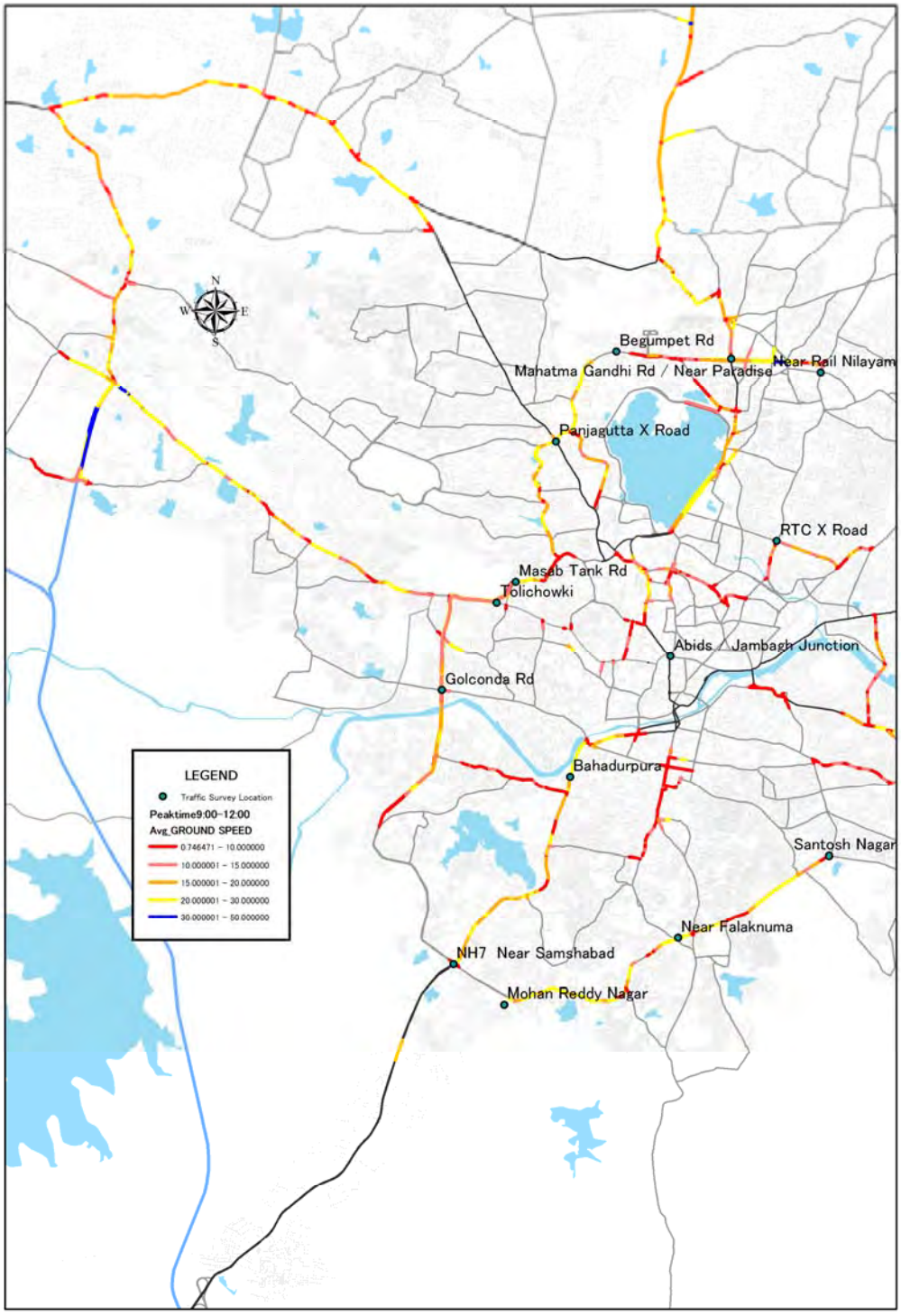


Source: JICA Study Team

Figure 87 Travel Speed Survey Result - Peak Time Average Data

(5) Western Part of Hyderabad Peak-Time

Although congestion point's tendency is same as the daily result, congestion level is higher than daily average speed. Especially, northern part of IRR is almost under 10 km/h and worse than daily average.

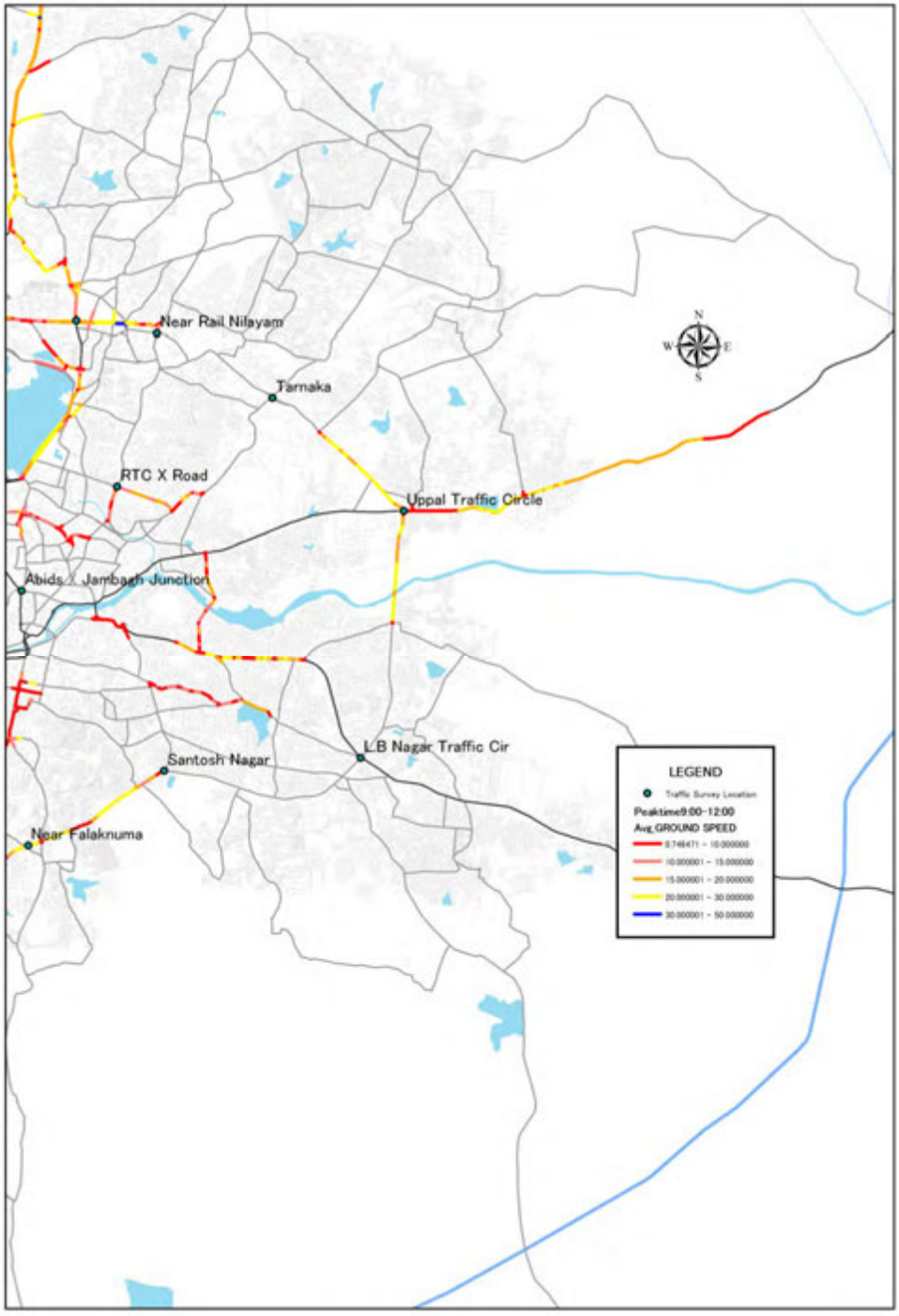


Source: JICA Study Team

Figure 88 West Part of Hyderabad Travel Speed Survey Result - Peak Time Average Data

(6) Eastern Part of Hyderabad Peak-Time

The travel time in Eastern part of Hyderabad city during peak-time is also same as daily average time. Some congestion points like Uppal traffic circle, RTC X road and near Rail Nilayam needs radical solutions to improve current situation.



Source: JICA Study Team

Figure 89 East Part of Hyderabad Travel Speed Survey Result Peak Time Average Data

2-10 Identified Issues

2-10-1 Summary of the Identified Issues

Based on the review of the current conditions and existing plans, the major issues are identified as summarized below.

Table 31 Summary of Identified Issues

Category	Identified Issues
Regional Socio-Economic Characteristics	Rapid growth of population (up to 2.5 times from 1991) due to continuous migration into the city of Hyderabad. Sprawl growth of urban area.
Regional Traffic Characteristics	Rapid growth of vehicles, high proportion of motorcycle and auto-rickshaw, heterogeneous traffic composition, heavy traffic volume inside IRR, chronic traffic congestion inside IRR and major roads. Low average travel speed, traffic mixed with low speed vehicles e.g. auto-rickshaw.
Regional Transportation Characteristics	Insufficient connectivity between different transport mode, limited number of railway crossing, insufficient information of the public transport, improper location of bus stops, insufficient maintenance of the public transport, large proportion of road transport mode usage, insufficient ticketing system, declining quality of bus services, increasing number of road traffic fatal accidents.
Road Infrastructure	Insufficient road infrastructure to accommodate the traffic demand in the city, absence of hierarchical road classification, insufficient facilities including sidewalks encroachment, inadequate parking spaces, improperly designed junctions/intersections, not properly working signals etc.
Traffic Manners	Lack of traffic discipline including lane hogging, no helmet, signal jumping, railway crossing pedestrians, wrong way driving, frequent phone usage, excessive number of people on vehicles/motorcycles, forcible overtaking. Insufficient awareness of importance of traffic discipline.
Existing Facilities	Not sufficient maintenance, absence of systems which support for planning/traffic and road management, absence of data base such as traffic data, road inventory, absence of cash less system, absence of travel information/traffic information, signals installed on the intersections which are not properly designed, insufficient facility for public transportation information provision.
Facility Management	Complex structure of facility management through procurement, installation, operation and management. (e.g. traffic signal procured, installed and maintained by GHMC, managed by Traffic Police and out-sourced to the private company for operation by BOT) The responsibility becomes unclear and results in lack of consistency for proper operation and management.
Administrative	Insufficient coordination for infrastructure planning, traffic management,

Structure	road management. Different agencies involvement for road and facility management including procurement, construction/implementation, operation and maintenance, complicated jurisdiction demarcation of road network, lack of human resources, lack of finance, lack of engineering experience/knowledge.

2-10-2 Most Critical Issues from a View Point of ITS

The most critical issues in Hyderabad from a view point of ITS are summarised as follows:

Table 32 Most Critical Issues in Hyderabad

Most Critical Issues in Hyderabad
1. Absence of Quantitative Traffic Data
2. Absence of Centrally Coordinated Administrative Structure
3. Lack of Basic Infrastructure
4. Insufficient Proper Facility Maintenance
5. Absence of National Framework

The details are explained below.

(1) Absence of Quantitative Traffic Data

The road infrastructure and traffic management need to be properly planned, implemented and improved for greater positive effects. This can be realised by utilizing the accumulated quantitative traffic data. However there are no basic facilities which can collect, cumulate and evaluate the measures taken. In addition, no major initiatives have been taken for this matter by the implementing and planning agencies either.

The traffic monitoring is solely dependent on CCTV in Hyderabad. It is planned to install more CCTV to be used to visually confirm the conditions at site to assist the operations. It cannot be used for quantitative measurement of the traffic.

Thus, the traffic/transportation measures such as road construction in the city, lane marking are taken on ad-hoc bases, not achieving a fundamental solution.

(2) Absence of Centrally Coordinated Administrative Structure

A variety of different agencies are planning ITS related facilities in Hyderabad. However these plans are not sufficiently coordinated among the involved agencies and this results in lack of integration and proper maintenance. The planning, implementation and evaluation of traffic management, road/transport infrastructure and urban development need to be carried out in well-coordinated manner among the related agencies. It is assumed that the absence of such coordination is one of the prime causes of many issues in Hyderabad.

(3) Lack of Basic Infrastructure

ITS is one of soft measures. Road infrastructure needs to be properly developed to bring out effect of ITS. For example, properly designed junctions/intersections, strait-structured road, footpath appropriately developed for pedestrians, etc. are basic conditions. However such road infrastructure is not sufficiently developed in Hyderabad. In addition, lack of driving manners is also challenging issue in Hyderabad although it is not infrastructure. For example, keeping lane is important factor to measure traffic by ITS.

(4) Insufficient Proper Facility Maintenance

Some preliminary facilities are in place in Hyderabad. They include CCTV at junctions, traffic signals, signal jumping violation equipment, etc. However many of them are not properly working due to insufficient proper maintenance. The reasons for this derive from the related issues including lack of human resources, finances, infrastructure, know-how, coordination among the agencies, etc. Assurance of the proper maintenance needs to be addressed for sustainable ITS operation.

(5) Absence of National Framework

ITS is a broad concept, which is not limited to particular facilities such as traffic signals. It involves a wide range of different subsystems and needs to be properly integrated / harmonized to function as a whole. It would be ideal to prepare the ITS under the framework of the National Policies. However the introduction of ITS has just started in recent years in India, and thus National policies have yet been established.

2-10-3 Clarification of Issues

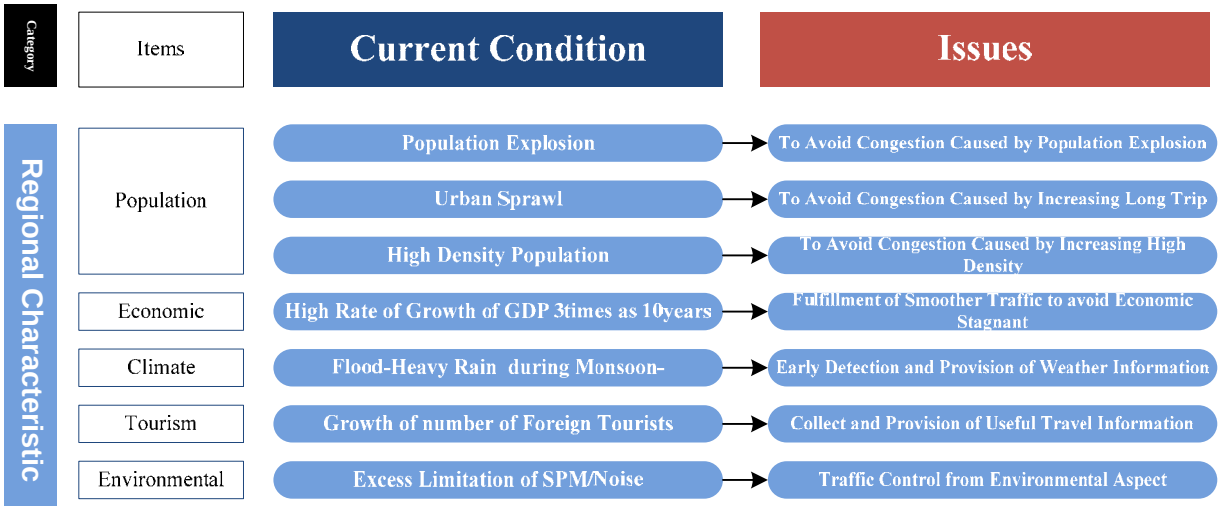
The major issues observed in Hyderabad can be categorized based on cause as below:

- Issues Caused by Regional Characteristic
- Issues Caused by Regional Traffic/Transportation Characteristic
- Issues Caused by Road and Related Infrastructures
- Issues Caused by Traffic Manners
- Issues Caused by Existing ITS Related Systems
- Issues Caused by Agencies Administrative Structure

(1) Issues Caused by Regional Characteristic

The main issues from the regional characteristic are population, economic, climate, tourism and environmental. The current condition of the regional population in Hyderabad is high and high density, in addition that it part of the reason for urban sprawl. Moreover, urban sprawl brings about traffic congestion, because urban sprawl makes long trips. Nevertheless this kind of current condition, Hyderabad Economic is growing constantly. For sustainable development, assuring smoother traffic is essential. During monsoon season, overhead flooding are often happened in Hyderabad. For effective road management and road user-friendliness, early detection and provision of weather information are the issues. Due to lack of the travel and tourism information, traveller from foreign countries faced poverty of tourism information at sightseeing spots. SPM and Noise factors are constantly exceeding limit, traffic control from environmental aspects should be prepared in promptly.

As referred to above, Issues cause by Hyderabad regional characteristic are summarized below.

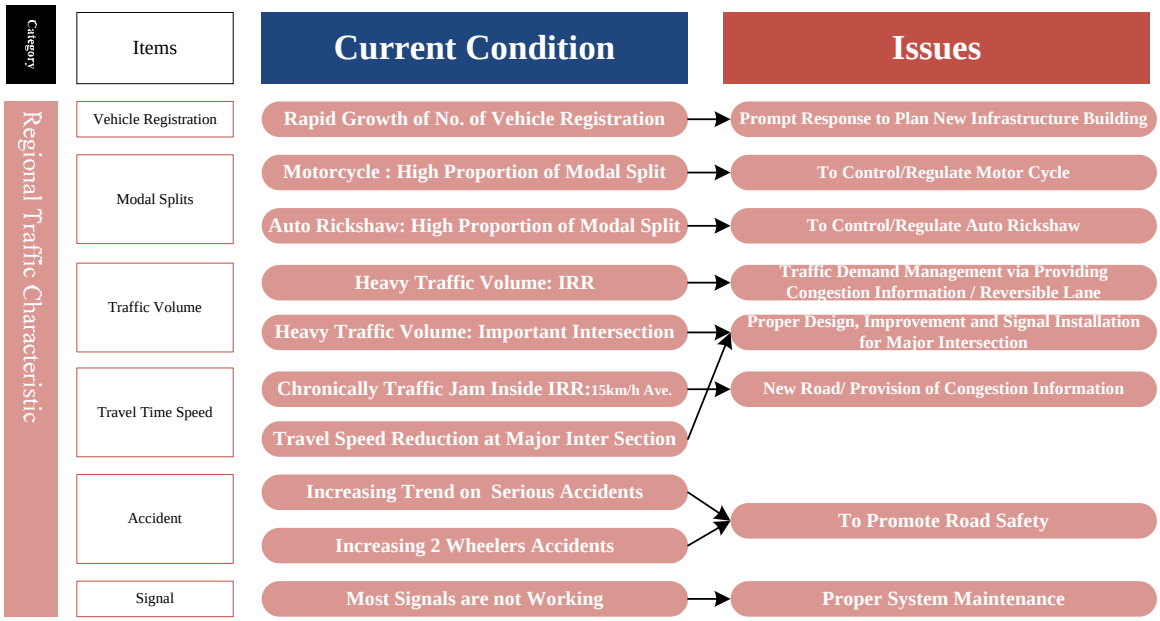


Source: JICA Study Team

Figure 90 Issues Caused by Regional Characteristic

(2) Issues Caused by Regional Traffic/Transportation Characteristic

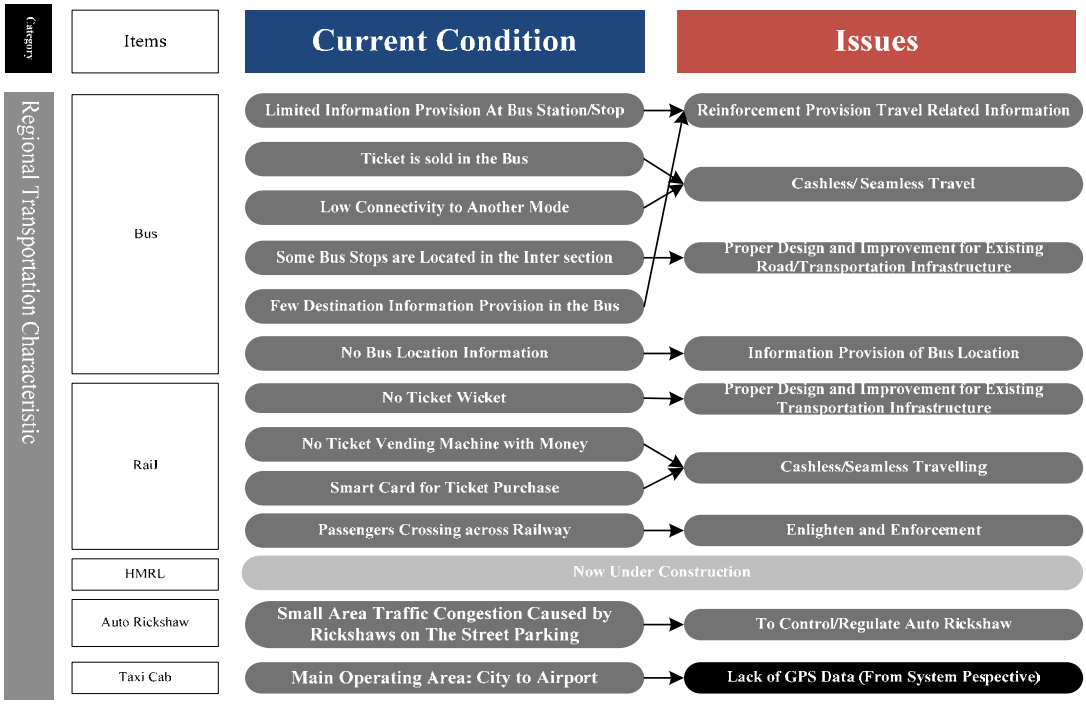
To indentify the issues from Regional Traffic/Transportation Characteristic, current conditions are itemized in 11 categories. From regional traffic characteristic, issues are derived such as "Lack of road infrastructure", "Improper design", "Traffic demand management" and "Proper signal system maintenance " and so on.



Source: JICA Study Team

Figure 91 Issues Caused by Regional Traffic Characteristic

By the same token, the issues caused by Hyderabad regional transportation characteristic are summarized below.

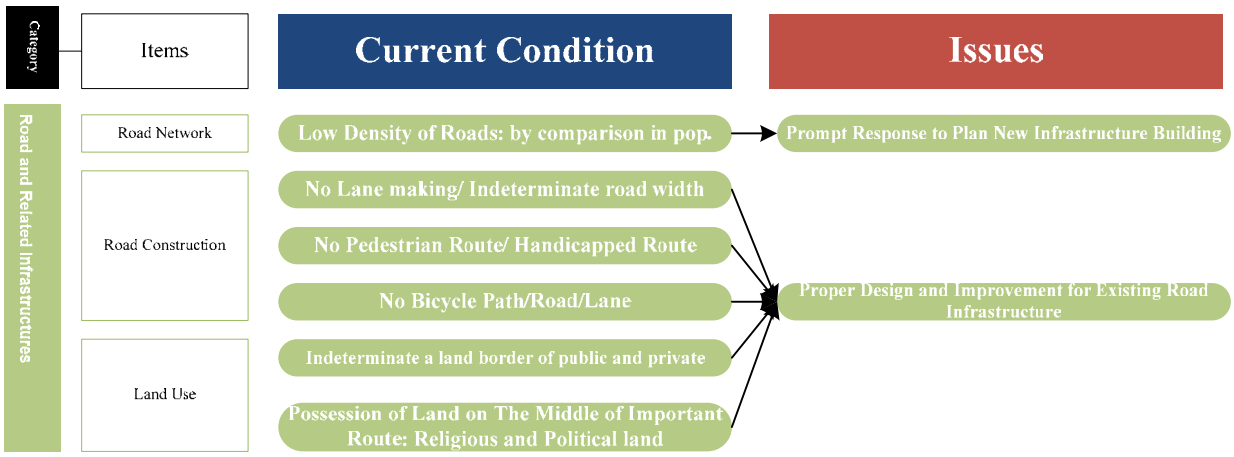


Source: JICA Study Team

Figure 92 Issues Caused by Regional Transportation Characteristic

(3) Issues Caused by Road and Related Infrastructures

The issues caused by road and related infrastructures are common sense in citizen, like lack of road density, no lane marking, no pedestrian route and indeterminate a land border of public and private.

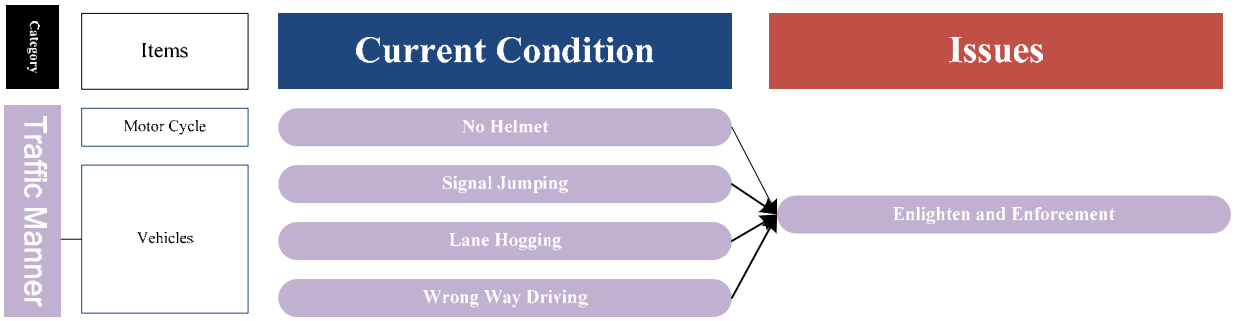


Source: JICA Study Team

Figure 93 Issues Caused by Road and Related Infrastructures

(4) Issues Caused by Traffic Manners

The traffic manners in Hyderabad are absolutely poor. The enlightening and enforcement for the traffic manners is promptly needed.

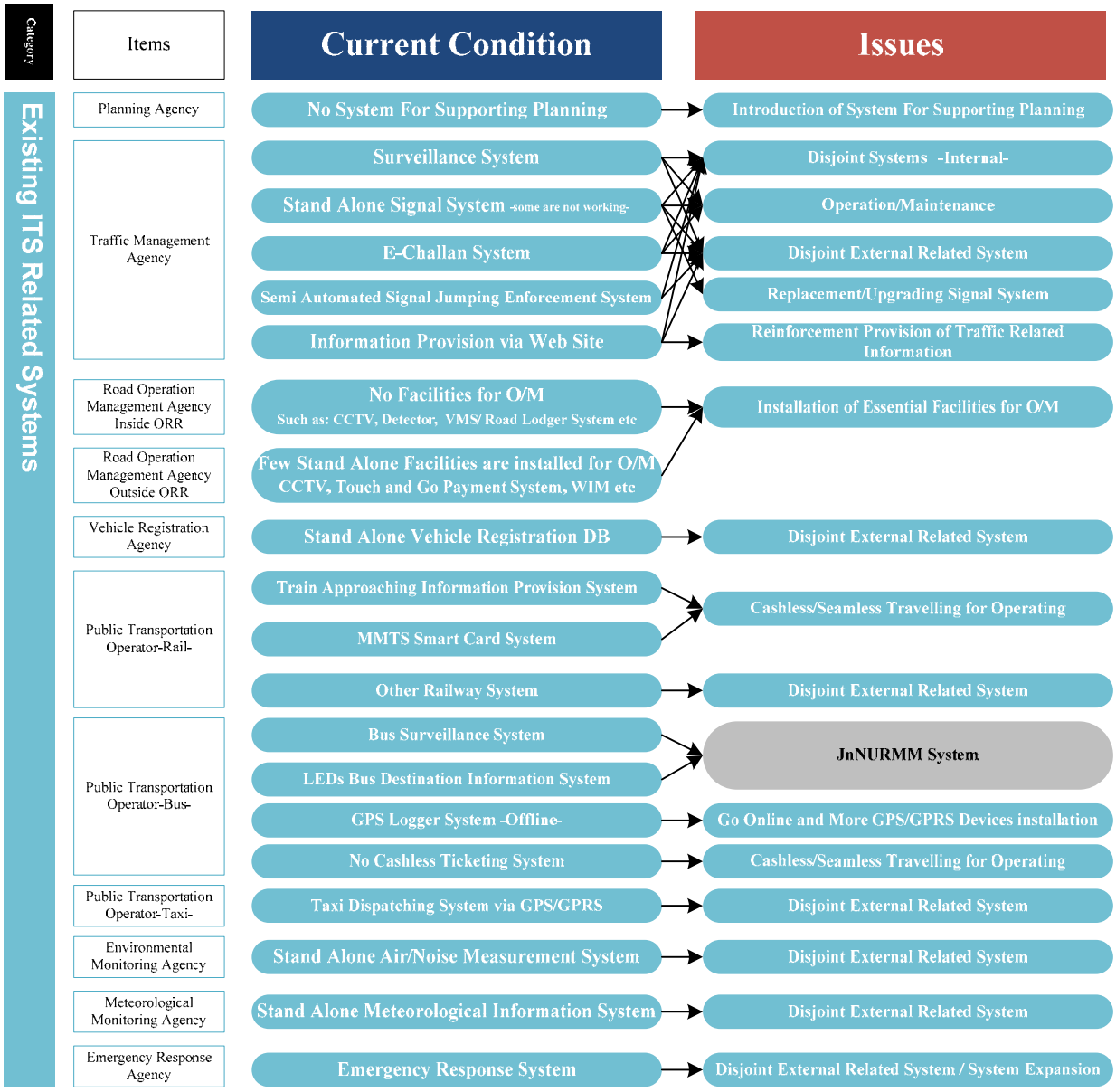


Source: JICA Study Team

Figure 94 Issues Caused by Traffic Manners

(5) Issues Caused by Existing ITS Related Systems

There are several kinds of existing ITS related systems. The planning agencies have no supporting system for planning, traffic management agency has several enforcement related systems and other agencies have their own ITS related system. However, due to lack of whole picture of ITS fields and integration, great majority of systems are disjointed not only external systems but also internal systems.



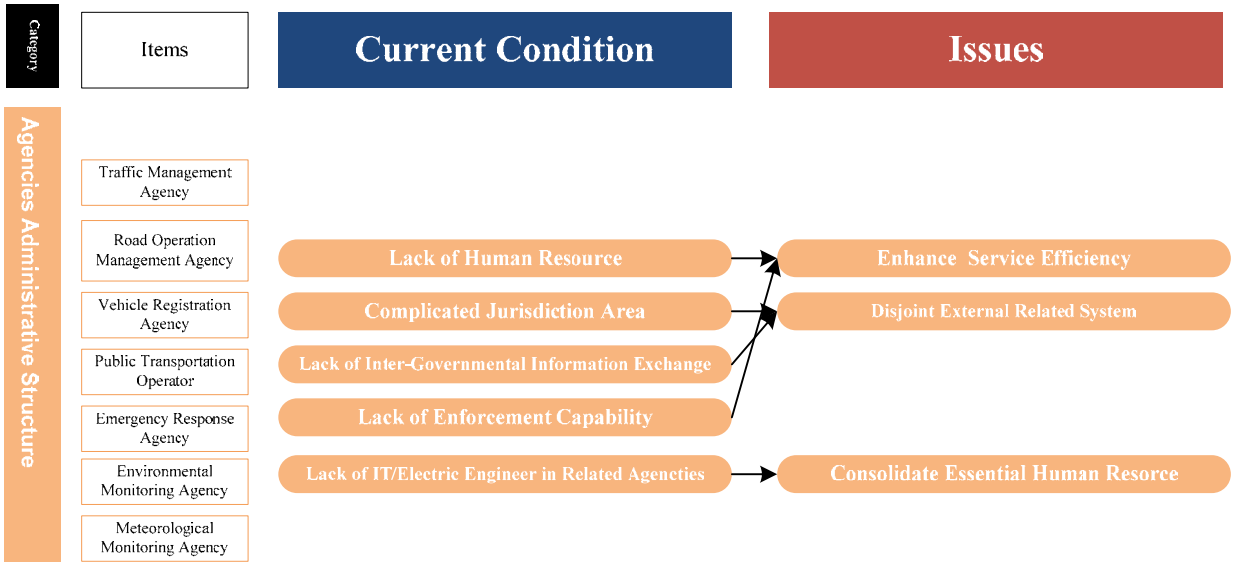
Source: JICA Study Team

Figure 95 Issues Caused by Existing ITS Related Systems

(6) Issues Caused by Agencies Administrative Structure

From the result of interviews and sight survey for related agencies, current conditions of agencies and administrative structure are summarized as figure below. Almost of all the agencies mentioned that they lack human resources especially, IT and electric engineers. In addition, from our observation, jurisdictional area is really complicated to administer whole of traffic and transport in Hyderabad city. Moreover, because of complicated jurisdictional area, there is lack of

inter-governmental information exchange. The issues are derived from this kind of current condition.

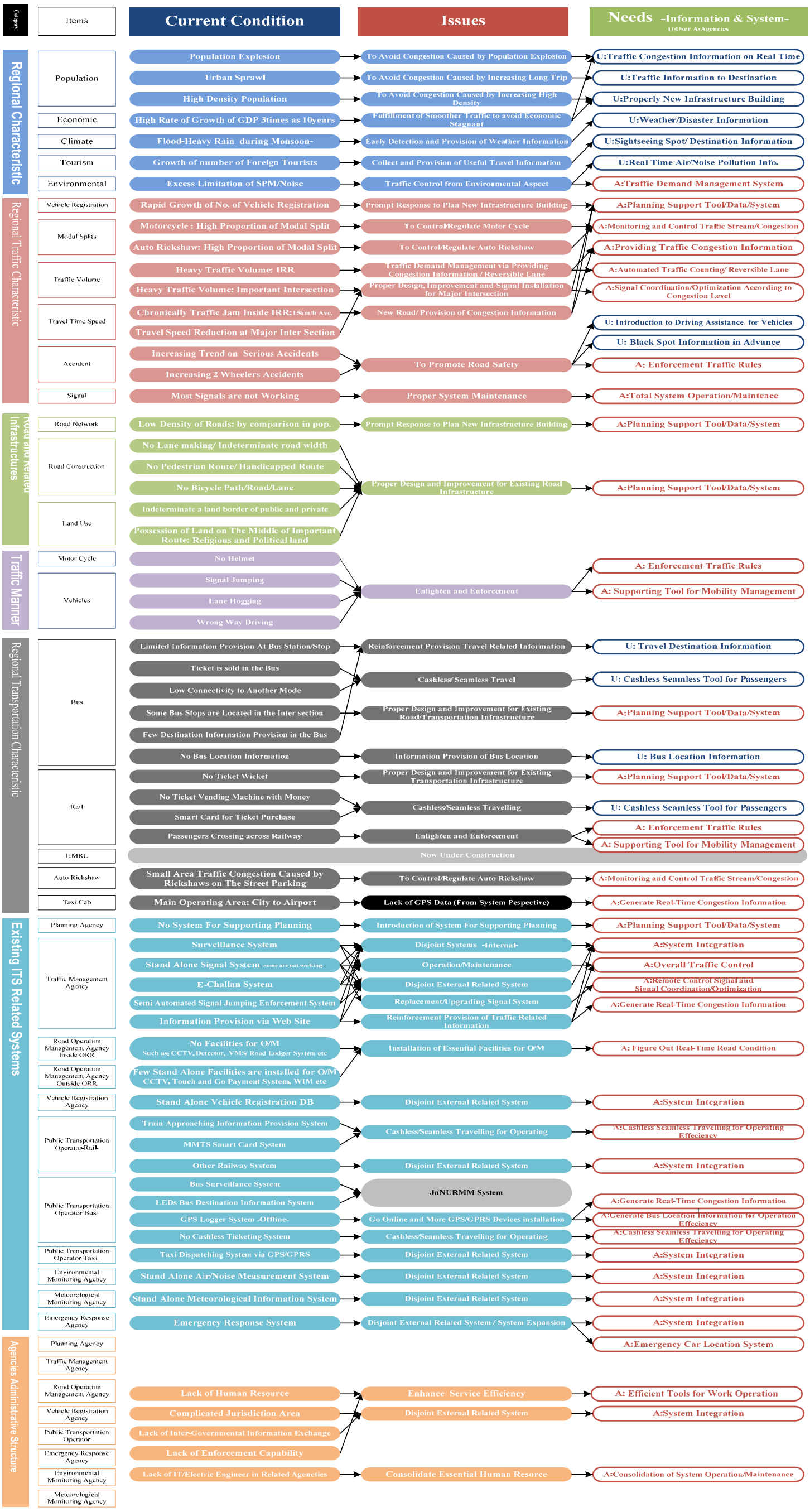


Source: JICA Study Team

Figure 96 Issues Caused by Agencies Administrative Structure

(7) Summary of Current Issues and Envisioned Needs for Information and Systems

The summary of current issues and envisioned needs for information and systems are shown below.



Source: JICA Study Team

Figure 97 Summary of Current Issues and Envisioned Needs for Information and Systems

3 Policy Framework for Introduction of ITS

The basic policies are set out for introduction and implementation of ITS in the Hyderabad Metropolitan Area, based on the review and studies thus far as follows.

3-1 Methodology for ITS Master Plan in Hyderabad

There exist a number of different subsystems of ITS including the advanced ones which are implemented in other countries in the world. It would not be appropriate to simply apply those which are in place in the different countries to Hyderabad Metropolitan Area. The particular local condition needs to be well considered for applying ITS. But, it is also true that there are many good examples which can be used as reference for consideration of ITS in Hyderabad. Thus, the following methods, as shown in the figure below, are taken for preparation of ITS Master Plan which can be best suited for the Hyderabad Metropolitan Area.

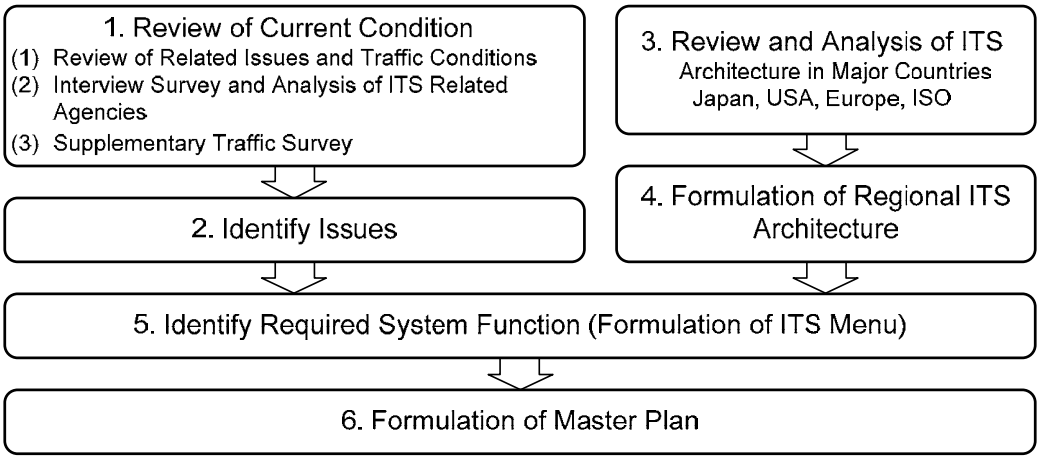


Figure 98 Methodology for Formulation of ITS Master Plan for Hyderabad

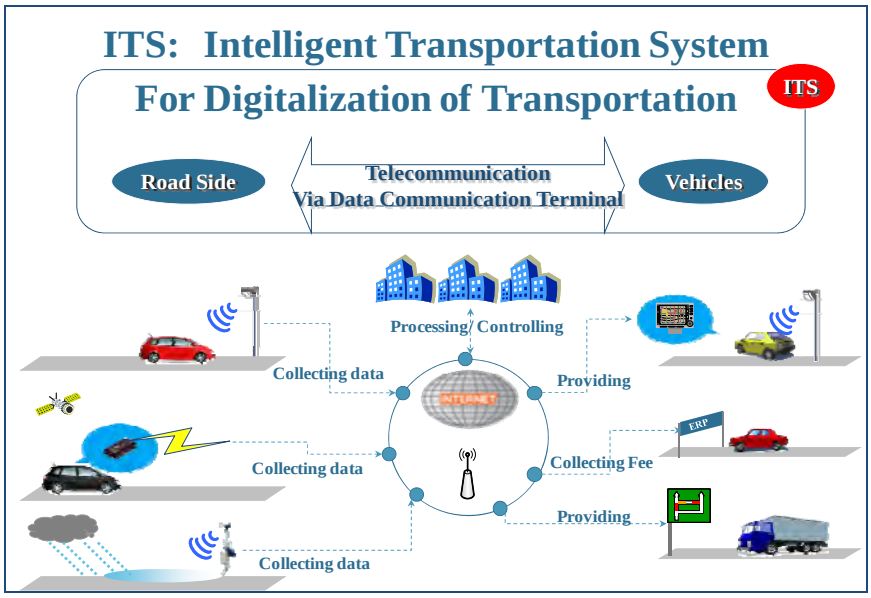
3-2 What is ITS?

ITS aims to realize the advanced transportation society utilizing/applying the information and telecommunication technologies. The ultimate goals of ITS are to enhance the safety, improve the road environment, comfort in the road usage and leading to the economic growth in ultimate meaning. In order to realise these, the important area to be addressed is improvement of traffic condition. In the adverse traffic congestion, the safety, environment and users' conveniences are sacrificed and consequently economy grows stagnant. The ITS enhances the efficiency of traffic control and road management by applying the information technology to the transportation sector, leading to the ultimate objectives.

The ITS realises 'Digitalization of Transportation' to support for:

- Optimization of Traffic Flow/Reduction of Congestion
- Reduction of Traffic Accident/Realization of Society in Safety and Security
- Reduction of Pollution, Vehicular Emission/Improvement of Environment
- Activation of Economy (Reduction of Loss by Improvement of Congestion)
- Vitalization of Local City by Attracting Tourists
- Promotion of Efficiency in Traffic Control/Road Maintenance
- Feedback to Transportation Planning, Infrastructure Development Planning (By Quantitative Measurement of Real Condition)

- Promote Usage of Public Transportation (In turn, reduce Congestion and improve Environment)
- Improvement of Comfortableness for Road Users



Source: JICA Study Team

Figure 99 Thematic Image of ITS

The hard measures e.g. road network development, fly over construction, road widening, etc, are important for stable economic development. But the soft measures such as proper traffic control and road management is also critical as well as the hard measure. The ITS addresses the soft measures and consequently enables the proper implementation of the hard measures.

3-3 Best Practice of ITS in the world

The best practices of ITS in the world are described below.

(1) Traffic Control Centre

The traffic control centre collects the road and traffic related data such as CCTV image, traffic volume, travel time, weather condition on the road, etc. Such data is monitored at the traffic control centre for 24 hours and 365 days by the road and traffic operators. The traffic congestion data is automatically generated. The incidents are identified by monitoring CCTV images at the traffic control centre and also based on the information reported by the traffic police at site and other agencies.

The road and traffic operators dynamically control traffic by traffic signals and providing information to road users through VMS, Website, SMS, etc.

Figure 100 below shows an example of the traffic control centre in Japan and Figure 101 below shows a congestion map on the website provided by the road operator in Japan. The red lines in Figure 101 indicate the heavily congested road sections. It is automatically and periodically updated based on the results of traffic analysis. The road users can obtain the road and traffic data through such media as car navigation and computers and mobile phones via the internet.

Figure 100 Traffic Control Centre

(Identified congested section and level of congestion on road network)

Figure 101 Congestion Information

(2) Variable Message Signboard

The Variable Message Signboard (VMS) is installed with the supporting structure on the road. There are several types of supporting structures such as cantilever, gantry, and pole. The size of VMS is designed to be large enough for drivers to be able to read the displayed information on the VMS. There are different types of VMS such as character display, graphic display, black & orange colour, full colour, etc.

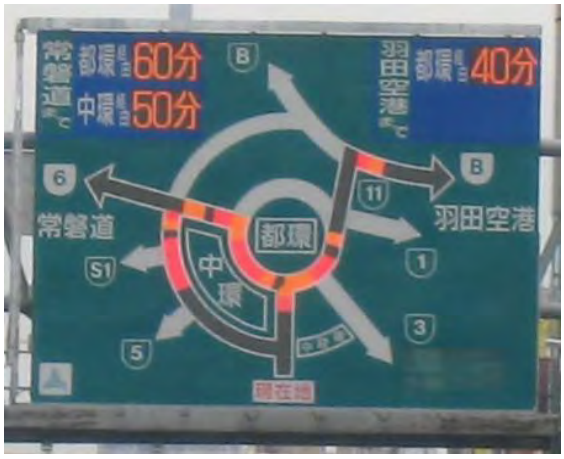
The LED is usually used as a light source because of its efficient energy consumption and long lifetime. VMS devices are controlled from the traffic control centre.

Examples of VMS in Japan are shown in the figures below. Figure 102 is the graphic type VMS to show the realtime simplified road image showing the traffic status such as road closure and congestion. Figure 103 is multi-colour and character type VMS. This type of VMS is often used on expressways in Japan. Figure 104 is a simplified road image type. It shows the traffic information such as road closure, congestion and travel time to several major destinations ahead. This type of VMS display helps the road user know the road network, alternative routes and select the optimum routes to reach his destination. It is often used on expressways in Japan.

(Showing road disaster and road closure ahead/ and providing alternative route guidance)

Figure 102 Graphic Variable Message Sign Board

Figure 103 Variable Message Signboard



(Showing congested section and level of congestion on road network)

Figure 104 Variable Message Signboard

Figures shown below are examples of VMS in Europe. The left picture in Figure 105 shows the combined graphic and character type of VMS. The right picture in Figure 105 shows two types of VMS: one is a standard single colour type; the other displays variable speed limit on each lane. The speed limit is dynamically changed according to the traffic condition.

Figure 105 Variable Message Signboards in Europe

(3) Camera System

The camera system is composed of CCTV camera, hi-speed communication line such as dedicated fibre optic line and TCP/IP based network, and remote monitoring and controlling system in the traffic control centre. The CCTV camera is installed on the roadside at critical locations, flood prone locations and congestion points.

Figure 106 shows the CCTV camera attached to structure pole. The camera is covered by special case to protect it against rain. Figure 107 is a large screen in the traffic control centre where the realtime traffic images at different locations are monitored. The road operator can monitor these pictures and recognize the road status such as congestion, vehicle accident, road weather and special events in realtime to take appropriate actions according to the road condition.

Figure 106 CCTV on Roadside

Figure 107 Visual Confirmation by Moving Picture Captured by CCTV

Figure 108 and Figure 109 show the examples of image processing analysis. Thin green or white lines drawn on the pictures are the results of dynamic image processing analysis. It can be seen that these thin lines are overlapped on the vehicle because the image processer recognizes the vehicle in realtime.

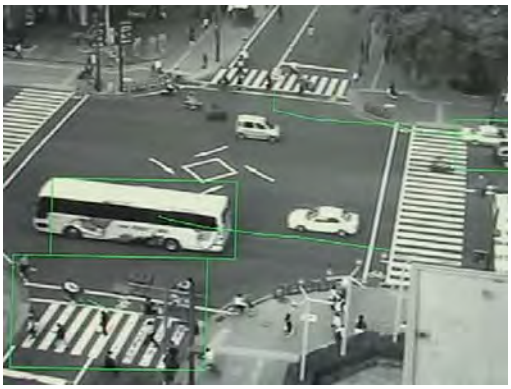


Figure 108 Image Processing Analysis for Traffic Measurement
(Traffic Volume, Speed, Occupancy)

Figure 109 Image Processing Analysis
(At different location)

The camera system is not only used for surveillance purpose. It is also used for traffic counting which is generally known as Automatic Traffic Counter and Classifier (ATCC), and number plate recognition which is generally called as Automatic Number Plate Recognition (ANPR).

(4) Probe Car (Floating Car)

The probe car, also known as a floating car, is a system to collect vehicle tracking information dynamically. A probe unit installed in a vehicle is composed of GPS unit, processor unit, communication unit and power supply unit. The probe unit sends the traffic data such as vehicle position, speed, direction and recorded time dynamically to the centre system. The Probe data collected at the centre from various vehicles is corrected for data discrepancies and analysed to dynamically generate travel time and travel speed on the road network. The analysed data is stored in database for future usage as the statistical and historical data by the road planning agencies for traffic and the urban development planning.

Human probe system is nowadays developed as an advanced probe system and is increasingly utilised by several agencies. Smart phones such as iPhone and android phones are used as human probe systems. The location is identified by GPS embedded in the smart-phone or Wi-Fi positioning system,

and travel time and travel direction are dynamically calculated. Such data is collected by communication carriers or mobile application companies like Google. The collected data is analysed in terms of traffic mode such as waking speed, vehicle travel speed on the city roads, on the expressway and travel speed on the train. The traffic data is categorised into each traffic mode.

Based on such data, the traffic congestion is identified, travel time is calculated, and traffic reports are rapidly generated.

The images shown below are birds-eye-views of road network by the satellite picture of a city in Japan. The light blue line means smooth traffic, yellow line slightly congested and red line highly congested. Figure 111 shows the damaged road after the massive earthquake in Tohoku-area in Japan in 2011. These maps are generated by utilising probe car data.

Figure 110 Probe System
(Identified congested section and level of congestion)

Figure 111 Probe System
(Identified damaged road section after massive earthquake in Japan)

(5) Bus Location System

The bus location system employs the same technology as the probe car system. It uses the probe unit in the bus for bus tracking on the road. The central computer system collects all probe data installed in the buses and analysis the location and speed of the buses, and estimate travel time to the next bus stops. The bus location system helps bus users know the arrival time. The below images are examples of the bus location system operated by bus agency in Japan. Figure 112 shows the bus locations and their travelling status on the city roads shown on the website. Figure 113 shows the information provided at bus stop. It helps the bus users know the expected arrival time and the bus routes to reach their destinations.

Figure 112 Bus Location Information Provided on Website

Figure 113 Bus Location Information Provided at Bus Stop

(6) Vehicle Information and Communication System

The Vehicle Information and Communication System (VICS) is a leading road traffic information system which is available over the entire area of Japan. It provides the dynamic road and traffic information to the road users. The road and traffic data is collected by the road and traffic administrators and processed at VICS Centre. The processed information is provided to the drivers and shown in the car navigation as shown in Figure 114.

Figure 114 Entire Overview of Traffic Information Provision: VICS in Japan

The information provided by VICS is shown by the car navigation unit. It includes congested section, congestion level, road closure notification, etc.

Figure 115 Traffic Condition Shown on Car Navigation through VICS

(7) Smart Card System

The smart card system is an integrated system that can be used across different transportation and for multi-purposes including buses, railways, shopping, etc. It is an electronic money rechargeable card and can be recharged at a shop or by internet. An auto rechargeable system linked with credit card company is also available for some smart card systems.

The figure below shows a smart card system in Japan.

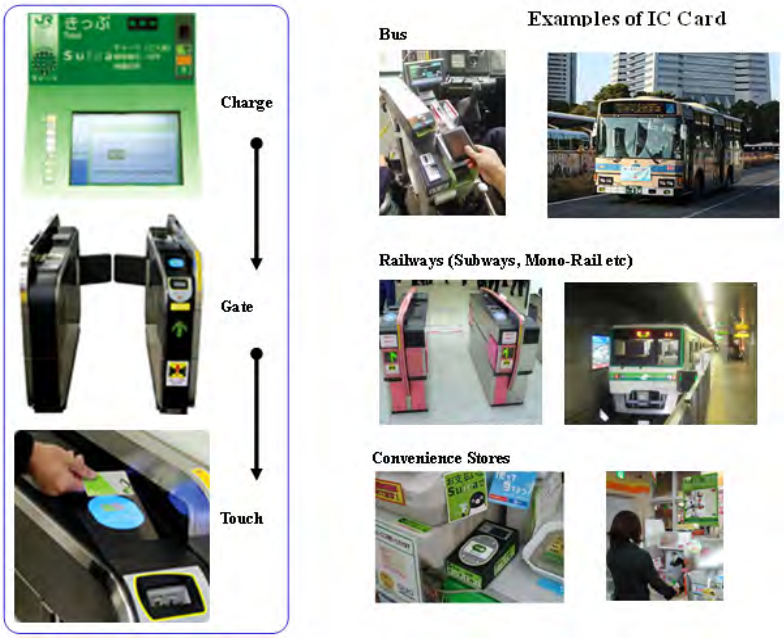


Figure 116 Multipurpose Smart Card

(8) Congestion Charging

The congestion charging is one of the methods for traffic demand management (TDM) to alleviate traffic congestion by imposing fees for road usage on road users. In recent years, the fees are electronically charged, using ITS. It is called, electronic road pricing (ERP). There are different methods and technologies of ERP implemented in the world. The major examples are DSRC based ERP in Singapore, ANPR based ERP in London, as exemplified below.

(a) Congestion Charging in Singapore:

ERP in Singapore was introduced in 1998 to regulate traffic flowing into central area of city. Currently, it is DSRC (Dedicated Short Range Communication) based ERP. It consists of on-board unit in vehicle, antenna on gantries on road and centre system. The fees are flexibly changed in accordance with traffic volume in the charging area. The vehicles to be charged include private 4 wheeler, taxi, truck, bus and 2 wheeler.

Figure 117 Electronic Road Pricing in Singapore

Vehicle detectors and cameras are attached to the gantries. In-vehicle unit is used to identify the vehicle and a smart card is inserted for payment of the road usage charges.

Above figure shows the ERP in Singapore. Singapore was the first city in the world to implement the electronic road toll collection system for the purpose of congestion pricing.

(b) Congestion Charging in London:

Congestion charging in London was introduced in 2003. It was initially applied to limited core area in the city and expanded to 40 sq. km. of central London including administrative district, financial district, major commercial areas, etc. It adopts automatic number plate recognition (ANPR) system. The number plates are registered in the database of Transport for London. The road users make payment, basically in advance. The payment can be made by various means such as on internet, by telephone, at counter in retail shops or petro station, etc.

The cameras monitor the number plate of vehicles, if they detect the vehicles which do not make payment in the charging area, the vehicle owner will be fined.

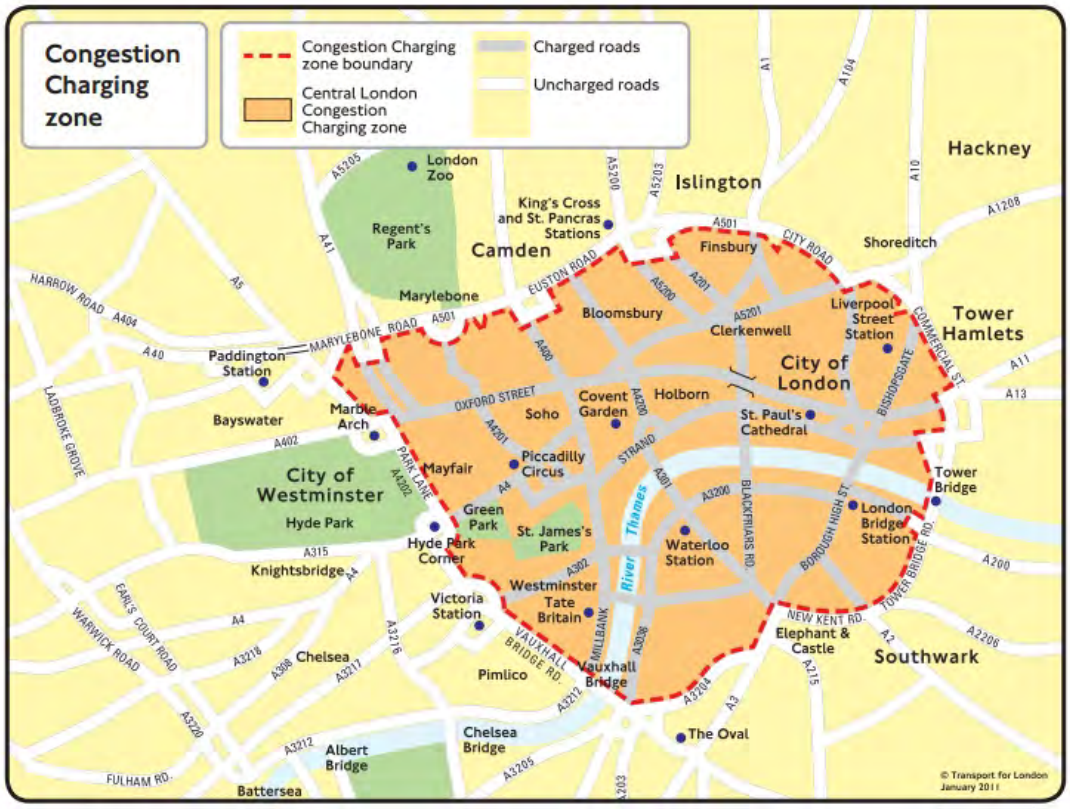


Figure 118 Example: Image of Congestion Charging Zone in London

(9) Lane Control System

There are various types of lane control system such as reversible lane, lane parking, variable speed controlled lane, etc.

The reversible lane is a lane in which traffic may travel in either direction, depending on traffic instructions. It controls traffic flow during rush hours, with the use of overhead traffic lights and VMS to notify drivers as to which lanes are open or closed. The reversible lanes are also used for the tunnels, bridges and surrounding roadways. Some recent cases of reversible lanes use a movable barriers to physically separate between allowed and not-allowed lanes of travel. In some systems, a concrete barrier is shifted during low-traffic hours to switch a central lane from one side of the road to the other.

The lane control system is a system that uses an area as parking as a part of the lane during the time of low traffic.

The variable speed controlled lane is a system that changes lane speed by displaying variable speed limit according to time and traffic conditions. Figure 5-20 shows the variable speed controlled lane system in USA.

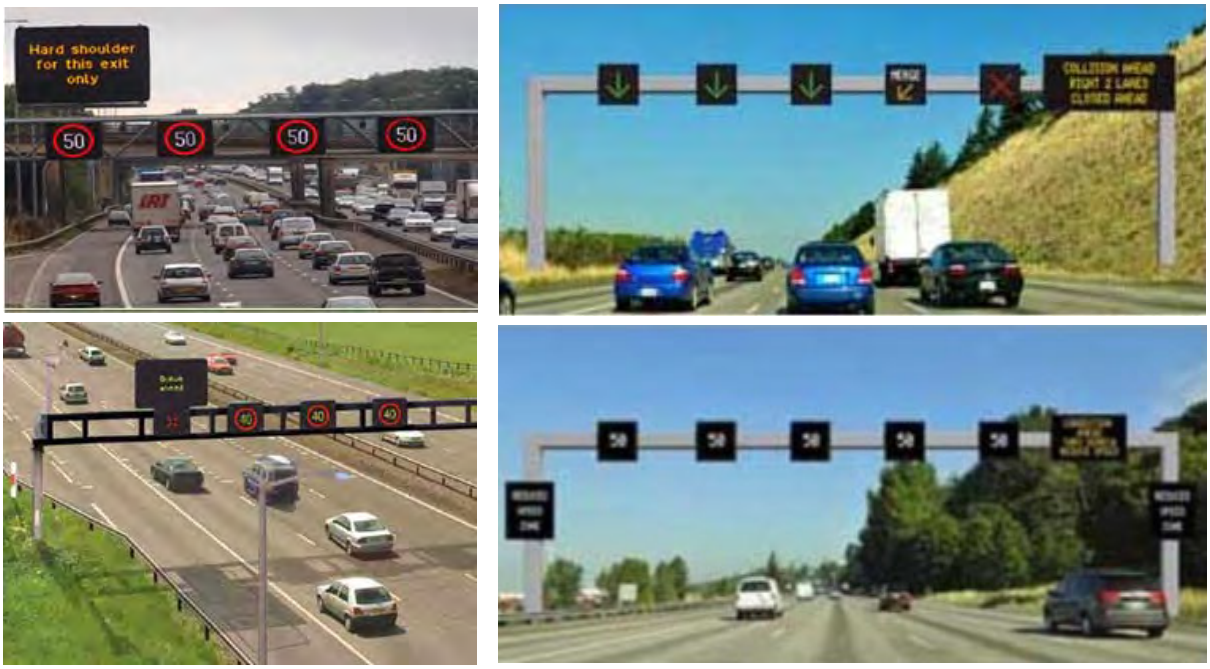


Figure 119 Lane Control by Showing Variable Speed Limit
According to time and traffic conditions in UK and USA

(10) Automatic Abnormal Traffic Detection

The automatic abnormal traffic detection is usually adopted at incident-prone locations such as blind curves, tunnels, merging sections on expressway, etc. It detects abnormal behaviour of traffic such as stopping vehicle caused by break-down, congestion, etc. by , in many cases, image processing. The main purpose of the system is to take prompt actions for accidents and pre-emptive measures to prevent secondary accidents.

The system provides, for example, warning message on occurrence of accident by VMS to the drivers running behind when it detects accident. The operators in the control centre take necessary actions upon receiving alarm announced by the system.

(11) Emergency Vehicle Preemption Systems

Fast Emergency Vehicle Preemption Systems (FAST) is one of the major examples of Emergency Vehicle Preemption System. It is available in Japan. It assists emergency vehicles such as police car, ambulance, etc. to arrive accident site as quickly as possible by giving them traffic signal priority along their path. It controls traffic signals to prioritise driving of emergency vehicles.

It is a part of the traffic control system and consists of in-car devices mounted on emergency vehicles and overhead infrared beacons installed along the roads as shown in the figure below.

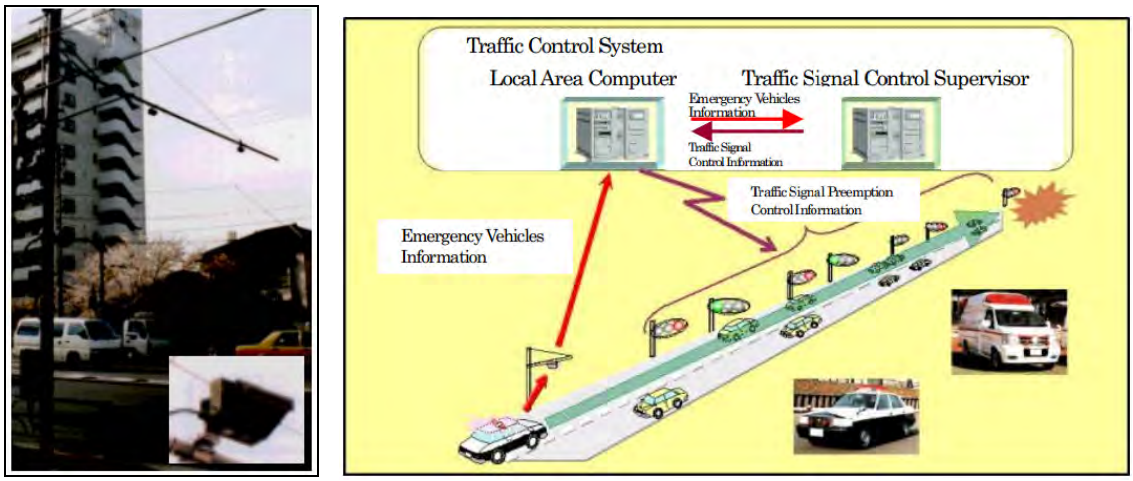


Figure 120 Example: Image of FAST System Configuration

The major benefits of the system are as follows:

- Improve life-saving rate
- Improve criminal arrest rate
- Prevent traffic accidents at intersections involving emergency vehicles

3-4 Differences of ITS between Developed Country and Developing Country

In all countries, an information strategy, which is a soft measure, is essential for the traffic network in addition to hard measures.

In developed countries where the road network is almost completed, ITS is more likely to be provided as value-added services to road users and administrators.

In developing countries, ITS may also be introduced as an advanced tool. However, the implication of ITS would be different in the developing countries where the hard measures such as the preparation of road infrastructure are not yet sufficient. In such situation, the soft measures are not limited to the domain of the information strategy, but imply more fundamental ways by which it can reinforce the hard measures for realizing better traffic flow. Under such scenario, ITS is regarded as an inclusive traffic strategy which equally encompasses the hard and soft measures in the developing country. In this sense, the meaning of the abbreviation ITS expresses '***Integrated Transportation System***', whereas generally it is '***Intelligent Transportation System***'.

3-5 Differences of ITS between National Level and Regional Level

National level ITS addresses standards for the entire country whereas regional level ITS addresses the particular local conditions. In case regional level ITS develops independently, the information exchange beyond the state border becomes difficult and manufacturers are required to provide different products for different regions.

In order to avoid such situation, it is necessary that national level policies and strategy across the regions. For example, standards shall be established and the regional level ITS will be prepared under the framework of the national level policies. The national level ITS strategy with clear vision allows industry to produce and supply products which are compatible across the regions. It also realises the information exchange by the regional ITS beyond regional borders.

In a huge country such as India, major transport is not limited to vehicles but also includes various transport modes such as airplanes, railways and sea vessels. Hence, it is necessary that an information strategy for the multi-modal transport environment is established as early as possible, and the regions and manufacturers cooperate and make advances towards the same objectives under the national vision.

The required national level ITS policies include:

- Traffic Network Strategy across the Nation
- Categorization of ITS and Clarification of Division of Roles among Industry-Government-Academia
- Strategic Investment for Research for the Systems
- Implementation of Pilot Projects
- Fibre Optic Cable Network Development
- Standardization of Digital Road Map
- Establishment of Regional and National ITS Centre
- Intercommunication Network Method

The features of the regional ITS include:

- Individual Systems Best Suited for Their Particular Needs
- Developed and Deployed In Line With Their Road Network
- Customized to Incorporate Above Under the Framework of the National ITS Strategy

3-6 Review of ITS Architectures in Major Countries

The architecture is a term used in the field of information technology. It is a framework which summarizes the policy and roles of the elements. In the field of ITS, the developed countries prepared their individual ITS Architecture.

For this study, the ITS Architectures prepared in the U.S.A., Canada, Europe, Japan and ISO were reviewed because these countries are leading in research, development and deployment of ITS technologies. The brief descriptions of the ITS Architectures in these countries are provided as follows:

(1) U.S.A.

The United States of America (USA) ITS architecture is the first country to have developed national ITS Architecture. It was developed in 1996 by the US Department of Transport (USDOT).

The USA ITS architecture adopts a process-oriented methodology. It is the method which defines functions and processes to realise the user requirements, which are expressed as specific user services in the field of ITS. It is a combination of the defined functions/processes, physical subsystems which contains field equipment and vehicles, communication interfaces required for information flow amongst the subsystems.

The benefits of the process-oriented methodology are:

- Integration: The architecture is designed by open standard. Thus the integration of subsystems becomes easy.
- Compatibility: The compatibility of equipment across boundary is needed.

Some disadvantages are:

- The architecture is required to be regularly maintained.

The maintaining and revising tasks are complex processes and require large amount of budget.

(2) Canada

The Canadian ITS architecture incorporates all aspects of the U.S. National ITS Architecture. The additional four services were identified which had not been included in the US Architecture e.g. safety of vulnerable road users, international border transportation management, etc. It was initiated by the guidance of the steering committee consisted by the representative from public and private transportation sectors. The Border Information Flow Architecture (BIFA) is undertaken in partnership with U.S. Federal Highway Administration.

(3) Europe

The ITS Architecture prepared in the Europe is called FRAME Architecture. It was prepared for building the common components across the different countries in consideration of the individual regional conditions under the framework of European Union.

(4) Japan

The Japanese national ITS architecture was completed in 1999. It was prepared in collaboration among five (5) related cabinet level ministries and agencies: National Police Agency, Ministry of Trade and Industry, Ministry of Transport, Ministry of Construction, and Ministry of Posts and Telecommunication. The ITS architecture is prepared in nine (9) development areas and has 21 user services with 172 sub-services.

The Japanese architecture adopts an object-oriented methodology. In this method, systems are developed by building self-contained modules or objects that can be replaced, reused, and individually modified. In this method, every entity is treated and regarded as an independent individual object. The entity includes user services, subsystems, modules and communication interfaces. Each object is complete and functional in itself.

The ITS architecture prepared by object-oriented methodology aims to achieve the following objectives:

- Assuring that the architecture flexibly meets changing social needs and evolving technology.
- Assuring that the architecture realises ITS which is inter-operable and inter-connectible with surrounding advanced technologies and telecommunication environment.

(5) ISO 14813-1 (ISO TC204)

The ISO 14813-1 2006 was prepared by the ISO technical committees as a reference model Architecture for the ITS sector. There are varying levels of details related to definitions of different services. These details differ from nation to nation, depending on whether the specific national architecture building blocks are based directly upon services or on groups of functions. Thus, it is intended to address the groups of services and the respective domains within which they fit. The Australian National ITS Architecture was prepared based on the ISO 14813

(6) Comparison Analysis of ITS Architecture in Major Counties

The following table compares the ITS Architectures in the above countries. For example, Japanese Architecture is featured as object-oriented method and defines the services in detail which is comparatively easy to maintain. ISO Reference Model Architecture is prepared as standard for reference by the regions/countries for preparation of ITS Architecture. It is considered that the ISO Reference

Model Architecture is appropriate base for the Master Plan study.

Table 33 Comparison Analysis of ITS Architecture in Major Counties

Country	U.S.A.	Canada	Japan	Europe	ISO
Name / Year Established	National ITS Architecture / 1996	ITS Architecture for Canada / 1999	Japanese National ITS Architecture / 1999	The FRAME Architecture / 2000	Reference Model Architecture / 2006
Agencies Owned by or Developed	The United States Department of Transportation (USDOT) established national ITS architecture in 1996. Since then, the US National ITS architecture has been updated several times, with Version 6 released in 2009.	Under the guidance of a steering committee of public and private sector representatives from the Canadian transport industries, the development of the ITS Architecture for Canada was initiated in 1999. Transport Canada is undertaking the development of the Border Information Flow Architecture (BIFA) in partnership with U.S. Federal Highway Administration.	Jointly developed by five (5) government agencies as follows: ・National Police Agency ・Ministry of International Trade and Industry ・Ministry of Transport ・Ministry of Posts and Telecommunications ・Ministry of Construction	The FRAME Architecture (originally called the European ITS Framework Architecture) was developed as a result of recommendations from the High Level Group on transport telematics, which were supported by a resolution of the Council of Ministers. It was established and first published by the EC funded project KAREN in 2000. ※Karen : Keystone Architecture Required for European Networks	ISO technical committees prepared ISO 14813-1 as a reference model Architecture for the ITS sector.
The No. of User Services	It is comprised of 33 user services and they bundled into 8 groups.	It is comprised of 37 user services and bundled into 9 groups.	It is composed 21 user services (56 specific user services) and bundled into 9 groups of development areas.	It is comprised of 677 user needs and bundled into 9 groups.	ISO 14813-1 identifies 11 service domains and 43 service groups.
Analysis Result	This defines the functions that must be performed to implement a given vehicle oriented user service. Therefore, services for pedestrians are not included. In contrast, Special feature of this architecture is to present specific goals for deployment services depending on either Urban, Inter-urban or Rural and timeframe either	This subsumes all of the U.S. National ITS Architecture work and extends and modified it to provide new services. This excluded “Traffic Management” as an independent category compare with The US’s. 4 services were specified also which are missing the US Architecture such as safety of vulnerable road users, international border	This Architecture is adopted the object-oriented method. This method makes it easier for future alteration and expansion. Because, there is no one-to-one correspondence between other countries and Japanese. Second advantage is each sub-services defined in detail so that particular services provided will be explicit.	This is defined by the user needs and functional view point. The “User Needs” of each group was described all aspects of tasks such as objective, planning, activation and so on. JICA study team assumes the reason of so many “users need” is that any nation within E.U. enables to adopt in accordance with specific situation of each. In addition, description of functionality for vehicle control	This is designed to assist the integration of services into cohesive architecture, assist interoperability and with common data definition. The definition of different services varying levels of detail. Because services and the respective domains should be useful for the nation preparing ITS architecture. Overall, this is function base like USA but it elaborates more

	5 years, 10 years or 20 years.	transportation management, etc.		system is limited.	detail and many descriptions for vulnerable users, disaster and facilities for across the border.

(7) Summary of ITS Architectures in the World

In view of above, the ITS Architectures in the world are summarized on the bases of the ISO Reference Model Architecture. The most upper level user services in all architectures are summed up by the category of user service bundles defined by ISO as shown in the table below.

Table 34 Summary of ITS Architecture in the World

No.	User Service Bundles	U.S.A.	Japan	Europe	France	Canada	ISO
1	Traffic Management and Operations(ISO)	✓	✓	✓	✓	✓	✓
2	Traveller Information(ISO)	✓	✓	✓	✓	✓	✓
3	Vehicle Systems(ISO)	✓	✓	✓	✓	✓	✓
4	Freight Transport(ISO)	✓	✓	✓	✓	✓	✓
5	Public Transport(ISO)	✓	✓	✓	✓	✓	✓
6	Emergency(ISO)	✓	✓	✓	✓	✓	✓
7	Transport-Related Electronic Payment(ISO)	✓	✓		✓	✓	✓
8	Road Transport-Related Personal Safety(ISO)		✓				✓
9	Weather and Environmental Conditions Monitoring(ISO)		✓				✓
10	Disaster Response Management and Coordination(ISO)						✓
11	National Security(ISO)						✓
12	ITS Data Management(ISO)	✓			✓	✓	✓
13	Maintenance and Construction Management	✓		✓	✓	✓	
14	Law Enforcement		✓	✓	✓		
15	Financial Transactions			✓			
16	Advances in Navigation Systems		✓				

Note: The ITS Architecture in each country employs different categorization. The items (No1 - No12) in the table are summarized in accordance with ISO categorization. The items (No13 - No16) are consolidated by the similar services/functions in the referred architectures.

It can be construed that the above shown services are basically the important ones as these are commonly in place across the major countries. The ITS service services for Hyderabad are considered based on the above listed services.

(8) Goals and Objectives of ITS

The ultimate goals of ITS are: 1) Safety, 2) Environmental / Energy, 3) Productivity, 4) Mobility, 5) Efficiency and 6) User Satisfaction. The objective to be achieved by ITS in line with the goals can be summarised as follows:

Table 35 Goals and Objectives of ITS

No.	Goal	Objectives
1	Safety	• To reduce risk in transportation • To reduce traffic accidents • To enhance communication and response in emergency • To reduce damage in disaster
2	Environment / Energy	• To reduce air pollution • To reduce CO_2 emissions • To reduce energy consumption
3	Productivity	• To increase national or regional economic output through efficient utilisation of transport facilities
4	Mobility	• To increase efficiency in reaching destination • To reduce travel time • To reduce travel costs • To give care to disabled people
5	Efficiency	• To invest efficiently in traffic related infrastructure • To increase efficiency in road use • To reduce cost of road management • To enhance appropriate management of ITS data
6	User Satisfaction	• To increase satisfaction with safety, environment and mobility • To increase satisfaction with convenient life

(9) General Measures and Examples of Required Services

The table outlines goals, objectives, general measures to achieve the objectives, and examples of required ITS services.

Table 36 General Measures and Examples of Required ITS Services

Goal	Objectives	General Measures	Examples of Required ITS Services
Safety	● To reduce risk in transportation ● To reduce traffic accidents	o Enhancing public transport o Promoting public transport use	▪ Information provision system of operation status of public transport ▪ Public transport assistance ▪ Multimodal transit information system ▪ Kiosk terminal ▪ Electronic money
		o Improving road infrastructure such as preparation of pedestrian facilities and separation of road use by traffic mode	▪ Traffic signal and pedestrian signal

Goal	Objectives	General Measures	Examples of Required ITS Services
		o Introducing and implementing appropriate regulation, enforcement and education o Improving traffic manners	▪ Automatic enforcement system
		o Improving safety of motor vehicles	▪ Safety measures taken by automobile manufacturers
	● To enhance communication and response in emergency	o Improving communication and response system for emergency o Enhancing cooperation amongst related organisations	▪ Emergency response system ▪ Emergency vehicle tracking system ▪ Emergency vehicle dispatching system ▪ Optimum route guidance provision ▪ Priority signal control
	● To reduce damage in disaster	o Implementing disaster prevention measures	▪ Rainfall and road flooding observation system ▪ Disaster detection system ▪ Disaster information collection and provision system
Environment and Energy	● To reduce air pollution	o Reduce vehicular emission gas together with promoting public transport use	▪ Remote sensing for air pollution
	● To reduce CO_2 emissions ● To reduce energy consumption	o Enhancing public transport o Promoting electric vehicle usage	(Same as the description of safety)
		o Improving fuel efficiency of vehicle o Promoting electric vehicle usage	▪ Electric vehicle/hybrid car ▪ Power charge facilities for electric vehicles

Goal	Objectives	General Measures	Examples of Required ITS Services
Productivity	● To increase national or regional economic output through efficient utilisation of transport facilities	o Enhancing smooth traffic o Reducing congestion	▪ Traffic signals and appropriate control ▪ Congestion information provision by VMS and Internet ▪ Optimum route guidance and selection by car navigation ▪ Congestion prediction and provision of information to road users ▪ Electronic road pricing for controlling traffic demand and restricting vehicle passage
		o Using ITS for commercial purpose	▪ Vehicle tracking ▪ Vehicle dispatch control
Mobility	● To increase efficiency in reaching destination ● To reduce travel time ● To reduce travel costs	o Enhancing public transport o Promoting public transport usage o Enhancing convenience of public transport	(Same as the description of safety)
		o Preparing parking	▪ Parking location guidance system ▪ Parking status information system
		o Enhancing smooth traffic o Reducing congestion	(Same as the description of productivity)
	● To give care to disabled people	o Enhancing barrier-free measures	▪ ITS services for disabled people
Efficiency	● To invest efficiently in traffic related infrastructure	o Preparing appropriate urban plan o Preparing appropriate transport plan	▪ Traffic census data collection and analysis ▪ Planning of lane parking system ▪ Planning of variable lane system ▪ Planning of electronic toll collection ▪ Planning if electronic road pricing

Goal	Objectives	General Measures	Examples of Required ITS Services
	● To increase efficiency in road use	o Enhancing smooth traffic o Reducing congestion	(Same as the description of productivity
	● To reduce cost of road management	o Integrating road management and organisation in terms of structure, budget, and authority o Saving labour by introducing ITS	▪ ITS control centre ▪ ITS for road management e.g. CCTV, vehicle probe, vehicle detector, meteorology monitoring, disaster detection, etc.
	● To enhance appropriate management of ITS data	o Managing road and traffic data e.g. probe data, traffic volume data, etc.	▪ ITS Data Centre (ITS control centre)
User Satisfaction	● To increase satisfaction with safety, productivity, environment, and mobility	o Realising all above measures and achieving the goals	▪ Questionnaire survey and user interviews
	● To increase satisfaction with convenience life	o Replacing properly public and commercial facilities and improving road environment	▪ Information provision of public and commercial facilities ▪ Questionnaire survey and user interviews

3-7 Consideration of ITS for Hyderabad

3-7-1 Basic Conditions for Introduction and Implementation of ITS

It should be noted that the ITS are tools for optimization of traffic and enhancement of management, and the problems cannot be solved by the ITS by themselves. In order for the ITS to maximize their effectiveness, at least the following conditions need to be prepared:

- Reasonably prepared road infrastructures including intersections, traffic signals, lanes, road structures, etc.
- Reasonably maintained the above infrastructures,
- Basic traffic manners such as absence or limited occasions of reversed driving, traffic violations, forcible interruption into lanes, overloaded with passengers, etc.

3-7-2 Policies for ITS Master Plan in Hyderabad Metropolitan Area

In view of above, the policies for ITS Master Plan in Hyderabad Metropolitan Area are set out as follows:

- To be prepared under the framework of ITS Architectures in Hyderabad,
- To be prepared in long-term view point,

- To be prepared in parallel with preparation/improvement of the basic road infrastructures,
- To be prepared in parallel with improvement of traffic manners,
- To be prepared by steps: i.e. short-term, mid-term and long-term in accordance with improvement of above and preparation of surrounding environment.

3-7-3 Review of the Issues in Hyderabad

As identified in the previous section, the critical issues in Hyderabad in terms of ITS are as follows:

Table 37 The Issues in Hyderabad

The Issues in Hyderabad
・ Absence of Quantitative Traffic Data
・ Absence of Centrally Coordinated Administrative Structure
・ Lack of Basic Infrastructure
・ Insufficient Proper Facility Management
・ Absence of National Framework

3-7-4 Social Needs for ITS in Hyderabad

On the bases of the analysis in the section of Clarification of Issues and Required System Functions, the needs of ITS are summarized as below. The details are described in the corresponded section before.

Table 38 Issues and Needs of ITS Introduction

Category	Issues and Needs to be Tackled by ITS
Regional Characteristics (Population, Economy, Climate, Tourism, Environment)	• Congestion Reduction Caused by Population Explosion and High Density
	• Congestion Reduction Caused by Increasing Long Trip
	• Congestion Reduction for Avoidance of Economic Stagnant
	• Measurement and Provision of Weather Information
	• Collection and Provision of Useful Travel Information to Users
	• Traffic Control for Environmental Protection
Regional Traffic Characteristics (Vehicle Registration, Modal Splits, Traffic Volume, Travel Speed, Accident, Signal)	• Proper t Planning of Infrastructure
	• Control and Regulate of Motorcycle
	• Control and Regulate of Auto-Rickshaw
	• Traffic Demand Management by Information Provision, Lane Control
	• Proper Design, Improvement and Installation of Signals at Major Intersection
	• Promotion of Road Safety
	• Proper System Maintenance e.g. Signals
Road and Related Infrastructure (Road Network, Road Construction, Land Use)	• Proper and Prompt Measures for Infrastructure Development/Improvement
	• Proper Design and Improvement of Existing Road Infrastructure
Regional Transportation	• More Strengthened Awareness and Enforcement

Characteristics (Bus, Railway, Metro, Auto-Rickshaw, Taxies)	• Provision of Travel Related Information
	• Cashless and Seamless Travel
	• Provision of Information of Bus Location
	• Regulation of Auto-Rickshaw
	• Proper Design and Improvement of Existing Transportation Infrastructure
	• More Strengthened Awareness and Enforcement
	• Insufficient GPS Data
Existing ITS Related Systems (Planning, Traffic Management, Road Operation and Maintenance, Public Transportation, Environmental/Weather Monitoring, Emergency)	• Introduction of System for Planning Support
	• Inter-Connection of Systems within Individual Agencies
	• Inter-Connection of Systems among Related Agencies
	• Improvement/Replacement of Traffic Signals
	• Installation of Essential Facilities for Operation and Maintenance
	• Cashless and Seamless Travelling for Operation
Administrative Characteristics (Same as above)	• Service Efficiency Improvement
	• Inter-Connection of Systems among Related Agencies
	• Reinforcement of Required Human Resources

3-7-5 Required Measures by ITS for Hyderabad

Under the above condition, the required measures which shall be realised by the ITS in Hyderabad are:

Table 39 Required Measures by ITS for Hyderabad

Required Measures by ITS for Hyderabad
1. Basic Data Collection and Proper Monitoring
2. Proper Road and Traffic Strategy
3. Proper Road Management
4. Proper Traffic Control
5. Proper Decision Making
6. ITS Promotion on Commercial Base
7. Coordination with Central Government for National Level ITS Policy
8. Establishment of Central Organisation

The issues are tackled by the above measures as illustrated in the Figure below.

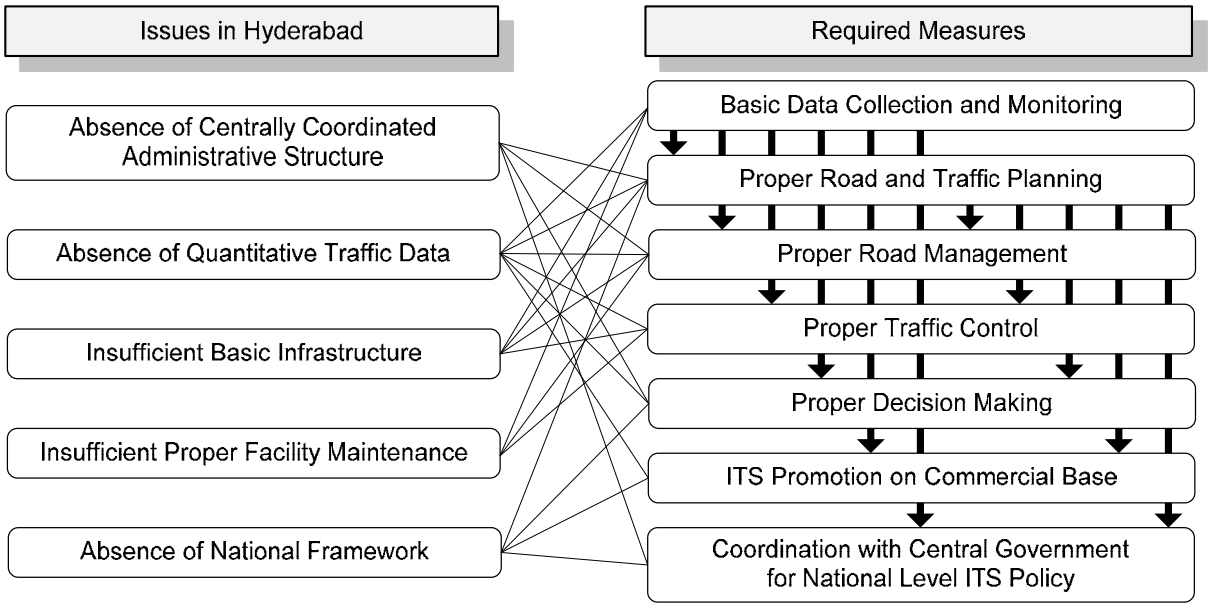


Figure 121 Target Items and Required Measures by ITS for Hyderabad

It shall be strongly stressed that it is important to start taking steps toward preparation and development of ITS in Hyderabad, as a software measure for road and traffic management.

The measures which shall be taken are explained in detail as follows:

(1) Basic Data Collection and Proper Monitoring

The basic environment which enables collection of basic traffic data and proper monitoring of traffic shall be put in place. The basic traffic data includes the real-time traffic conditions such as traffic volume, travel time, occupancy, etc. by section and on-road/road-side condition data collection.

(2) Proper Road and Traffic Planning

Development/improvement of road network and required traffic measures need to be properly planned. Cumulated basic traffic data which is collected by ITS needs to be utilised for planning. Such

basic environment which enables proper planning based on quantitative traffic data shall to be prepared.

(3) Proper Road Management

The basic environment which enables proper road management needs to be put in place. For example, major bottle neck on road network needs to be quantitatively identified by traffic volume. The necessary action needs to be taken by monitoring flood condition on road. Such data shall be utilised for road improvement, construction and evaluation.

(4) Proper Traffic Control

The basic environment which enables proper traffic control shall be put in place. For example, the road traffic shall be properly controlled in accordance with traffic conditions which continuously change. In order to realise this, dynamic real-time traffic monitoring and control is required.

(5) Proper Decision Making

The basic environment which enables proper decision making on road and traffic measures needs to be put in place. For example, result of quantitative analysis on traffic condition based on cumulated traffic data can be used for making policy for short, mid and long term on road and traffic measures. Furthermore, such result can also become a basis for accountability to public for investment of public project.

(6) ITS Promotion on Commercial Base

Financial mechanism needs to be put in place for continuous operation of ITS. The possible schemes includes incorporation of toll charge on the major road in the future, IC-Card usage such as common mobility card, and selling value added traffic information to the private sector. The scheme which generates revenue on a commercial basis needs to be prepared.

(7) Coordination with National Government for National ITS Policy

As discussed above, a National ITS policy needs to be put in place to derive Regional and Local ITS policies. But at present, ITS is prepared at Regional levels in India. It is critical that the regional ITS is implemented under the framework of the National ITS Policy which is set out by the Government of India.

(8) Establishment of Central Organisation

An entity to enable all items described above needs to be established. It will have roles for initiating the ITS development, coordinating among the involved agencies/upper level ministries, taking care of standardisation, taking charges for planning, management and promotion of ITS.

The improvement of the road and transport infrastructure such as road network expansion, flyover construction, etc., enforcement and education for improvement of traffic discipline need to be accelerated in parallel with/in accordance with the improvement of ITS as well. In such circumstances, an independent single agency is favourable.

3-8 Roles of Public Sector and Private Sector for ITS

3-8-1 Agencies Closely Related to ITS Promotion and Implementation

The most important agencies which are closely related to ITS promotion and implementation are listed as (i) HMDA, (ii) GHMC, (iii) Hyderabad/Cyberabad Traffic Police, and (iv) APSRTC. The HGCL is a Special Purpose Vehicle (SPV) for construction of ORR.

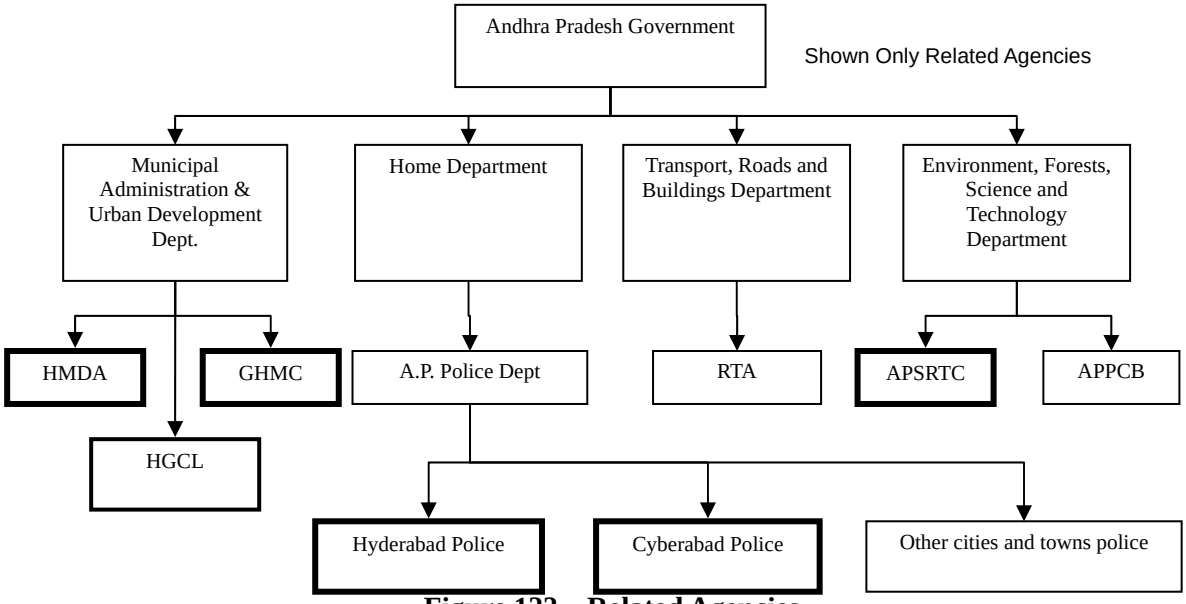


Figure 122 Related Agencies

3-8-2 Stakeholders of ITS in Hyderabad

(a) Mainly Involved Organisations for ITS in Hyderabad

Based on the current review and studies thus far, the mainly involved organisation as important stakeholders were listed as follows:

- Hyderabad Metropolitan Agency (HMDA)
- Hyderabad Growth Corridor Limited (HGCL)
- Hyderabad Traffic Police, Cyberabad Traffic Police
- Greater Hyderabad Municipal Corporation (GHMC)
- Andhra Pradesh State Road Transport Corporation (APSRTC)
- Regional Transport Authority (RTA)
- Hyderabad Metro Railway Limited (HMRL)
- National Institute of Technology (Professor Prasad)
- Pollution Control Board
- Centre for Development of Advanced Computing (C-DAC)
- Roads & Buildings Department (R&B)
- National Informatics Centre (NIC)
- Meteorological Department
- National Highway Authority of India (NHAI)
- Emergency Management and Research Institute (EMRI)
- Centre for Railway Information Systems (CRIS)

(b) Other Players Involved in Private Sector

In addition to the above, the parties in the private sector are important stakeholders as well, as listed below.

- Taxi Companies (MERU CAB, etc)
- Advertising Companies
- Concessionaires of BOT for Implementation of the ITS Projects
- Traffic Information Providers
- Digital Road Map Developers
- Commercial Vehicle Companies
- Business Enterprises, e.g. MacDonald’s as potential purchasers of the traffic information for their business strategies

3-9 Proposed ITS Services for Hyderabad

ITS services for Hyderabad were identified based on the ITS Architectures studied so far, as detailed below.

(a) Criteria for Selection of ITS Services

In view of above, the ITS services for Hyderabad shall be identified. The following criteria is applied for identifying the ITS services.

Table 40 The Criteria for Selection of ITS Services

The Criteria for Selection of ITS Services
1. To introduce critical components as basic ITS infrastructure as the first priority
2. To introduce the components that are critically necessary and practical for the current conditions and issues in Hyderabad
3. To introduce the components which shall be initiated by the public sector/governmental agencies
4. To introduce ITS in phases suitably in line with budget and policies
5. To introduce the components which do not immediately require large scale hard/ infrastructure improvements at the beginning of implementation
6. To introduce the components which do not require immediate drastic policy changes at the beginning of implementation

The following components are excluded from the services selected, due to the nature of ITS in terms of private sector industry

- Components which will be prepared by car manufacturers
- Components which will be prepared by private companies
- Components which will be prepared on the commercial base in general

(b) ITS Services to be Introduced in Hyderabad

The ITS services which need to be introduced in Hyderabad are identified as shown in the Table below. They were selected by referring to practices included in the user services in ITS Architecture in the world which is shown in the previous section and the required measures in Hyderabad based on the current conditions by applying the above selection criteria. They are mapped to the user service bundles defined in the World ITS Architecture which are shown in the Table 34 in the previous section.

Table 41 ITS Services for Hyderabad

No.	User Service Bundle of World ITS Architecture	ITS Services for Hyderabad
1	Traffic Management and Operations (ISO)	Data Collection
		Information Provision
		Traffic Control
		Optimum Route Guidance
		Parking Management
2	Public Transport (ISO)	Bus Operation
		Rail Transportation
		Taxi / Auto-Rickshaw Operation
3	Emergency (ISO)	Emergency Alert and Response

		Emergency Optimum Route Guidance
		Emergency Signal Control
4	Transport-Related Electronic Payment	Transport-Related Electronic Financial Transactions
		Integration of Transport-Related Electronic Payment Services
5	Road Transport-Related Personal Safety (ISO)	Driving Support
		Signal Dedicated for Pedestrian
6	Weather and Environmental Conditions Monitoring(ISO)	Collection of Weather Information
		Collection of Air Pollution Information
7	Disaster Response Management and Coordination (ISO)	Disaster Alert and Response
		Disaster Operation Assistance
8	ITS Data Management	Collection, Store and Aggregation of Data
		Traffic Data Analysis
		Traffic Accident Analysis
		Emergency and Disaster Information Analysis
9	Maintenance and Construction Management	Road Management
10	Law Enforcement	Assistance of Police Activities
		Automated Speed Enforcement
		Automated Signal Jumping Enforcement
		Automated Wrong way Driving Enforcement
		Automated Illegal Parking Enforcement
		Automated Overloaded Vehicle Enforcement

The items below which are defined by the ITS Architecture in the World are excluded because (i) the items (1 – 4) are the service which are prepared by the private sector in general, (ii) item (5) is the service which shall be prepared by the national level.

The standardization such as traffic data format, exchange method needs to be prepared for the ITS services prepared by the private sector to be applicable across entire India. The standardization shall be initiated by the Indian government at national level. The services related to the national security needs to be initiated and implemented by the national level.

Table 42 ITS Services Excluded from Above

No.	User Service Bundle of World ITS Architecture	Sub-System in Hyderabad
1	Traveller Information(ISO)	To be Implemented by Private Sector
2	Vehicle Systems(ISO)	
3	Freight Transport(ISO)	
4	Advances in Navigation Systems	
5	National Security(ISO)	National Level Implementation

3-10 Road Map for ITS in Hyderabad

3-10-1 Phased Implementation Policy

In consideration of the current condition in Hyderabad and required measures, the ITS shall be prepared in phased manner. The first priority shall be preparation of the basis ITS component and more advanced services are gradually expanded. The road infrastructures need to be improved along with expansion of ITS. The advanced ITS components are gradually introduced in accordance with road infrastructure improvement and maturity of ITS industry.

On the basis of this discipline, the following phased expansion policies are set out:

Table 43 Phased Implementation Policy

Phases	Policy
Phase-1 (1-5 years)	Establishment of ITSC Preparation of Basic ITS Component
Phase-2 (6-10 years)	Expansion of Basic ITS Component Introduction of Advanced ITS Component
Phase-3 (After 10 years)	Expansion of More Advanced ITS Component

Notes:

- **Number of Years Set Out:** The information technology advancement is very rapid in nature. Hence, it is appropriate to set out for 5 years for Phase-1 and 10 years for Phase-2. The systems to be introduced in Phase-3 will have to be re-considered because the surrounding environment will become significantly different such as emergence of new technology in the future, due to the same reason of the rapid technological advancement.
- **System Review:** During the following phases after Phase-1, the systems prepared in the previous phases will be reviewed/evaluated and the systems to be further upgraded or newly introduced will be identified.
- **Equipment Replacement:** It should be noted that the equipment needs to be replaced at certain intervals as indicated below.

Table 44 Equipment Replacement Term

Items	Replacement Term
Central Processing Unit	5 years
Roadside Equipment	10 – 15 years
Communication	10 – 15 years
Electric Equipment	20 years
Civil Work	30 years

3-10-2 Establishment of ITS Centre

It is strongly recommended to establish a single agency, temporarily called ITS Centre, which shall become responsible for planning, procuring, installing, operating and management of ITS. It also shall be responsible for traffic management and infrastructure development.

The ITS is indispensable social infrastructure which shall be prepared together with the road infrastructure development. In the absence of a central single agency of this kind, it is obvious that the

different planning without proper and sufficient coordination will be independently carried out by the individual agencies such as GHMC, Traffic Police, APSRTC, HMDA etc. The integrated ITS development, traffic control and road management will become difficult in such condition, and more importantly, it will result in huge loss of human-power, cost and time.

It is also necessary for ITS planning to have consistency with the national ITS framework in India and to coordinate with the central governments and regional public agencies in neighbouring regions. The traffic information generated by the ITS will be provided to the private sector with/without charge. The coordination and collaboration with the private sector will become necessary as well, in this view point. Moreover, the engine for continuous promotion of ITS in Hyderabad is strongly required under the condition where the ITS implementation has not fledged at full scale yet in India.

The image of ITS Centre to be established in phase-1 is shown in Figure 5-4.

The purpose and the functions which shall be equipped are as follows:

(1) Purpose of ITS Centre

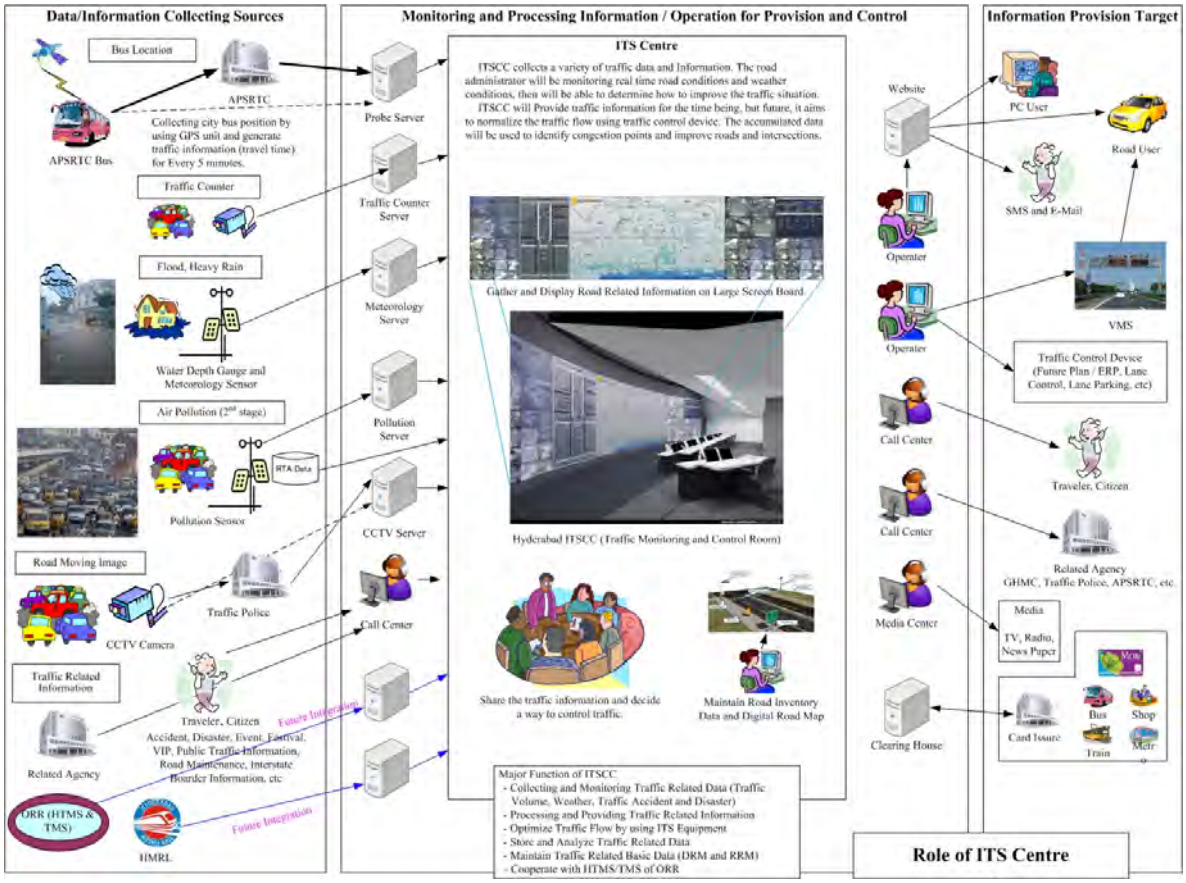
The purposes of ITS Centre are as follows.

- It plays as a central engine for continuous ITS initiative to expand in Hyderabad
- It assures the coordination with the National ITS Policy for ITS expansion in Hyderabad
- It carries out the business with the private sector by selling the generated traffic information for assuring the revenue for the operation of ITS Centre
- It functions as a central single agency responsible for planning, implementing, evaluating the ITS systems and development/expansion
- It collects all the road/traffic data and provides to the users and relevant agencies

(2) Functions of ITS Centre

The following functions shall be handled by ITS Centre:

- Collection of traffic data from the roadside/probe based sensors and related information from the related agencies (like Probe data of APSRTC, etc)
- Traffic information provision to the public through internet, SMS, call centre
- Traffic information provision for traffic flow control through VMS on roadside
- Automatic traffic signal control and related facilities for traffic flow control
- Analysis of realtime dynamic data and offline based on cumulated data for identifying traffic bottleneck, before and after evaluation of the project
- Planning and evaluation of traffic management and road infrastructure
- Owning the right of traffic data generated by ITS CENTRE
- Sales of the generated traffic information to private sector
- Management of standardization of ITS technologies and related data such as digital road map
- Management of road inventory
- Management of ITS equipment
- Operation and management of clearing house of common mobility card



Source: JICA Study Team

Figure 123 ITS Centre to be Established in Phase-1

(3) Important Issues in Establishment of ITS Centre

The following issues need to be taken into consideration in establishing the ITS Centre:

(a) Establishment Scheme

The most recommended scheme is that the ITS Centre is established as Special Purpose Vehicle (SPV) invested by the related agencies such as HMDA, GHMC, Traffic Police, etc in consideration of its functions. However the financial reliability needs to be assured to form the SPV and it may take some time until the revenue becomes stabilised after commencement of operation. Hence, it would be practical that the ITS Centre will start as one of the department of HMDA in cooperation with GHMC and Traffic Police in the initial period. Then it will be shifted into the SPV as the revenues become assured after certain period.

(b) Authority for Traffic Control Vested with ITS Centre

The ITS Centre shall function as a central body for traffic management in the Hyderabad, as proposed above. One of the major important roles is controlling the traffic such as controlling the traffic signals, diverting the traffic by providing the traffic information through VMS or SMS, implementing ERP in the future. Hence, the authority for traffic control shall be vested with the ITS Centre.

(c) Property Right of Traffic Data/Information

Various kinds of traffic related data will be collected through a number of different equipment such as traffic counter, flood monitoring sensors, bus probe systems, etc. Then the collected data will be processed and the traffic information will be generated at the ITS Centre. Such generated traffic

information will have added value and can be used as a major source of revenue generation for the operation of the Centre by selling to the interested parties including in the public and private sectors. In order to assure this, the property right of the collected data and generated information shall be assured to the ITS Centre.

The detail diagram and the image of ITS Centre in the phase-1 are shown in the following figures respectively.

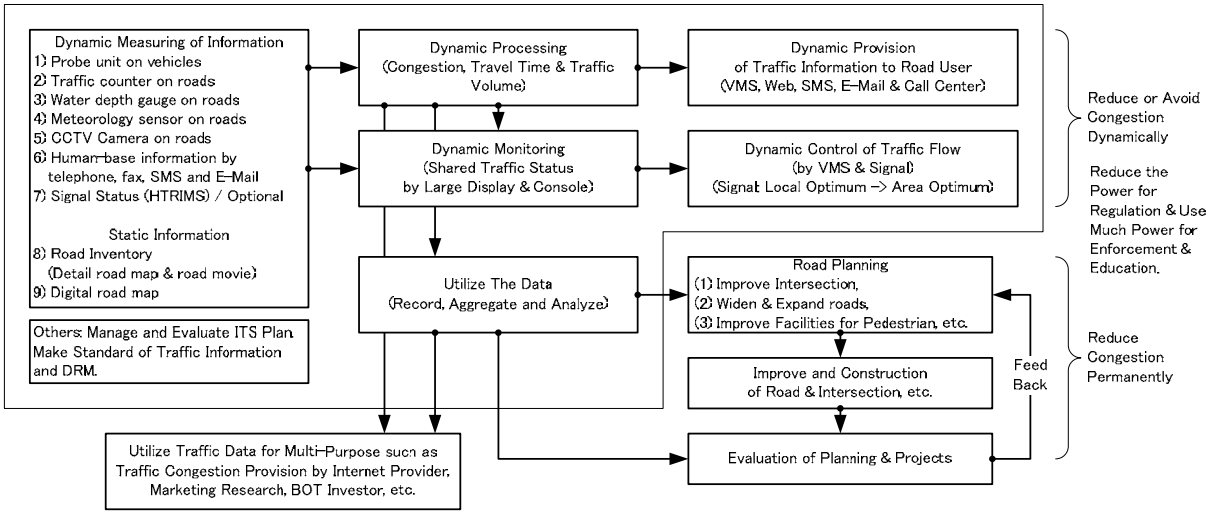


Figure 124 Detail Diagram of Functions of ITS Centre

3-10-3 Equipment Installation Policy

In accordance with the above policy for implementation, the ITS equipment will be installed with the following policies:

(1) Road Classification:

It was recommended to prepare the hierarchical system of the road classification for road administration by the previous different studies. But it seems that any such kind of the classification has yet been established. Hence, the roads are classified in this Master Plan for prioritizing the target roads for equipment implementation as follows:

Table 45 Road Classification

No	Classification	Road	Remarks
1	Highway	ORR	Partially in operation
		Inter Mediate Ring Road	Planned
2	Principal Road	NH7, NH9, NH202	(National Highway)
		Inner Ring Road	
3	Distribute Road	State Highway	
		Radial Road	
4	Link Road	Road which connects above road	
		Road which connects major intersection/junction in city	
5	Residential Road	Colony Road	

(2) Basic Principle:

The ITS equipment will be installed to cover the major roads and important areas in the city at first in Phase-1. The targets include national roads, Inner Ring Roads and other critical locations including heavily congested sections in the centre of the city. The coverage areas will be gradually expanded in the following phases and ultimately covers all areas of Hyderabad in Phase-3.

The prioritization is set out in accordance with the road classification shown above.

(3) Conditions:

(a) Intermediate roads and expressway planned in the revised master plan of HMDA

They are under planning. But the specific locations/alignments have not been identified yet. Hence they are excluded from the target.

(b) Radial Road

The improvement of the radial roads is under planning. Some sections/roads will be newly constructed, and others will be extended or widened. The specific location/alignment of some sections is not clear. Hence, the existing radial roads are basically considered by the location plan.

(c) ORR

The ITS installation is planned by other project. Hence they are excluded from the scope of the location plan of this Master Plan. Instead, the integration/information exchanges are considered.

(d) Others

The installation of the equipment on some particular sections in phase-1 shall be postponed/ adjusted to avoid rework in case of the road-widening, alignment change and overlap with metro construction.

(4) Installation Policy:

Based on the above disciplines, the following implementation policies are set out:

Table 46 Installation Policy

Phases	Policy
Phase-1 (5 years)	The equipment will be installed on principal roads, which are National Highway (NH) and Inner Ring Road (IRR), major state highway (SH), and other critical locations in city to cover the major traffic.
Phase-2 (10 years)	The equipment will be expanded along the distribute roads, which are other state highway (SH) and existing radial road, major link road connecting between the state highway and the radial road, and other critical locations in the city.
Phase-3 (After 10 years)	The equipment will be expanded along other link roads, which are major link roads connecting the major junctions, and major residential roads.

Based on the above basic policies, the location plans for the individual equipment are set out as described in the conceptual design section.

3-10-4 Relation between ITS Centre and Existing Plans

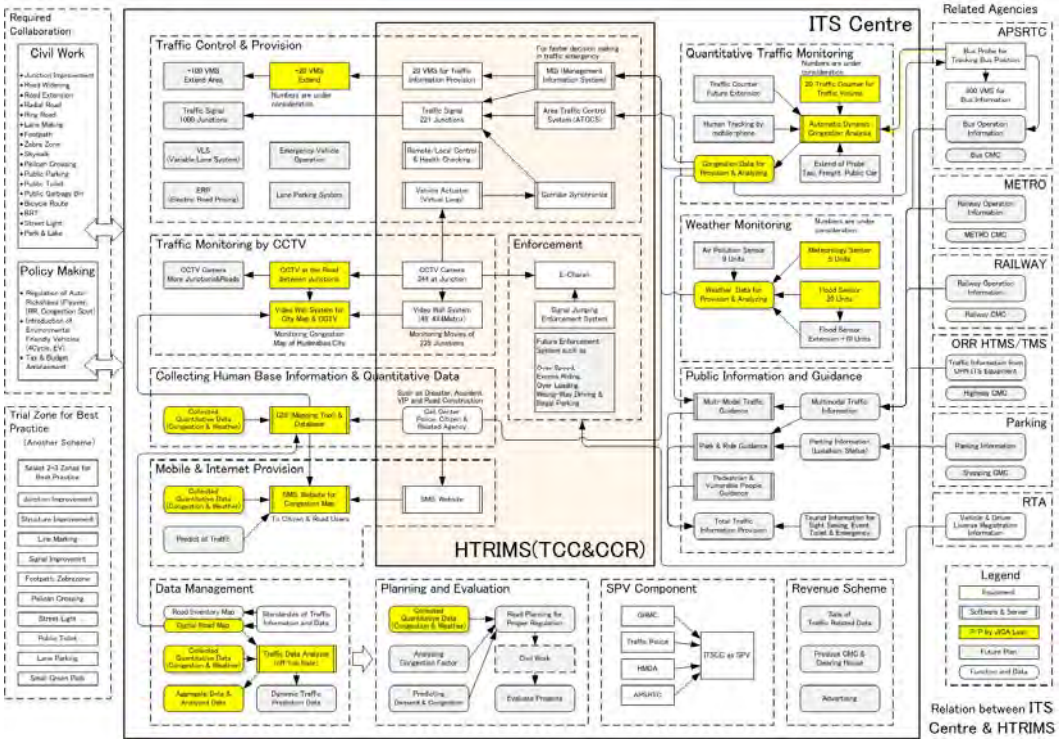
(1) HTRIMS

Hyderabad Traffic Police has the control centre in the headquarters and operates CCTV monitoring at junctions. Currently the CCTV monitoring in the jurisdiction of Cyberabad Traffic Police is separately conducted by the Cyberabad Traffic Police headquarters. The traffic signals in both of jurisdictions are standalone and not connected to their headquarters, and many of them are not properly working.Hyderabad Traffic Police along with GHMC is planning to introduce Hyderabad Traffic Integrated Management System (HTRIMS). The outlines of the plan are:

- Prepare Traffic Command Centre (TCC) at Hyderabad Traffic Police Headquarters,
- The existing centre of the Cyberabad Traffic Police will become the buck-up,
- CCTV monitoring in both jurisdiction of Hyderabad Traffic Police and Cyberabad Traffic Police will be conducted at the Hyderabad Traffic Police Headquarters,
- Two hundred twenty one (221), including existing one hundred eighty (180) and new forty one (41) signals will be prepared at junctions,
- Twenty (20) VMS will be installed in the city,
- A Centralised Management Information System (MIS) for supporting a decision making in the traffic event such as traffic disaster, VIP movement will be prepared,
- A Video Wall System will be prepared at the TCC.

Under such situation, it has been agreed that the ITS Centre will incorporate their HTRIMS on the meeting held on the 16th of April in 2012, convened by the GHMC Commissioner participated by HMDA, Hyderabad Traffic Police, Cyberabad Traffic Police, APSRTC and ASCII which is a project management unit (PMU) for the HTRIMS.

The relation between ITS Centre and HTRIMS is show in the Figure below.



Source: JICA Study Team

Figure 125 Relation between ITS Centre and HTRIMS

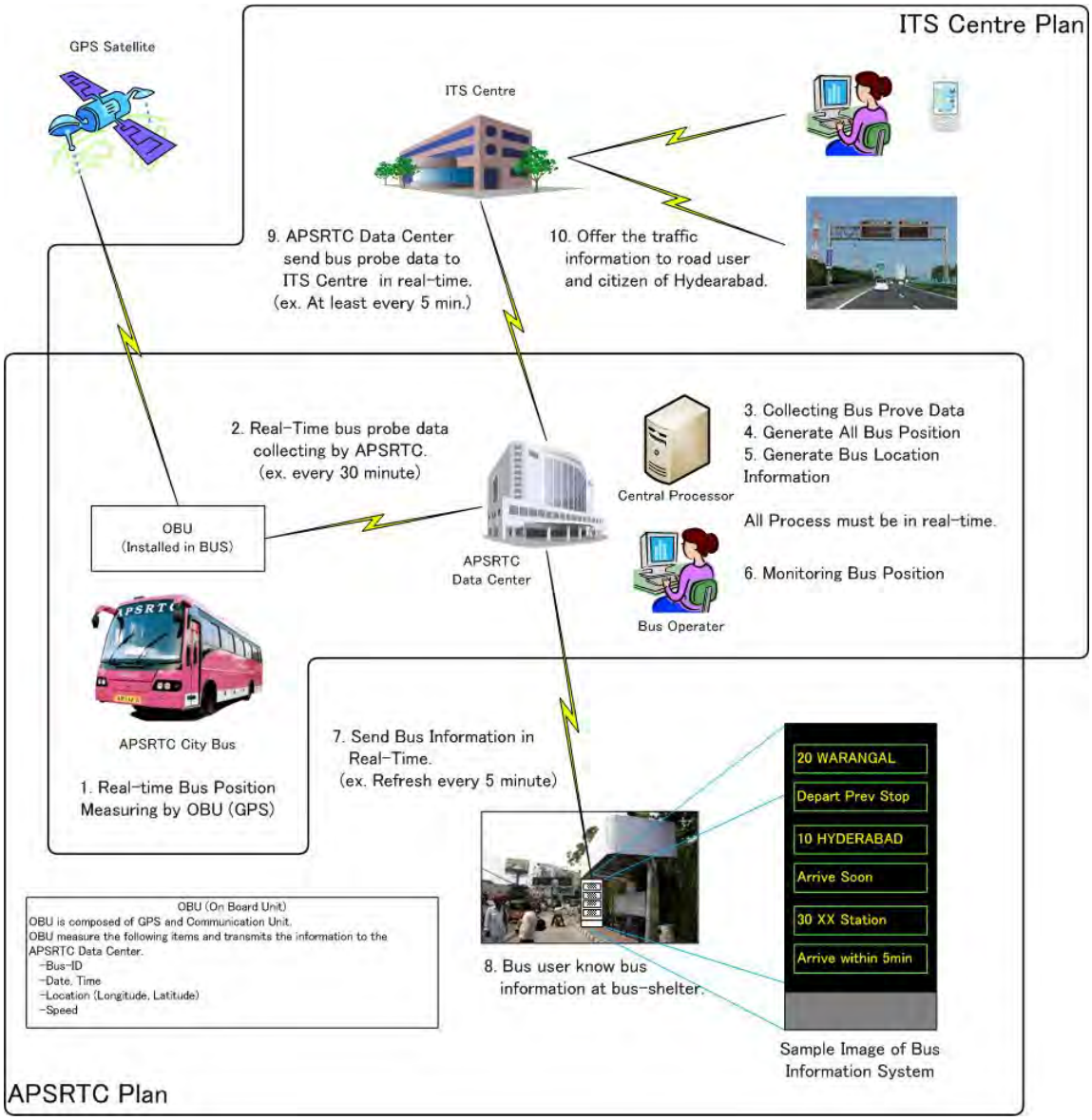
(2) APSRTC Bus Location System

APSRTC is planning to introduce GPS/GPRS based Bus location system for its fleet of 12,000 buses in phase I and extended it to the remaining buses in the next phases. The main purpose of the planned system is to track the location of their buses from the Central Control Room in APSRTC and provide the bus location information to passengers at bus stops.

It has been agreed that the bus location data measured by their GPS devices and collected by their centre will be transmitted to ITS Centre. This data will be used for traffic congestion information generation in Hyderabad.

The GPS units shall be separately installed on the APSRTC buses by this project in case of any technical difficulties or problems. In this case, approximately 4,000 GPS shall be installed.

The relation between ITS Centre and APSRTC is shown in the Figure below.



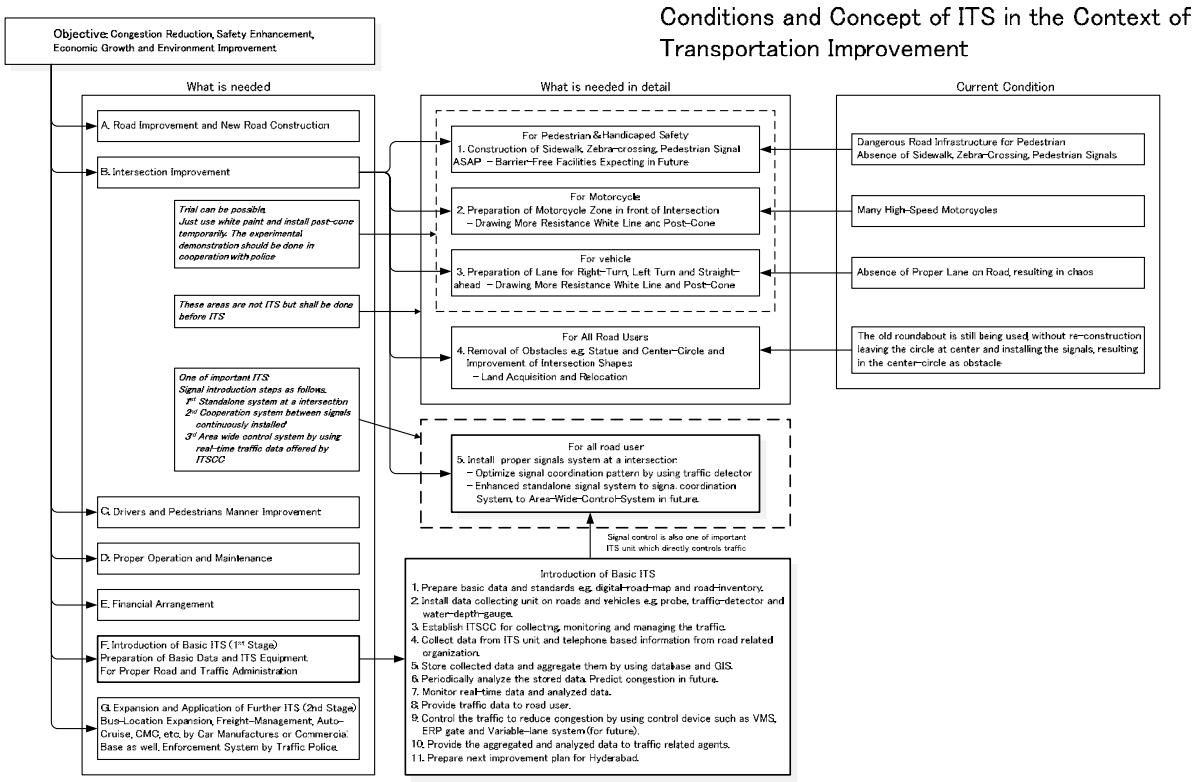
Source: JICA Study Team

Figure 126 Relation between APSRTC and ITS Centre

3-10-5 Required Hard and Soft Measures in Parallel with ITS Preparations

As described earlier, it is important that the hard and soft measures such as improvement of traffic discipline are taken in parallel with the preparation of ITS.

The figure below shows the ITS in the context of the required soft and hard measures for road transportation. The steps from A to E need to be taken in order to achieve the goals, which are reduction of congestion, enhancement of safety, improvement of environment and consequently growth of economy. The required steps are A) Improvement of Road Network, B) Improvement of Intersections, C) Improvement of Driver and Pedestrian Manners, D) Proper Operation and Maintenance, E) Preparation of Financial Arrangement. On the ground of this preparation, the ITS is introduced to realise the goals in the road transportation sector.



Source: JICA Study Team

Figure 127 Conditions and Concept of ITS in the context of Transportation Improvement

3-10-6 Implementation Schedule

(1) Master Plan Schedule

Based on all the considerations so far, the Master Plan of ITS for Hyderabad shall be implemented as shown in Table below.

Table 47 Master Plan Implementation Schedule

Items	Phase-1	Phase-2	Phase-3
Installation Priority	- Major road: NH-44 (old NH-7), NH-65 (old NH-9), NH-163 (old NH202), IRR, SH - Other important locations in city	- Distribute road: radial road - Link road: the road linking between above roads - Other important locations	- Link road: the road linking between major junctions - Residential road - Important locations on colony road
	Installation shall be postponed to avoid re-working on the sections with planned civil construction/improvement which includes e.g.: ・ Widening/Extension on Radial Road ・ Sections along Planned Metro Construction		
ITSC	- ITSC establishment - Organisation setup - Preparation of 1st phase systems	- Expansion of system in 2nd phase.	- Expansion of system in 3rd phase.
	ITSC Roles: ・ Traffic monitoring and analysis, traffic information provision, traffic control ・ Planning, implementation, evaluation of ITS ・ System integration, ITS development initiative		
Collection Method	CCTV, ATCC, Probes, related information from agencies and citizens	Expansion of those left	Expansion of those left and Human Probes
Provision Method	VMS, Website, SMS, E-Mail and Call Centre	Expansion of those left	Expansion of those left
Traffic Control Method	Signals on the Road VMS on the road	• Expansion of those left • Variable Lane System • Park & Ride Guidance • Multi modal transport guidance • Parking information guidance	• Expansion of those left • ERP (Electronic Road Pricing)
	To be expanded in 2nd and 3rd phases in line with preparation of • Public & Lane Parking, Public Based Multi Modal Transportations		

(2) Important Issues which shall come along

In addition to the above implementation, the following issues need to come along in order for ITS to smoothly implemented.

- For ITS Centre to take off successfully, ITS specialist shall be dispatched from JICA.
- The next phase ITS projects need to be carried out to complete the ITS Centre.
- ITS shall be prepared in accordance with other road infrastructure improvement such as

flyover construction, road widening and side-walk preparation for pedestrian.

(3) Road Map for ITS in Hyderabad

The road map for ITS in Hyderabad is set out as shown in the Figure below based on the following concepts:

(a) Phase-1 (1-5 years):

- **Policy**:
  Establishment of ITS Centre, Preparation of Basic ITS Component
- **Concept**:
  During this period, the basic mechanism which enables proper road traffic information collection, processing, provision and accumulation, in turn proper road and traffic management, together with necessary basic component for ITS such as digital road map will be prepared. The hard measures such as road infrastructure improvement and soft measure such as traffic discipline improvement will be taken in parallel.

(b) Phase-2 (6 – 10 years):

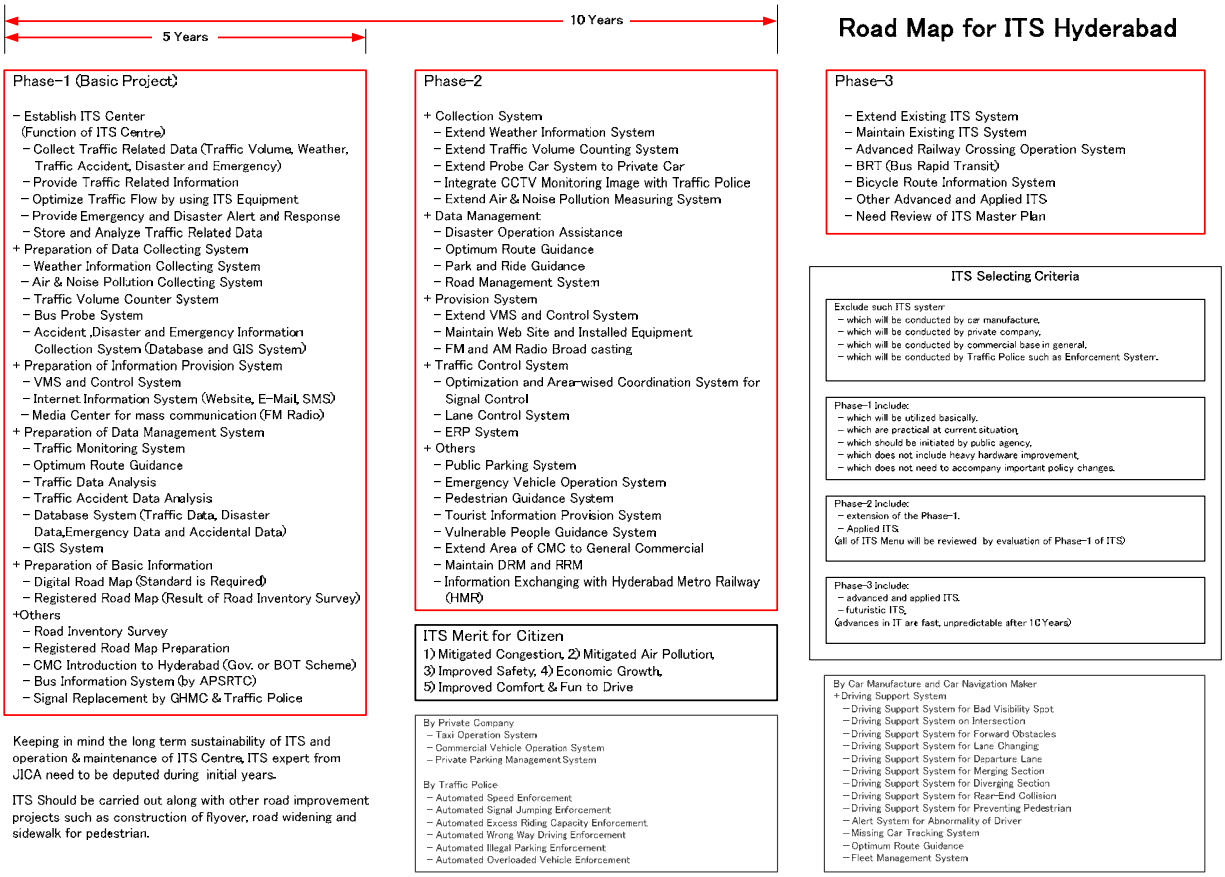
- **Policy**:
  Expansion of Basic ITS Component, Introduction of Advanced ITS Component
- **Concept**:
  During this period, the systems prepared in Phase-1 will be reviewed. Base on the review, the components already introduced will be expanded and additional component will be introduced. The expansion of the existing system and introduction of additional components will be carried in accordance with improvement realised by the hard and soft measures.

(c) Phase-3 (After 10 years):

- **Policy**:
  Expansion of More Advance ITS Component
- **Concept**:
  During this period, the systems prepared in Phase-2 will be reviewed. However as the advancement of information technology is very rapid, it is almost impossible to identify the specific ITS components in this period at the time of this Master Plan. Hence, the ITS components will be further identified towards the end of Phase-2, in accordance with the maturity of ITS industry in Hyderabad, new technologies emerged and improvements realised by the hard and soft measures.

(d) Others to Be Noted:

- **ITS Services Prepared by Private Sector:**
  The ITS services which are generally prepared by the private sector are not included in the ITS Master Plan. The ITS Master Plan lists the services which shall be initiated by the public sector. Hence those to be prepared by the private sector are differently categorized as such.



Source: JICA Study Team

Figure 128 Road Map for ITS in Hyderabad