



Mobility for development

Bangalore | India



The Energy and Resources Institute



World Business Council for Sustainable Development

Acknowledgement

We would like to thank The Energy and Resources Institute (TERI) for preparing this report. We would also like to thank Toyota Motor Corporation and Renault S.A. for their support in preparing this case study and for their invaluable contribution in organizing the stakeholder dialogue in Bangalore. We also deeply appreciate the valuable input we received from the participants who took part in the stakeholder dialogue in Bangalore.

Disclaimer

This case study has been prepared by The Energy and Resources Institute (TERI) with input from several member companies as a part of the Mobility for Development (M4D) project at the World Business Council for Sustainable Development (WBCSD). It includes views and opinions from a stakeholder dialogue that was held in Bangalore. This does not mean, however, that every WBCSD member company agrees with every word.



Mobility for development

Bangalore | India

Contents

Project team	i
Acknowledgements	ii
Abbreviations	v
Executive summary	1
CHAPTER 1 Introduction.....	12
1.1 What is sustainable mobility?.....	12
1.2 Study background and objectives	13
1.3 Approach and method adopted	14
1.4 Organization of the report	15
CHAPTER 2 Overview of transport infrastructure in India	17
2.1 Economic importance of the transport sector	17
2.2 Overview of India's transport sector	18
2.2.1 Roads	21
2.2.1.1 Current status	21
2.2.1.2 Initiatives and investments	21
2.2.1.3 Issues	24
2.2.2 Rail	25
2.2.2.1 Current status	25
2.2.2.2 Initiatives and investments	25
2.2.2.3 Issues	26
2.2.3 Ports	26
2.2.3.1 Current status	26
2.2.3.2 Initiatives and investments	28
2.2.3.3 Issues	28
2.2.4 Water transport	29
2.2.4.1 Current status	29
2.2.4.2 Investments and initiatives	29
2.2.4.3 Issues	29
2.2.5 Air.....	30
2.2.5.1 Current status	30
2.2.5.2 Initiatives and investments	31
2.2.5.3 Issues	31
2.3 Urbanization, motorization and policy responses.....	31
2.3.1 Urbanization	32
2.3.2 Rapidly increasing motorization.....	32
2.3.3 Policy responses	35
2.4 Summing-up	36
CHAPTER 3 Mobility in Karnataka and Bangalore.....	38
3.1 Background – Karnataka state	38
3.1.1 Overview of Karnataka's transport sector	39
3.1.1.1 The Transport Department of the Government of Karnataka.....	39
3.1.1.2 Urban Development Department (UDD)	40
3.1.1.3 Karnataka State Pollution Control Board (KSPCB).....	40
3.1.1.4 Public Works Department, Government of Karnataka.....	40
3.1.1.5 Karnataka State Road Transport Corporation (KSRTC).....	40

3.1.2 Investments and initiatives in the transport sector	40
3.1.3 Communication infrastructure in Karnataka	41
3.2 Bangalore.....	42
3.2.1 Study area location and definition	42
3.2.1.1 Location.....	42
3.2.1.2 The study area.....	42
3.2.2 Population characteristics	46
3.2.2.1 Growth	46
3.2.2.2 Migration	47
3.2.2.3 Demographic characteristics.....	48
3.2.2.4 Projected population	49
3.2.2.5 Density	49
3.2.3 Economy	50
3.2.3.1 Evolution and status	50
3.2.3.2 Occupational structure	50
3.2.3.3 Income divide in the city	51
3.2.4 Spatial growth and structure	53
3.2.4.1 Land use and transport.....	55
3.2.4.2 Land and housing situation.....	58
3.2.4.3 Growth of satellite towns.....	59
3.3 Summing-up	59
CHAPTER 4 Mobility in Bangalore.....	61
4.1 Some characteristics of mobility in Bangalore.....	61
4.1.1 Number and length of trips	62
4.1.2 Growth and status of motorized vehicles	63
4.1.3 Rise in motorized vehicle ownership	64
4.1.4 The modal paradox	65
4.1.5 Road environment and infrastructure	66
4.1.6 Suburban rail	68
4.2 The sustainability of mobility in Bangalore	68
4.2.1 Accessibility (Indicator 1 and Goals 6 & 7)	70
4.2.1.1 Status of public transport in Bangalore	71
4.2.1.2 Intermediate personalized transport (IPT) and paratransit	77
4.2.1.3 Access to education facilities	77
4.2.1.4 Access to health facilities	78
4.2.1.5 Goods movement in the city.....	78
4.2.2 Safety (Indicator 5 and Goal 3)	79
4.2.3 Impact on environment & GHG emissions (Indicators 7 & 8 and Goals 1, 2 & 4).....	81
4.2.3.1 Emission standards	81
4.2.3.2 Air quality.....	84
4.2.3.3 Vehicle inspection and maintenance	87
4.2.3.4 Noise levels (Indicator 8 & Goal 7).....	88
4.2.4 Resource use (Indicator 9 and Goals 2 & 7).....	89
4.2.5 Congestion and parking (Indicators 2, 3, 4, 9 & 10 and Goal 5).....	90
4.2.6 The “mobility opportunity divides” around and within Bangalore (Indicators 1, 2, 3, 4, 5, 6 & 10 and Goal 6)	92
4.2.6.1 The urban-rural mobility divide	92
4.2.6.2 The income-related mobility divide	94
4.3 Urban planning and policy responses.....	103

4.4 Summing-up	106
CHAPTER 5 Use of Information and Communications Technology to achieve sustainable mobility	108
5.1 Introduction	108
5.2 Defining the scope of the section	109
5.3 Virtual mobility	111
5.3.1 Virtual mobility and the citizen – e-governance	112
5.3.1.1 BangaloreOne (B1).....	113
5.3.2 Virtual mobility and business – e-work/telework	114
5.4 Intelligent Transport Systems (ITS)	119
5.4.1 Advanced Public Transportation Systems in India:	120
5.4.2 ITS and Bangalore Metropolitan Transport Corporation (BMTC)	120
5.4.3 ITS and Bangalore Traffic Police	122
5.4.4 Future scenario of ITS in India.....	125
5.5 Internet-based carpooling	125
5.6 Summing-up	127
CHAPTER 6 Summary of the Stakeholder Dialogue.....	128
6.1 Introduction	128
6.2 Opening session.....	128
6.3 Session 1: The mobility challenge in Bangalore	130
6.4 Session 2: Addressing the mobility divide in the city	134
6.5 Session 3: Use of technology to achieve sustainable mobility	138
6.6 Summing-up	141
CHAPTER 7 Conclusions and recommendations	142
7.1 Introduction	142
7.2 TERI’s recommendations in the light of sustainable mobility goals.....	142
7.2.1 Improving air quality and reducing GHG emissions (Goals 1 and 2)	143
7.2.2 Improving road safety (Goal 3)	144
7.2.3 Reducing noise (Goal 4)	146
7.2.4 Reducing congestion (Goal 5)	146
7.2.5 Closing the mobility divide (Goal 6).....	148
7.2.6 Improving mobility opportunities (Goal 7)	150
7.3 Use of ICT for sustainable mobility	152
References	155
Annex 2.1 National Highways Development Project.....	161
Annex 4.1 Motor vehicles and traffic data	163
Annex 4.2 Circulation plan for Bangalore City.....	165
Annex 5.1 About BangaloreOne or B1 Project	166
Annex 5.2 Eco driving as defined by the Japan Automobile Manufacturer’s Association	172
Annex 6.1 List of Stakeholder Dialogue participants.....	173

Tables

Table 2.1 Share of transport sector in GDP	17
Table 2.2 Historical trends and modal shares of various transportation modes in passenger traffic.....	18
Table 2.3 Historical trends and modal split of various transportation modes in freight traffic	19
Table 2.4 Different phases of National Highway Development Program.....	22
Table 2.5 Amount of private investment made during the different phases of the project	23
Table 3.1 Communications infrastructure in Karnataka	41
Table 3.2 Projected population growth.....	49
Table 3.3 Occupational structure of Bangalore (2001).....	51
Table 3.4 Land use distribution (2003).....	55
Table 4.1 Overview of urban transport indicators in Bangalore and their variation over time (Table format adopted from the SMP Case studies, 2003)	61
Table 4.2 Increase in motorized vehicle ownership	64
Table 4.3 Comparison between share of trips made by and actual fleet size of various modes in 2006.....	66
Table 4.4 BMTC operational details over time	73
Table 4.5 Road map for vehicle emission norms for new vehicles (except 2 & 3 wheelers).....	82
Table 4.6 Mass emission norms for Indian vehicles: notified till 2000 and auto industry plan beyond 2000	83
Table 4.7 Values of conventional pollutants monitored at Amco Batteries location in Bangalore.....	85
Table 4.8 Noise levels at night and day in Bangalore*.....	89
Table 4.9 Variation in the performance levels of the road network in Bangalore.....	90
Table 4.10 Average travel delays.....	90
Table 4.11 Investment plan for transport infrastructure in Bangalore – JNNURM period (2006-12)	104
Table 4.12 Overview of Bangalore’s future transport projects.....	105
Table 7.1 Possible ITS services in India.....	153

Figures

Figure 2.1 India's rate of economic growth.....	17
Figure 2.2 Percentage share of passengers between road and rail transport (1950-51 to 2004-05)	19
Figure 2.3 Percentage share of freight between road and rail transport (1950-51 to 2004-05)	20
Figure 2.4 Major ports in India.....	27
Figure 2.5 Annual growth of domestic and international passenger traffic (2001-2005)	30
Figure 2.6 Annual growth of domestic and international cargo traffic (2003-2006)	30
Figure 2.7 Trends in population growth in India (1951-2026).....	32
Figure 2.8 Trends in total number of registered motor vehicles in India	33
Figure 2.9 Proportion of registered vehicles in India	34
Figure 2.10 Vehicle composition in India, 2003	34
Figure 2.11 Investments envisaged under JNNURM in different sectors	36
Figure 3.1 Sector contributions in Karnataka's economy	38
Figure 3.2 Location of Bangalore Urban Agglomeration in India (2001).....	43
Figure 3.3 Location of Bangalore Urban Agglomeration in Karnataka State	44
Figure 3.4 Map showing jurisdictional limits of older Bangalore Mahanagara Palike (BMP), newly added City Municipal Councils (CMCs) and Town Municipal Council (TMC) and the newly formed Bruhat Bangalore Mahanagara Palike	45
Figure 3.5 Population growth in Bangalore city from 1850 to 2001	46
Figure 3.6 Comparison of population of Bangalore with other metros for the year 2001	47
Figure 3.7 Population density map of Bangalore	50
Figure 3.8 Locations and population density of poor settlements (Slums) in Bangalore	53
Figure 3.9 Urban expansion from 1950 to 2003.....	54
Figure 3.10 Existing land use map of the study area, (SOURCE: BDA, 2007).....	56
Figure 4.1 Vehicular growth rates in Bangalore between 1985 and 2005.....	63
Figure 4.2 Changing vehicular fleet composition in Bangalore	65
Figure 4.3 BMTc jurisdiction map (Source: BMTc, 2007)	72
Figure 4.4 Trends of RTIs in Bangalore (1988-2006).....	80
Figure 4.5 Comparison of monitored values of conventional pollutants in major cities of India between 1999-2006.....	87
Figure 4.6 Change in peak traffic flow volumes on three of the major intercity corridors for Bangalore - 1999 and 2006.....	91
Figure 4.7 Map of Bangalore highlighting the key locations for slum assessments	96
Figure 5.1 Focus of the literature review, field study and related areas	109
Figure 5.2 Monthly transactions performed through B1 citizen service centers in Bangalore.....	114

Project team

Mr. S. Sundar, *Advisor*

Ms. Chhavi Dhingra, *Principal Investigator*

Ms. Shikha Gandhi

Ms. Akshima Dogra

Mr. Pratik Ghosh

Dr. Ranjan Kumar Bose

Dr. Vinod Tewari, *Reviewer*

Mr. Rakesh Kumar Hooda

Ms. Sonia Khanduri, *Documentation and coordination*

Acknowledgements

The Energy and Resources Institute (TERI), New Delhi, acknowledges the financial support provided by the World Business Council for Sustainable Development (WBCSD), Toyota Motor Corporation (TMC), and Renault in order to undertake this study.

TERI is grateful for the constructive inputs provided by Dr. Shona Grant, WBCSD, and Dr. George Eads, Charles River Associates International, Washington D.C. throughout the study. The project team is also grateful to the entire TMC team including Ms. Masayo Hasegawa, Ms. Satomi Tomomitsu, Mr. Satoshi Kato and Mr. Stephan Herbst for their contribution to the report. TERI also thanks Mr. Jean Grebert, Renault, France, for his constructive inputs to the study report. TERI is also thankful to Ms. Mihoko Kimura, WBCSD, for her inputs and coordination of this project. Help and support provided by Toyota Kirloskar Motor (TKM) Pvt. Ltd., in coordinating various activities is also appreciated.

It would not have been possible to complete a case study on Bangalore without the cooperation and active participation of a number of different stakeholders from the city. The TERI team is most grateful to the following persons for their valuable insights and constructive inputs for this study:

1. *Dr. Gururaj Gopalakrishna* - National Institute of Mental Health & Neuro Sciences (NIMHANS)
2. *Mr. Nusrath Ahmed Khan, Mr. Dastagir Shariieff and Mr. Upendra Tripathy* - Bangalore Metropolitan Transport Corporation (BMTC)
3. *Mr. N.P.Sharma* - Bangalore Metro Rail Corporation Ltd. (BMRCL)
4. *Mr. A. P. Joshi* - Karnataka State Road Transport Corporation (KSRTC)
5. *Mr. Jawaid Akhtar and Mr. N.R.N. Simha* - Karnataka Urban Infrastructure Development and Finance Corporation (KUIDFC)
6. *Mr. Ramaiah, Mr. M.N. Jayaprakash and Mr. N.R. Raju* - Karnataka State Pollution Control Board (KSPCB)
7. *Mr. M.G. Nagendra Kumar* - Karnataka State Police
8. *Mr. A.K. Aiyappa* - Department of Transport, Bangalore
9. *Mr. Vipin Singh* - Directorate of BangaloreOne, Government of Karnataka
10. *Dr. W.M. Sivakumar* - Bruhat Bangalore Mahanagar Palike (BBMP)

11. *Mr. V. S. Basavaraju* - The Association of People with Disability (APD)
12. *Mr. Yash Sachdeva* - RITES Ltd.

TERI also gratefully acknowledges the following institutions for their help and cooperation:

1. Directorate of Economics and Statistics, Government of Karnataka
2. Indian Institute of Management (IIM), Bangalore
3. The Office of the Minister of Transport, Government of Karnataka
4. Urban Development Department/Directorate of Town Planning, Government of Karnataka
5. Department of Rural Development & Panchayati Raj, Government of Karnataka
6. Bangalore Traffic Police
7. Bangalore Development Authority (BDA)
8. Bangalore Metropolitan Regional Development Authority (BMRDA)
9. Central Road Research Institute (CRRI), New Delhi

As a part of this study, TERI carried out mobility assessments in five-slum areas – Vivek Nagar, Ambedkar Nagar - Old Baipanalli, Ambedkarnagar-Sunnadigudi, Ramakrishna Sewa Nagar and Ambedkar Nagar - Opposite Audgudi Police Staff Quarters in Bangalore. TERI extends gratitude to all the slum dwellers residing in these areas for giving of their time to interact with the TERI team. TERI is also thankful to the survey team from RITES Ltd. that accompanied the TERI team during the slum assessments.

Towards the end of the study, a Stakeholder Dialogue was held in Bangalore, this was a major milestone in this project. The main objective of this Dialogue was to get feedback on the issues and priority mobility areas identified in this case study, as well as to seek participants' views and suggest sustainability directions and policy recommendations for Bangalore. TERI extends a heartfelt thanks to all the panelists and participants who actively participated in the Stakeholder Dialogue and helped to make it a success. In particular, TERI would like to thank the following speakers who with their valuable insights and recommendations made the dialogue more meaningful and interesting:

1. Dr. A. Ramachandran, Chairman TERI
2. Mr. Atsushi Toyoshima, Managing Director, Toyota Kirloskar Motor Pvt. Ltd
3. Prof. Yoshitsugu Hayashi, Dean of Graduate School of Environmental Studies, Nagoya University, Japan and Chair of Scientific Committee, World Conference on Transport Research Society (WCTRS)

4. Mr. D. Thangaraj, Principal Secretary, Department of Transport, Government of Karnataka
5. Ms. K. Chamaraj, Executive Trustee, CIVIC, Bangalore
6. Mr. N.A. Khan, Asst. Traffic Manager, Bangalore Metropolitan Transport Corporation (BMTC)
7. Mr. K. Jairaj, Principal Secretary, Rural Development and Panchayati Raj Department, Government of Karnataka
8. Mr. M. Lakshminarayana, Commissioner for Transport & Road Safety, Government of Karnataka
9. Dr. G. Gururaj, Professor and HOD, Dept. of Epidemiology, National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore
10. Mr. Abhijit Mukherjee, Asst. Director, Association of People with Disability, Bangalore
11. Mr. M.A. Saleem, Director (Security & Vigilance), Karnataka State Road Transport Corporation (KSRTC)
12. Dr. Hiroyuki Watanabe, Senior Technical Executive, Toyota Motor Corporation, Japan
13. Mr. Chetan Maini, Deputy Chairman & Chief Technical Officer, REVA Electric Car Company Private Limited
14. Ms. N.S. Rama, Head, Bangalore Development Center & Product Engineering Business Unit, Infosys Technologies Limited
15. Mr. Madhukar Shetty, Deputy Commissioner of Police, Bangalore Traffic Police

Last but not the least the team is grateful to Mr. S.Sundar, Distinguished Fellow, TERI, for his extremely valuable inputs, expert guidance and full support during the course of this project, as the project advisor. We also thank Dr. Vinod Tewari, Advisor, Urban Systems, TERI for his constructive suggestions as reviewer of the report. The team is also grateful to Ms. Annapurna Vancheswaran, Director, Sustainable Development Outreach, TERI, for her help and encouragement at various stages of the project.

Finally, the team gratefully acknowledges the consistent support and efforts of the TERI Southern Regional Center in Bangalore, which played an instrumental role in coordinating various activities and events for the project.

Abbreviations

ADB	Asian Development Bank
APTS	Advanced Public Transport Systems
ATCs	Area Traffic Controls
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
B1	BangaloreOne
B2C	Business to Citizen
BBMP	Bruhat Bangalore Mahanagara Palike
BDA	Bangalore Development Authority
BMP	Bangalore Mahanagara Palike
BMTC	Bangalore Metropolitan Transport Corporation
BOOT	Build, Own, Operate & Transfer
BPO	Business Process Outsourcing
BTKM	Billion Ton Km
CAGR	Compounded Annual Growth Rate
CASUMM	Collaborative for the Advancement of the Study of Urbanism through Mixed Media
CBD	Central Business District
CDPs	City Development Plans
CIVIC	Citizen's Voluntary Initiative for the City
CMCs	City Municipal Councils
CRAI	Charles River Associates International
CRRI	Central Road Research Institute
CVO	Commercial Vehicle Operations
DoT	Department of Telecommunications
E-governance	Electronic governance
ETTM	Electronic Toll Collection and Traffic Management
EWS	Economically Weaker section
FDI	Foreign Direct Investment
FGD	Focus Group Discussion
FIR	First Information Report
FY	Financial Year
G2C	Government to Citizen
GBMA	Greater Bangalore Municipal Area
GOE	Government Owned Enterprises
GoI	Government of India
GoK	Government of Karnataka
HCV	Heavy Commercial Vehicle
HR	Human Resources
I & M	Inspection and Maintenance
ICSC	Integrated Citizen Service Centers
ICT	Information and Communication Technologies
IIM	Indian Institute of Management
IMO	International Maritime Organization
IPT	Intermediate Public Transport

ISD	International Subscriber Dialing
IT	Information Technology
ITAC	International Telework Association and Council
ITS	Intelligent Transport Systems
IVRS	Interactive Voice Response System
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JNPT	Jawaharlal Nehru Port Trust
KSPCB	Karnataka State Pollution Control Board
KSRTC	Karnataka State Road Transport Corporation
LCV	Light Commercial Vehicle
M4D	Mobility for Development
MAAP	Micro Accident Analysis Package
MDR	Major District Roads
MESO	Mumbai Environmental Social Organization
MoCA	Ministry of Civil Aviation
MoEF	Ministry of Environment and Forests
MoR	Ministry of Railways
MoSRTTH	Ministry of Shipping, Road Transport and Highways
MoUD	Ministry of Urban Development
MMGRAY	Mukhya Mantri Grameena Raste Ahivruddi Yojane
NAAQS	National Ambient Air Quality Standards
NABARD	National Bank for Agriculture and Rural Development
NEKSRTC	North Eastern Karnataka State Road Transport Corporation
NGO	Non-Governmental Organization
NH	National Highways
NHDP	National Highway Development Project
NIMHANS	National Institute of Mental Health and Neurosciences
NIPFP	National Institute of Public Finance and Policy
NMDP	National Maritime Development Programme
NMT	Non-Motorized Transport
NUTP	National Urban Transport Policy
NWKSRTC	North Western Karnataka State Road Transport Corporation
O&M	Operation and Maintenance
PCU	Passenger Car Unit
PIS	Passenger Information System
PMGSY	Prime Minister's Gram Sadak Yojana
PPPs	Public Private Partnerships
PWD	Public Works Department
RIDF	Rural Infrastructure Development Fund
RITES	Rail India Technical and Economic Services Limited
ROW	Right of Way
RPIS	Real-time Passenger Information System
RSPM	Respirable Suspended Particulate Matter
RTI	Road Traffic Injuries
SARS	Student Association for Road Safety
SH	State Highways
SMP	Sustainable Mobility Project
SPM	Suspended Particulate Matter

STD	Subscriber Trunk Dialing
TERI	The Energy and Resources Institute
TKM	Toyota Kirloskar Motor Pvt. Ltd.
TMC	Town Municipal Council
TRL	Transport Research Laboratory
TTOE	Thousand Tons of Oil Equivalent
UA	Urban Agglomeration
UPS	Uninterrupted power supply
VICS	Vehicle Information and Communications System
WBCSD	World Business Council for Sustainable Development
WHO	World Health Organization

Background

India is one of the major emerging economies in the world today. With a growth rate of slightly over 9% in 2006-07, the tertiary sectors, especially the transport and communications sectors, are increasingly contributing to this growth. It is only recently that transport infrastructure has started to receive the attention it deserves and the country is now on the fast track to develop each of its transport sub-sectors: roads, railways, ports, waterways and civil aviation, in order to increase capacity and keep up with increasing levels of demand.

Economic and social progress in India has not come without its negative spin-offs and increasing levels of urbanization, more and bigger cities, unprecedented levels of motorization, have all led to a number of mobility challenges. These have manifested themselves in increased levels of pollution, road fatalities, energy security concerns, congestion and increasing disparities in travel between rich and poor. In order to address these challenges the Government of India has come up with a few policies and plans. However, overall emphasis continues to be on the creation of infrastructure for transport, with the result that the sustainability of the system from an environmental, social and economic perspective has garnered scant attention.

Given this background and in order to address the sustainable mobility challenges in Indian cities, in April 2007, TERI initiated the study *Mobility for development (M4D) - A case study of Bangalore*. This study was carried out under the auspices of the World Business Council for Sustainable Development with support from Toyota Motor Corporation and Renault.

Bangalore has become a “magnet” city in India, offering a package of attractions like good employment opportunities, education, climate, quality of life, etc., thereby increasing the levels of economic activity and consequently, mobility. It is home to some of the most hi-tech industries and is known as the “Silicon Valley of India”. The sharp rise in the city’s growth has transformed the character of the city and has put tremendous stress on its mobility infrastructure, which has started to succumb to the twin pressures of increasing demand and inadequate resources. Bangalore also exhibits one of the highest rich-poor income divides in India, which raises added concerns surrounding the equitability of mobility. Bangalore was selected for this study because it is typical of a changing

cosmopolitan Indian city (with all the associated mobility challenges).

The objectives of the study were:

- § To raise awareness of the importance of mobility as a driver for economic development in Bangalore
- § To examine opportunities to narrow the mobility divide in Bangalore
- § To discuss sustainable mobility solutions (including virtual mobility solutions) for the rapidly growing city of Bangalore.

Because of the short-term nature of this study, it relied essentially on secondary information sources and primary interactions with certain specific stakeholders from time to time, in order to assess the different characteristics of mobility in the city. Towards the end of the study a Stakeholder Dialogue was organized in Bangalore. This was a critical component of this case study. It provided a unique opportunity to discuss various mobility-related issues identified by TERI with a diverse group of stakeholders (including government, NGOs, civil society, students, traders, transport providers, property developers, academics, auto manufacturers, etc.). The overall aim of the Dialogue was to obtain feedback on the issues and priority mobility areas identified in the case study, as well as to seek participants' views and suggest sustainability directions and policy recommendations for Bangalore. The outcome of the Dialogue was used to finalize the case study report.

Characteristics of mobility in Bangalore

Mobility in Bangalore has been characterized by explosive rates of motorization (largely driven by growth in the motorized two-wheeler segment), narrow roads, severe congestion problems, inadequate infrastructure for pedestrians and non-motorized users, deteriorating air quality, road accidents and a stark mobility divide between rich and poor. The city's transport system has fallen behind the needs of Bangalore's economy and citizens.

As a result of rising incomes, the number of personal vehicles in the city has grown exponentially and, in the absence of any policy to regulate ownership and utilization of personal vehicles, has resulted in a number of negative externalities. Bangalore today has the highest vehicle growth rate among all million-plus people cities in India, second only to Delhi. Vehicle growth in the city has been largely characterized by growth in the motorized two-wheeler segment. Together cars, two-wheelers and paratransit solutions (auto-rickshaws, taxis, cabs, etc.)

accounted for over 90% of the city's entire vehicle fleet in 2007. Ironically, while cars, motorized two-wheelers and paratransit solutions constitute over 90% of the total vehicle fleet, they account for less than 40% of trips, while buses account for a mere 2% of the city's fleet, and account for over 46% of the trips by volume. Despite the declining share of non-motorized vehicles and increasing share of motorized vehicles in the vehicle fleet, overall journey speeds and road network performance in the city have fallen drastically over the past few decades. One of the key reasons for this has been the inability of road infrastructure development to keep pace with the rapid increase in the number of vehicles. The road network in the city is unable to handle current volumes of traffic for a number of reasons (see Chapter 4) and solutions such as widening roads and adding more capacity by building flyovers, etc. have proven to be reactive and short-term. Every day, almost 900 new vehicles are registered in Bangalore. Given that the share of public transport and non-motorized transport is declining, this has huge implications for the sustainability of mobility in the city.

Bangalore's area grew from approx. 177 km² in 1977 to almost 565 km² in 2001. Increasing levels of motorization have encouraged urban sprawl; this in turn has led to an increase in the number of kilometers traveled and hence increased demand for transport in the city. The sprawl has manifested itself in the form of mushrooming satellite townships on the edge of the city, while the absence of a good and well-developed public transport system has increased dependency on personal vehicles, thereby increasing average journey lengths in the city.

Bangalore has a relatively good and progressive public transport system when compared to most Indian cities. Over the years transport officials have been trying to introduce a number of innovations like differentiated services for different income travel groups, special subsidies for students, disabled persons, etc. to serve the masses and increase passenger numbers. However, given that buses are not given priority on the roads, and the undeniable reality of the comfort of a personal vehicle over a public one, public transport in Bangalore continues to lose its market share. There is close to 60 km of suburban rail in the city, which serves a limited share of the travel demand, but which could be used more effectively. In addition to this, there is a significant fleet of intermediate public transport solutions (auto-rickshaws, taxis, vans, etc.) plying their business on Bangalore's roads, that are more flexible and demand-responsive than public transport. However, they are viewed as unwanted competition by the public buses. The Bangalore metro will be the latest addition to the public transport market

and its integration with the existing buses and impact on the poor will assume critical importance.

Sustainability of mobility in Bangalore

TERI examined the mobility situation in Bangalore through the lens of the 12 sustainable mobility indicators and seven sustainable mobility goals developed by the WBCSD's Sustainable Mobility Project in 2004.

The indicators were:

1. Accessibility
2. Financial outlay required by users
3. Travel time
4. Reliability
5. Safety
6. Security
7. Emissions of GHGs
8. Impact on the environment and public well-being
9. Resource use
10. Equity implications
11. Impact on public revenues & expenditures
12. Prospective rate of returns to private business

The goals were to:

1. Ensure that the emissions of transport-related conventional pollutants do not constitute a significant public health concern anywhere in the world.
2. Limit transport-related GHG emissions to sustainable levels.
3. Significantly reduce the total number of road vehicle-related deaths and serious injuries from current levels in both the developed and developing worlds.
4. Reduce transport-related noise.
5. Mitigate congestion.
6. Narrow the "mobility opportunity divides" that inhibit the inhabitants of the poorest countries and members of economically and socially disadvantaged groups within nearly all countries from achieving better lives for themselves and their families.
7. Preserve and enhance mobility opportunities for the general population of both developed and developing world countries.

Below is a summary analysis of mobility in Bangalore in the light of the above indicators and goals. The issues and recommendations identified are a combination of TERI's research, the feedback received from the Stakeholder Dialogue,

and the views of the WBCSD member companies engaged in this study.

Unfortunately, given the various data challenges and limited timeframe allocated to the study not all indicators could be addressed.

Accessibility (Indicator 1 and Goals 6 & 7):

Status: One in three households owned a motorized vehicle and bus stops were found usually within a 1-km radius of every location.

Issues: Ease of access to public transport and quality of public transport, rather than availability of transport services (private or public), was the key issue here. The ease and quality of mobility varied drastically for different groups in the city. Poor pedestrian infrastructure and lack of proper waiting facilities were highlighted. Even though public buses were available, accessing them with ease, comfort and safety was a challenge.

Recommendations: Improve pedestrian facilities connecting to transport nodes, improve infrastructure for public transport such as bus stops, sheds, etc.

Safety (Indicator 5 and Goal 3):

Status: Close to 900 deaths were recorded on Bangalore's roads in 2006. Motorized two-wheeler users, cyclists and pedestrians were most at risk from serious injury or death. It also became clear that in terms of long-term and social damage, the urban and rural poor were at a greater disadvantage than their urban and urban rich counterparts.

Issues: Improper road and structural design, poor visibility, driving under the influence, violation of helmet laws, lack of separate pathways for pedestrians and cyclists were the key issues identified. On a broader level, the main issues identified included lack of consideration of health issues in transport policies, absence of standardized mechanisms for data retrieval from various authorities, poor enforcement, improper crash investigations, lack of good trauma and pre-hospital care, inadequate capacity building to deal with the various aspects of pre-, during and post-crash situations, etc. However, the overarching and key issues highlighted were lack of accountability and clearly-defined and well-integrated road safety policy at the state level, and an absence of supporting institutional structures and programs.

Recommendations: Ensure greater safety for vulnerable groups i.e., pedestrians and rural populations, through the creation of dedicated pedestrian pathways, and speed-control mechanisms

on rural highways. Strengthen databases through better coordination between traffic police, hospitals, etc. Improve crash investigation procedures and work towards a state road safety policy. Create a state road safety board to look at the different issues in an integrated manner. Improve law enforcement and compliance in the city.

Impact on environment & GHG emissions (Indicators 7 & 8 and Goals 1, 2 & 4):

Status: Bangalore, India's "garden city" is fast losing its charm because of traffic woes. In terms of emission regulation, Bangalore has adopted Euro III norms and plans to move to Euro IV by 2010. As far as air quality is concerned, with the exception of SO₂, all other regulated pollutants (NO_x, SPM¹, RSPM²), either exceed or are at the upper limits of NAAQS. Available data point to a reduction in SO₂ levels in the city over the last few years. This can be explained by a reduction in sulfur levels in petrol and diesel. The increase in the number of diesel vehicles in the city and a shift from two-stroke to four-stroke technologies has resulted in a slight increase in NO_x levels; however, RSPM levels have come down. Noise levels in the city are much higher than the permissible limits prescribed by the Pollution Control Board.

Issues: There is no roadmap for fuel quality beyond 2010, and even the Euro IV regulation from April 2010 is applicable only for newer vehicles. Fuel quality is a key issue and the state government needs to take a major stand if it wants to improve fuel quality and make emission norms more stringent. Initiatives on the use of alternative fuels like biofuels, LPG, etc. are still limited.

Recommendations: The state government should pursue stricter emission norms and fuel quality standards in consultation with the central government and auto and oil companies. The city must have a chain of modern Inspection & Maintenance facilities. Regular maintenance obligations should be introduced and noise regulation enforced. Bus companies also need to explore the use of biofuels.

Resource use (Indicator 9 and Goals 2 & 7):

In 2000-01, over 77% of gasoline and 21% of diesel sold in Karnataka were consumed in the transport sector for the intra-city movement of traffic in Bangalore; use is growing with increasing levels of motorization.

¹ RSPM are particles of less than 2.5 micrometers in size suspended in the air.

² SPM are particles of less than 10 micrometers in size suspended in the air.

Congestion and parking (Indicators 2 and 3 and Goal 5):

Status: Congestion levels are high in Bangalore. Nearly all major junctions operate over capacity resulting in traffic jams, reduced speed and congestion. Average delays have increased over the years, and a lack of parking facilities and policies is another issue facing the city today. This adds to the congestion problem in the already limited road space.

Issues: The addition of more capacity in the form of roads and flyovers has not been able to meet surging demand by private vehicles. These measures have only succeeded in shifting the point of congestion further up the traffic stream, without really improving the overall performance of the network. Congestion is not really the problem; rather, the problem lies with urban planning and management.

Recommendations: Separate fast and slow-moving traffic and make special provisions for public transport and NMT users. Encourage use of ITS and carpooling, ridesharing, etc. to help ease congestion. In the longer run, integrating land use and transport planning to shorten distances traveled will help to reduce congestion. The use of virtual mobility solutions such as e-work and e-governance measures should be further explored and, where possible, institutionalized to reduce the number of trips required.

The “mobility opportunity divides” around and within Bangalore (Indicators 1, 2, 3, 4, 5 & 10 and Goal 6):

(a) Urban-rural divide: KSRTC buses serve the urban rural corridors in the state. Road connectivity is being improved through various central and state-sponsored schemes. However, safety on rural roads remains a key issue. High-speed highways crossing rural belts lack safe crossings and speed control mechanisms. The inadequate number of buses has resulted in overcrowding and an increase in the number of private vehicles on public routes; this is evidence of demand exceeding current supply. There is a need to explore this area further so as to better understand the mobility needs of the surrounding rural areas of Bangalore.

(b) Rich-poor divide: In order to address the mobility divide in the city, for the purposes of this study, TERI defined the city's population as:

- a. *The rich or the mobility served:* Those who have access to a personalized means of travel and/or are located close to a public transport system of a minimum quality
- b. *The poor or the mobility unserved:* Those who have no access to personalized means of transport and have

problems accessing/using the public transport systems in the city.

Issues: No data was available about the number of people falling into each of the two defined categories. The government acknowledged that mobility planning for the poor is inadequately addressed and that more lucrative projects tend to be given precedence. There was speculation as to the success of the future metro in improving mobility for the poor on account of concerns surrounding affordability. This issue requires further investigation.

Various kinds of mobility divides were identified in the city. TERI's research was supplemented by assessments of mobility patterns carried out in five different slum areas in the city. Broadly, the findings were as follows:

Spatial and temporal divide: Bus network coverage in the city as deemed to be satisfactory. But infrequency of buses and longer travel times were identified as pressing issues. The poor sometimes have to cover long distances on foot because they are unable to afford public transport.

Financial divide: Not only did the poor surveyed spend a longer proportion of time traveling, they also spent a significant portion of their income on transport (15-25%).

Personal divides: These included (1) overcrowding and lack of security in buses, (2) lack of special provisions to meet the needs of the disabled and other disadvantaged groups in the city, (3) safety concerns mainly for pedestrians, two-wheeler users and public transport users.

Recommendations: Timely, clean, safe and affordable public transport is the answer to the mobility divide. Several measures like better integration with IPT modes (particularly in the light of the future metro), priority traffic lanes, an increase in the number of peak-hour services, facilitated access to bus stations, improved passenger information systems, better liaison with the IT industry for the management of the software/corporate traffic system, etc. were identified as possible solutions to improve current public transport systems.

Finally, the importance of integrated urban planning and policy making cannot be overemphasized. Given the sheer number of organizations working in different areas, there is a lack of proper coordination and integrated solutions; both extremely important from the point of view of sustainability. Bangalore's Master Plan and City Development Plan (CDP) are being used to guide current and future transport project investments in

Bangalore. Although these are supposed to coalesce with the guidelines of the National Urban Transport Policy, which is concerned with the movement of people not vehicles, and is in favor of a public transport and non-motorized transport policy, it was found that planned investments were principally aimed at increasing infrastructure (mainly roads through the construction of additional flyovers, etc.) with only a small portion (less than 50%) earmarked for mass transport. In addition, hardly any investment has been earmarked for pedestrian and non-motorized transport infrastructure. If the mobility divide is to be addressed, the focus will need to be on allocating road space to vulnerable groups, making major investments in public transport, and integrating public and private means of transport. The government needs to address the lack of integrated land use and transport planning which could serve to minimize travel needs and distances, the use of technology to facilitate this, and the lack of institutional structures and capacity to tackle present day mobility challenges.

Use of Information and Communications Technology to achieve sustainable mobility

Technological improvements in fuels, vehicles, and traffic management are some of the measures identified in the WBCSD Mobility 2030 report. Information and Communications Technology (ICT) is increasingly seen as a possible means to complement and/or improve the efficiency of physical mobility. Given Bangalore's position as the information technology (IT) capital of India, it was logical to explore the possible role of IT in addressing some of the city's mobility challenges.

Bangalore's government-based ICT facilities, with their emphasis on e-governance programs and internet use to substitute for travel to government offices, was highlighted as an example of best practice. E-governance initiatives can help to improve the traffic situation in the city to some extent, because:

- € People either don't have to undertake trips, or
- € Have to undertake shorter trips, or
- € Can combine multiple trips into a single trip.

Such initiatives, with their impacts on traffic in the city, constitute innovative/technological solutions to traffic problems. Given Bangalore's relative advancement and its position as the IT hub of the country, such solutions are relatively easy to implement. The Government of Karnataka (GoK) has used ICT to create a "one-stop-shop" facility to provide citizens speedier, more convenient, and reliable

services. In addition, it has implemented an e-governance project, the BangaloreOne or B1 Project.

Using Bangalore's software industry as a starting point, the idea of "virtual mobility and business", involving working from home or telecommuting was explored. It was discovered, however, that terms such as e-work are still unfamiliar in India, even in mega cities. At present, it remains a needs-based option among Indian firms. However, there is some evidence that e-working can reduce travel either by reducing distances required and/or the number of trips. Further research is needed to quantify the effects of e-working in reducing demand for transport.

Intelligent Transportation Systems (ITS) are still in their infancy in India. However, tests have been carried out and initial results have been very encouraging. Initiatives by the Bangalore Metropolitan Transport Corporation (BMTC) and Bangalore Traffic Police that focus on the use of new technology to manage traffic have been judged positive. Similarly, the "Bangalore Traffic Improvement Project - BTRAC 2010", a joint initiative of the Bangalore City Police and the Urban Development Department, which sets out to address traffic congestion caused by the spiraling growth in the number of vehicles in the city, as well as safety-related problems, has been welcomed as a step in the right direction.

The possibilities in this area for India, and especially Bangalore, are huge. Far-sighted vision and total commitment are needed to tap into this potential. However, this is testing the city's modern technology preparedness. It appears that there is a lack of preparedness for new technology, both from an operational and a social perspective. Among the bureaucracy there appears to be an inherent opposition to change. This is likely to be the biggest challenge as far as the success of ITS in India is concerned.

Other potential solutions identified to address traffic woes included the creation of carpooling lanes, toll taxes, higher parking fees for single-driver cars, and the provision of improved parking areas for carpool vehicles.

The findings of this study suggest that ICT could have a role to play in both social and transport policy, creating access to activities where it has previously been denied. Following an analysis of the results of this case study, the research team believes that ICT could and should provide a useful, though not exclusive, tool in both social and transport policy. Its value should be recognized as a tool to increase access to transport where it has previously been denied. Equally, the value of

virtual mobility in enabling virtual interaction, learning, information-sharing and opportunity, should be recognized.

1.1 What is sustainable mobility?

Mobility is a key enabler of economic growth and social progress. The World Business Council for Sustainable Development (WBCSD) has defined sustainable mobility as “the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future”. Countries the world over, especially developing nations, are exhibiting increasing levels of personal and freight mobility which in turn are fuelling economic growth. However, transport *can* produce negative socio-economic and environmental impacts and externalities, which if unchecked, inhibit transport performance and subsequently impact the sustainability of economic growth. Therefore, increased mobility brings with it positive and negative impacts, which need to be borne in mind when planning for mobility in any city.

India is no exception. Urbanization in India has been very rapid; the concentration of the urban population in the comparatively larger (more than 1 million people) cities has been one of the key features of this process. Some 52% of India’s Gross Domestic Product (GDP) comes from urban areas. Owing to the enhanced economic opportunities in these urban areas, these have become fast growing magnets for populations from surrounding areas. As a result, the suburbs of most large Indian cities are growing faster than the city centers. The result is urban sprawl. This in turn has a direct bearing on mobility as it necessitates longer trips and better travel facilities. The central problem in most Indian cities, like most other cities in the developing world, is that these cities are growing and motorizing very rapidly, while the requisite infrastructure and societal conditions required to sustain this growth are not yet in place.

Mobility today has become an enormously complex subject. It touches on all aspects of life – economic, social and environmental – and is therefore subject to a multitude of pressures. Mobility and its sustainability are the end result of a complex mix of human behavior, economic growth and public policy. As a result, industries, their suppliers and their customers have an important stake in ensuring the sustainability of mobility (WBCSD, 2004).

The WBCSD’s Mobility for Development (M4D) project aims to address the complex challenges associated with achieving sustainable mobility in various cities of the developing world.

The M4D project targets four case study locations (Bangalore in India, Dar-es-Salaam in Tanzania, Shanghai in China and São Paulo in Brazil) to study the challenges and opportunities inherent in making mobility more sustainable.

The WBCSD has defined a set of seven goals that it believes will improve the outlook for sustainable mobility in cities. These are:

1. Ensure that the emissions of transport-related conventional pollutants do not constitute a significant public health concern anywhere in the world.
2. Limit transport-related GHG emissions to sustainable levels.
3. Significantly reduce the total number of road vehicle-related deaths and serious injuries from current levels in both the developed and developing worlds.
4. Reduce transport-related noise.
5. Mitigate congestion.
6. Narrow the “mobility opportunity divides” that inhibit the inhabitants of the poorest countries and members of economically and socially disadvantaged groups within nearly all countries from achieving better lives for themselves and their families.
7. Preserve and enhance mobility opportunities for the general population of both developed and developing world countries.

The importance of some of these goals over others may vary from region to region. However, it is generally accepted that in order to achieve sustainable mobility in cities, it is essential to focus on these goals and develop ways and means to achieve them.

1.2 Study background and objectives

The overall objective of WBCSD’s Sustainable Mobility Project (SMP), which began in 2000, is to address the complex challenges associated with the road transport sector in order to simultaneously enable economic growth, environmental improvement and social progress. The project takes into consideration how global mobility patterns might evolve in the period to 2030 and beyond, what strategies exist to influence this evolution in ways that might make transport more sustainable, and what is required to enable these strategies to succeed¹.

¹<http://www.wbcd.org/templates/TemplateWBCSD1/layout.asp?type=p&MenuId=MTQ0>

Bangalore, one of the fastest growing cities in India, and home to a number of IT and transport-related industries, was identified as one of the “archetype cities” (WBCSD, 2004) (the others being Dar-es-Salaam in Tanzania, Shanghai in China and São Paulo in Brazil) for the Mobility for Development project.

In order to address the sustainable mobility challenge in Bangalore, in April 2007, TERI initiated the study *Mobility for Development (M4D) - A case study of Bangalore*. This study was carried out under the auspices of the World Business Council for Sustainable Development with support from Toyota Motor Corporation and Renault.

The objectives of the study were:

- § To raise awareness of the importance of mobility as a driver of economic development in Bangalore
- § To examine opportunities to narrow the mobility divide in Bangalore
- § To discuss sustainable mobility solutions (including virtual mobility solutions) for the rapidly growing city of Bangalore.

The Stakeholder Dialogue held in Bangalore on 12 September 2007 was a critical component of this case study. It offered a unique opportunity to discuss the various issues identified by TERI (discussed in Chapters 4 and 5 of this report), dealing with different aspects of mobility in Bangalore, with a diverse group of stakeholders (including government representatives, planners, consultants, NGOs, civil society organizations, students, traders, transport providers, property developers, academics, auto manufacturers, etc.). The overall aim of the dialogue was to get feedback on the issues and priority mobility areas identified in the case study, as well as to seek participants' views on these and suggest sustainability directions and policy recommendations for Bangalore. The outcome of the dialogue has been used to finalize this case study report and, where appropriate, key observations/findings from the dialogue have been used to supplement the research done by TERI.

1.3 Approach and method adopted

Given the short timeframe for the study (April 2007- November 2007), TERI had to rely mainly on available existing secondary data, which was supplemented by TERI's past research work in Bangalore. The secondary information was substantiated by personal interviews and primary assessments. For example, through meetings with experts working in city and state governments in various departments like the Transport Department, the Bangalore Development Authority (BDA), the

National Institute of Mental Health and Neurosciences (NIMHANS), the Bangalore Metropolitan Transport Corporation (BMTC) etc.; first-hand assessments of travel patterns of people residing in five different slum areas in Bangalore; and the Stakeholder Dialogue held in Bangalore on 12 September 2007. Traffic and transportation-related survey reports prepared by institutes like the Central Road Research Institute (CRRI) and RITES India Ltd., who have worked extensively in the region in the past, were also referred to.

In various places, data availability proved to be a huge challenge and some issues like the movement of goods in the city, financial and income divides, fuel consumption for transport, etc. could not be addressed in detail.

Several recommendations emerged during the Stakeholder Dialogue. These have been incorporated throughout the report. They have also been used, along with TERI's research findings, to suggest policy directions and future actions for the government to consider.

1.4 Organization of the report

In order to address the study objectives in a systematic manner, the report has been divided into eight chapters.

Chapter 1 gives a brief introduction to the study, its objectives, and the approach followed.

Chapter 2 gives an overview of India's economy, the role of transport, and transport infrastructure in the country. It also throws light on the current patterns of urbanization and motorization in the country and brings into focus some of the key policy initiatives that have been introduced to combat the negative effects of these.

Chapter 3 goes on to give an overview of Karnataka state in terms of economic standing and transport and communications infrastructure. The chapter then zeroes in on Bangalore, the case study location, and briefly describes the city's rapidly changing social, economic and spatial characteristics and their implications for mobility in the city. This is followed by a brief discussion of urban planning processes, key planning documents, and the various institutions involved in planning land use and transport in the city and the associated challenges.

Chapter 4 gives an in-depth account of mobility in Bangalore and identifies some of the key mobility characteristics in the city. It then goes on to assess the mobility situation in the city

through the lens of some of the sustainable mobility goals and indicators developed by WBCSD. This includes parameters like air quality, safety, energy use, and the different mobility divides in the city and their manifestations. It also includes a discussion of transport projects and investments being planned for the city in the future and their possible implications for mobility, etc. Suggested policy directions and recommendations made during the course of the Stakeholder Dialogue are included in relevant places throughout the chapter.

Chapter 5 gives the reader a snapshot of Bangalore's technology initiatives (with more India-centric and Bangalore-centric real-time data) and their influence on travel patterns, if any. The chapter discusses different schemes that use technology in an attempt to make mobility more sustainable such as e-governance, e-work, ITS initiatives, and emerging concepts like internet-based carpooling and their current state of implementation in Bangalore, etc.

Chapter 6 gives a detailed description of the observations made during the Stakeholder Dialogue discussions held in Bangalore on 12 September 2007.

Chapter 7 essentially sums up the recommendations that have emerged from a combination of TERI's research, feedback from the Stakeholder Dialogue, and the views of the WBCSD member companies engaged in this study.

The final section contains a series of Annexes.

2.1 Economic importance of the transport sector

India is one of the major emerging economies in the world today. Gross Domestic Product has grown at a rate of 9.2% during the period 2006-07 as against 6% in 2001-02. This growth was mainly spurred by the industrial and service sectors, which recorded a rise of 10% and 11.2% respectively in 2006-07 as compared to 6.4% and 5.7% respectively in 2001-02 (MoF, 2007). Figure 2.1 shows the growth rates of the Indian economy over the last few years of development.

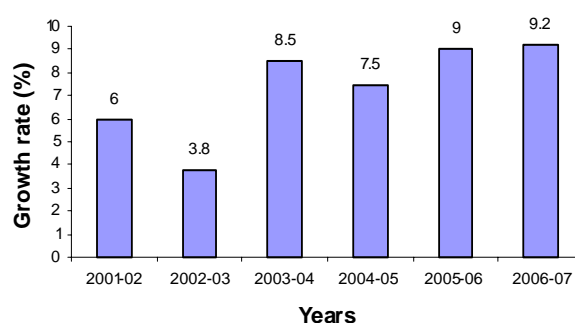


Figure 2.1 India's rate of economic growth

(SOURCE: MoF, 2007)

Within the industrial and services sector, it is the manufacturing and transport and communications sectors that have propelled the growth of GDP in the country. It is important to note here that the transport sector has been a major player in facilitating the overall development of the country by supporting internal trade and commerce, diversifying production and exports of merchandise, and improving the quality of life. The transport sector accounted for an increasing share of India's GDP growth from 5.7% in 1999-2000 to 6.4 % 2004-05¹ (Planning Commission, 2007), as shown in Table 2.1.

Table 2.1 Share of transport sector in GDP

Sector	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
	As percentage of GDP (at factor cost and cost constant prices)					
Transport	5.7	5.8	5.8	6.1	6.2	6.4

(SOURCE: Planning Commission, 2007)

¹Total GDP in India in 2004/05 was Rupees 28,439 billion at current prices and Rupees 23,937 billion at constant 1993-94 prices.

2.2 Overview of India's transport sector

India's transport sector is large and diverse; it caters to the needs of about 1.1 billion people. The sector has grown tremendously over the last fifty years of planned development, both in terms of outreach and capacity. Today, more than ever, the sector is on the verge of major expansion and development.

India's passenger and freight transport system has witnessed a shift away from railways in favor of roads. However, rail is still the dominant form of transport for long-haul passenger movement, while road transport accounts for most of the short-haul movement. If past and present trends in demand for passenger and freight travel continue and GDP continues to grow, the modal split will become increasingly skewed in favor of roads, with worsening impacts for energy use and the environment.

The rate of growth has varied considerably by sub-sectors. Road, air and water transport have grown rapidly, while rail transport has grown more slowly (see Tables 2.2 & 2.3 and Figures 2.2 & 2.3).

Table 2.2 Historical trends and modal shares of various transportation modes in passenger traffic

Year	Passengers (billion passenger kms)				Modal shares (%)			
	Road	Railways	Airlines	Total	Road	Railways	Airlines	Total
1950-51	23.0	66.5	NA	89.5	25.7%	74.3%	NA	100%
1960-61	80.9	77.7	NA	158.6	51.0%	49.0%	NA	100%
1970-71	210.0	118.1	NA	328.1	64.0%	36.0%	NA	100%
1980-81	541.8	208.6	NA	750.4	72.2%	27.8%	NA	100%
1990-91	767.7	295.6	NA	1063.3	72.2%	27.8%	NA	100%
1999-2000	1831.6	430.7	11	2273.7	80.6%	18.9%	0.5%	100%
2000-01	2075.5	457.0	12	2544.8	81.6%	18.0%	0.5%	100%
2001-02	2413.1	490.9	12	2915.6	82.8%	16.8%	0.4%	100%
2002-03	2814.7	515.0	13	3342.5	84.2%	15.4%	0.4%	100%
2003-04	3070.2	541.2	15	3626.0	84.7%	14.9%	0.4%	100%
2004-05 (Provisional)	3469.3	515.7	18	4003.0	86.7%	12.9%	0.4%	100%

NA – Not available

(SOURCE: Planning Commission, 2007)

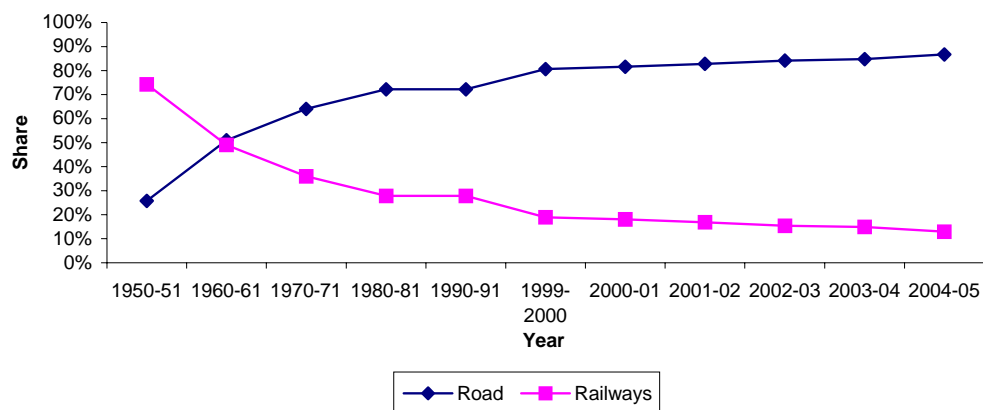


Figure 2.2 Percentage share of passengers between road and rail transport (1950-51 to 2004-05)

(SOURCE: MoR, 2007)

Table 2.3 Historical trends and modal split of various transportation modes in freight traffic

Year	Goods (billion ton kms)				Total	Modal shares (%)				
	Road	Railways	Airlines	Water		Road	Railways	Airlines	Water	Total
1950-51	6.0	37.60	NA	NA	44	13.8%	86.2%	NA	NA	100%
1960-61	14.0	72.30	NA	NA	86	16.2%	83.8%	NA	NA	100%
1970-71	47.7	110.70	NA	NA	158	30.1%	69.9%	NA	NA	100%
1980-81	90.9	147.70	NA	NA	239	38.1%	61.9%	NA	NA	100%
1990-91	145.1	235.80	NA	NA	381	38.1%	61.9%	NA	NA	100%
1999-										100%
2000	467.0	305.20	0.1	NA	772	60.5%	39.5%	0.018%	NA	
2000-01	494.0	312.40	0.1	1.5	808	61.1%	38.7%	0.018%	0.2%	100%
2001-02	515.0	333.20	0.2	1.7	850	60.6%	39.2%	0.019%	0.2%	100%
2002-03	545.0	353.20	0.2	1.7	900	60.5%	39.2%	0.018%	0.2%	100%
2003-04	595.0	381.20	0.2	1.8	978	60.8%	39.0%	0.020%	0.2%	100%
2004-05	646.0	407.4	0.2	2.1	1056	61.2%	38.6%	0.022%	0.2%	100%
(Provisional)										

NA – Not available

SOURCE – (SOURCE: Planning Commission, 2007)

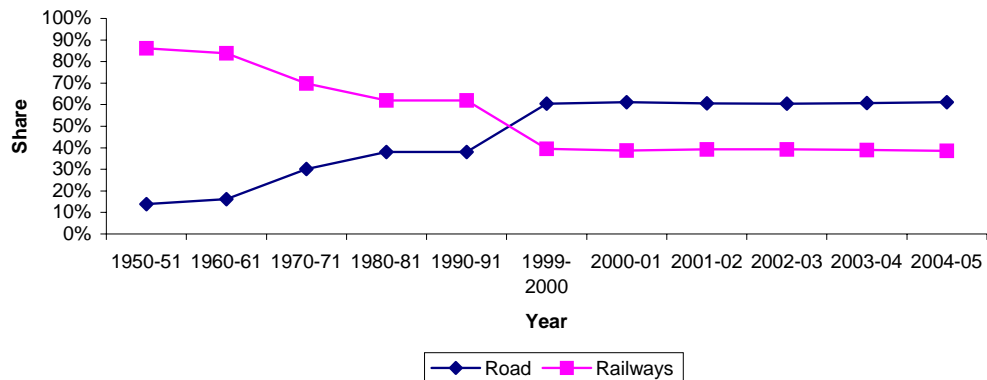


Figure 2.3 Percentage share of freight between road and rail transport (1950-51 to 2004-05)

(SOURCE: MoR, 2007)

Institutionally, responsibility for transport in the country is devolved to several agencies that are responsible for regulatory and management functions. Each sub-sector of the transport sector like roads, urban transport, shipping, aviation and railways comes under the responsibility of a central ministry. This ministry guides the overall national policy for that sub-sector, maintains databases of statistics, initiates national level programs, etc. At the state and city level, responsibilities are further divided between various departments. For example, in the context of urban transport, the planning and development mechanism for urban areas in the country involves a hierarchy of institutions at national, state, regional, local or settlement, sub-city and site levels. At the central level, the Planning Commission, through successive five-year plans formulates economic and social policies. The Ministry of Urban Development (MoUD) deals with administrative and financial control of centrally-sponsored schemes relating to towns, urban basic services, and urban slums. At the central level, agencies such as the Ministry of Road Transport and Highways, the Ministry of Urban Development, the Ministry of Environment and Forests, the Ministry of Railways, the Ministry of Petroleum and Natural Gas, the Planning Commission and others are involved in different aspects of urban transport. The Central Pollution Control Board (CPCB) is a statutory body and provides technical assistance and services to the Ministry of Environment and Forests in setting and monitoring ambient air quality and noise levels in the various cities in India. At the state level, the Department of Transport, the Public Works Department, the Municipalities, the State Pollution Control

Board, the State Transport Undertaking, the Development Authority, and the police are responsible in one way or another for the various aspects of urban transport. These and more departments exist again at the individual city level. The following chapters will provide a better understanding of the roles and responsibilities of these different institutions.

The sections which follow provide a brief overview of each of the transport sub-sectors in the country.

2.2.1 Roads

2.2.1.1 Current status

Road transport is a very important sector for both passenger and freight movement in India. India has the second largest road network in the world, which grew from 2.3 million km in 1991 to 3.3 million km in 2004. It consists of about 0.067 million km of national highways (NH) and 0.128 million km of state highways (SH) along with village, PWD and other roads. Roads occupy a crucial position in the country's transportation sector as they carry nearly 65% of freight and 85% of total passenger traffic (Rastogi, 2007). They have made an enormous impact on the Indian economy by contributing about 4.5% of GDP, the highest when compared to other transport sectors (Planning Commission, 2007). The existing road network in India is inadequate, unable to handle high-density traffic, and the surface quality is poor in most places.

2.2.1.2 Initiatives and investments

National highways

National highways make up about 2% of the road network in India. The density of the highway network is 0.66 km of highway per square kilometer of land, which is comparable to that of the United States of America (0.65) and much greater than China's (0.16) or Brazil's (0.20). Highways in India are narrow and congested, with poor surface quality, yet they carry about 40% of the total road traffic across the country (MoSRTTH, 2007). Road maintenance remains significantly under-funded and accounts for only 3 to 4% of public sector fund allocation. This has resulted in the deterioration of roads and high transport costs for users (MoSRTTH, 2007). Given the economic importance of improvements in the transport sector and their development implications for India, investment in the maintenance and connectivity of highways has now become a key component of India's ambition to achieve a sustained economic growth rate of 8% over the next decade. The Government of India has reinvigorated the Central Road Fund by levying additional excise duty on petrol and diesel; over the next five years, some Rs. 1,000 billion are likely to be made

available for state highways and major district roads (MDR) (MoSRTTH, 2007).

One of the most ambitious projects ever undertaken by the Indian government was the National Highway Development Project (NHDP) in 1998, which aimed to develop national highways to international standards. Under the NHDP, the National Highway Development Program will require total investments of Rs. 2,200 billion and provide about 45,947 km² of new and improved road networks (MoF, 2007). The program has been divided into seven phases/segments, summarized in Table 2.4. Maps showing the different phases of the National Highway Development Program I to III are provided in Annex 2.1.

Table 2.4 Different phases of National Highway Development Program

Phase/segment	Description	Length (in km)	Cost (in Rs. billion)
NHDP-I	Golden quadrilateral	1738	88.11
NHDP-II	East-west/north-south corridors	6736	436.23
NHDP-III	Four-laning of important sections	10000	651.97
NHDP-IV	Two-laning	20000	278.00
NHDP-V	Six-laning of Golden quadrilateral	6500	412.30
NHDP-VI	Expressways	1000	166.80
NHDP-VII	Bypasses, ring-roads, etc.	Yet to be decided	166.80
Total		45947	2200.00

(SOURCE: MoF, 2006)

The NHDP is funded through fuel (petrol and diesel) taxes and tolls, external assistance, market borrowing and private sector investment. The initial phases (I & II) of NHDP were publicly funded; the share of private participation accounted for no more than 10% of the entire program. Because of the uncertainty of future toll receipts, the initial response to BOT (build, operate, transfer) schemes in the road sector was not satisfactory. In order to attract private sector investment and facilitate the NHDP, the government has set out a number of policy initiatives. The private sector can invest in national highway projects, levy, collect, and retain user fees; it is also empowered to regulate traffic on such highways. Model concession agreements are presently used to encourage private sector participation (under the BOT and annuity methods). Other incentives put in place to encourage private-sector participation include import duty concessions and concession extensions. NHDP III is being implemented largely on a BOT basis and PPP are being maximized in the other phases as well. Table 2.5, below, illustrates the increasing share of private investment during the different phases of the project.

Table 2.5 Amount of private investment made during the different phases of the project

Phase/segment	Amount of private investment
Phase-I	Rs. 35.92 billion (at 1999 prices)
Phase-II	Rs. 33.10 billion (at 2002 prices)
Phase-III	Rs.120 billion (at 2004 prices).

(SOURCE: MoSRTTH, 2007)

Rural roads

There is also a renewed focus on rural roads. The Prime Minister's Gram Sadak Yojana (PMGSY), a 100% centrally sponsored scheme, was launched in December 2000 with the aim of providing all-weather access to the following segments¹:

- € All unconnected habitations with a population of 1,000 persons and above in a three-year period (2000-2003)
- € All unconnected habitations with a population of 500 persons and above by the end of the tenth Five-year Plan Period (i.e., 2007).
- € Habitations with a population of 250 persons and above in the hill states, desert areas and the tribal areas also, by the end of the tenth Five-Year Plan Period.

Where roads already exist, the program will upgrade the more traffic-heavy routes.

While NHDP is expected to improve mobility, PMGSY aims to ensure good accessibility to the villages and markets. So far under PMGSY, a total of 51,739 road works have been approved, of which 38,510 will provide new connectivity, and 13,229 are being upgraded. A total of 27,833 works have been completed and 23,867 works are in progress, making a total length of 166,712 km of roads (TERI, 2007). The scheme is funded by the cess² on diesel, which is likely to be of the order of Rs. 38 billion annually, through the Central Road Fund, and through borrowing from domestic financial institutions and multilateral funding agencies.

Subsequently, in the context of the Eleventh Plan, the PMGSY program has been expanded to achieve the Bharat Nirman³ targets of connecting 66,802 habitations with all-weather roads and constructing 146,185 km of the new rural road networks. It also includes a plan to upgrade 194,132 km of the existing rural

¹ <http://pmsgsy.nic.in/>

² Tax

³ Bharat Nirman is a time-bound action plan for improvement in rural infrastructure over the next four years (2005-09).

road network through an investment of Rs. 480 billion over four years (2005-2009)¹.

2.2.1.3 Issues

Highway development programs are intended to yield benefits such as better road surfaces, faster and more comfortable journeys, reduced fuel consumption, savings in vehicle operating costs, faster door-to-door trade (especially for perishable commodities), improved access, and ultimately better economic opportunities for surrounding areas, etc. By extension, they are also intended to increase employment opportunities and growth in various sectors like the manufacturing and construction industries, civil engineering consultancy firms, etc. However, they have raised the following issues of concern:

1. *Road safety*: There is always a threat of an increase in the number of road traffic injuries as a result of increased use of highways and the poor quality of roads. Furthermore, safety on rural roads is a key issue, as high-speed highways rarely provide safe crossing spaces and access points to the villagers and nearby residents, who account for a significant number of accident victims. Though the NHDP claims to take into account internationally-recognized safety features in the design and construction of roads, an Indian government-implemented regulatory framework is required to monitor the design and implementation of these roads on a continual basis, and provide a mechanism for highway patrolling/policing of the highways as part of incident management. The Sundar Committee Report on Road Safety and Traffic Management proposed by the Ministry of Shipping, Road Transport and Highways is a step in this direction².

Implications for road-rail share: Compared to rail systems, road transport is more energy intensive. The share of GHG emissions from the road transport sector in the country was around 90% in 1994 (MoEF, 2004). Greater emphasis on road infrastructure development runs contrary to the objective of reversing the rail-road share back in the favor of the railways, which is a more sustainable option and has been continuously advocated in all policy documents.

¹ <http://www.pmgysy.nic.in/>

² <http://morth.nic.in/index2.asp?sublinkid=374&langid=2>

2.2.2 Rail

2.2.2.1 Current status

The Indian rail network is extensive and covers 63,465 RKM (route kilometers), 28% of which are electrified (TERI, 2007). The rail transport system in India is the largest in Asia and the fourth most heavily used system in the world. It serves three distinct market functions: intercity freight movement, intercity passenger movement and suburban passenger movement.

The rail transport system fulfils an important function in carrying passengers and cargo across India's vast territory but capacity constraints on its high-density corridors, maintenance backlogs, inherent weaknesses in railway policies, have resulted in the sector losing market share to the road sector. During the period 1992-93 to 2004-05 the volume of freight (billion ton kilometers) carried by road grew at an annual average rate of 6.5% compared with a growth of 3.6% in rail freight. The modal split in freight and passenger movement between rail and road has become skewed in favor of roads over the years (as illustrated by Tables 2.1 and 2.2). The share of road transport in freight movement, which was around 31% in 1970-71, increased to around 61% in 2003-04 while that of railways fell from about 66% to 39% during the same period. Similarly, the share of bus transport in passenger movement, which was around 67%, increased to around 87% while that of railways fell from around 33% to barely 13% over the same period (also see Figure 2.2 & Figure 2.3).

2.2.2.2 Initiatives and investments

The railways have implemented a number of passenger and freight-friendly measures over the last few years in order to make improvements in the system and to facilitate the hassle-free and fast movement of passenger and freight trains, ensure safety and punctuality of trains and passenger amenities, etc. Several initiatives have also been taken to rationalize freight tariffs, regularize overloading, improve wagon turnaround time, and increase utilization of empty wagons, etc. These have contributed significantly to improving the financial health of the railways. As a result, the railways made a surplus of about Rs. 200 billion in 2006-07, three times higher than 2004-05 figures (Rastogi, 2007).

Private investment, which was previously restricted in the sector, is now being sought for dedicated freight corridor projects, modernization of railway stations, manufacturing facilities for locomotives, coaches, other railway equipment, high-speed passenger corridors, container services, etc. Connectivity has also been provided to the ports of Pipavav and Mundhra in partnership with the port operators. Efforts are also

being made to enhance the quality of passenger trains to compete with the low-cost airlines. The Eleventh Five-Year Plan (2007-2012) also projects an investment of about Rs. 600 billion from the private sector through PPP during the period (MoR, 2007).

2.2.2.3 Issues

With all these reforms the rail transport system in the country has been attempting to revive and consolidate its position. But despite various initiatives in the sector, the railways have still not become commercial in their approach to inter-modal arrangements for the movement of freight. Although the major service provider and regulator, they have been unable to provide a necessary regulatory framework to attract private investment in core areas. At only 28%, electrification of the railways has not progressed satisfactorily. Increased capacity is required not only for the network but also for rolling assets. Further improvements in operating efficiency and profitability of the railways call for substantial investments. The introduction of competition in the provision of services and in the manufacture of wagons and accessories also needs to be expedited.

2.2.3 Ports

2.2.3.1 Current status

India has 12 major and 187 minor ports along its vast 7,527 km long coastline (MoF, 2007). Figure 2.4 shows the location of 12 major seaports in India.



Figure 2.4 Major ports in India

(SOURCE: <http://www.mapsofindia.com/maps/india/sea-ports.htm>)

The 12 major ports established by the Central Government handle about 75% of the country's maritime cargo. Port traffic has increased from 56 million tons in 1970-71 to about 424 million tons in 2006-07 (MoSRTH, 2007a); this is expected to grow to 900 million tons by 2011-12.¹

2.2.3.2 Initiatives and investments

The cumulative/total capacity available at the ports needs to be matched with current requirements. To improve port infrastructure, including road and rail connectivity, the National Maritime Development Program (NMDP) is expected to make a total investment of over Rs. 540 billion for major ports and Rs. 180 billion for minor ports². Out of this, a major chunk, Rs. 307 billion is expected to come from the private sector through commercially viable projects such as the construction of berths and the operation of berths and terminals. Currently, about 15 private sector projects are operational in various major ports, with four more projects under implementation. The maritime states are also developing plans to improve the capacity of the minor ports and modernize their operations. With the laws relating to privatization already in place, an allowance of 100% FDI and concessional import duties facilitated through the liberalized trade policy, this sector is emerging as one of the most attractive sectors for private investment. Measures to strengthen the regulatory structures of major ports have also been initiated. These include tariff rationalization and the establishment, in a phased manner, of a corporate structure for the existing ports. Such improvements in the scale and quality of Indian port infrastructure, if actually achieved, will significantly improve India's competitive advantage in an increasingly globalized world.

2.2.3.3 Issues

Given their current capacities, India's major ports are unable to handle sufficiently large size container vessels. In addition, the ports are unable to handle additional traffic because of access difficulties caused by inadequate road and rail connectivity or narrow and congested roads.

Thus, despite having adequate capacity and modern handling facilities, the ports are not able to ensure a quicker turnaround of ships (present average turnaround time at major ports is 3.42 days) (MoSRTH, 2007). This undermines the competitiveness of Indian ports vis-à-vis other ports in the region. Thus, initiatives like private sector participation in the sector are being taken along with improvements in port management and operations. Also changes in the size of ships, especially

¹ <http://www.investmentcommission.in/ports.htm>

² <http://www.investmentcommission.in/ports.htm>

container vessels, increasing containerization and more stringent International Maritime Organization (IMO) regulations make it necessary to reconsider port facilities and the movement of freight and container traffic in India.

2.2.4 Water transport

2.2.4.1 Current status

India has about 14,500 km of navigable waterways (of which about 5,700 km are navigable by mechanized vehicles). There is tremendous potential for the movement of freight through coastal shipping and inland waterways but only about 60 million tons are currently moved by coastal ships. In terms of ton kilometers, this represents an increase of about 15% from 1.8 billion ton km in 2003-04 to 2.1 billion ton km in 2004-05. The cargo moved by Inland Water Transport (IWT) only represented 48.21 million tons in 2004-05, although it registered an increase of 8.4% from 44.48 million tons in 2003-04 (MoSRTTH, 2007a).

2.2.4.2 Investments and initiatives

In order to further encourage the development of IWT, the Government of India has approved an IWT Policy, which includes several fiscal concessions, policy guidelines for the development of this sector, and encourages private sector participation in the development of infrastructure, ownership and the operation of inland vessels – since there has been very little growth in the sector. The Inland Waterways Authority of India (IWAI) has also been authorized to undertake joint ventures and equity participation in BOT projects.

2.2.4.3 Issues

The major impediment to the growth of the sector rests in a lack of policy measures. This sector accounts for only 7% of domestic cargo movement (ADB, 2007) and needs to be expanded. Other factors that have hindered growth of the sector include cumbersome customs procedures and non-availability of concessional finance to acquire coastal vessels. High import duties on bunker oil and spares, requirements for high levels of manpower which increase operational costs, stringent specifications relating to construction of vessels, which lead to higher capital costs, are other bottlenecks, along with inadequate berthing and handling facilities at major and minor ports.

2.2.5 Air

2.2.5.1 Current status

India has 60 airports, including 11 international airports, which cater to 14 domestic, and 80 international airlines (MoCA, 2006). During the past couple of years, the Indian civil aviation industry witnessed the opening up of Indian skies, thereby paving the way for increased international and domestic mobility and connectivity. This is illustrated in Figures 2.5 and 2.6 which show the annual growth of domestic and international passenger and cargo traffic in India since 2001.

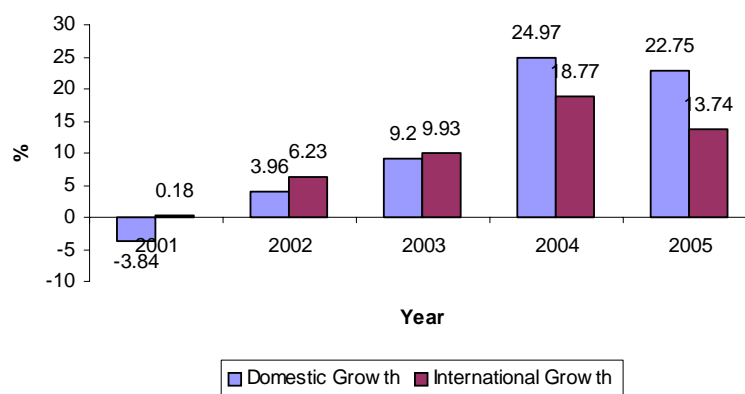


Figure 2.5 Annual growth of domestic and international passenger traffic (2001-2005)

(SOURCE: MoCA, 2006)

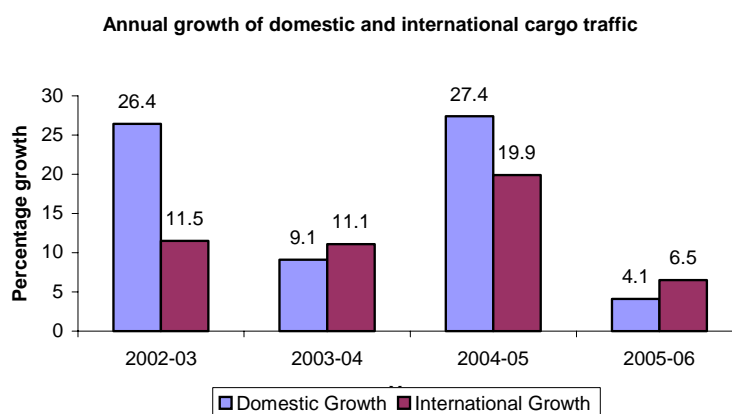


Figure 2.6 Annual growth of domestic and international cargo traffic (2003-2006)

(SOURCE: MoCA, 2006)

2.2.5.2 Initiatives and investments

Factors contributing to increased air traffic include rising incomes, entry of low cost carriers, growing popularity of India as a tourist destination, and increasing business opportunities with increased FDI in various sectors. Reforms in the sector are already in place with government and private players taking initiatives for investment in the sector. The government's development plan proposes investments of Rs. 400 billion by 2010 of which approximately Rs. 310 billion will come from PPPs. The Eleventh Plan (2007-2012) provides for an outlay of Rs. 521 billion for the civil aviation sector. It also envisages world-class gateway airports providing aviation services and passenger/cargo facilities of global standards, in a safe and secure environment. This will be implemented in major cities during the same period in partnership with the private sector (PPPs) and the Airports Authority of India (MoCA, 2006).

2.2.5.3 Issues

The most pressing issue facing the aviation sector is high growth in air traffic along with inadequate infrastructure, air control and navigation facilities, which have put a strain on aviation infrastructure, resulting traffic congestion and delays at the majority of the airports. Also, inadequate air infrastructure continues to be a major stumbling block stifling the growth of air cargo. Indian airports are hampered by poor cargo and passenger handling facilities; these need to be improved if the sector is to be made more attractive.

2.3 Urbanization, motorization and policy responses

India is one of the major emerging economies in the world with about 52% of GDP generated in urban areas (NIPFP, 2007). The population of India stood at 1.027 billion on 1 March 2001, of which 742 million lived in rural and 286.1 million in urban areas (GoI, 2001). Figure 2.7 shows the population growth pattern in India since 1951.

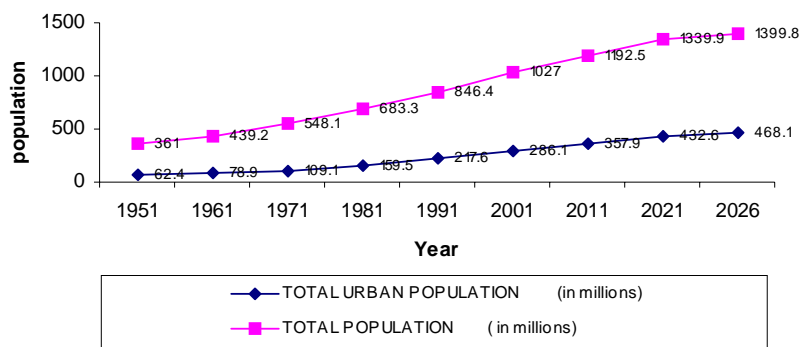


Figure 2.7 Trends in population growth in India (1951-2026)

(SOURCE: GOI, 2006)

2.3.1 Urbanization

The country is growing rapidly with 27.8 % of its population residing in urban areas in 2001 as compared to 25.7% in 1991; this is expected to increase to 40% by 2030 (NIPFP, 2007). The number and size of cities and towns have been increasing and the total number of cities and towns in the country has increased from 4,651 in 1991 to 5,161 in 2001 (NIPFP, 2007). In addition, the number of cities with populations above 1 million has grown dramatically from 12 in 1981 to 35 in 2001 (NIPFP, 2007). According to the Planning Commission, increasing population coupled with continued urbanization and current economic development trends is likely to result in the emergence of 60-70 such cities by the year 2021. This shift in the population shares of different sizes in cities and towns is one of the most visible changes in Indian urban settlement patterns. This growing trend towards urbanization and eventually suburbanization in the country is extending to the other cities (above 1 million), which are today witnessing greater movement of capital and labor between city centers and peripheries, with serious implications for infrastructure and management structures.

2.3.2 Rapidly increasing motorization

India has witnessed wholesale growth in levels of motorization; this is inextricably linked to urbanization. Rapid motorization can be attributed to a number of factors. These include rising per-capita income, higher aspiration levels of customers, price reductions and availability of new vehicle models – variants launched by auto manufacturers. In addition, the opportunity to pay for the purchase of a vehicle in low monthly installments as a result of stable interest rates and higher tenures, and recent cuts in excise duty for small cars, have also encouraged increased car-ownership.

While the total population and urban population have almost doubled during 1980-2003, the number of registered motor vehicles has risen by a factor of 15.

The number of registered motor vehicles in India has risen from 3.68 million in 1980-81 to 68.05 million in 2004-05, making an average annual growth rate of 12.7 % for the period (see Figure 2.8). Two-wheelers (i.e., motor cycles and scooters) and cars together account for more than three-quarters of the total number of registered vehicles with an average annual growth rate of 14.36% between 1980 and 2004. In comparison, the number of registered buses has increased at an average annual growth rate of only 7.42%.

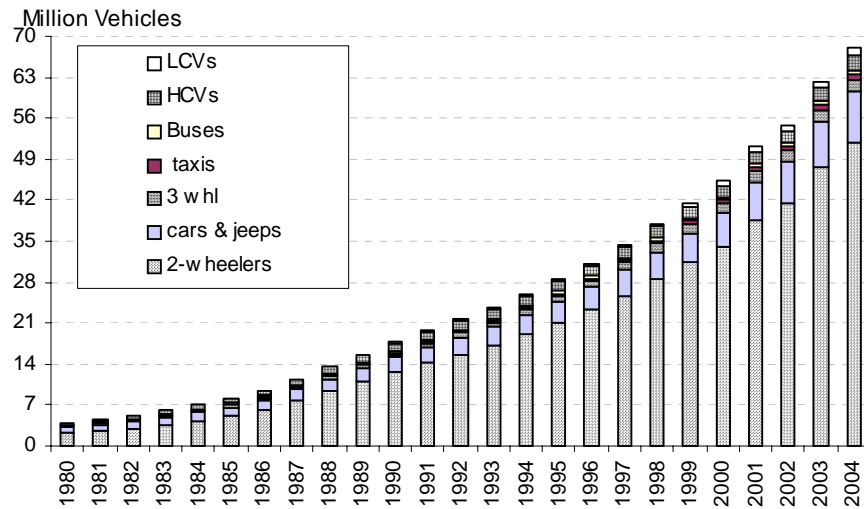


Figure 2.8 Trends in total number of registered motor vehicles in India

(SOURCE: MoRTH, 2007)

The proportion of buses in relation to the total registered fleet of vehicles has fallen from 5% in 1971 to 1.1% in 2004. Correspondingly, the proportion of personalized vehicles (two-wheelers and cars) in relation to the total number of registered vehicles in India has increased from 65% in 1971, to 88% in 2004 (Figure 2.9).

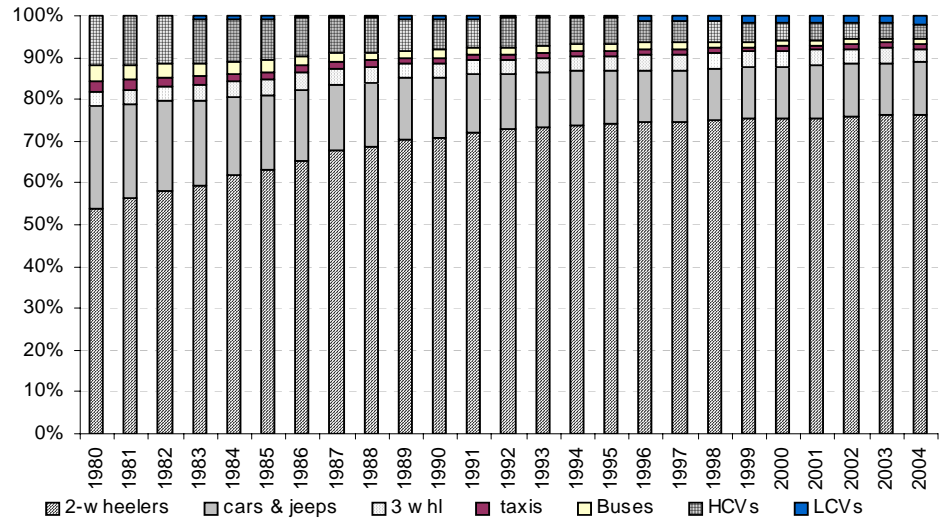


Figure 2.9 Proportion of registered vehicles in India
(SOURCE: MoRTH, 2007)

Motorized two-wheeler vehicles are the dominant mode of road transport in the country. They account for more than three-quarters of the total number of registered vehicles and have seen the highest average annual growth rate of 14.5% between 1980 and 2003. Cars, jeeps, and taxis taken together have grown at an average annual rate of 9.5% during the period, whereas the number of registered buses has grown at an average annual rate of 7.5% in the same period.

In 2003–2004, 23 out of 35 metropolitan cities — each with over one million people — accounted for about one-third of the total of 62.7 million vehicles registered in the country. About 45% of the total number of cars is confined to these metropolitan cities. The corresponding figures for other vehicular modes are shown in Figure 2.10.

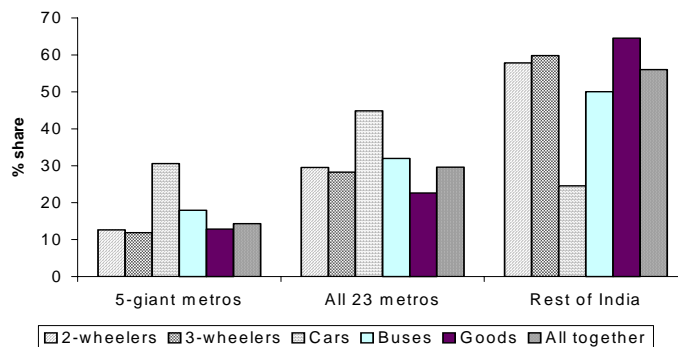


Figure 2.10 Vehicle composition in India, 2003
(SOURCE: MoRTH, 2005)

2.3.3 Policy responses

The growth in the number of vehicles has led to congestion, air pollution, increasing accidents in cities, and dependence upon scarce fossil fuels. Public transport has largely proved ineffective in providing an alternative to personalized travel. Land use planning in Indian cities has largely been carried out independently of transport planning. The challenge now is to integrate the two so that urban demand for travel is contained and trip lengths reduced. Some of the other challenges before policy makers are to develop an optimal modal mix in cities, promote the use of non-motorized means of transport, reduce emissions from motor vehicles, and ensure accessibility to good and efficient public transport systems.

Given this, the National Urban Transport Policy (NUTP) was announced in January 2006. This policy was formulated to meet the mobility needs of the current and projected population and ensure sustained flow of goods and people in urban areas fuelled by economic growth. The policy aims to address some of the key problems currently faced by most urban areas, namely:

- § Congestion and difficulty in accessing jobs, healthcare, educational and leisure facilities, all required for an improved standard of living
- § High rate of personal travel thereby increasing costs (both monetary and non-monetary) to the urban poor, causing them inequities and negative externalities
- § Threat to safety, especially to non-motorized vehicle users, pedestrians, and public transport users who are also pedestrians
- § Increased air pollution.

In December 2005, the Government of India launched the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), which aimed to rejuvenate the urban milieu through implementation of a number of projects with active private sector participation. Cities with million-plus populations, state capitals, and cities of cultural and tourist importance were to be included under the Mission. This major initiative sought to bring about comprehensive improvements in urban infrastructure, through the commitment of substantial funds and required a series of reforms to make the investments sustainable.

Most of the policy objectives of the NUTP are meant to be realized as proposals and projects under the JNNURM; 63 Indian cities have been selected and an urban reform agenda, of which urban transport is a component, is being implemented. Each of these 63 cities has come up with a City Development Plan, which is a policy and investment plan for the city for the

next 5 years (2007-2012). An outlay of about Rs. 10,000 billion has been allocated for the Mission, which includes investment for basic infrastructure and services over the next 7 years. These include urban transport, water supply, sewerage, urban renewal, etc. Both the NUTP and the Mission make funding conditional upon the cities taking up projects in line with the recommendations made in the NUTP. However, this is not being implemented on ground.

Figure 2.11 provides details of the investment envisaged under JNNURM for various sectors (2005-2012). An investment of Rs. 1372.91 billion is envisaged for transport sector development under JNNURM, which is the highest when compared to other sectors (MoUD, 2007).

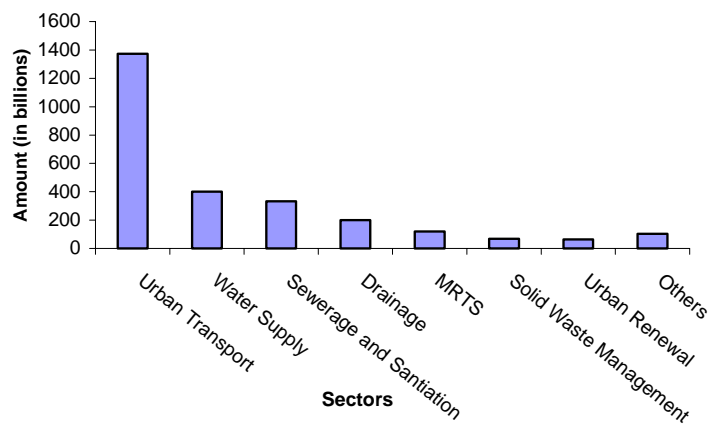


Figure 2.11 Investments envisaged under JNNURM in different sectors
(SOURCE: MoUD, 2007)

Though the investment under JNNURM for urban transport is the highest, the plans do not include sustainability and focus purely on the creation of more infrastructure as a mobility solution for the city. More details of this are discussed in section 4.2.6.3. The sectors identified for intervention by the JNNURM are those that fall under the purview of city-level governments. Therefore issues like the environment and energy are not addressed in this program.

2.4 Summing-up

India's economy has shown signs of rapid progress and the transport sector is a large contributor to this. Its share of GDP in 2004-05 was 6.4%. With increasing urbanization and

demand for basic services in rapidly growing urban centers, there has been huge emphasis on infrastructure development in the country. Transport is no exception and there are several initiatives and projects being undertaken in the various sub-sectors of transport, namely roads, rail, water transport, civil aviation, etc. that are drawing huge investments from both the public and private sectors. Another effect of the country's economic progress and urbanization has been rapid levels of motorization, especially in medium-large sized cities. This has contributed to increasing levels of pollution, congestion and safety problems in the cities and also to energy security and climate change problems at the national level. The trend has been for an increasing shift in freight and passenger traffic from railways to roads. The Government of India recently announced the National Urban Transport Policy and the JNNURM program in order to address the various challenges faced by urban areas with regard to mobility and infrastructure deficiencies, respectively. The subsequent chapters throw light on the mobility challenges, ways in which they are being addressed, and what more could be done to make mobility more sustainable in the city of Bangalore in Karnataka.

CHAPTER 3 Mobility in Karnataka and Bangalore

3.1 Background – Karnataka state

The state of Karnataka is the ninth largest in the country in terms of population. It accounts for 5.1% of India's population i.e., about 53 million people (GoI, 2001), and 5.8% of India's geographical area. The state economy has also been growing at a fast rate with state income registering an increase of 9.5% per annum. State income increased from Rs. 3,00,870 million in 1990-91 to Rs. 6,13,860 million in 2001-02 .Per capita income at constant prices increased from Rs.6739 to Rs.11, 516 showing an annual increase of 7.1 % during the same period (GoK, 2005).

Figure 3.1 shows the changes in sectoral contributions to Karnataka's economy. Over the years, Karnataka has witnessed high growth with the economy of the state, which was predominantly agrarian, shifting significantly towards an industrial and service-based economy. The share of the primary sector has declined from 60% in 1960-61 to 43% in 2000-01, however the share of the tertiary sector in state GDP has risen from 24.8 % in 1960-61 to 48 % in 2000-01. This can be explained by the growth of the Information Technology (IT) sector, which today accounts for about 40 % of India's software exports (GoK, 2005). While the trend towards diversification is a characteristic of a modern economy, there is cause for concern given that the size of the workforce dependant on the primary sector is not commensurate with its share of GDP (GoK, 2005).

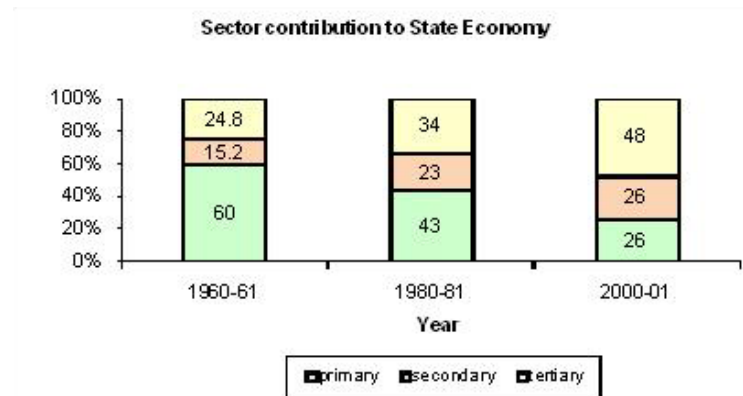


Figure 3.1 Sector contributions in Karnataka's economy

(SOURCE: GoK, 2005)

There are wide regional disparities in Karnataka. According to the Human Development Report (2005) for Karnataka, by 2001-02, Bangalore Urban, Kodagu, Dakshina Kannada, Bangalore Rural, Udupi, Mysore and Chikmagalur were generating a higher than state average per capita domestic product. The city of Bangalore alone contributed about 22% of state income and Bangalore Rural and Urban districts together generated a quarter of the state income. These two districts accounted for nearly 16% of the state's population in 2001 (GoK, 2005).

With rising incomes and more prosperity this state has undoubtedly been a magnet for people in other parts of the country. Accordingly, the state has made investments for the improvement and development of its basic infrastructure, particularly transport and communications infrastructure. Transport and communications play an important role in meeting the social and economic needs of the people, allowing movement and access, and helping to promote trade in the state.

3.1.1 Overview of Karnataka's transport sector

The state has a rail network of 3,172 km, which includes broad gauge, meter gauge and narrow gauge (GoK^a, 2005). Four important airports of the state are located in Bangalore, Belgaum, Mangalore and Hubli and the state has an all-weather seaport at Mangalore, which mainly handles cargo vessels. One of Asia's biggest naval bases (INS Kadamba) is situated at Karwar in Uttara Kannada district (GoK^a, 2005). In addition, six national highways pass through the state and the existing road network has facilitated intercity and town communication making them easy and accessible. Karnataka had 168,000 km of motorable⁷ roads in March 2005 of which national highways accounted for 2.4%, state highways for 10.3%, major district roads for 18.5% and rural roads for 68.9% of the total network (GoK 2005^b).

Institutionally, the transport sector in the state is managed by different organizations at the state and city levels, which are responsible for various aspects of transport planning, policy, regulation, etc. The state level agencies responsible for transport and the functions of the various state level departments are discussed below.

3.1.1.1 The Transport Department of the Government of Karnataka

⁷ Suitable to be driven on by motor vehicles

The transport department was set up to raise funds – through the collection of motor vehicle taxes – to improve transport. The Commissioner for Transport heads the Department of Transport and is assisted by a team of joint commissioners, deputy commissioners, directors, etc. (GoK, 2004).

3.1.1.2 Urban Development Department (UDD)

The Urban Development Department of the GoK is broadly responsible for framing and endorsing the state’s urban development plans. In the urban transport domain, the Urban Development Department examines proposals and ideas from agencies such as the Bangalore Metropolitan Transport Corporation (BMTC) and endorses or modifies them in consultation with other agencies such as the Bangalore Development Authority.

3.1.1.3 Karnataka State Pollution Control Board (KSPCB)

The mission of the Karnataka State Pollution Control Board (KSPCB) is to safeguard the natural environment of the state. In addition to enforcing the various Acts pertaining to water and air, the Board works with the Central Pollution Control Board to manage noise pollution, waste, etc. It is responsible for setting standards, carrying out monitoring and evaluation, and formulating policies for the enforcement of national and state-level Acts. The Board also advises the state government on matters of environmental protection.

3.1.1.4 Public Works Department, Government of Karnataka

The Public Works Department is responsible for road works including maintenance of national highways, state highways, and major district roads in the state.

3.1.1.5 Karnataka State Road Transport Corporation (KSRTC)

Most intercity and urban-rural connectivity in Karnataka is ensured by Karnataka State Road Transport Corporation (KSRTC) bus services. KSRTC is responsible for providing transport services and caters to urban as well as rural passenger traffic in the state.

However, at city level, different organizations and agencies manage the transport system. The institutional setup of Bangalore is discussed in Chapter 3.

3.1.2 Investments and initiatives in the transport sector

An outlay of Rs. 24,652.1 million for the transport sector has been proposed in the Annual Plan (2007-08) for Karnataka of which about Rs. 24534.6 million has been allocated for development of roads and road infrastructure, with Rs. 110

million earmarked for the development of the port sector (GoK, 2007). Initiatives and schemes like the Mukhya Mantri Grameena Raste Ahivruddi Yojane (MMGRAY) and development projects with the National Bank for Agriculture and Rural Development (NABARD) and the Rural Infrastructure Development Fund (RIDF) at the state level have also been undertaken for development of the road sector in rural areas, alongside the PMGSY.

3.1.3 Communication infrastructure in Karnataka

Besides transport, communication infrastructure in the state has also made rapid strides and is witnessing new growth characterized by new access networks and an ever-growing community of users. There are presently 13,193,402 telephone lines in the state with a teledensity¹ of 23.28, which is greater than the national average of 16.83. Teledensity is as high as 60.47 in urban areas as compared to a mere 2.53 in rural Karnataka, which is again higher than the national average of 53.34 in urban India and 1.86 in rural India, respectively (DoT, 2006). Table 3.1 provides an overview of communications infrastructure in Karnataka. The state also has about 7,475,837 mobile connections.² Subscriber Trunk Dialing (STD) and International Subscriber Dialing (ISD) are now available in all major cities (70 cities) of the state. Karnataka has over 9,864 post offices and 2,710 telephone exchanges (GoK^a, 2005).

Table 3.1 Communications infrastructure in Karnataka

Communications infrastructure	<i>Karnataka</i>	<i>Urban</i>	<i>Rural</i>
Total telephone lines	13193402	12378798	914604
Teledensity	23.28	60.47	2.53

(SOURCE: DoT, 2006)

A relatively well-developed communications infrastructure in the state has contributed to its overall development. It is now recognized that high economic development is indeed crucial to a country's development as it improves the quality of life of its people. Karnataka has emerged as a technology and knowledge capital and a pioneer in industry, contributing to the national growth and leading the country into the information age. A large share of credit goes to Bangalore, as it has been the key driver for growth and development in the state. The next section focuses on Bangalore, the case study region.

¹ Number of connections every 100 individuals

² www.coai.com

3.2 Bangalore

Bangalore is the capital of the state of Karnataka, and is today the fastest growing Indian metropolis after New Delhi⁷ in terms of population. It is home to some of the most hi-tech industries and is known as the “Silicon Valley of India”. The IT industry views Bangalore as the “byte-basket” of India. The city also houses some of India's premier scientific establishments, industries and education centers. Blessed with a clement climate, gardens, parks, natural lakes and architectural landmarks, the city is now a hub for shopping malls, restaurants, pubs, business opportunities, and is fast on its way to becoming an international metropolis.

The impact of globalization and rapid urbanization is clearly evident in Bangalore city, which has experienced unprecedented growth in the past three decades. This sharp rise in the city's growth has transformed the character of the city and has put tremendous stress on its infrastructure, which has ultimately affected the quality of life in the city, including mobility.

3.2.1 Study area location and definition

3.2.1.1 Location

Bangalore is situated in the southeastern part of Karnataka state. Figures 3.2 and 3.3 give the location of the Bangalore Urban Agglomeration (UA) within India and within Karnataka state.

3.2.1.2 The study area

The city of Bangalore has begun to show evidence of considerable urban sprawl in the last three decades. Its area grew from approximately 177 km² in 1977 to almost 565 km² in 2001 (JNNURM, 2006). The municipal area of Bangalore – Bangalore Mahanagara Palike (BMP) – has recently been extended to include seven other City Municipal Councils (CMCs) and one Town Municipal Council (TMC) to form the Bruhat Bangalore Mahanagara Palike (BBMP) or Greater Bangalore Municipal Area. Figure 3.4 shows the older limits of BMP, the seven CMCs and the TMC, and the newly formed BBMP limits. The area for this study included the entire area under the BBMP limits (Figure 3.4), with a population of 6.1 million in 2001 (BDA, 2007).

⁷ Population growth rate of Delhi was 47% during 1991-2001. For the same period, Bangalore registered a population growth rate of 38%



Figure 3.3 Location of Bangalore Urban Agglomeration in Karnataka State
 (SOURCE: <http://www.mapsofindia.com/maps/karnataka/karnatakaroads.htm>)

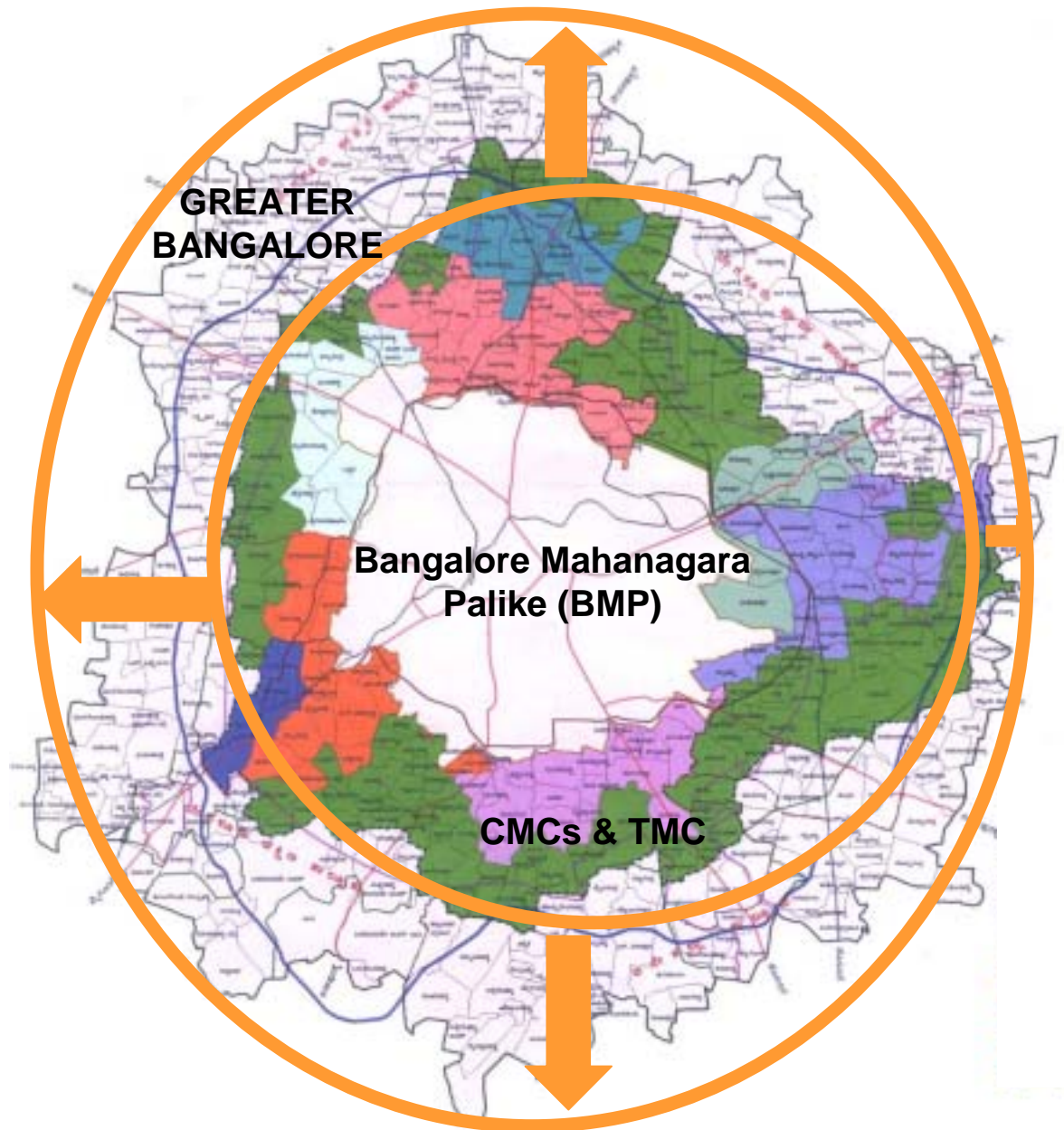


Figure 3.4 Map showing jurisdictional limits of older Bangalore Mahanagara Palike (BMP), newly added City Municipal Councils (CMCs) and Town Municipal Council (TMC) and the newly formed Bruhat Bangalore Mahanagara Palike

(SOURCE: <http://www.bmponline.org>)

3.2.2 Population characteristics

3.2.2.1 Growth

Over the years, increasing employment and educational opportunities in Bangalore have attracted significant numbers of people from outside the city, adding to the already exploding population and transforming it into a cosmopolitan and international city.

Population growth in Bangalore from 1850 to 2001 is shown in Figure 3.5.

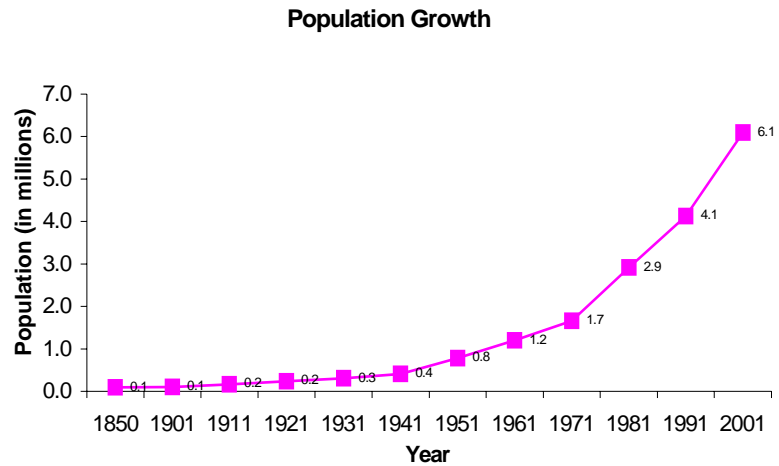


Figure 3.5 Population growth in Bangalore city from 1850 to 2001

(SOURCE: JNNURM, 2006)

Between 1941 and 1961, Bangalore experienced rapid population growth, becoming the sixth most populated city in the country with a population of 1.2 million (JNNURM, 2006). From 1961 onwards, the city has been growing at an even faster rate. In the last decade (1991-2001), the city experienced a population growth rate of 38% (JNNURM, 2006), which is comparable to other metropolitan cities like Chennai, Hyderabad and Ahmedabad.

**Comparison of Population of Bangalore with other metros
(2001)**

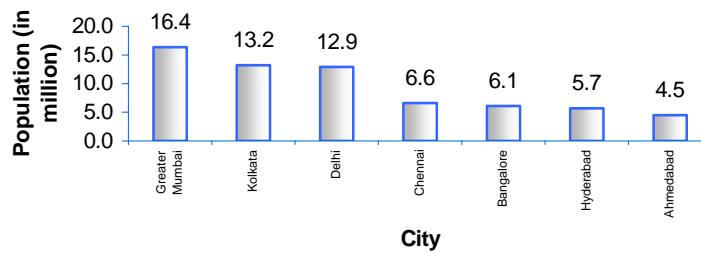


Figure 3.6 Comparison of population of Bangalore with other metros for the year 2001

(SOURCE: <http://iipsenvis.nic.in/nlsept05/ds2.pdf>)

The “Revised Master Plan – 2015” by BDA estimated the population of Bangalore Metropolitan Area (our study area) at 6.1 million in 2001 (BDA, 2007) making it the fifth largest Urban Agglomeration after Greater Mumbai (16.4 million), Kolkata (13.2 million), Delhi (12.9 million) and Chennai (6.6 million) (Figure 3.6 shows the comparison of population of Bangalore with other metros).

The growth of Bangalore from a town to a metropolis between 1850 to 2001 – (See Figure 3.5) has been a result of five major events (JNNURM, 2006):

- € Shifting of the state capital from Mysore to Bangalore
- € Establishment of the cantonment in the city
- € Setting up of public sector undertakings (PSUs)/ academic institutions
- € Development of the textile industry
- € Development of information technology/biotech-based industries.

Each of the above has added to the attractiveness of the city for job seekers, and led to further population growth and urbanization. This in turn has led to greater demand for mobility.

3.2.2.2 Migration

Over 60% of Bangalore’s growth comes from natural growth. The migrant population constitutes about 25% (BDA, 2007) of the total. The remaining 15% growth can be attributed to the integration of rural areas within the urban boundaries of Bangalore (Group SCE India Pvt. Ltd, 2006).

The social and cultural profile of the migrants is also changing and recent migrants have been more educated and qualified than those who moved to the city prior to 1991. The impact of a

rapidly increasing, educated and skilled migrant population in Bangalore is evident in terms of the added mobility needs of this section of the population, primarily for work and recreation purposes.

Apart from permanent migration, a lot of the populace also migrates to the city daily, as floating population from the nearby urban and rural areas, for work, education, health, trade, etc. Daily commuting by this share of the population has created a demand for more efficient transport services to connect the peripheral and surrounding areas of Bangalore to the city center, thereby creating huge demand for mobility and connectivity.

The city and peri-urban populations of Bangalore require two types of strong and efficient transport service on a daily basis: intercity transport and peri-urban to city-center transport.

3.2.2.3 Demographic characteristics

Some key demographic characteristics of Bangalore as discussed in the Bangalore Urban Atlas, 2006 prepared by Group SCE India Pvt. Ltd have been cited in this section.

The age structure of Bangalore's population reveals an important decrease in the youth growth rate, while the growth rate among the 20-29 year age group continues to increase. The number of over 40s has also increased significantly. This is an indication of the attractiveness of Bangalore for this section of the population. This type of growth is fed by migration of active populations, attracted by employment opportunities, thereby increasing the overall demand for mobility for work-related travel in the city.

In Bangalore, the distribution of the sex ratio per ward and village in 2001 indicated an equal distribution of men and women in the interior of the BCC area. On the outskirts of the city, zones of unequal distribution with a greater concentration of men are easily identified. Variation in the mix of male and female populations in various parts of the city results in a mix of different mobility needs across the city.

The literacy rate is an indicator of the economic and social level of a population. In Bangalore, the literacy rate for men and women is 86% as compared to 80% for urban India. The female literacy rate depends on the economic level of a family as much as on the level of its social maturity. While the female literacy rate in Bangalore in 1991 was below that of the national urban literacy rate, today it stands at 82% as against 73% for urban India. Improving literacy rates among women are an indicator

of their employment potential; therefore their mobility needs in the city assume a greater significance.

3.2.2.4 Projected population

According to the population projections given in the Revised Master Plan for the city, the current rate of growth cannot be sustained in the future. Hence, the Plan assumes a reduced growth rate for the city. The assessments made based on these trends indicate an estimated population of 8.02 million by 2011 and 10 million by 2021 (BDA, 2007). This predicted population growth for Bangalore is indicated in Table 3.2.

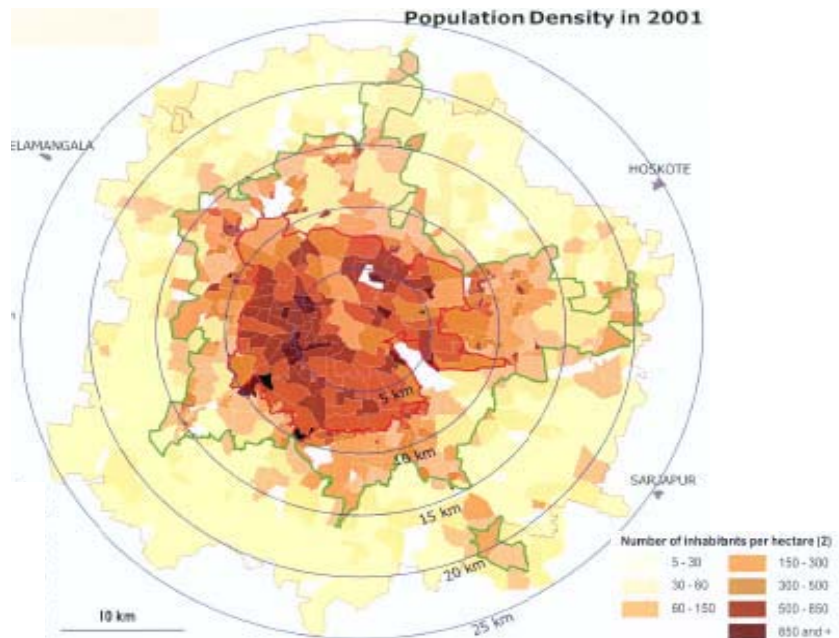
Table 3.2 Projected population growth

Area	1991	2001	2011	2021
Population growth (million)	4.13	6.17	8.02	9.97
Annual growth rate	-	4.10%	2.65%	2.20%

(SOURCE: BDA, 2007)

3.2.2.5 Density

The residential density⁷ distribution divides Bangalore into three zones of different population densities: core, intermediary and periphery, with population density ranging from >600 per hectare to < 50 per hectare (JNNURM, 2006). The overall residential density of the city is around 300 persons/ha (BDA, 2007). The distribution and concentration (density) of population in Bangalore are shown in Figure 3.7.



⁷ Residential density (persons per hectare) is the ratio of total population to the net residential area in hectares.

Figure 3.7 Population density map of Bangalore

(SOURCE: BDA, 2007)

3.2.3 Economy

3.2.3.1 Evolution and status

Over the last decade, the economy of Bangalore has transitioned from a public sector-based economy to a textile industry-based economy and finally to high-technology industries. The establishment and success of high technology firms in Bangalore have led to the growth of Information Technology (IT) in India. IT firms in Bangalore employ about 35% of India's pool of close to 1 million IT professionals¹. Bangalore accounts for the highest IT-related exports in the country² and also for the highest IT salaries. Bangalore's IT sector has made this city nationally and internationally famous attracting 50% of IT investments in India (Group SCE India Pvt. Ltd, 2006). Besides developments in the IT, science, engineering, industrial and educational fields, the city is fast emerging as a specialized center for health care and a center for high-end research and design (BDA, 2007). However, most economic figures fail to include the informal economy, which accounts for a significant share. The informal/unorganized sector accounts for between 70-85% of employment in most Indian cities (Group SCE India Pvt. Ltd, 2006).

Again, according to the Bangalore Urban Atlas, 2006, the economy of Bangalore shows a triangulated relationship between industries, the quality and level of infrastructure and services, and urban location; the disparity becomes wider in the case of intensively pro-poor economies. Many of the economically productive areas of the city face serious infrastructure deficiencies. Since many of the lower and middle level economies and trade are inter-linked via sub-contracting relationships, a constraint in one part of the system weakens a much larger set of firms leading to significant disparities. Therefore, the overall economic structure of the city shows disparities in terms of location and infrastructure provision for small, medium and large economic activities. These disparities in the economic system of the city are one of the root causes of the "divides", especially the "mobility divide", in the city.

3.2.3.2 Occupational structure

The total number of workers in Bangalore had increased to 0.6 million by 2001 (BDA, 2007). With the establishment of public sector industries soon after Indian independence, the number of people engaged in primary activities (agriculture,

¹ The Deccan Herald (Bangalore Edition), October 2006

² http://en.wikipedia.org/wiki/Economy_of_Bangalore

horticulture, animal husbandry, etc.) in Bangalore decreased drastically and there was a major shift towards industries (secondary sector). After 1960, the shift towards trade and commerce (tertiary sector) became more visible with an increasing proportion of workers entering areas like transport, communications and storage. The 1970s saw an increase in the construction sector workforce. Today, most of the workforce is employed in industry (like Bharat Heavy Electricals Limited, Hindustan Machine Tools, etc.), trade and commerce, and services (around 90%). Since the 1980s, employment in the service industries has increased and today around 32% of the workforce is employed in services. The present occupational pattern (2001) of the city is given in the Table 3.3.

Table 3.3 Occupational structure of Bangalore (2001)

Sector	No. of workers	Percentage of total
Primary sector (agriculture, animal husbandry etc.)	5000	0.8
Manufacturing	254000	43.4
Electricity, gas & water supply	8000	1.4
Construction	6000	1.0
Transport, storage & communication	43000	7.3
Banking & insurance	65000	11.1
Trade & business	21000	3.6
Services	184000	31.5
Total	586000	100.0

(SOURCE: JNNURM, 2006)

On the whole, the occupational structure of the city reveals that employment is dominated by the secondary and tertiary sectors. The recent increase in employment opportunities in technology industries has drastically increased the share of the population employed in manufacturing and services. This has also led to increased demand for more and better mobility services in the city.

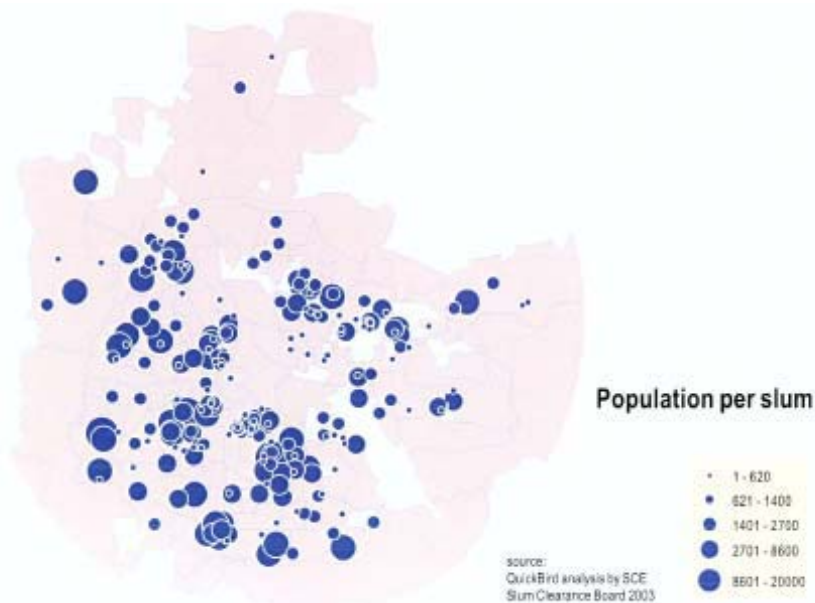
3.2.3.3 Income divide in the city

The sudden transition towards high-technology industries, high-end research, etc. in the private sector has also created an unequal economic mix among the population. The city now stands as an economically heterogeneous entity with soaring high incomes on the one hand and a sizeable amount of population (around 10%) below the poverty line⁷ on the other hand. The latter are known as the urban poor (JNNURM, 2006).

⁷ Number of the population whose per capita income is less than Rs. 1,000/per month (Source: Selected Socio-Economic Statistics India 2000, CSO, New Delhi, October, 2001).

As reported by the media, among Indian cities, Bangalore exhibits the highest levels of income disparity¹. This is because the rise in income levels has very rapidly skewed incomes in selected industries, especially IT-based industries. Although per capita income in the city has increased from Rs. 2,630 in 1985 to Rs. 5,908 in 2003², the gap between the rich and the poor in the city has widened even more.

According to the Bangalore Urban Atlas (2006), overall, total incomes have risen by 10% from 1991 to 2001. If the city's entire population is divided into five quintiles starting from lowest income category (I quintile) to the highest income category (V quintile), with each quintile containing 20% of the population, then the last quintile enjoyed 63% of the benefits arising from this income growth, while the benefits to the first amounted to a mere 1.5%. In other words, more than half of the city's incomes came to a select 20% of the population. Also the disparity between the first and last quintiles was 4.9 in 1991 and 13.9 in 2001 (Group SCE India Pvt. Ltd, 2006). In fact, the share of urban poor has been growing in the city and stood at 0.43 million (10% of total population) (JNNURM, 2006) in 2001. The number of slums in the city is increasing at an alarming rate and there were around 542 slums housing around 217,257 households (BDA, 2007) in 2001. Figure 3.8 shows the location and population density of poor settlements in Bangalore.



¹ <http://indianeconomy.org/2007/08/11/income-inequality-in-india-is-the-sky-falling-on-our-heads/>

² National Council for Applied Economics and Research (NCAER) in 2002 estimated the average annual household income to almost double from Rs. 52,496 in 1991 to Rs. 107,299 in 2001 in Bangalore (IIM, 2006). The average household size in the city is 4 (Census of India, 2001).

Figure 3.8 Locations and population density of poor settlements (Slums) in Bangalore

(SOURCE: BDA, 2007)

As a part of this study, TERI carried out an assessment of the mobility situation of slum dwellers in the city. This is described in the next chapter.

The increase in per capita incomes in the city has translated into better lifestyles and increased preference for personal mobility by the richer segments. However, provision of mass transport facilities for the lower income groups has been inadequate. The income divide has translated as inequitable distribution of transport infrastructure and services in the city, and has affected the mobility opportunities available to various people, thereby resulting in a mobility divide in the city. This is further elaborated upon in the next chapter.

3.2.4 Spatial growth and structure

From 1779 onwards the city of Bangalore came under the rule of the British who developed the Cantonment area. The Bangalore Municipality came into existence in 1862 and had jurisdictional control over the city area, but not the cantonment area. The first two decades of the 20th century witnessed the rapid and haphazard growth of the city. After the formation of the Bangalore City Improvement Trust in 1945, expansion of the city was planned. In 1956, Bangalore became the capital of the larger state of Mysore. Large-scale migration took place at this time, increasing the size of city. In 1976, the Bangalore Development Authority was formed. The Authority started on a large scale; it began integrated planning (Master Plan) for the city to respond to the exceptional rate of growth.

From a small urban area of 28 km² in 1901 (CRRI, 1999), the city had expanded, in all directions and along its major roads, to an area of 565 km² by 2003 (BDA, 2007). This expansion was characterized by concentric ring-roads and five major and five minor radial roads which converged at the city center. Figure 3.9 shows the urban expansion of Bangalore from 1990 to 2003.

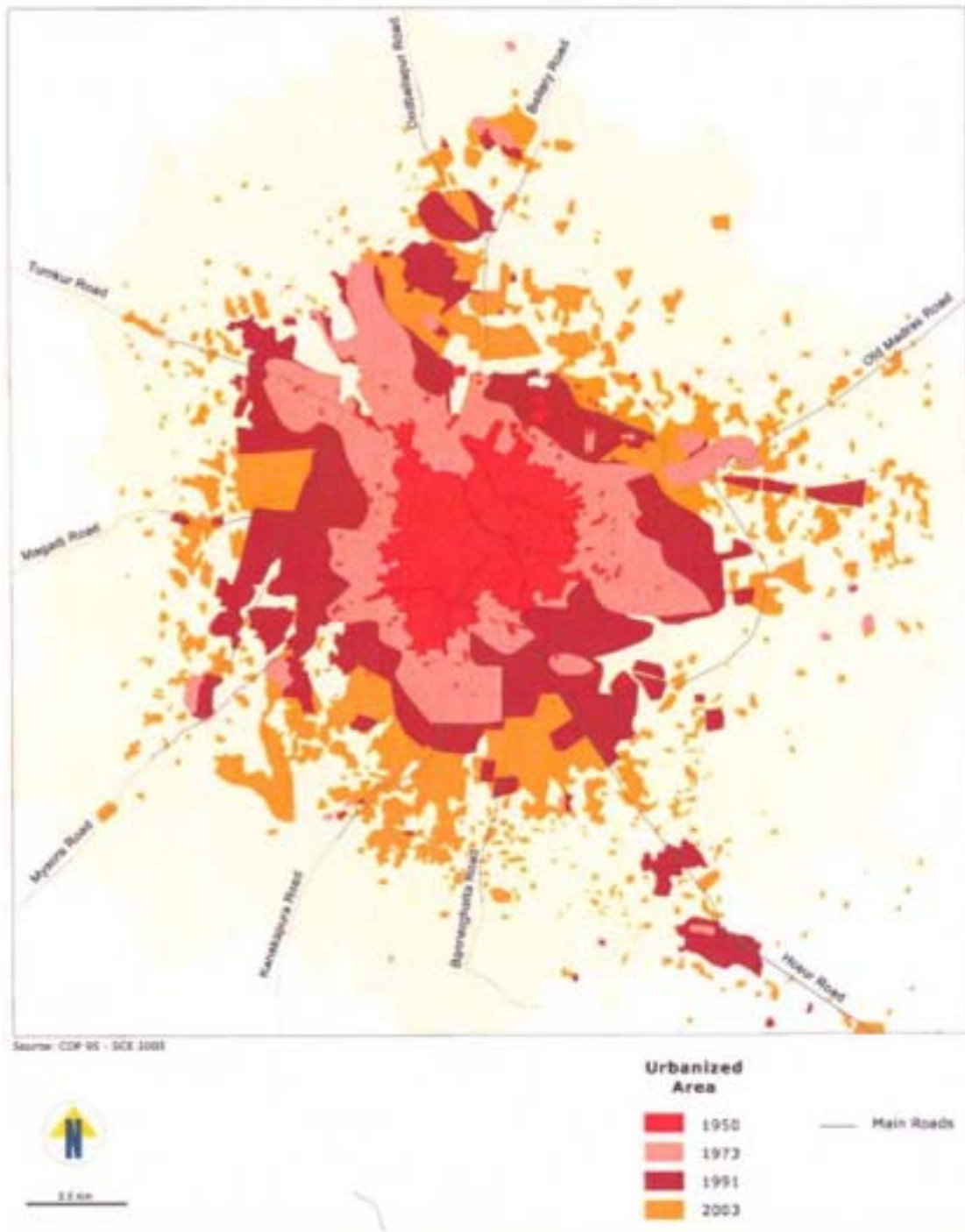


Figure 3.9 Urban expansion from 1950 to 2003

(SOURCE: BDA, 2007)

The changing economic profile of the city over the last decade has deeply affected the structure of the city. The original concentric and uniformly spread growth of the city has now assumed a more sectoral and radial (linear) shape. This sectoral growth is concentrated more in the northeastern and southern

parts of the city thanks to the concentration of high-technology industries in these areas. The result is differentiated and unbalanced development in the city. This has had implications for average distances traveled in the city, which have increased significantly.

The existing spatial structure of Bangalore can be classified into five major zones (JNNURM, 2006):

1. The core area – traditional business areas, administrative center, and the Central Business District.
2. The peri-central area – older planned residential areas, institutions.
3. The recent extensions (shadow area lacking infrastructure) – on both sides of the outer ring-road.
4. The new layouts – on the outskirts of the city.
5. The green belt and the agricultural area – on the city's outskirts.

Bangalore is a sprawling city and this has led to increased trip lengths, longer travel times and the need for well-connected and efficient public transport systems. The presence of new and upcoming residential and industrial areas on the outskirts in particular imply the presence of a large work force many of whom cannot afford personal means of transport but whose travel needs have to be met.

3.2.4.1 Land use and transport

The existing land-use distribution for the city is given in Table 3.4. It can be observed that the share of land area given over to transport and communications as a part of total area in Bangalore is not projected to change in the future. However, the actual size of the area is expected to grow by approximately 31%.

Table 3.4 Land use distribution (2003)

Land use	Proposed area (2011) (sq. km)	Percentage (%)	Existing area (2003) (sq. km)	Percentage (%)
Residential	243.69	43.16	159.76	37.91
Commercial	16.43	2.91	12.83	3.04
Industrial	38.44	6.81	58.83	13.96
Open spaces	77.88	3.79	13.10	3.11
Public & semi-public uses	49.08	8.69	46.56	11.05
Public utilities	-	0.00	2.49	0.59
Offices & services	-	0.00	4.27	1.01
Transport & communication	116.97	20.72	88.31	20.96
Unclassified	22.14	3.92	35.26	8.37

Land use	Proposed area (2011) (sq. km)	Percentage (%)	Existing area (2003) (sq. km)	Percentage (%)
Total	564.63	100.00	421.41	100.00
Agriculture land ⁷	-		649.24	
Lake & tank	-		39.02	
Quarry	-		9.61	
Vacant	-		187.72	
Total	1307.00		1307.00	

(SOURCE: BDA, 2007)

The land use map for the city is given in Figure 3.10

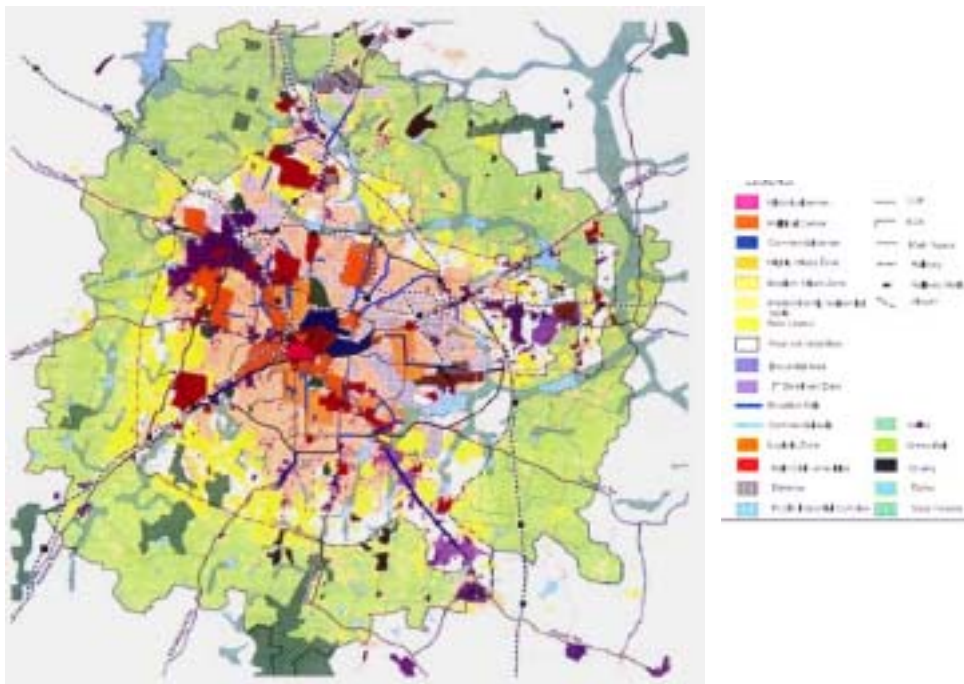


Figure 3.10 Existing land use map of the study area, (SOURCE: BDA, 2007)

⁷ Estimates for the break up of these categories of land in the future were not available with BDA.

At present, the core of the city acts as the Central Business District (CBD) with commercial use concentrated in two focal locations i.e., City Market and Russell Market. The area surrounding the CBD has residential (old residential areas) areas and land under public and semi-public use. The eastern and southeastern parts of the city have a large number of high technology industries. The main radial roads are host to a large concentration of industries, commerce, and services with residential areas sandwiched between them.



Discussions with various stakeholders in the city revealed that the city lacks integrated land use and transport planning and this has led to urban sprawl and high rates of motorization. Members of the workforce have to travel long distances to reach their places of work creating a demand for transportation infrastructure and services in the city (Ravindra A., 1989).

Box 1 Land use and transport planning

Like most other Indian cities, development in Bangalore also has been very organic and has lacked an integrated land use and transport planning approach. Transport has always followed development and the result has been low-density urban sprawl with increased mobility needs.

After the 1950s, the Master Plan as a policy document attempted to address the issue of integrated planning within cities but there have hardly been any success stories. None of the Master Plans for any of the major metropolises (Delhi, Bangalore etc.) have been able to control the horizontal expansion of cities. The very fact that personal vehicles have grown explosively and more infrastructure has been provided to satisfy individual mobility needs, shows that there has been a lack of a proper vision and sustainable transport policies for the cities.

Recently the Government of India launched the JNNURM program wherein the local bodies have been asked to prepare City Development Plans (CDPs) which are supposed to be vision documents for the cities charting out a policy and investment plan in a few identified infrastructure sectors. These, along with the Master Plan, are the two key documents guiding the future growth of the city. However, the focus in both the documents is purely on increasing infrastructure without looking at sustainability issues. For example, some policy interventions identified in these are:

1. Develop a structured road network;
2. Organize transportation/logistics facilities; and
3. Develop a multi-modal public transportation system.

The focus so far has been on improving and providing better infrastructure that will undoubtedly enhance mobility, however, to what extent this will benefit the poor is uncertain.

Below is a list of institutions involved with urban transport and land use planning in Bangalore:

Institutions involved

The main institutions involved in the various aspects of land use and transport planning processes are described below:

Level	Planning	Finance	Execution	Management	Service provider	Control/regulation
State	Dept of Urban Development; Directorate of Town Planning	State Govt; Karnataka Urban Infrastructure & Finance Corp	Public Works Dept	-	Karnataka State Road Transport Corp	Dept of Transport; Karnataka State Pollution Control Board
Region	Bangalore Metropolitan Land Transport Authority; Bangalore Metropolitan Region Development Authority;	-	Public Works Dept	-	Karnataka State Road Transport Corp	-
City	Bangalore Development Authority; Bruhat Bangalore Mahanagra Palike; Private Consultants, Universities, Research Institutes	-	Bangalore Development Authority; Bruhat Bangalore Mahanagra Palike; Public Works Dept; Bangalore Metro Rail Corp	Bangalore Traffic Police; Bangalore Development Authority; Bruhat Bangalore Mahanagra Palike	Bangalore Metropolitan Transport Corp; Bangalore Metro Rail Corp	-

It is clear from the table above that overall institutional structure is provided by a several agencies operating at various levels, which require coordination and integrated efforts if they are to undertake city planning in a holistic manner. Unfortunately this does not happen effectively. This issue was also raised during the Stakeholders Dialogue where it was recognized that due to the sheer number of agencies involved, planning processes become disoriented and their implementation slow. Hence it was recommended that integrated transport planning in Bangalore should be based on NUTP Guidelines and the possibility of a unified transport and land use authority should be explored. Need was also felt for capacity building and training⁷ in government departments for successful planning and implementation of NUTP Guidelines and integrated planning initiatives. Citizen participation becomes important here, something else that was emphasized in the Stakeholder Dialogue. Integrated planning and institutional mechanisms, good governance and self-enforcement by society were identified as key to a better Bangalore.

3.2.4.2 Land and housing situation

⁷ Capacity building and training of government departments so as to improve their financial status and technical know-how.

The housing situation in Bangalore is paradoxical. The city presents a number of advantages and prices are much lower in comparison to other metros. Significantly, there are also higher levels of land availability. Despite this, however, housing presents certain pressing issues. Poor families have difficulty obtaining housing and face a lack of appropriate alternative solutions to fit their means.

Vacant areas in the city represent 35% of the urban surface area. This is a result of strategies deployed by the urban housing authorities who are on the lookout for the best deals and therefore unable to meet housing demands efficiently (Group SCE India Pvt. Ltd, 2006).

During 1991-2001, an important part of the demand for housing was met by the surrounding villages and by non-regulatory forms of accommodation developed on the periphery of the city. This had the effect of expanding the city limits far beyond the existing boundaries. The extensive spread of city, especially to cater to the housing needs of the population, has generated an urgent demand for efficient transport services to connect these peripheral areas.

3.2.4.3 Growth of satellite towns

Increasing motorization and car ownership levels, increasing economic opportunities in the city, and increasing demand for quality and spacious residential areas, have resulted in the development of satellite towns around Bangalore. There are a number of real estate projects and proposals in the pipeline for developing such townships. The overall impact of developing more satellite towns in the periphery (30 to 50 km radius from the city center) of Bangalore in future would require more efficient transportation systems to cater to the increased mobility needs and distances traveled, for which planning should be done now.

3.3 Summing-up

Karnataka as a state has progressed economically thanks to the influx of the service sector, and very recently, the IT sector in Bangalore. The state economy has grown at a fast rate with state income registering an increase of 9.5% per annum. Today Bangalore has become a major attraction for job seekers, particularly in the IT sector. Over the years, the physical, social and economic fabric of the city have changed. From a garden city favored by retirees, to one of India's busiest cosmopolitan cities, Bangalore has witnessed a number of changes. The rapid population growth in Bangalore due to an increase in economic and educational opportunities on one hand, and a lack of

integrated land use and transport planning on the other, has resulted in tremendous pressure on the existing mobility infrastructure. Given that Bangalore has one of the largest rich-poor income divides in the country, it becomes important to address the mobility divide between the rich and the poor and other sustainable mobility issues in the city. The next chapter throws light on some of these issues.

CHAPTER 4 Mobility in Bangalore

4.1 Some characteristics of mobility in Bangalore

In the last chapter the rapidly changing socio-economic fabric of Bangalore was discussed along with the fact that wide economic divides exist between various groups in the city. The capacity, reliability and overall performance of Bangalore's transport systems have fallen far behind the needs of Bangalore's economy and citizens (Group SCE India Pvt. Ltd., 2006). Urban sprawl, traffic congestion, longer travel times, road accidents, high noise levels, and bad air quality are some of Bangalore's key mobility challenges. This chapter presents an overview of the current mobility situation in Bangalore and identifies challenges that require a closer look by the concerned authorities in order to make mobility in Bangalore more sustainable.

Table 4.1 summarizes a number of characteristics of mobility in Bangalore. Several of these characteristics are discussed in more detail in the remainder of section 4.1 and/or elsewhere in this chapter.

Table 4.1 Overview of urban transport indicators in Bangalore and their variation over time (Table format adopted from the SMP Case studies, 2003)

Parameter	Data available		Sources
Average trip length			
2006	12-13 km		IIM, 2006
Motorization Rate			
Private motor vehicles per 1,000 people	(2-wheelers)	(Cars, jeeps & MUVs)	Census of India, 2001 and Transport Department, GoK, 2003
1991	122	24	
2001	204	40	
Present status of motorization			
Number of motor vehicles as of 31 January 2007	Two-wheelers	2,101,174	Transport Department, GoK, 2007
	Cars, jeeps, MUVs	437,799	
	Three-wheelers (auto-rickshaws)	91,899	
	Taxis and cabs	9,848	
	Buses	50,629	
	Goods	119,402	
	Others	33,312	
	Total	2,874,267	
Motorized vehicle ownership			
1988	1 in 16 households		CRRRI, 1999
1998	1 in 10 households		CRRRI, 1999
2001	1 in 8 households		RITES, 2003

Parameter	Data available						Sources
2007	1 in 3 households						BDA-VOL.1, 2007
Mode shares by percentage share of trips (excludes walking)							
	Cars	2W	3W	Bus	Bicycle	Others	
1994	2.38	22.45	5.28	60.19	9.05	0.65	IIM, 2006
2002	5.44	36.31	6.9	48.91	2.00	0.44	RITES, 2002
2006	7.22	32.03	12.61	45.72	2.42	0.62	RITES, 2006
Average traffic speeds							
1990	15-18 kmph						IIM, 2006
2006	10-13.6 kmph						IIM, 2006
Indicators of congestion							
	<i>Road length:</i> About 16% roads in the city are arterials/primary roads <i>Road width:</i> almost 80% of the roads are less than 30m wide <i>Performance levels of roads w.r.t. journey speeds:</i> Only about 11% of the entire road length allows for journey speeds over 30kmph <i>Average vehicle delays:</i> 2 minutes in 1998 and 5-6 minutes in 2006 <i>Vehicle occupancy:</i> Dropped from 2.10 in 1998 to 1.7 in 2006						RITES, 2003 CRRRI, 1999 RITES, 2003 RITES, 2003 & 2006 CRRRI, 1999 & RITES, 2006
Road crashes¹							
	Persons killed		Persons injured				
1994	587		6,616				MoSRTTH, 2007
2004	897		6,958				
Available public/intermediate public transport(IPT)²							
Buses	About 4,812 BMTC buses provide services on more than 1,844 routes within the city corporation limits and 25km beyond						BMTC interviews
Auto-rickshaws	About 91,900 auto-rickshaws provide point-to-point on demand services in the city						Transport Department, GoK, 2007
Taxis	There are about 40,000 taxis in the city						

4.1.1 Number and length of trips

As already discussed in the preceding chapter, Bangalore is growing rapidly both in terms of population as well as land area. This has direct implications on the number of trips made in a day in the city and the average trip lengths, respectively. The average length of a trip in the city was reported at 12-13 km (IIM, 2006). TERI's first-hand mobility assessments in a few poor locations in the city and interviews with certain stakeholders, however, revealed that trips as long as 20 km are not uncommon in the city.

¹ There are usually inconsistencies found to exist between data reported by different bodies and this is a challenge.

² These refer to vehicles like auto-rickshaws, cabs, vans, etc. that carry passengers collectively on a per seat fare basis.

4.1.2 Growth and status of motorized vehicles

The number of personal vehicles in the city has grown exponentially. In the absence of any policy to regulate ownership and utilization of personal vehicles, this has resulted in a number of negative externalities like pollution, congestion and road accidents. The total number of vehicles in the city on 31 January 2007 was 2,874,267 (GoK, 2007). Table 1 in Annex 4.1 gives a breakdown of the total number of vehicles in Bangalore and their growth between the years 2004 and 2007.

Between 1991 and 2001, annual population growth in the city stood at 3.3%, whereas the vehicle growth rate was 10.8% (Group SCE India Pvt. Ltd., 2006). Bangalore today has the highest vehicle growth rate among all million-plus people cities, second only to Delhi. The rate of growth of various categories of vehicles in Bangalore city between 1985 and 2005 is shown in Figure 4.1

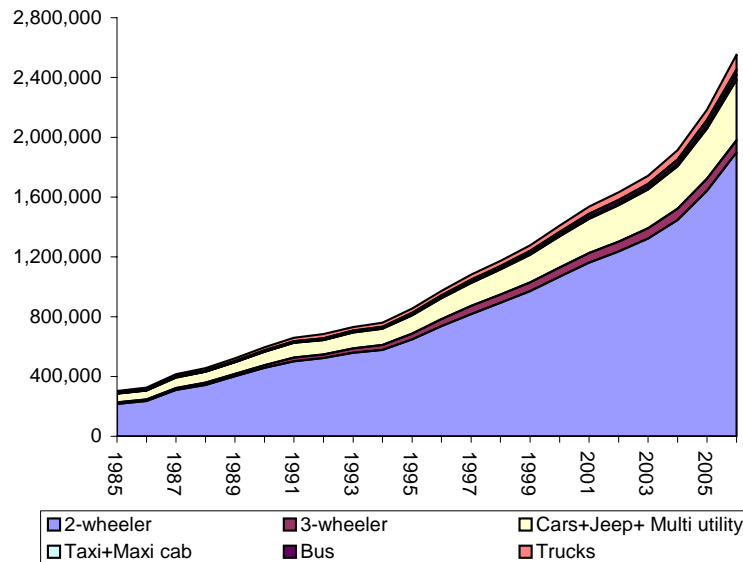


Figure 4.1 Vehicular growth rates in Bangalore between 1985 and 2005

(SOURCE: MoSRTTH, 2007)

It can be seen that vehicles grew at a compounded annual growth rate (CAGR) of approximately 12.4 % during the period 1985-



2006, which has largely been driven by growth in the motorized two-wheeler (scooters and motorbikes) segment. The average yearly growth rates of two-wheelers, cars and intermediate public transport (IPT) modes have been 9.5%, 10.5% and 11%, respectively (Group SCE India Pvt. Ltd., 2006). Motorized two-wheelers dominate the fleet share, followed by cars and IPT modes. Together, these three categories account for over 90% of the city's total number of vehicles. In fact, Bangalore has the highest share of motorized two-wheelers when compared to rest of the five metro cities in India, namely, Delhi, Mumbai, Chennai, Kolkata and Hyderabad. The key reasons for such a high share of motorized two-wheelers in the city are increasing income levels, and the option of making repayments in monthly installments. Also, there is a high preference among women for motorized two-wheelers for reasons of security and personal comfort, both features which are not offered by the public transport services. In addition, obvious characteristics like ease of maneuverability on the city's relatively narrow road network, etc. also explain this growth. During the Stakeholder Dialogue the point was made that there is close competition between buses and motorized two-wheelers in terms of cost per kilometer, and this has made motorized two-wheelers a clear choice for those travelers who can afford them.

4.1.3 Rise in motorized vehicle ownership

As in other growing cities in the world, there is a strong correlation between per capita income and level of motorization in Bangalore. Between 1991 and 2001, Bangalore's household incomes increased at an average rate of almost 10% per year (Group SCE India Pvt. Ltd., 2006). In a study carried out by TERI in 2003, it was found that a continuous increase in per capita real income in Bangalore has led to a continuous increase in the number of vehicles per 1,000 of the population. It was observed that while the number of vehicles per 1,000 of the population went up from 95 in 1985 to 285 in 2003, the phenomena of motorization was driven essentially by motorized two-wheelers, whose ownership tripled from 67 to 216 during the same period (TERI, 2003). However there is still a large unsatisfied demand among households and individuals who would like to buy a motorcycle or a car once they can afford it (Bose R.K., 2007).

The average number of households in Bangalore possessing a personal motor vehicle has increased significantly over the years (see Table 4.2).

Table 4.2 Increase in motorized vehicle ownership

Year	Vehicle ownership
1988	1 in 16 households

1998	1 in 10 households
2001	1 in 8 households
2007	1 in 3 households

(SOURCE: CRRI 1999 & BDA-VOL.1, 2007)

The fast growing patterns of vehicle ownership are evident from the table above. Media reports have lately stated that close to 900 motorized vehicles get registered in Bangalore daily and this is fast becoming a matter of growing concern not only among the planners and policy makers but also the citizens of the city who, in the absence of a sufficiently attractive public transport system, are faced with no other choice but to use their personal means of transport. This was also emphasized in the Stakeholder Dialogue. Therefore it is excessive vehicle utilization and not ownership, which is the matter of real concern.

4.1.4 The modal paradox

The city has witnessed a drastic change in the shares of different types of vehicle in the total vehicle fleet over the past few decades. Figure 4.2 below depicts the changing vehicular fleet composition in the city, over the past four decades.

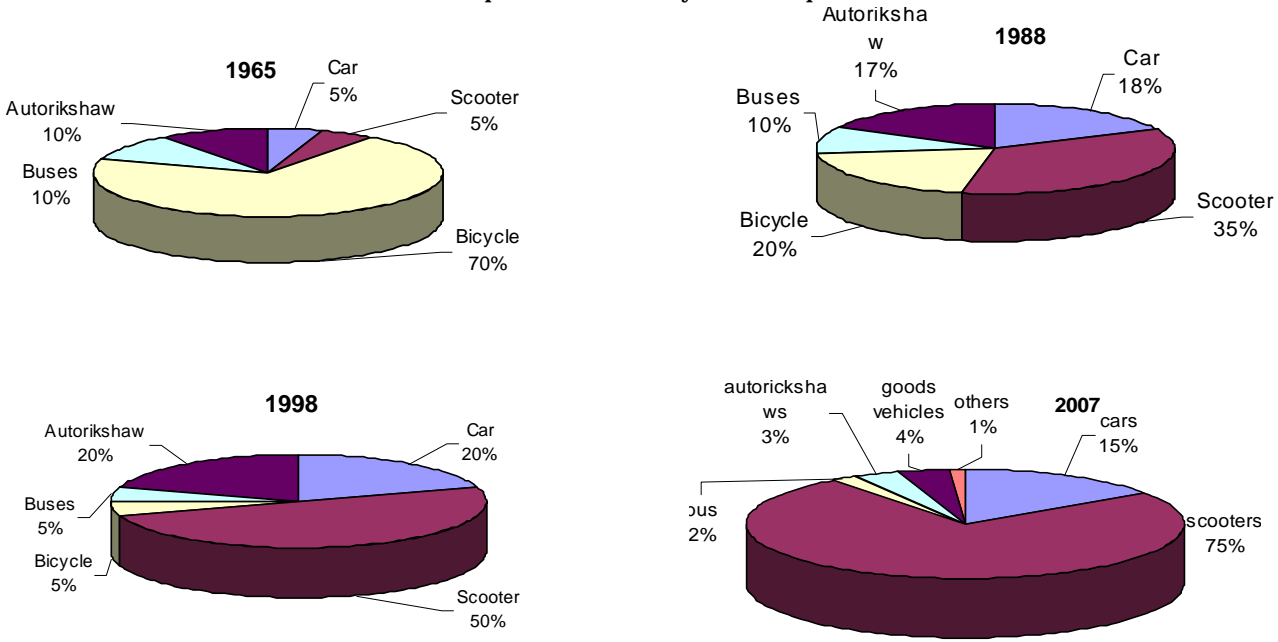


Figure 4.2 Changing vehicular fleet composition in Bangalore

(SOURCE: CRRI, 1999 & RITES, 2006)

The figure above shows that there has been a complete reversal in the share of motorized and non-motorized vehicles in the city, owing largely to the explosion in the number of motorized

two-wheelers (largely scooters). While in the 1960s, bicycles dominated the vehicle fleet in Bangalore; their share was reduced to a mere 5% in 1998.

In order to understand the composition of traffic at a given time on the road, data on vehicle composition during peak hours reported in earlier studies was compared for a few locations. The comparisons are presented in Table 2 in Annex 4.1. It is thus evident from the table that motorized two-wheelers are the most prevalent mode of transport on the roads during peak hours, followed by cars, auto-rickshaws and buses.

Despite the declining share of non-motorized vehicles and increasing share of motorized vehicles, overall journey speeds and road network performance have fallen drastically over the past few decades. A comparison of the share of trips made by various means and the size of registered fleet for each mode type revealed a paradoxical situation (See Table 4.3).

Table 4.3 Comparison between share of trips made by and actual fleet size of various modes in 2006

Modes	Share of trips served (%)	Share in the total registered fleet (%)
Motorized two - wheelers	32	73
Cars	7	15
Buses	46	2
Three wheelers	12	2

(SOURCE: RITES, 2006 & MoSRTTH, 2007)

It is evident from the above table that even though buses and three-wheelers together serve close to 60% of the entire passenger travel demand, their share of the fleet size is insignificant. On the contrary, cars and two-wheelers dominate the vehicular fleet, while they serve less than 40% of the total travel demand. It is however well recognized that though bus systems in large cities carry a large share of urban travelers, they are responsible for only a small part of traffic congestion, energy use and pollution (IEA, 2002). This also begins to highlight the mobility divide between users of public and personal transport in the city. More in-depth discussions on this divide follow in section 4.2.6.2.

4.1.5 Road environment and infrastructure

Bangalore has a ten-axis star shaped road system that consists of five major radial roads and five secondary radial roads that converge towards the city center from all directions. Of these, four are national highways and the remaining are state highways. The total road network in the city is close to 5,900

km, out of which about 3,000 km are roads in urban areas while the rest connect to nearby rural areas (BDA, 2007). A map of the city showing the road network can be seen in Annex 4.2.

Below is a list of key limitations of Bangalore's road network and its performance:

1. The ring-roads are unable to serve their purpose due to lack of proper connectivity with radials at various places.
2. The widths of roads are inconsistent and therefore affect the free-flowing traffic, both vehicular and pedestrian.
3. The intercity roads converging into the city bring in large volumes of goods traffic along with intra-city traffic, resulting in further strain on the central roads.
4. The existing route systems have been designed to encourage destination and not direction-oriented travel, which essentially has led to traffic flows becoming unmanageable.
5. Only 16% of the total urban road network in the city is an arterial/primary road network (BDA, 2007). These too have become severely congested due to various industrial and commercial developments that have sprung up along their lengths. This has led to the roads being forced to function both as an arterial as well as an access road, thereby drastically affecting road performance.
6. Almost 80% of the road network has a Right of Way¹ (ROW) of less than 30m thereby limiting road widths. However, land acquisition resulting in the displacement or cutting down of trees to increase road widths is a challenge for the city's road expansion. The issue of saving of trees vs. widening of roads was debated extensively during the Stakeholder Dialogue. The conclusion arrived at was that the garden character of the city should be preserved and widening the roads was not a long-term solution given the uncontrollably high rates of vehicular growth in the city.
7. Only about 11% of the total network allows for journey speeds over 30kmph.
8. The absence of transverse links between the radials is a major cause of congestion in the city's core area, as this makes the radial system very restrictive.
9. There are no dedicated lanes for buses, high occupancy vehicles, pedestrians or cyclists, etc.
10. The roads lack pedestrian crossings. New road developments have eaten into a lot of pedestrian space and this is continuing to happen. In most places, pedestrian sidewalks are either non-existent or very

¹ Maximum space available for road purpose in terms of road widths.

narrow or frequently obstructed by signposts, digging and refilling activities, etc.



Pedestrian footpath obstructed by other activities



Pedestrians crossing under a flyover in an unsafe manner

To sum up, not only is the road infrastructure in Bangalore unable to meet present traffic levels, the road environment is also characterized by inequitable road space allocation, which is skewed towards facilitating the movement of faster motorized vehicles. Little emphasis has been given to the pedestrian or non-motorized users, who are forced to squeeze and find their way into the congested road space thereby exposing themselves to higher levels of pollution and greater levels of risk than their “motorized” counterparts.

4.1.6 Suburban rail

There is approximately 62 km of surface rail in Bangalore. The intra-city suburban railway services, run by the Southern Railways wing of the Indian Railways, are much more limited (when compared to the buses) at the moment. In order to exploit the existing sub-urban railway infrastructure and to ensure it links up properly (both physically and in terms of level of service) with the forthcoming metro, airport and other means, investments and projects are currently under consideration.

4.2 The sustainability of mobility in Bangalore

In this section, TERI examines mobility in Bangalore through the lens of the twelve sustainable mobility indicators and seven sustainable mobility goals (see the goals in Chapter 1, page 13) developed by the WBCSD’s Sustainable Mobility Project (WBCSD, 2004). The indicators are:

1. Accessibility
2. Financial outlay required of users
3. Travel time
4. Reliability

5. Safety
6. Security
7. Emissions of GHGs
8. Impact on the environment and public well-being
9. Resource use
10. Equity implications
11. Impact on public revenues and expenditures
12. Prospective rates of return to private business

Unfortunately, given the various data challenges and limited timeframe of the study, TERI could not address all of the sustainability indicators, and it was felt that quantifying some of the indicators would take more time and in-depth research. As a result, some of the indicators such as impact on public revenues and expenditures, and prospective rate of return to private businesses are not addressed in this study. The indicator on GHG levels has been addressed at the all-India level and the indicator on impact on the environment is addressed in light of changing air quality and noise levels at the city level. Resource use is addressed from the viewpoint of demand for energy in the transport sector in the city. Indicators such as travel time, security, equity, reliability and financial outlay required by users are all addressed under the discussion of the different mobility divides in the city. Also, due to a lack of available data, most of TERI's analyses relate to passenger mobility.

4.2.1 Accessibility (Indicator 1 and Goals 6 & 7)

*Do households have access to either a motorized personal vehicle or public transport of a certain quality? Can goods be delivered and received where and when they are needed?*⁷

Bangalore Development Authority's estimates found that while one-third of the total households in Bangalore owned personal means of travel, 50% of households in the city still relied on public transport to meet their travel needs. Interviews with BMTc and slum dwellers in the city revealed that bus stops were usually found within 1 km walking distance anywhere in the city. However, this information did not give any indication of the ease of access/egress to public transport, frequency of service, level of service, affordability, etc. Also in the present Indian context, there is no definition or concept of "minimum quality of public transport" and this adds a different dimension to the accessibility indicator. The accessibility challenges found in the city were:

- ∄ Approaching public transport nodes safely and comfortably through basic yet good pedestrian/IPT/non-motorized facilities, and
- ∄ Lack of proper integration between various transport modes and between land use and transport.

The ease and quality of mobility were found to vary drastically for different groups in the city. A detailed discussion on how this has led to different mobility divides can be found later in the chapter.

With the recent announcement of the National Urban Transport Policy, which is a pro-public transport policy and emphasizes moving people and not vehicles, there is an increasing recognition that to achieve sustainability, cities must have an attractive and efficient public transport system. It is worth noting that there is increasing recognition that public transport has not been at the forefront of policy matters and that it is imperative to make public transport visible and attractive in the city. Today, for those who can afford it, purchasing a personal vehicle is a very easy process (due to open access to the financial market, easy bank loans, monthly installment processes, etc.). However, public transport continues to serve its existing users inadequately and has not yet become an attractive or "easy" alternative for most personal vehicle users. Immediate steps need to be taken to rectify this imbalance. This was also highlighted repeatedly during the Stakeholder Dialogue.

⁷ These questions have been cited against each sustainable mobility indicator on page 5 in "Mobility for Development: Facts and Trends", WBCSD, 2007.

Having recognized this, it is worth mentioning that despite its problems, the public bus service in Bangalore is one of the few popular and profit-making bus services in Asia¹. A brief overview of Bangalore's public transport system and the issues it faces are described below.

4.2.1.1 Status of public transport in Bangalore

Currently public bus transport in Bangalore is provided by the Bangalore Metropolitan Transport Corporation (BMTC) through the following mechanisms:

- § BMTC's own city services, which are operated using its own fleet; and
- § The *Kilometer Scheme* under which private buses are hired to run services.

The corporation's operations are divided into city and suburban services. Out of a total of 1,844 routes, 1,355 (almost 60%) are suburban routes, which serve surrounding satellite towns and rural areas. As of 31 July 2007, BMTC²:

- § Deployed 4,655 schedules
- § Deployed 4,812 buses
- § Made 65,121 trips daily
- § Carried 3.7 million passengers daily
- § Earned profits of Rs. 1148.8 million in 2005-06 and Rs. 2,243.2 million in 2006-07
- § Paid Rs. 12.7 million to the government in Motor Vehicle Tax.

Originally BMTC coverage was restricted to the Bangalore Mahanagara Palike (BMP) area and 25 km beyond the BMP area. With the formation of BBMP in 2006, (as discussed in Chapter 3), the coverage of BMTC has now been extended to include the BBMP area and an additional 25 km beyond that. Figure 4.3 shows the present area served by BMTC, which covers the entire BBMP area and 25 km beyond that.

¹ Source: Discussions with BMTC and various other stakeholders.

² <http://www.bmtcinfo.com/english/atpresent.htm>

Following the increase in the area under its jurisdiction, BMTC is building a number of new depots and acquiring almost 3,000 more buses. BMTC made this point during the Stakeholder Dialogue.

The BMTC buses serve grid routes which provide for better accessibility to all areas on the essentially hub and spoke-shaped road network. Routes under BMTC are either allocated on the basis of demand from a group of commuters, or political pressures, or are based on the success of experimental routes tried by BMTC which are shown to generate high monthly revenues.

Another problem, which adds to congestion levels in the city, rests in the fact that all four major bus terminals, namely Majestic, Shivajinagar, Shanthinagar and City Market, are located in or very near the city center, thereby leading to a huge concentration of buses and pedestrians in these areas. Moreover, the access roads to the terminals are unable to handle the large volume of traffic, including buses, resulting in perpetual congestion on the surrounding road networks.

Different types of services offered by BMTC include:

1. *Ordinary service*: 4154 no.s; Fare: Rs.3-15; Cost per km: Rs.20
2. *Pushpak service*: 297 no.s; Fare: Rs. 2-20; Cost per km: Rs.22. The interior of these buses is slightly more comfortable than the ordinary services.
3. *Volvo service (air conditioned)*: 55 no.s; Fare: Rs.10-15; Cost per km: Rs.47.

The variation in operational details of BMTC over time is presented in Table 4.4.

Table 4.4 BMTC operational details over time

Parameters	1997/98	1998/99	1999/2000	2006/2007
Number of routes	1036	1048	1063	1844
Average route length (km)	19.45	19.54	19.66	20
Number of trips	1934	2030	2121	63000
Daily schedule km	442953	472289	500553	1038000

(SOURCE: TERI (2003) & interviews with BMTC (2007))

The performance of BMTC has improved year-on-year. An interesting perspective on this was offered during the Stakeholder Dialogue, where a BMTC official noted that one of the reasons for implementing initiatives to improve public bus services was to change people's perception of public transport as being inferior to personal means of transport. As a consequence, service providers have started running new, improved and attractive services such as Volvo buses, ladies

special pink buses, hospital service buses; and there are several plans in the pipeline for more innovative services like improved peak hour services, etc.

BMTC recently acquired 25 units of low-floor buses from Volvo. Expectations were that for every Volvo bus in operation, at least 20 cars and around 40 auto-rickshaws would be removed from the roads¹. However, this needs to be substantiated by credible data. In a survey conducted by BMTC for Volvo between February and May 2006², feedback on the quality of service and travel was gathered from around 5,013 passengers traveling in the new buses. This survey revealed that almost 50% of the Volvo bus users were previously general bus users, 18% were auto-rickshaw users, 16% were two-wheeler users, and 13% were car users. Almost 71% of the passengers felt the Volvo fares were too high, however 40% of the passengers said they would pay extra for travel, while 26% people said they would not. The rest were unsure.

These buses have been introduced to capture mainly the two-wheeler and car users in the city and are serving strategic routes like International technology Park, Whitefield, Electronics City, etc. which are high-income generating destinations and fast becoming major work hubs for Bangalore. As quoted by a BMTC official during the Stakeholder Dialogue, these buses are being run for the status conscious and slightly more affluent travelers who want an equally comfortable, if not more comfortable mode of travel than a personal motorized vehicle. It was encouraging to see that most companies like Wipro, Infosys, etc. in Bangalore have tied up with BMTC, and are providing public transport to their employees at subsidized costs. This is a good practice. It was also highlighted during the Stakeholder Dialogue as an action point for the government to consider. BMTC could consider taking over all the traffic generated by the software industry, call centers, business process outsourcing (BPO), etc. in the city, by joining hands with the individual companies. However, as also mentioned earlier, making public transport in the city a more attractive option than personal means of transport will eventually have to be accompanied by simultaneous measures to discourage car use.

In its guidelines the NUTP clearly states that states/cities need to give priority to public transport which:

- € Adopts a technology (high capacity bus, metro, LRT, monorail, etc.) best suited to the city's travel requirements in various corridors over the next 30 years

¹ <http://www.hindu.com/2006/05/03/stories/2006050304460500.htm>

² Presentation made by Volvo Bus Corporation at a BRT training workshop in Jaipur on 4th September 2006.

- € Is preceded by comprehensive city-wide plans drawn up comprising trunk and feeder corridors
- € Is a single system and allows seamless travel between different modes of transport and also between systems managed by different operators
- € Has taken into account proper provisions of non-motorized transport to improve safe access to public transport
- € Is backed by institutional mechanisms set up by the government to ensure good coordination.

Bangalore has fallen short of addressing these guidelines in several places. Today in most Indian cities, analyses of future travel demand are usually carried out by consultants; the datasets and assumptions used for creating such models are questionable; and the decision process of how one particular mode was arrived upon as the best suited technology for the city, is not transparent. There exist no standardized procedures to carry out various kinds of impact analyses or alternate analysis for such projects, and therefore the basis upon which one particular option was selected and others disqualified is not clear. This is also partly because the policy does not spell out clear guidelines on how to do this. With more and more cities opting for new capital-intensive options like metro rail (Bangalore being no exception, see box item on Bangalore metro) and little being done to improve the existing public transport systems, there is a risk of cities making inappropriate choices for sustainable mobility solutions. Also the proposed new systems need to be integrated into city-wide plans and this calls for detailed micro and macro-level planning with a focus on issues like land use, transport, social benefits, etc. Again, how consultative these processes are remains unclear. As of now most of the investments in transport in Bangalore have been targeted at the creation of road infrastructure (discussed in below) and the amounts and level of priority allocated to non-motorized transport are not clear. There has always been a need in the city for better planning and coordination among the various transport-related departments, and with the upcoming metro, there is a need to ensure an integrated institutional arrangement or mechanism for coordination in order to start on the right footing.

According to BMTC, there is a need for more financial support from civic authorities to provide for better infrastructure like bus bays, better bus stops, improved passenger information systems, etc. in order to improve the accessibility and quality of bus services for its users. Public transport needs to garner greater priority both on the roads and in political decisions, and its image needs to be improved further. With almost 900 vehicles being added to Bangalore's roads daily and given that

road capacity cannot match this, personalized vehicles will take up road space much faster than public transport despite plans by BMTC to increase its fleet of buses. Therefore, there is a need for stringent action to increase the share of trips made by public transport by giving it priority over personal vehicles.

Bangalore’s “Namma Metro” – Is it the solution?

For nearly 25 years there have been various proposals and plans for Mass Rapid Transit Systems in the city. Given the fact that road space is a constraint in Bangalore, MRTS was identified by transport consultants as the only solution to rid Bangalore of its traffic woes. Delhi Metro Rail Corporation (DMRC) in partnership with RITES prepared a Detailed Project Report (DPR) for Bangalore Metro Rail, Phase I in 2003 where it proposed two double line corridors: east-west (18.1 km) and north-south (14.9) with a total length of 33km, and with both elevated and underground sections. The project took off in April 2006 after gaining approval from state and union authorities. A total of 32 stations have been proposed, and the expected passenger numbers estimated at 820,000 per day. BMTC’s passengers currently number close to 63,000 per day. Metro fares will be 1.33-1.66 times the bus fares, with an annual increase set at 4%. The total cost reported for the project is Rs. 62,070 million, and this figure is expected to be revised upwards from time to time. The Government of Karnataka and Government of India are financing the project by providing equity funding of 15% each. The implementing agency for this project is Bangalore Metro Rail Corporation (BMRC). It has estimated the benefits of the metro as follows:

Externalities	Savings in Rs. (million) per annum
Traffic decongestion (avoidance of new buses and private vehicles)	3,470
Reduced fuel consumption (existing vehicles)	2,530
Less strain on roads	1,280
Savings in travel time	2,890
Reduction in number of crashes	780
Reduction in air pollution	600
Total	11,550

(Sources: <http://www.karnataka.com/watch/blr-metro/> & <http://www.bmrc.co.in>)

Given the challenges facing mobility in Bangalore today, the metro has brought in its wake a large number of expectations from both the government and the public. However, the government needs to exercise caution and address the following issues:

- € People’s preference for owning a private vehicle may not necessarily be curbed by the advent of the metro, unless the metro offers a truly seamless and well connected journey, offering its passengers a door-to-door journey as comfortable as a personal vehicle. This will need to be accompanied by schemes like congestion charging, heavy parking fees, etc. to discourage use of personal transport.
- € The fares need to be affordable for the poor; without this they will continue to use the public buses and the benefits of such a “mass transit” project may actually not trickle down to the masses. This is critical from the viewpoint of both the sustainability of the system as well as addressing the mobility divide in the city. It was also highlighted during the Stakeholder Dialogue.
- € As a sprawling city with inadequate densities to support the potential numbers that could be moved by a metro, the Bangalore system will require integration with other modes (buses, IPT, etc.) and good feeder services in the city to ensure uptake by the optimum number of passengers required to make it effective.

4.2.1.2 Intermediate personalized transport (IPT) and paratransit

In most Indian cities, public transport facilities are inadequate and insufficient to provide a meaningful mobility alternative for the general population, let alone for socially excluded groups (WBCSD, 2004). In such situations, IPT and paratransit modes are potential solutions that could serve to bridge some of the gaps in the existing public transport system in terms of availability, access and flexibility.

The IPT modes in Bangalore have maintained a consistent share of almost 4% of total vehicles, for the last four years. Typically these include auto-rickshaws, maxi cabs and motor cabs. Under the provisions of the Motor Vehicles Act, “maxi-cab” means any motor vehicle constructed or adapted to carry more than six passengers but not more than twelve passengers, excluding the driver, for hire or remuneration. Similarly, the term motor cab also excludes any motor vehicle for hire or remuneration.

Auto-rickshaws are a very important mode of travel in the city and compete with the car or Volvo bus on the road in terms of cost. Most of these autos are individually operated, and are not provided designated waiting spaces on the roads.

The reasons why IPT and personal means are preferred over organized ones, is because they provide greater flexibility, frequency, better access and/or comfort over existing public transport, and also at times compared to privately owned and operated motorized transport means. However, there are issues of safety and security associated with these as they lack accountability to the government. In the absence of any policy to recognize and regulate such modes of transport by the city government, and integrate them with the existing public transport systems, the local bus companies and other “competing” services typically look them upon as “parasites” or a “menace”.

There is a need to look at ways to recognize and regulate such modes of transport by making them complementary and not competitive to the existing public transport system, assigning them specific routes and hours, providing them with proper lay-bys near bus stops and terminals in the city, etc.

4.2.1.3 Access to education facilities

Bangalore is an important center for higher education in India with educational institutions spread across the city (Group SCE India Pvt. Ltd., 2006). Bangalore Metropolitan Transport Corporation (BMTC), as a service provider, provide subsidized bus passes to all students in the city to make travel easier and more affordable.

4.2.1.4 Access to health facilities

Access to different levels of health care is generally satisfactory in the city. The concentration of health facilities is greater in central areas compared to the periphery. Facilitating availability of transportation was one of the key actions required to make Bangalore a center for health care (BDA, 2007). In recognition of this, BMTC has recently started the Hospital Bus Service to facilitate easy access to hospitals from one of the bus stations to important government and private hospitals in the city and its surroundings between 8am and 6pm. This practice needs to be expanded and the services made accessible from different places in the city.

4.2.1.5 Goods movement in the city

The need for the fast and reliable distribution of goods, the increasing pace of containerization, and the selection of transport options on the basis of service rather than price have increased the reliance on trucks for freight transport in the city.

Typically, the types of freight vehicles seen in Bangalore are three-wheel goods carriers (called “tempos”), trucks and trailers. Their carrying capacity ranges from 3 to 40 tons. Light commercial vehicles like delivery vans are used in the city for door-to-door delivery of goods and items. All materials, which are movable, ranging from heavy machinery to construction materials, flowers, vegetables, etc. are transported by these. These vehicles are usually Leyland, Tata, Eicher, Swaraj Mazda, Volvo, etc. types of vehicles, which are owned largely by individual owners and goods associations. Freight vehicles in the city are banned between 8am-11 am and 5pm-8 pm. However, only 1% goods vehicles with national permits are allowed to enter the city at any time during the day. These vehicles are regulated by the state Transport Department.

Unfortunately, not much information was available to assess the goods mobility situation in the city; however some of the broad issues and problems associated with freight mobility in Bangalore city were identified as:

- § Lack of adequate number of truck terminals at the city peripheries, and the need to always pass through the city center. However, this is being addressed now with four new terminals being constructed, one in each direction, on the outskirts of the city. This was highlighted during the Stakeholder Dialogue.
- § Road blocks and frequent police checks in the city are perceived to be major cause of delay by the transporters.
- § Inadequate road infrastructure to allow for fast movement of freight.

§ State-wide variability in diesel prices creates unnecessary trips and traffic into/out of the city.

Transport of goods is an integral aspect of sustaining the economic vitality of the city. However it requires more appropriate logistics planning in terms of facilities/terminals/offices/storage connections as well as integration with other means of transport like rail, road and air for hassle free movement.

4.2.2 Safety (Indicator 5 and Goal 3)

Can individuals reasonably expect to travel without threat of death or serious injury? Can goods be transported without damage or loss?

In India, road traffic injuries (RTIs) result in economic losses to the tune of Rs. 550,000 million or nearly 3% of GDP every year (Gururaj G., 2006). However the approach in the country to tackle road safety issues has been passive, not pro-active, with more stress being laid on user education and awareness, rather than improvements of the actual mobility environment and making road safety a priority on the political agendas of the country, state and city governments.

The total number of RTIs in Bangalore was until recently on the rise, but has now begun to decline (Figure 4.4). However, the total number of road-related deaths has been on the rise. A study conducted by NIMHANS on traumatic brain injuries in Bangalore found that “almost 60% of all neuro-trauma was caused by RTIs. These occurred predominantly in the 15 - 40 year age group, among men and during evenings and nights (66%). Pedestrians (26%), two-wheeler riders (31%) and pillions (12%) and cyclists (8%) were represented in higher numbers. Not wearing helmets, driving under the influence of alcohol, speeding and overtaking, crossing in the middle of the road were the major behavioral factors. Poor visibility of vehicles and on roads and mechanical problems were responsible for one-third of injuries, road design and structural issues were responsible for another 30% of traumatic brain injuries” (Gururaj et al., 2005).

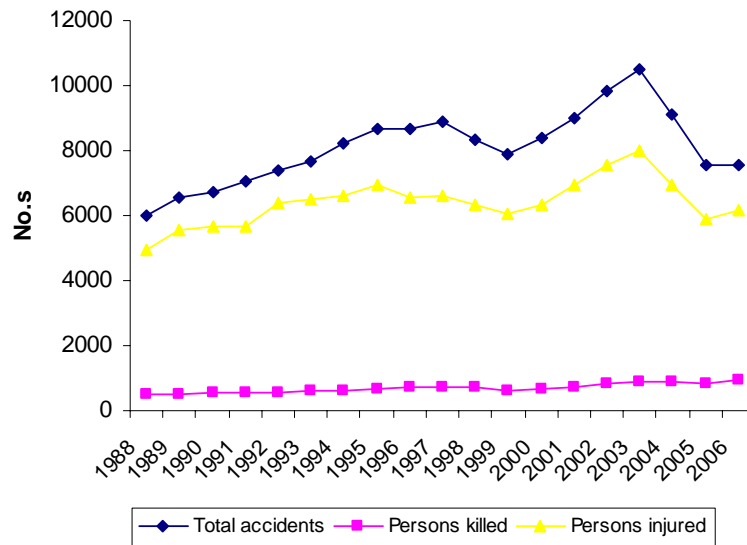


Figure 4.4 Trends of RTIs in Bangalore (1988-2006)

(SOURCE: MoSRTH, 2007)

In 2001, Bangalore ranked fifth among India's fourteen major cities in terms of RTI deaths per 100,000 of the population, with a reported annual rate of almost 13 RTI deaths per 100,000 of the population (Gururaj G., 2006).

The severity of the road safety problem is not recognized adequately in the city, and it has been difficult to implement even proven and effective interventions like seat belt and helmet laws, low cost engineering solutions, and visibility-related improvements on roads, etc. Despite the fact that more than 75% of Bangalore's total vehicle fleet consists of motorized two-wheelers, the helmet rule only came into force after much debate and opposition in late 2006 and only applies to drivers, not passengers. This is an indication of the institutional and political challenges involved in implementing crucial measures. Even though the law has entered into force, it is still violated on Bangalore's roads: an indication of weak enforcement.

Some of the other road safety issues that are now acknowledged at the national level include:

- § The absence of a clearly defined and well integrated road safety policy
- § Lack of coordination among agencies, since road safety is a multi-disciplinary field
- § Lack of scientific crash investigations, proper accident reporting or data collection
- § Lack of good trauma care and pre-hospital care
- § Inadequate capacity building to deal with related issues.

There is much to be done in this particular area of mobility, not only in Bangalore but in the entire country. In Bangalore, two-wheelers are the single largest group of road users. Among this group, head injuries are the single most important type of injury; head injuries lead to death and poor quality of life among those who survive (Gururaj G., 2006). Ensuring strict compliance with helmet laws in the city would be a big step towards achieving sustainability. Other measures needed include addressing under/incorrect reporting by police and hospitals (and the mismatch between their data), and involving/training traffic police (who are mostly busy managing traffic flows) in the process of RTI prevention, reporting and management.

4.2.3 Impact on environment & GHG emissions (Indicators 7 & 8 and Goals 1, 2 & 4)

Are mobility related “conventional” emissions, noise and impacts on ecosystems at acceptable levels?

The environmental impacts of transport in Bangalore are severe, especially where air quality is concerned. Firstly, congested roads lead to longer travel times, extra fuel consumption, and associated air pollution and greenhouse gas problems. Secondly, use of inefficient engines like motorized two-stroke two- and three-wheeled vehicles, and uncontrolled emissions from diesel buses serving city corridors contribute to pollution. Thirdly, a large percentage of the population in Bangalore spends time outdoors due to increasing travel distances, lengths and travel times, and gets exposed to automotive pollutants, especially pedestrian and non-motorized groups. Most of these groups belong to the lowest income categories and therefore suffer most from the negative impacts of motorized travel.

4.2.3.1 Emission standards

In India, there has been a stage wise drive to tighten emission norms for different vehicle categories. Between 1994 and 2000, measures were implemented to phase out lead from gasoline and sulfur from diesel. In India, the general consensus is to comply with European standards. India's emission norms lag behind Europe's by four to five years for all vehicle categories except for two- and three-wheelers. For two- and three-wheelers, India 2000 norms are far stricter than Euro II norms and are some of the world's most stringent. These norms have been implemented throughout the country since April 2000. Emission standards for different vehicle categories, including transport vehicles, were introduced in 1990 and subsequently modified with stringent standards effective from 1992, 1996 and 2000. Euro I norms were brought into force throughout the

country with effect from 4 January 2000 for all vehicle categories. India's Auto Fuel Policy formulated in 2002, devised a road map for emissions, and recommended suitable automobile fuels and technologies, and fiscal and institutional measures. The underlining principle of the policy was achieving the twin objectives of providing assured supply of fuels at minimum costs; and meeting environmental concerns by making available liquid fuels of the specified quality as the main auto fuels throughout the country, and alternative auto fuels in cities with high levels of vehicle pollution (TERI, 2004). The roadmap for vehicle emission norms for new vehicles prescribed by the Auto Fuel Policy is explained in Table 4.5.

Table 4.5 Road map for vehicle emission norms for new vehicles (except 2 & 3 wheelers)

<i>Entire country</i>	
€	<i>Bharat Stage¹ II emission norms</i> From 1 April, 2005
€	<i>Euro III equivalent emission norms</i> From 1 April, 2010
For cities of Delhi/NCR, Mumbai, Kolkata, Cehnnai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra	
€	<i>Bharat Stage II emission norms</i> <ul style="list-style-type: none"> ○ Delhi, Mumbai, Kolkata & Chennai Already introduced in the year 2000 & 2001 ○ Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra From 1 April 2010 Already introduced in the year 2000 & 2001
€	<i>Euro III equivalent emission norms for all private vehicles, city public service vehicles and city commercial vehicles</i> From 1 April, 2005
€	<i>Euro IV equivalent emission norms for all private vehicles, city public service vehicles and city commercial vehicles</i> From 1 April, 2010

(SOURCE: MoPNG, 2002)

Table 4.6 provides a summary of the progressively stringent mass emission standards for Indian vehicles, based on government notifications in the past, and the auto industry's response to the target dates for implementing these norms beyond the year 2000 (TERI, 2001).

¹ In India, applicable emission norms have been named Bharat Stage. The difference in, for example, Bharat Stage III and Euro III is that the maximum speed at which the vehicle is tested on the chassis dyno is limited to 90kmph for BS III, whereas it is 120kmph for Euro III. The emission limits are the same.
(source: <http://www.maruti.co.in/bp/faq.asp?ch=2&ct=14&sc=3#MF3>)

Table 4.6 Mass emission norms for Indian vehicles: notified till 2000 and auto industry plan beyond 2000

A. Petrol-driven four-wheeled passenger vehicles							
Pollutant/fuel	1.4.91	1.4.96		1.6.1999	1.4.2000	1.4.2004 ^a	1.4.2007 ^a
		Without catalytic converter	With catalytic converter	Euro 1	Euro 2	Euro 3	Euro 4
CO (g/km)	14.3–27.1	8.68–12.40	4.34–6.20	2.72	2.2	2.3	1.0
HC (g/km)	2.0–2.9	—	—	—	—	0.2	0.1
HC+NO _x (g/km)	—	3.00–4.36	1.50–2.18	0.97	0.50	0.35	0.18
Maximum sulfur (ppm ^b)	—	—	—	—	500	150	50

B. Petrol-driven two-wheelers						
Pollutant/fuel	1.4.91	1.4.96	1.4.2000	1.4.2005 ^a	1.4.2009 ^a	
			Bharat stage 1	Bharat stage 2	Bharat stage 3	
CO (g/km)	12–30	4.5	2.0	1.5	1.25	
HC (g/km)	8–12	—	—	—	—	
HC+NO _x (g/km)	—	3.6	2.0	1.5	1.25	
Maximum sulfur (ppm)	—	—	—	150	50	

C. Petrol-driven three-wheelers						
Pollutant/fuel	1.4.91	1.4.96	1.4.2000	1.4.2005 ^a	1.4.2009 ^a	
			Bharat stage 1	Bharat stage 2	Bharat stage 3	
CO (g/km)	12–30	6.75	4.0	2.25	1.88	
HC (g/km)	8–12	—	—	—	—	
HC+NO _x (g/km)	—	5.4	2.0	1.88	1.88	
Maximum sulfur (ppm)	—	—	—	150	50	

D. Diesel-driven vehicles with gross vehicle weight more than 3.5 tons						
Pollutant/fuel	1.4.92	1.4.96	1.4.2000	1.4.2003 ^a	Skip ^a	1.4.2008 ^a
			Euro 1	Euro 2	Euro 3	Euro 4
CO (g/kW-h)	14	11.2	4.5	4.0	2.1	1.50
HC (g/kW-h)	3.5	2.4	1.1	1.10	0.66	0.46
NO _x (g/kW-h)	18	14.4	8.0	7.00	5.0	3.5
PMc for > 85 kW (g/kW-h)	—	—	0.36	0.15	0.10	0.02
PM for < 85 kW (g/kW-h)	—	—	0.61	0.23	0.13	0.02
Maximum Sulfur (ppm)	—	—	—	500	350	50

E. Diesel driven vehicles with gross vehicle weight less than 3.5 tons

Pollutant/fuel	1.4.92	1.4.96	1.6.1999 Euro 1	1.4.2000 Euro 2	1.4.2004a Euro 3	1.4.2007 ^a Euro 4
CO (g/km)	14.3– 27.1	5.0-9.0	2.72	1.00	0.64	0.5
HC (g/km)	—	—	—	—	—	—
NOx (g/km)	—	—	—	0.56	0.5	0.25
HC+NOx (g/km)	2.7–6.9	2.0–4.0	0.97	0.7	0.56	0.30
PM (g/km)	—	—	0.14	0.08	0.05	0.025
Maximum sulfur (PPM)	—	—	—	500	350	50

^a Proposed in the Indian auto industry road map to the government; ^bppm: parts per million; cpm: particulate matter

¹particulate matter; ² parts per million

(SOURCES: IIP (1994); Bose (1998); Bose, Sundar and Nesamani (2000); SIAM (2000); CONCAWE (1999); cited in TERI, 2001)

Unfortunately, as of now, there is no roadmap for the auto industry to follow beyond 2010. Fuel quality and emissions standards are a central and not state level responsibility in India, and this acts as a constraint for the local authorities should they wish to implement change. It was recommended during the Dialogue that institutional mechanisms enabling states or cities to opt for more stringent emission norms in collaboration with auto and oil companies should be considered.

Alternative fuels

Motor Vehicle Rules in India have been amended to allow the use of alternative fuels like CNG and LPG in the transport sector. The policy suggests that the use of these fuels should be encouraged in those cities that are most affected by vehicle pollution. In Bangalore, like many other cities in India, there are issues of costing when it comes to supply of CNG. However, since LPG is in abundant supply in Karnataka, government initiatives are increasingly looking at LPG as the preferred alternative fuel. Also, low sulfur diesel is supplied by the oil companies to petrol bunks and to bulk buyers of diesel like bus companies such as the Karnataka State Road Transport Corporation (KSRTC) and the Bangalore Metropolitan Transport Corporation (BMTC). Many auto-rickshaws in Bangalore were running on adulterated petrol and it was mandated to convert some 30,000 auto-rickshaws in Bangalore to LPG by end of 2005. However, for various reasons, the implementation has faced several hiccups and in 2006 only 58% of the entire three-wheeler fleet was on LPG (KSPCB, 2007). An analysis of regular air quality monitoring conducted by Karnataka State Pollution Control Board (KSPCB) mobile laboratories during 2004-05 reveals that efforts like auto-rickshaws switching over to LPG and industries within the outer ring-road using cleaner fuels, alone will not be sufficient to reduce overall pollution levels in the city; a more concerted effort is needed.

BMTC and KSRTC buses have already initiated experiments with buses running on biofuels, and during the stakeholder discussions, the state bus companies and transport department acknowledged a need to expand this initiative further.

4.2.3.2 Air quality

The transport sector is the largest emitter of CO₂ in the city, while other pollutants like NO_x and SO₂ come from various

other industrial, commercial and domestic sources. RSPM¹ and SPM² are caused by road dust, construction, quarrying, fireplaces, mechanical breaking and erosion of materials, etc. in addition to vehicle emissions. The Central Pollution Control Board (CPCB) monitors air quality at different locations in Bangalore and publishes this data as the average of the annual mean concentrations of NO_x, SO_x, RSPM and SPM. As an illustration, air quality data monitored by CPCB at a location called Amco Batteries for the last ten years has been given below in Table 4.7.

Table 4.7 Values of conventional pollutants monitored at Amco Batteries location in Bangalore

Year	SO ₂	NO _x	SPM	RSPM
1995	33	27	160	-
1996	37	25	155	-
1997	26	31	192	-
1998	28	19	207	-
1999	38	26	173	-
2000	32	31	160	110
2001	24	30	151	52
2002	12	24	122	53
2003	12	26	119	55
2004	6.9	28.4	181	78
2005	8.7	44.2	138	68

(SOURCE: CPCB, various years)

From the table above it is evident that SO₂ levels in the city have come down considerably over the past few years. This can be explained by improving quality of fuels, i.e., low sulfur petrol and diesel, being supplied in the market. The increased penetration of diesel vehicles in the city and shift from two-stroke to four-stroke technologies, especially post-2004, has resulted in increasing NO_x levels and this is a matter of concern. This was also emphasized during the Stakeholder Dialogue. The levels of RSPM and SPM have been more or less consistent over time. This can be explained by the fact that though various interventions have taken place in the transport and industry sector over the last few years, these efforts have also been offset by increased penetration of industrial activities and vehicles.

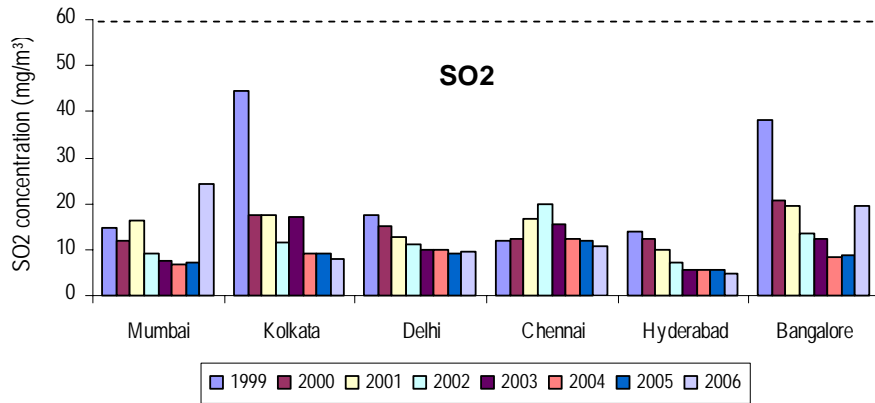
Figure 4.5, below, gives a comparison of the monitored values³ of the four conventional pollutants for the six large metropolises of India, and their variation over the last seven years. The

¹ RSPM are particles of less than 2.5 micrometers in size suspended in the air.

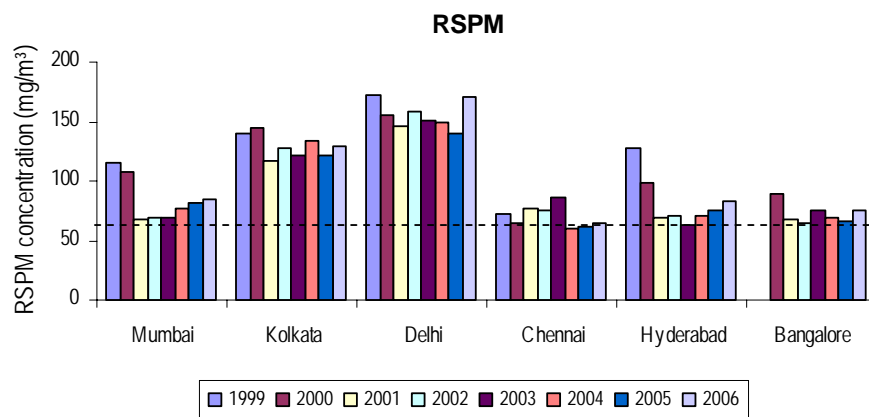
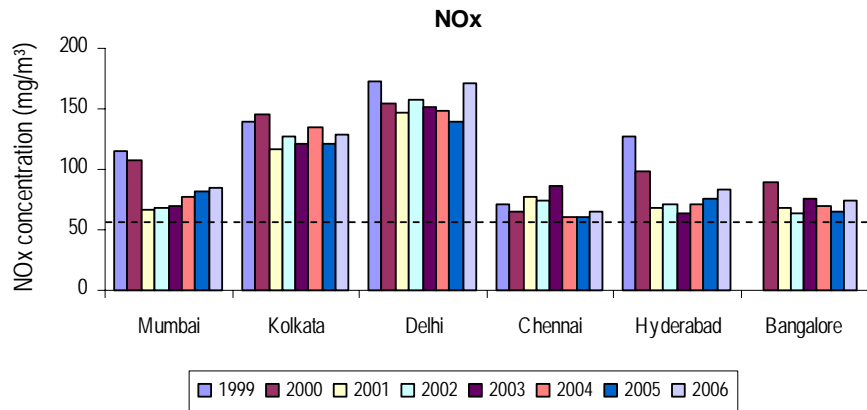
² SPM are particles of less than 10 micrometers in size suspended in the air.

³ Averaged out for all the monitoring stations in a city.

dashed lines indicate the National Ambient Air Quality



Standards (NAAQS) for each pollutant.



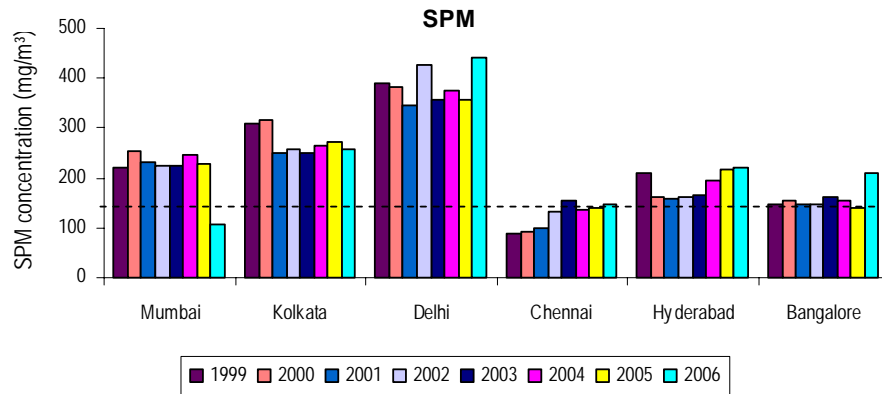


Figure 4.5 Comparison of monitored values of conventional pollutants in major cities of India between 1999-2006

(SOURCE: CPCB, Various years)

With the exception of SO₂, where all other pollutants are concerned Bangalore like most other Indian cities, is either exceeding the NAAQS or at the upper end of permitted limits.

The two major transport sources of particles in Bangalore are diesel vehicles (which include all commercial vehicles, buses and many cars/taxis) and two-stroke engine two- and three-wheelers; especially since two-wheelers comprise nearly 73% of the entire traffic fleet. In both cases, but particularly in the case of commercial vehicles, age and poor maintenance serve to further exacerbate the impacts of pollution on air quality. The share of diesel to petrol vehicles in Bangalore in 2000 was 1:3 (Bose, R.K., 2007). According to the media, at the all-India level, this share is approx. 2:3.

In terms of GHG emissions, a report published by the Asian Development Bank (ADB) estimated total CO₂ emissions in India at 208 million tons of CO₂ in 2005, these are predicted to rise to 1,212 million tons of CO₂ in 2035 (ADB, 2006).

During the stakeholder discussions in Bangalore, the need to push for high quality diesel, check NO_x levels more strictly, and adopt more alternative fuel technologies in the city were raised as key action points to improve air quality.

4.2.3.3 Vehicle inspection and maintenance

Among the various measures taken at the city level to control air quality, the introduction of the “green tax” (a special tax on all vehicles that are over 15 years old), a new legislation that

requires a “Green Fitness License” for vehicles older than 15 years has now been made mandatory in Bangalore. Pollution check in the city is mandatory and the validity period is 6 months. Spot-checks of emissions by traffic police are also carried out. However, despite some of the initiatives already in place, the importance of vehicle fitness centers and regulating inspection and maintenance regimes to bring down levels of regulated pollutants, have not been addressed appropriately, not only in Bangalore but also all over the country.

Technological improvements in vehicles and fuels alone are not sufficient to address air quality concerns. On-road vehicles must undergo regular inspections and maintenance in order to be fit. During the Stakeholder Dialogue it was suggested that a hi-tech city like Bangalore should develop a chain of modern I&M centers for all categories of vehicles, and set an example for other Indian cities.

4.2.3.4 Noise levels (Indicator 8 & Goal 7)






The noise levels in the city are found to be much higher than the permissible limits prescribed by the Pollution Control Board. Table 4.8 below, shows the noise levels at night and day observed by Bangalore Metro Rail Corporation (BMRC) during January to December 2006, as a part of its before and after studies to assess impact of the upcoming metro rail on certain locations.

The study showed that the noise level was beyond 65 decibels during the day in all selected locations along the proposed metro route; and invariably, the readings were at least 10 decibels higher than permissible levels. The same was true of noise levels during the night – some decibels higher than the permissible limit of 55⁷.

To sum up, the deterioration of Bangalore’s environment, caused in part by increasing levels of personal mobility, is a major concern. It is now on the radar screens of both the city and state governments. Besides looking at improving fuel quality and reducing emissions per vehicle, there has to be a long-term reduction in total kilometers traveled through integration of transport and land use, etc.

⁷ <http://www.hindu.com/2007/07/08/stories/2007070860720300.htm>

Table 4.8 Noise levels at night and day in Bangalore*

Locations	In decibels (dB)		Norms (Central Pollution Control Board)
	Day	Night	
			Industrial area
Junction of Ring-road & Tumkur Road	80.5	76.0	
Near Yeshwanthpur Railway Station	76.8	74.2	
Junction of MKK Road & West of Chord Road	76.4	71.7	
Majestic Circle	78.9	74.0	
			Commercial area
Junction of KR Road & Albert Victor Road	75.7	68.7	
Near Harischandra Ghat on NKK Road	76.5	70.8	
Siddaiah Chowk/Circle	76.0	69.3	
Junction of South End Road & RV Road	76.8	69.7	
			Residential area
Near Police Station, Byppanaha Depot	76.5	69.1	
Junction of CMH Road & 5V Road	76.6	69.3	
Junction of CMH Road & 100 Ft. Road	76.9	70.5	
Trinity Circle	76.0	70.5	
			Silence area
Junction of Queens Road and MG Road	75.3	71.7	
Opposite high Court	75.7	71.6	
Central Leprosarium on Magadi Road	74.8	69.3	
Junction of Magadi Road & Chord Road	76.4	70.3	
Junction of Magadi Road & Mysore Road	77.9	73.7	
			

* Bangalore Metro Rail Corporation Study (Jan-Dec, 2006)

(SOURCE: <http://www.hindu.com/2007/07/08/stories/2007070860720300.htm>)

4.2.4 Resource use (Indicator 9 and Goals 2 & 7)

Is mobility-related energy, land and material use sustainable in the context of overall supply and alternative demands for these resources?

According to R.K. Bose (2007), over 77% of the gasoline and 21% of the diesel sold in Karnataka were consumed in the transport sector for the intra-city movement of traffic in Bangalore. According to him, if present trends in vehicle growth continue, the total transport energy demand would grow from about 1,184 thousand tons of oil equivalent (TTOE) in 2005 to 1,754 TTOE in 2010 and 3,684 TTOE in 2020, a 3.1-time increase between 2000 and 2020 in the baseline scenario. Therefore, policies and strategies are urgently needed to curb present levels of vehicle and energy use in order to address the energy security issue.

In the absence of data, further assessment of this indicator for both energy and other resources like land use, materials, etc. could not be carried out.

4.2.5 Congestion and parking (Indicators 2, 3, 4, 9 & 10 and Goal 5)

Congestion levels are high in Bangalore. Some of the key indicators of rising congestion and therefore deteriorating mobility and accessibility in the city include:

- § The number of roads allowing journey speeds of 30-40 kmph has dropped significantly in the last fifteen years (see Table 4.9 below).

Table 4.9 Variation in the performance levels of the road network in Bangalore

Journey speed	Percentage of road network surveyed		
	1965	1988	1998
<10kmph	3	5	3
10-20 kmph	11	28	26
20-30 kmph	32	45	45
30-40 kmph	54	23	23
>40 kmph	0	0	0

(SOURCE: CRRI, 1999)

- § Average vehicle delays¹ have increased to 5-6 minutes in 2006 from 2 minutes in 1988 (RITES 2006 & CRRI, 1999). Changes in delays per km of travel and delays per minute of travel between 1988 and 1999 are shown in Table 4.10.

Table 4.10 Average travel delays

	Delay (in seconds) per km of travel	Delay (in seconds) per minute of travel
1988 (RITES)	20.3	7.9
1998 (CRRI)	26.8	9.9

(SOURCE: CRRI, 1999)

- § Vehicle occupancy has dropped from 2.1 in 1998 to 1.7 in 2006.
- § Peak traffic hours in the city range from 9-11 am and 6-8 pm.
- § Average traffic volumes were recorded to at 1,500-19,000 PCU/hr in 2006, as opposed to 7,000-14,000 PCU in 1999.
- § Peak hour traffic on some of the roads connecting Bangalore to other cities like Chennai, Hyderabad, etc. has doubled in the last three years (see Figure 4.6 below).

¹ The difference between the actual travel time and the travel time traversed at an average speed equal to that for an un-congested traffic flow.

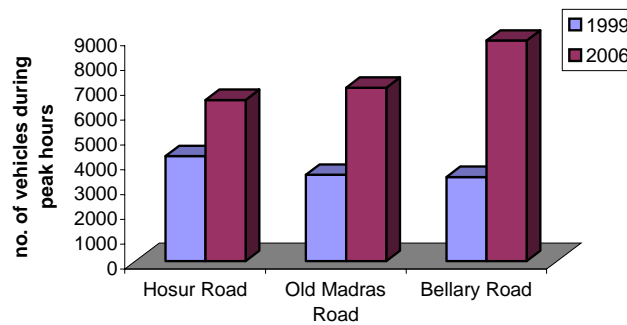


Figure 4.6 Change in peak traffic flow volumes on three of the major intercity corridors for Bangalore - 1999 and 2006

(SOURCE: CRRI, 1999; RITES, 2006)

- § In terms of traffic composition, motorized two-wheelers occupy 0.4-0.7 passenger car units (PCU); given their increasing numbers, they are the foremost cause of road congestion in Bangalore (BDA, 2007).

Lack of parking facilities is another issue in the city today, which adds to the problem of congestion and already limited road space. On-street parking, especially in commercial areas of the city, has severely affected road performance and further reduced traffic speeds. A study conducted by CRRI in 1998, found that parking demand had increased almost three times between 1966 and 1998 on the city's busy streets. Although strict regulations have been enforced by the traffic authorities in the form of short duration (0.5-1 hour) and long duration (greater than 3 hours) parking, along with restricted parking in certain areas of the city to ease the problem, these initiatives do not offer long term sustainability solutions.

As discussed above, the most common response to the problem of congestion and inefficient utilization of road space has been to increase the road capacity in Bangalore by, for example, building grade separators and flyovers and/or converting a number of roads into one-way streets. However, this added capacity has not been able to meet the surging demand of private vehicles and these measures have only succeeded in shifting the point of congestion further up the traffic stream, without really improving the overall performance of the network.

As stated in the Stakeholder Dialogue, congestion is not the problem but a symptom of a bigger problem of poor urban planning and uncontrolled rates of motorization. It was emphasized that there needs to more equitable allocation of

road space, by giving separate spaces and priority to public transport and non-motorized transport, thereby making them a more attractive alternative to personal means of transport. This could be supported later by introducing policies like congestion charging, area licensing schemes, high parking fees, etc. Current parking facilities need to be upgraded and improved.

4.2.6 The “mobility opportunity divides” around and within Bangalore (Indicators 1, 2, 3, 4, 5, 6 & 10 and Goal 6)

“Lack of access to transportation and information are both symptoms of poverty and key factors in keeping families, communities and nations poor” (WBCSD, 2007). Such individuals are therefore deprived of mobility opportunities (WBCSD, 2004). This section focuses on the physical mobility divide in the context of Bangalore. Discussions on the use of technology to achieve sustainable mobility follow in Chapter 5.

In this study, TERI has chosen to address the various mobility divides in Bangalore at two levels:

1. The mobility divide between urban and rural populations within and surrounding Bangalore; and
2. The mobility divide between rich and poor populations in the city.

4.2.6.1 The urban-rural mobility divide

Drawing on the Mobility 2030 report, the urban-rural divide can be defined as the “disparity between the mobility opportunities available in terms of roads and travel modes to the average village dweller in the poorest rural areas as compared to the average city dweller” (WBCSD, 2004).

With the benefits of urbanization spreading into rural areas, and rural areas providing goods for the urban market, there is an increase in the demand for connectivity between village production centers and urban markets. Bangalore is flanked by a number of villages, most of which are dependent on the city for their livelihoods through the sale of produce such as flowers, fruits, vegetables, grains, etc.

Several initiatives are being implemented by the Government of India and the Karnataka state government to provide infrastructure for urban-rural connectivity. The PMGSY has already been discussed in Chapter 2. This has been an extremely important initiative in ensuring that the benefits of development extend beyond the limited confines of the developed urban centers of Karnataka to the vast hinterland and to the millions of toiling farmers to ensure that they too can benefit from progress in the state. In Karnataka, rural roads served about 27,683 villages (76% of villages of the state) (GoK,

2007) in 2005. In addition to the PMGSY, there is the Mukhya Mantri Grameena Raste Ahivruddi Yojana (MMGRAY), as well as various development projects at the Karnataka state level, including projects with the National Bank for Agriculture and Rural Development (NABARD) and the Rural Infrastructure Development Fund (RIDF), for the development of the road sector. These initiatives are being implemented as part of efforts to improve and enhance road connectivity within the state, and to promote access to economic and social services, thereby generating increased agricultural productivity, non-agricultural employment and non-agricultural productivity. These in turn will expand rural opportunities and generate real income within the state.

Urban-rural passenger connectivity in Karnataka state is provided by four separate Government Owned Enterprises (GOEs) that operate buses in 18 of the 28 districts of the state; private operators service the remaining 10 districts. The four GOEs managing urban-rural transport services are:

- § The Bangalore Metropolitan Transport Corporation (BMTC), which provides bus services within the city and up to 25 km beyond the municipal limits of the city. This inevitably includes rural belts. With the recent expansion of the city and the creation of Greater Bangalore, BMTC has also increased its catchment area accordingly. Of the 63,000 passenger trips catered daily by the BMTC, 60% are rural trips.
- § The North Western Karnataka State Road Transport Corporation (NWKSRTC), which has a fleet of 4,400 buses and a monopoly on all routes in northwestern areas of the state.
- § The North Eastern Karnataka State Road Transport Corporation (NEKSRTC), which has a fleet of 2,600 buses and the monopoly over all routes in the northeastern area of the state (Wilson, S.).
- § The Karnataka State Road Transport Corporation (KSRTC), which caters to most transport requirements in central and some parts of southern Karnataka.

In addition, there is an increase in the number of private buses and maxi cabs serving some bus routes.

Initiatives being implemented to ease and enhance urban-rural connectivity necessarily raise issues which require attention.

Among them are included:

- a. Safety on most rural roads is a major concern. This was strongly emphasized during the Stakeholder Dialogue. Better quality road networks encourage higher speeds. However, the inadequate provision of speed regulating devices in the places where these rural roads pass

through settlements is leading to high rates of morbidity. Several fatalities have been reported on these highways, something that needs to be immediately addressed.

- b. The inadequate number of buses has resulted in overcrowding on the transport system and an increase in the number of private vehicles serving public routes; evidence of the demand for transport exceeding current supply.
- c. Transport frequency varies depending on the route. Although there are no published studies to substantiate this observation, public service providers appear to service profitable routes more frequently than non-profitable routes. As a result, bus frequency varies from 10 minutes to twice a day depending on the route.
- d. The presence of illegal, private means of transport on village routes raises questions of safety, fuel quality, overcharging, accountability, etc.

Given the lack of data it was not possible to conduct a detailed cost and time analysis in relation to rural travelers, etc. However, urban-rural connectivity in the state is an area that warrants further research.

4.2.6.2 The income-related mobility divide

With rising incomes, demand for speed, comfort, privacy, etc. in the city has increased. In the absence of inclusive transport planning, the income divide in the city (discussed in Chapter 3) has led to growing disparities in travel opportunity, resulting in several mobility divides. The method used to assess these divides is based on direction provided in the Mobility 2030 document.

In order to address the mobility divide in the city, for the purposes of this study, TERI looked at the city's population in terms of:

- a. *The rich or the mobility served* – those who have access to a personalized means of travel and/or are located close to a public transport system of a minimum quality; and
- b. *The poor or the mobility unserved* – those who have no access to personalized means of transport and have problems accessing/using the public transport systems in the city.

It is worth mentioning here that these definitions were adopted for the sake of simplicity. To properly assess levels of disparity would require considerably more time and effort. In the absence of primary data to quantify groups a and b above, it was difficult

to properly estimate the share of population belonging to each of these so-called rich and poor segments, and hence the extent of the mobility divide.

TERI therefore decided to conduct a qualitative evaluation of the rich-poor mobility divide based on criteria such as time, cost, space, etc. Again, since the poor were more approachable and easier to interview than the richer sections of the population, TERI restricted most of the primary assessments poorer groups in order to understand the mobility challenges that they face. A decision also in part motivated by the fact that challenges facing the poor are considered to be more pressing than those confronting the rich. This review was conducted through a quick mobility assessment in a few selected slums in the city. It is also based on feedback received during the Stakeholder Dialogue.

The following section describes TERI's findings in some of the poorer areas of the city.

4.2.6.2.1 TERI's assessment of the mobility situation in "poor pockets" of Bangalore

TERI conducted rapid primary assessments in a few poor areas in the north, south, east and west of Bangalore. "Poor pockets" (as defined by the Census of India, 2001) are defined as a compact area with a population of least 300 or about 60-70 households of poorly-built congested tenements, in an unhygienic environment and with inadequate facilities. Five "poor pockets" located in different parts of the city were assessed. These locations are highlighted in Figure 4.7, they include:

1. Economically Weaker Section (EWS) housing, in Vivek Nagar (southeast)
2. Ambedkar Nagar slum, Old Baipanalli (east)
3. Ambedkarnagar slum, Sunnadiguddi, Yeshwantpur (north)
4. Ambedkar Nagar, Ramakrishna Sewa Nagar, Srirampuram (west)
5. Ambedkar Nagar, Audgudi (south).

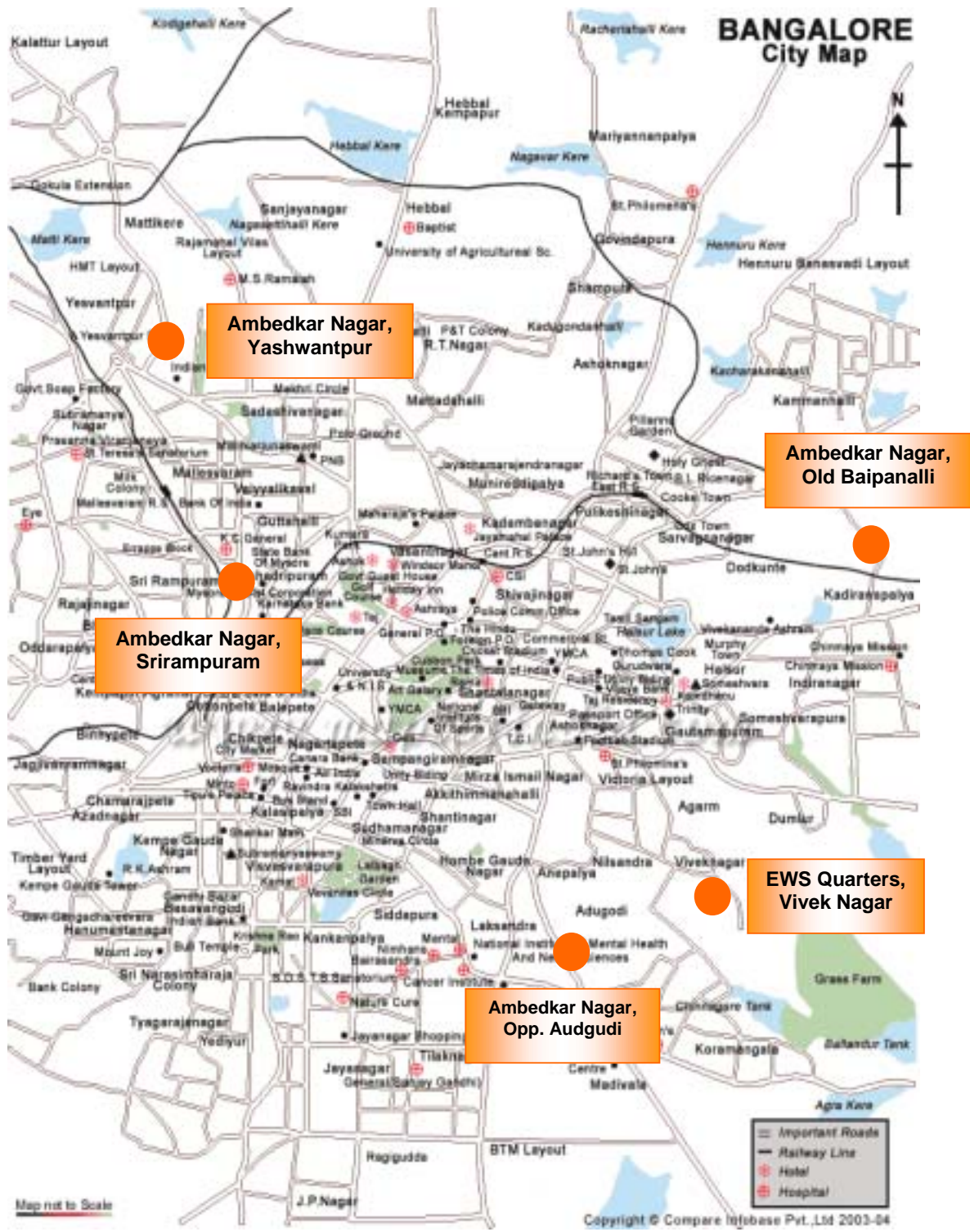


Figure 4.7 Map of Bangalore highlighting the key locations for slum assessments

In each of the five slums, a Focus Group Discussion (FGD) was conducted with separate groups of men and women, of varying age groups. Each group varied in size from 15-20 persons. A

total of ten FGDs were conducted in the five slums. The main objective was to obtain first-hand information (based on a checklist prepared by TERI) about the public transport mobility situation in terms of access, reliability, affordability and travel time. Almost all the slum dwellers were dependent on public transport.

The key findings of the FGDs are summarized below:

- € *Trip purpose:* The majority of the male population of the “poor pockets” were laborers earning a daily wage. The women were either employed as servants or ran small household units. The main purpose of adult travel was for work, while for children it was education. Travel for other basic needs like health and religious visits was largely needs-based and on average trips were undertaken once or twice a month.
- € *Accessibility:* The majority of the slum dwellers did not possess motorized vehicles, with the exception of a few auto drivers who owned and operated auto-rickshaws for a living. Thus, the public system was the main mode of transport. On the whole, the public transport system was easily accessible with bus stops located within a convenient walking distance (average distance of 1 km) from the habitations. The average waiting time and frequency of the buses varied from 15-30 minutes. Most travel routes were served, however, the poor often had to change buses, walk long distances or switch to other means, like intermediate public transport, to reach their final work destinations. This resulted in increased travel time and costs. Overall bus network coverage in the city was reported to be satisfactory.
- € *Travel distances and travel times:* Average travel distances varied from 3-25 km. Time spent commuting averaged 1-2 hours per trip. Most slum dwellers voiced their distress at the long travel times caused by congestion in the city.
- € *Average house incomes and travel expenditure:* Total travel costs varied from Rs. 5-20 per trip. Average household incomes reported ranged from Rs. 2,000-4,000 with a significant portion, about 15%-25%, being spent on travel. Children’s fares were lower and student travel passes have recently been introduced. Despite this, however, slum dwellers highlighted travel costs as a cause for concern.

€ *Social issues:* Many women voiced concern about the unavailability of seats; as a result of men occupying seats reserved for women. Pick-pocketing on the buses was also a cause for concern. Finally, parents voiced concern over the safety and well-being of their children on account of the long distances they often have to walk to get to bus stops.

The slum dwellers felt that their mobility needs could be better served by increasing the number of buses; this would increase the number of available seats, reduce travel time and make travel easier and more convenient. The future Bangalore metro was acknowledged during the Stakeholder Dialogue as an important step to improve public transport. However, there was concern about its affordability for the poorer segments of the population; metro fares are likely to be 1.33-1.66 times higher than bus fares, with an annual increase of 4%¹.

4.2.6.2.2 Assessing the different mobility divides: spatial, temporal, affordability and personal

Based on the assessments conducted in the slums, other secondary data sources, and Stakeholder Dialogue discussions, TERI attempted to summarize the mobility divide in the city by addressing following questions:

(A) The spatial mobility divide

Does everyone in the city have easy access to transport services?

Existing public transport services in the city are run by BMTC. According to TERI's assessments conducted in the poor pockets/slum areas in the city and interviews with BMTC, bus coverage in the city was satisfactory as most people were able to find bus stops within 1 km of their location. Also, many poor people in the city had to travel distances of up to 25 km. Infrequency of buses and long travel times were causes for concern rather than access to bus stops and long walking distances.

(B) The temporal mobility divide

Does everyone in the city take an equal amount of time to travel between any two points at a given time?

The effects of congestion were magnified when it came to the poor as they were most likely to walk, use non-motorized means of transport or take buses, all of which are considered "slow modes" when compared to fast moving cars and two-wheelers.

¹ <http://www.karnataka.com/watch/blr-metro/> & <http://www.bmrc.co.in>

TERI's own observations and interviews with local stakeholders, revealed that for the same distance, typically, a two-wheeler user took the least time to travel, followed by an auto-rickshaw and car user, while the bus took the longest to travel the same stretch of road. TERI noted that long waits at bus stops (typically between 15-30 minutes) and additional time spent changing buses, was a major problem for users of public transport, i.e., the poor. This also highlights the need for a faster public transport system in the city.

In a survey conducted by RITES in 2006 at the major bus stations in the city, it was found that more than 70% of the passengers reported delays and long waiting times, lower frequencies, and long walking distances to bus stops as the top three problems facing buses in the city. Almost 66% of people interviewed were employees and 30% were students. There were also a significant number of housewives and elderly people traveling by bus. More than 90% of people had a journey time longer than 60 minutes, and for 85% of the passengers, waiting times ranged from 15-30 minutes (RITES, 2006).

(C) The affordability mobility divide

Can everyone in the city easily afford transport when needed?

Given the income disparities existing in the city and the dependence of the poor on public transport, the financial divide needs to be approached in terms of share of monthly income spent on travel by the poor in comparison to their total income. Ideally, to understand how affordable mobility is to different income groups in Bangalore, average shopping basket data for different income groups in the city is required. In the absence of shopping basket data for Bangalore, it was not possible to address this question fully in this study. But this could be a topic for further research. However, TERI's assessments in the slums did reveal that travel costs were an important issue for the poor who reportedly spend 15-25% of their household income on travel every month, which is a significant share. This affects their ability to pay for other necessary services like health, education, shelter and food.

(D) The mobility divide based upon personal capacities/characteristics

Does everyone in the city have the mental and/or physical capacity to access available means of mobility?

This aspect of the personal mobility divide includes gender issues, vulnerable groups like the elderly, children, and disabled persons. It also includes questions of safety, security, health

problems resulting from mobility, etc. Broadly, in the context of Bangalore, the findings can be summarized as follows:

a. Pedestrian and non-motorized transport environment: Journeys on foot and by bicycle represent 1.7% and 16%, of all trips, respectively (Group SCE India Pvt. Ltd., 2006). Despite the fact that the number of motor vehicles in the city has been growing at a compounded annual growth rate (CAGR) of 10.12% in the period from 1998 to 2007, pedestrian traffic has also grown at roughly 17% CAGR in the same period. To illustrate, in 1998 pedestrian numbers ranged from 500-3,000 people per hour crossing the streets along a few major corridors (CRRRI, 1999). The volume of pedestrians observed in 2006 by a RITES survey along the major corridors ranged from roughly 2,000-11,000 per hour. The highest numbers of pedestrians in the city can be observed between 10-11 am and 5-6 pm, which also coincides with peak vehicle traffic hours. Poorly maintained sidewalks and footpaths in the city, which force the pedestrians to walk on the road, thereby putting them at risk, compound this problem.

Owing to its mildly rolling terrain, there are hardly any cycle rickshaws operating in Bangalore, unlike other Indian cities like Delhi and Kolkata. Also, non-motorized traffic like animal-drawn carts, bicycles and pedal carts share the same road space as motorized traffic. It is important to bear in mind that since part of every trip made by public transport requires a certain amount of walking, and given that public transport accounts for 46% of journeys made in the city, there is an urgent need to address pedestrian requirements and plan for dedicated pedestrian-friendly infrastructure, including well-protected sidewalks, etc. so that pedestrian movement on the city roads can be made safer and easier.

According to the NUTP guidelines, NMT needs to be given high priority through the formulation and implementation of specific "Area Plans" in congested urban areas. These should include an appropriate mix of various means of transport and the creation of exclusive zones for non-motorized transit. Also, construction should be undertaken of separate lanes for bicycles and pedestrians, not just to improve mobility, but also to improve access to major public transport stations. However, these measures have not as yet been implemented. The authorities responsible should give priority to addressing these measures.

b. Overcrowding and lack of security in buses: In Bangalore, many women choose not to ride the overcrowded buses for reasons of both security and comfort, and are forced to resort to either a personal two-wheelers or auto-rickshaws.

Although BMTC provides women-only buses, it was felt that the number of such services needs to be increased.

c. *No special provisions to meet the needs of the disabled and other disadvantaged groups in the city:*

During the Stakeholder Dialogue, groups working for the welfare of disabled people in Bangalore highlighted that mobility needs for disabled sections of the population in the city are rarely addressed. Even though each and every disabled person in the city is entitled to a pass to travel up to 100 km a day, the burden on the disabled has increased recently. Obtaining a disabled pass requires identification and recommendation by the Directorate for the Welfare of the Disabled. Although little information was available to substantiate this, it appeared that this requirement represents an additional constraint to mobility, especially for the poor.

The government provides transport subsidies (to the tune of Rs. 700 million) for special categories of people traveling in the city. In addition to daily, weekly and monthly passes for all passengers; special passes exist for senior citizens (the elderly), the disabled, journalists, fire fighters, family members descended from freedom fighters (citizens engaged in fighting the British for Indian independence), policemen, students, etc. In addition to providing subsidies, participants in the Stakeholder Dialogue recommended that the government should implement other measures to improve mobility for disabled persons, including reserving fixed numbers of seats for disabled people in public vehicles, providing special small capacity services for disabled people during peak hours, and designing more disabled-friendly vehicles.

d. *Safety concerns primarily surrounding pedestrians, two-wheeler users and public transport users*

It was emphasized during the stakeholder dialogue that the vulnerable travel groups (which also include the poor) are not considered and provided for while creating infrastructure. Neither are the socio-economic and health impacts of crashes on the poor given much thought at the planning and policy level. There is also no special provision for separate lanes for pedestrians and non-motorized mode users. The same study also revealed that among the 1,076 pedestrians injured in a survey, 41% were hit by a motorized two-wheeler, 15% by a car and 11% by three-wheeled auto rickshaw (Gururaj et al., 2005). One-quarter of all collisions involving heavy vehicles like buses, lorries and medium-sized vehicles like matadors, resulted in injuries to pedestrians. Most injuries to pedestrians occurred in the middle of the road (78.2%), at the end of the road (4.6%), at circles (4.2%) and near traffic signals (0.4%). Given that over 73% of Bangalore's traffic is made up of two-wheelers, two-

wheeler riders' and pillion riders' safety is a pressing issue. This, along with pedestrian safety, needs to figure high on government agendas. Furthermore, there needs to be special emphasis on and recognition of the fact that it is the poor who suffer the most long-term effects from RTIs.

Rich-poor and urban-rural safety divide in Bangalore

RTIs have both direct and indirect impacts not only on the victims, but on their families, employers and society at large who are financially, emotionally, and socially affected in the long run (Gururaj, G. 2006). What is not very well understood is the extent to which the poor in low-income countries are involved in road crashes and the impact these have on their families and livelihoods. Transport Research Laboratory (TRL) in the United Kingdom conducted a study to evaluate the level and impact of road crashes on poor and non-poor populations in Bangalore and Bangladesh in 2004 (TRL, 2004). Some 96,414 people and 19,797 households were surveyed including in rural, urban and slum areas in and around Bangalore. Some of the key findings re-iterated the mobility divide in terms of safety between the rich and the poor in Bangalore, and these have been listed below:

- € The poor reported a higher incidence of road deaths in both urban and rural areas with significant differences in rural households. The non-poor were found to be more affected and suffer higher greater incidence of serious injury.
- € Two modes of transport were found to dominate road deaths and serious injuries. Among the poor, pedestrians were more likely to be involved in traffic accidents, while among the non-poor, motor-cyclists were the most common road accident victims.
- € Over half of all those killed and seriously injured were young – middle age adults. There were more casualties among those over the age of 45 than among children.
- € While the non-poor reported paying more than the poor in medical costs, this was only significant in the case of serious injuries sustained in urban areas.
- € On average, road victims of school age missed between 4-6 months of schooling.
- € Although the majority of seriously injured were able to return to work, almost half of the rural non-poor had to find new jobs.
- € The majority of poor households had to borrow money after a road death or serious injury.
- € The majority of bereaved urban households and almost all households in which there was a victim of a serious injury reported having to give up work or studies.
- € Very few bereaved or injured had received compensation at the time of the survey.
- € Fatal and serious injury crashes had a devastating effect on many households; 71% of bereaved urban poor and 53% of poor rural households reported not being poor before the accident. Among households with seriously injured victims, 17% of urban and 25% of rural households reported not being poor before the serious injury.

The main recommendations emerging from this study were to focus on the following key areas in order to reduce the safety divide:

- o Include hospital and community-based surveys when estimating road deaths and injuries
- o Road traffic injury prevention should be targeted at vulnerable road users
- o Post-crash medical care plans should be included in road safety plans and strategies
- o Access to justice for all and more credibility and faith in the present system, including proper data recording, scientific investigation and restorative programs for victims and their families.

In order to achieve sustainable mobility, Bangalore needs to plan for transport infrastructure and provide mobility services to reduce the mobility divide to a maximum. This was also highlighted during the Stakeholder Dialogue by policy makers and government representatives present who admitted that insufficient efforts had been made for vulnerable populations in the city, namely the urban poor, who had not been targeted for reforms. An efficient and affordable public transport system was

identified as a key step towards reducing the mobility divides in the city.

Narrowing the mobility opportunity divide hinges on the overall urban planning process and policy responses to present-day mobility challenges. These are discussed in the following section.

4.3 Urban planning and policy responses

At present, current and future investment in transport projects in Bangalore come under the aegis of the Master Plan and the City Development Plan (CDP) of Bangalore. Typically, funding under the JNNURM is only made available to cities once they have prepared detailed plans for urban development (a policy and investment plan) covering a period of 20-25 years (with 5 yearly updates) and indicating the policies, programs and strategies to be implemented to meet funding requirements. Based on technical and financial analysis, these plans should contain a list of transport projects being planned for the city to meet its mobility needs and challenges. These projects are required to be in line with the NUTP.

Though the JNNURM is a well-intentioned program, the CDP formulated for the city fails to address certain very important issues, which are critical from the viewpoint of sustainability. Some of the lacunae identified in the Bangalore CDP include:

1. Emphasis is purely on physical infrastructure expansion and sustainability (social, environmental and economic) is not addressed.
2. Key areas like environmental protection, addressing the mobility divide, transport energy issues, policy instruments to manage travel demand, etc. are not adequately addressed.
3. Mechanisms to integrate identified initiatives under JNNURM with other national/state level policies and plans like NUTP, are not clearly spelt out in the program.
4. No emphasis on or provision for “inclusive planning and growth”.
5. Impacts of transport development in other areas have not been addressed.
6. Projections for the future are based on existing datasets, which are already inadequate and deficient, and coupled with assumptions; this may lead to unrealistic scenarios for the future.
7. The overall investments are again skewed in favor of the creation of more road space for vehicles rather than on mechanisms to move masses efficiently, providing space

for pedestrians and non-motorized transport users, improving levels of accessibility and service quality for vulnerable sections like the poor, disabled, etc. For example, Table 4.11 below shows the investments planned for roads and transportation in Bangalore for the period 2006-2012.

Table 4.11 Investment plan for transport infrastructure in Bangalore – JNNURM period (2006-12)

Description							Total (Rs. crores)
	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	1 crore= 10 million
Capital Expenditure							
Roads	492.5	568.2	644.0	681.9	681.9	719.7	3788.2
Inter-modal transit centers	65.0	75.0	85.0	90.0	90.0	95.0	500.0
Commuter rail system	42.3	48.8	55.3	58.5	58.5	61.8	325.2
Other mass transit system	94.1	108.6	123.1	130.3	130.3	137.6	724.0
ROBs / RUBs	20.8	24.0	27.2	28.8	28.8	30.4	160.0
<i>Total CAPEX</i>	714.6	824.6	934.5	989.5	989.5	1044.5	5497.2
Operation & Maintenance Expenses							
Roads	24.4	28.2	32.0	33.8	33.8	35.7	188.0
Inter-modal transit centers	32.5	37.5	42.5	45.0	45.0	47.5	250.0
Commuter rail system	4.1	4.8	5.4	5.7	5.7	6.1	31.9
Other mass transit system	8.2	9.5	10.7	11.4	11.4	12.0	63.2
ROBs / RUBs	4.2	4.8	5.4	5.8	5.8	6.1	32.0
<i>Total OPEX</i>	73.5	84.8	96.1	101.7	101.7	107.4	565.1
Land Acquisition							
Commuter rail system	12.9	14.9	16.9	17.9	17.9	18.8	99.2
Other mass transit system	8.1	9.4	10.6	11.2	11.2	11.9	62.4
<i>Total-LA</i>	21.0	24.2	27.5	29.1	29.1	30.7	161.6
Rolling Stock	170.6	196.8	223.1	236.2	236.2	249.3	1312.1
Grand Total	979.7	1130.4	1281.1	1356.5	1356.5	1431.8	7536.0

(SOURCE: JNNURM, 2006)

A simple calculation of the share of investment in public transport vs. road development reveals that almost 52% of the total investments targeted are still earmarked for capital and operation and maintenance (O&M) expenses for road transportation. In addition to capital expenditure on public transport, the remaining 48% of investments include land acquisition, transit centers and O& M costs, etc. Finally, there is no investment earmarked for pedestrian and non-motorized transport infrastructure.

If these issues are not addressed adequately, the city may again end up repeating mistakes of the past and create more negative externalities from mobility in the long run. Therefore, these issues must be given due consideration. Furthermore, the projects need to be in line with the NUTP vision¹, which is:

¹ <http://urbanindia.nic.in/moud/programme/ut/TransportPolicy.pdf>

- € “To recognize that people occupy center-stage in our cities and all plans would be for their common benefit and well-being”
- € “To make our cities the most livable in the world and enable them to become the ‘engines of economic growth’ that power India’s development in the 21st century”
- € “To allow our cities to evolve into an urban form that is best suited for the unique geography of their locations and is best placed to support the main social and economic activities that take place in the city”.

A list of the categories under which transport-related projects are being planned for the city and TERI’s views on each of those has been summarized below in Table 4.12. Details of each project under these can be found in the CDP for Bangalore City⁷.

Table 4.12 Overview of Bangalore’s future transport projects

S. No	Project (as described in the CDP, JNNURM, 2006)	TERI’s remarks
1	Develop elevated core ring-roads with key axial roads to decongest the city, peripheral ring-roads and satellite township ring-roads	Creating more road space may not necessarily decongest the city, unless policies to make public transport a more attractive travel option are brought in. Also development of satellite township ring-roads to provide connectivity to the upcoming satellite towns will lead to further sprawl, longer trip distances and therefore more mobility-related negative externalities in the future. Peripheral development around the city should consider creating working, educational and recreational facilities also, and at the same time connect the city center with good public transport services, so that the benefits of newly developed roads are not restricted to the rich auto users only but are shared by the poor who for various reasons are forced to settle at the city’s periphery.
2	Improve existing arterial roads and local link roads	Rehabilitation of roads needs to be carried out with strict quality controls in order to avoid the need to rehabilitate them again in the near future. Road safety audits need to be conducted on these roads; and most importantly without proper land use planning, there is always the danger that these arterial road will become access roads, thereby impacting the overall road network performance in the city.
3	Construct railway over bridges and under bridges at key locations in the city	Utilizing the existing suburban railway network passing through the city in order to meet local and wherever possible urban-rural travel demand, should be looked at more seriously.
4	A modern high capacity bus system on the outer ring-roads, and on a dedicated corridor wherever road	In order to make the initiative more sustainable, it will be essential to ensure equally good quality feeder or connecting services to the interior parts of the city from the outer ring-

⁷ <http://jnnurm.nic.in/toolkit/Bangalore.htm>

S. No	Project (as described in the CDP, JNNURM, 2006)	TERI's remarks
	width permits	roads.
5	Enhancing various operations under BMTC like introducing the grid route concept, increasing the fleet-size schedules, improved and new depots, better passenger information and ticketing systems, etc.	This will go a long way towards improving the image of public transport in a city, however planning needs to be backed with good research on passenger traveler behavior and unless priority on the road is given to public buses, they will not succeed in attracting the personal vehicle users.
6	Two intermodal change centers (centers facilitating transfers and connectivity between rail and bus links or bus and IPT links) to be built on a PPP basis	This will be a good means of providing integration between various modes of transport.
7	B-TRAC 2010, an integrated traffic improvement program by the Bangalore City Police to reduce congestion, crashes, pollution levels in the city and ensure better traffic enforcement and set up trauma care centers, capacity building, etc.	Integrated initiatives like these are a good way of dealing with current mobility problems, however a task like this may require cooperation and coordination among multiple agencies including hospitals, traffic police, pollution control boards, etc. who need to work in tandem and bring about change.
8	Airport Rail Link, a dedicated high speed airport rail service between the city and the new international airport	Lower cost options for this could be explored, for example giving priority to dedicated airport buses, and connections to efficient paratransit solutions as rail systems have usually proven to be more cost intensive and chances of breaking even are almost nil.
9	Development of a commuter rail system providing a mass urban transport system along existing railway line covering a total of 62 km along N-S and E-W axes of the city	This would no doubt be a more sustainable measure in terms of air quality and safety, when compared to road-based improvements; however the costs involved in land acquisition and rolling stock, etc. again need to be justified with if not more but equal returns from users. A key factor determining use will be the level of intermodal integration with road-based transport and the future metro rail.
10	Bangalore Metro Rail (already discussed in earlier sections)	Again the lifecycle costs of the metro need to be considered carefully and justified with equal benefits in mobility. Compact land use developments along the metro corridors, equally good quality feeder services and competitive fares should be kept in mind while planning for the metro. Also the impact of the metro on the poor should be analyzed.

4.4 Summing-up

Mobility is not sustainable in Bangalore. With the explosive growth in the number of personal vehicles, infrastructure in the city today is unable to meet the current level of mobility demand. Road infrastructure in the city is presently inadequate and creating more road space will not decongest the city.

Typical mobility solutions in Bangalore have been ad hoc and quick fixes, like grade separation and creating one-way roads, but have not been able to successfully prevent congestion, pollution levels, pedestrian access problems, road crashes, etc. in the long term. The result is that the “garden city” is plagued by problems like severe congestion, deteriorating air quality, increasing number of road crashes, and a modal mix skewed heavily towards personal transport. There are a number of mobility divides in the city and a lack of integrated land use planning. All these negative impacts of mobility will only serve to damage the economic growth and attractiveness of the city. Most importantly, future planning and investments require a more careful analysis as the city needs to adopt a pro-public transport and pro non-motorized transport plan, which is more sustainable in the long run than creating more and more spaces for personal vehicles. These measures could help to address the mobility divides and other mobility challenges in the city.

CHAPTER 5 Use of Information and Communications Technology to achieve sustainable mobility

5.1 Introduction

The WBCSD Mobility 2030 report identified a number of ways to make mobility more sustainable, and summarized these in the seven goals that were described in Section 4.3. Many of the actions required to achieve these goals require infrastructure improvement, behavioral change, as well as technological improvements in fuels, vehicles, traffic management, etc.

Electronic vehicle technologies are integral to modern motorized vehicles today and will continue to play a pivotal role in future vehicle design to achieve the goal of sustainable mobility. Information and Communications Technology (ICT) is increasingly seen as a possible means to complement and/or improve the efficiency of physical mobility. Given the importance of Bangalore as the ICT capital of India, this chapter examines the evidence for this hypothesis in Bangalore.

To do this, the study examines the current role that Intelligent Transport Systems (ITS)¹ and virtual mobility² play in complementing mobility in Bangalore. It then cites future opportunities where ICT may improve the outlook for sustainable mobility.

The case study team consulted experts, practitioners, users and related stakeholders during a series of field visits to Bangalore to better understand current uses of ICT and the potential consequences of using the internet to supplement personal travel.

¹ Intelligent transport systems (ITS) encompass a broad range of wireless and wire line communications-based information, control and electronics technologies. When integrated into the transport system (infrastructure and vehicles), these technologies help monitor and manage traffic flows, reduce congestion, provide alternative routes to travelers, enhance productivity and save lives, time and money.

² Virtual mobility is defined as the use of Information and Communication Technologies (ICT) to obtain the same benefits as one would have with physical mobility but without the need to travel.

5.2 Defining the scope of the section

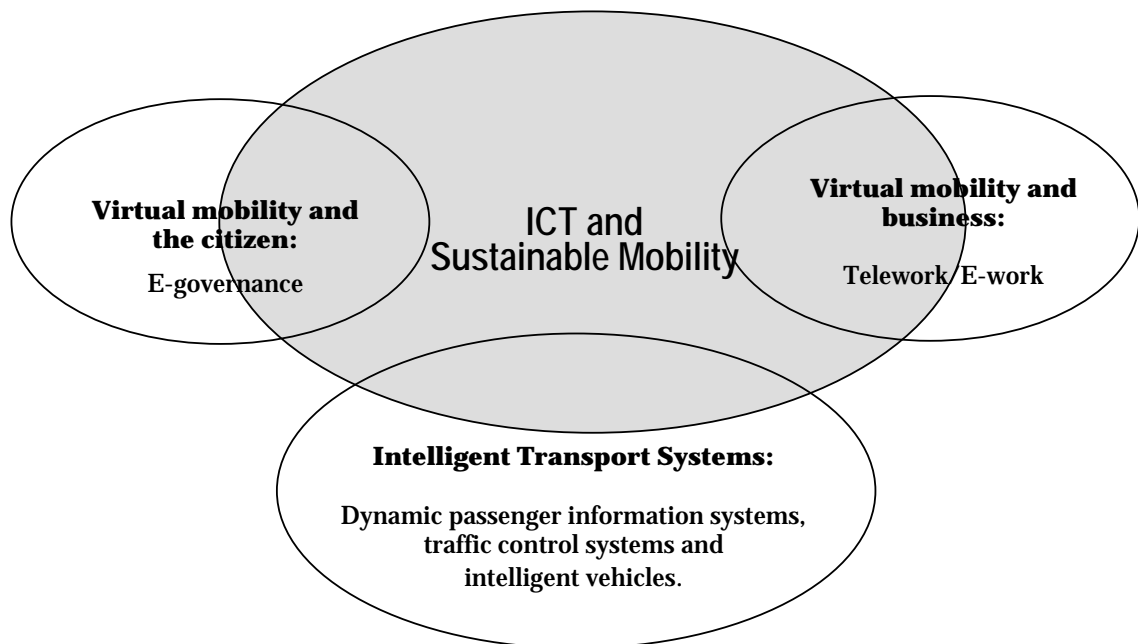


Figure 5.1 Focus of the literature review, field study and related areas

As Figure 5.1 depicts, the field we have styled “virtual mobility and the citizen” covers issues such as the deployment of public services using ICT. Public service delivery systems are undergoing fundamental changes. E-governance solutions are being deployed to provide online public services and record keeping, including online bill payment, taxes, land records, birth and death certificates, loans, driving licenses, income certificates and various government entitlement programs. The case study depicts best practices in Bangalore’s government-based ICT facilities with special reference to its e-governance programs. The study team consulted related government departments to better understand current uses of e-governance and the potential consequences of internet use as a substitute for personal travel to government offices.

There are not many studies in India that consider the role of “virtual mobility and business”. Telecommuting is an established phenomenon across the world with over 100 million telecommuters, but in India it is still in its infancy. A study of three cities – Mumbai, Bangalore and Calcutta – shows that the concept of telework is more commonly understood in the context of international outsourcing in software services or remote processing of transactions than in the context of

telecommuting¹. However, working from home or telecommuting has gained rapid ground in Bangalore's software industry. Using Infosys Technologies, a major software company, as a case study, the current study has sought to explore the relationship between e-work and travel needs.

"Intelligent Transport Systems" (ITS) encompass a broad range of wireless and wire line communications-based information, control and electronic technologies. When integrated into the infrastructure of the transport system, and in vehicles themselves, these technologies help monitor and manage traffic flows, reduce congestion, provide alternative routes to travelers, enhance productivity, and save lives, time and money. The case study cites ITS initiatives by the Bangalore Metropolitan Transport Corporation (BMTc) and Bangalore Traffic Police that focus on use of new technology for managing traffic. The study has also referred to the "Bangalore Traffic Improvement Project - BTRAC 2010", which sets out to address the traffic congestion caused by spiraling vehicle growth in the city and to tackle safety-related problems, as part of a joint initiative by the Bangalore City Police and the Urban Development Department.

Example technologies that may contribute to making mobility more sustainable:

Vehicle technology²

Recognizing that petroleum/diesel will continue to be the main energy source for automobiles for at least the next several decades, it is imperative to promote technical improvements for both gasoline and diesel powered vehicles. To achieve this in India it will be necessary to introduce the latest diesel technology, such as common rail fuel injection systems, and piezo injectors to reduce friction. Diesel engine air is injected into the cylinder and compressed to a high temperature. Fuel is then injected into this super-heated air and self-ignited. However, this self-ignition tends to destabilize the combustion process inside the cylinder, which results in an incomplete combustion generating particulate matters (PM). The common rail system was developed in the 1990s to eliminate this problem. By storing high-pressure fuel in a reservoir that precedes the cylinders and by injecting fuel by opening and closing the valves of the fuel injection system for a short period of time, this technology increases the contact area between fuel and air and helps reduce particulate matter and improve fuel economy. The amount of NO_x (Nitrogen oxide) and PM emissions from modern diesel engines has been reduced by more than 90% since the 1990s. In order to reduce particulate matter further, a diesel particulate filter will be needed and should be introduced in markets where high quality fuel is available. In order to reduce NO_x emissions further there are basically two technologies available:

- A NO_x storage-reduction catalyst; and
- A urea SCR (Selective Catalytic Reduction) system.

The catalyst technology stores NO_x in a catalyst and uses hydrocarbon, carbon monoxide, etc. to convert it into non-hazardous substances such as water, while the urea SRC method sprays urea water directly on to the exhaust gas to generate ammonia and convert it into non-hazardous substances.

¹ See: <http://www.sacw.net/Labour/SMitter.pdf> (Article: Teleworking and and Teletrade in India Combining Diverse Perspectives and Visions – Swasti Mitter – Economic and Political Weekly - 24 June 2000.

² This piece has been contributed by Toyota Motor Corporation Ltd.

- € Another way to improve the fuel efficiency of vehicles is to introduce hybrid vehicles that help to create energy savings of around 30%; later, plug-in hybrid vehicles, which combine an even stronger electrical power with a combustion engine can be introduced, these will lead to further energy improvements. A plug-in hybrid vehicle can be charged at home during the night when the cost of electricity is usually lower; it can be used as an electric vehicle for short-distance driving in cities, and as a normal hybrid vehicle for long-distance and high-speed travel when needed.
- € Further in the future is the Fuel Cell Vehicle. A fuel cell is a clean and efficient device that directly generates electricity by using a chemical reaction between hydrogen and oxygen. A fuel cell can theoretically convert 83% of the hydrogen into electricity. While a conventional gasoline engine has a well-to-wheel energy efficiency of around 14%, current hybrid technology demonstrates an energy efficiency of around 32%. A fuel cell vehicle will have an energy efficiency of at least 42%.
- € Other measures that help to improve the efficiency of a vehicle and/or to reduce CO₂ emissions are e.g.
 - o Weight reduction
 - o Optimized design
 - o Low resistance tires
 - o Use of biofuels

All these need to be developed further and implemented in order to reduce emissions further.

Assistance Technologies

In addition to improvements in vehicle technology, environmental impacts can be further reduced by educating drivers on how to drive in a more environmentally friendly manner. E.g. the fuel consumption indicator is one technology that helps the driver to monitor and reduce fuel consumption. Another technology is the so-called Gear Shift Indicator. This system indicates to the driver the optimal timing for shifting the gears in order to save fuel. The Gear Shift Indicator helps to reduce the fuel consumption up to 5%.

5.3 Virtual mobility

Increasingly, people are accessing information and communicating using electronic means alongside or instead of face-to-face communication. Improvements in physical mobility alone may not be sufficient to tackle mobility-related exclusion. Further, public transport is unlikely to ever be able to meet the needs of all members of society; and any improvements in public transport will take substantial time and considerable finance to implement. An increase in private car use will be similarly expensive to implement; and will continue to exclude people who are poor, or unable to drive (the elderly, young or people with disabilities).

Thus, as the primary purpose of mobility is to connect people to each other and goods to markets, virtual mobility (telecommunications, internet, etc.) is increasingly seen as a possible means to supplement and/or improve the efficiency of physical mobility.

ICT are changing the way we undertake many activities – working, shopping, learning, and many kinds of social

interaction. Historically, these functions have been associated with transport. Either we need to travel to do them, or we have needed to have physical objects sent and received. This has been changing for well over a century, with the arrival of telecommunications, information and broadcast technologies. So, for example, travel is not always necessary to communicate with distant friends and business partners (due to the telegraph, telephone, e-mail and fax); nor is it necessary to go to the theatre or cinema to see a play or a film (thanks to television). So "virtual mobility" or "virtual accessibility" is not an entirely new phenomenon.

However, the "convergence" of information technology (IT), telecommunications and broadcast technologies in the latter years of the 20th century – accelerated by both increased processing power and affordability – has led to many new possibilities for carrying out activities virtually instead of physically. It is important for transport analysts and planners to understand the effects on transport of these new technologies. Virtual mobility is about using ICT as the means of "getting to" activities that would previously have required transport – or would have been impossible (DLTR, 2002). ICT are impacting upon our travel behavior and the way we transport things.

In the sections that follow we look at the role of "virtual mobility and the citizen", followed by "virtual mobility and business".

5.3.1 Virtual mobility and the citizen – e-governance

Bangalore is currently witnessing substantial investment in the e-government sector. E-governance initiatives help to improve the traffic situation in the city to some extent. This happens because:

- ∄ People either don't have to perform trips, or
- ∄ Have to perform shorter trips, or
- ∄ Can combine multiple trips into a single trip.

Hence such initiatives and their resultant impact on traffic in the city can be considered innovative/technological solutions to traffic problems. Bangalore, as a well advanced city and also the IT hub of the country, it becomes much easier to implement such solutions. This section provides an overview of the major e-governance initiatives put in place by various government departments in Bangalore.

The Government of Karnataka (GoK) has used ICT to provide citizens speedier, more convenient, and reliable services through the implementation of a "one-stop-shop" facility. It has implemented an e-governance project called the BangaloreOne or B1 Project.

5.3.1.1 BangaloreOne (B1)⁷

The B1 Project seeks to redefine public service through its focus on the common man. The vision of the B1 Project is to provide the citizens of Karnataka, one-stop G2C (government to citizen) services and information about the departments and agencies of the central, state and local governments in an efficient, reliable, transparent and integrated manner. The service is provided through easy access to a chain of computerized Integrated Citizen Service Centers (ICSC's), delivered via several channels, including electronic kiosks, mobile phones and the internet. In addition to providing easy and speedy access to services, the project is beginning to have an impact on the number and length of road trips in the city.

At present there are 16 hi-tech Integrated Citizen Service Centers in the city. It is estimated that Bangalore will eventually need about 50 citizen service centers to provide about 100 G2C and B2C (business to citizen) services in the city. The GoK has decided to establish 15 service centers initially in different parts of the city and provide 24 basic services from an initial eight government departments participating in the B1 Project. The vision of B1 is to eventually bring all the G2C services within the purview of the B1 Project so as to obviate the need for citizens and business people to visit government offices except for specialized and complex services.

Examples of where various government departments that have integrated their services with BangaloreOne are described in Annex 5.1.

This project is already beginning to have a direct impact on the number and length of trips being undertaken. Fewer trips are undertaken because:

- ∉ People can either sit at home and use these services through an online portal, or
- ∉ They can combine many services and perform them together rather than making separate trips for each.

Distances covered are shortened as destinations change from centrally located government offices to locally distributed citizen centers. Quantification of the impact of B1 transactions on city roads is difficult but the growth in the number of users of B1 facilities provides an indicator changing travel patterns brought about by the provision of B1 services.

Figure 5.2 shows the number of monthly transactions performed through B1 citizen service centers during 2005-

⁷ See: <http://www.bangaloreone.gov.in>

2007. The number of transactions has continued to increase at a rapid pace since the inception of the project. These transactions may have helped reduce pressure on Bangalore’s roads either by reducing the need for travel or by shortening the distances required for travel. Savings in the number and length of trips help to reduce traffic congestion. All the initiatives described in Annex 5.1 provide glimpses of the e-governance situation in Bangalore. E-governance is an effective tool/measure for solving the challenges of physical mobility indirectly. Its role in reducing the burden on the roads needs to be recognized and further programs implemented.

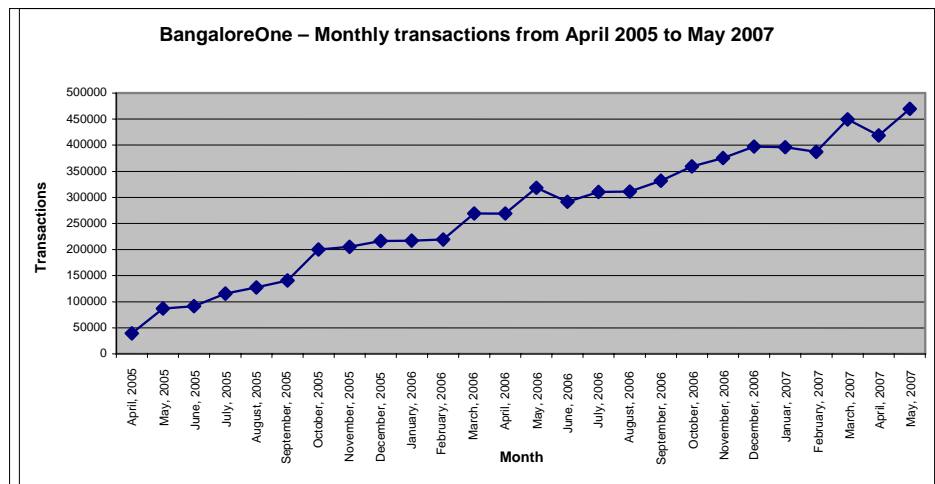


Figure 5.2 Monthly transactions performed through B1 citizen service centers in Bangalore

(SOURCE: Bangalore1 Department (E-governance Secretariat), Bangalore)

5.3.2 Virtual mobility and business – e-work/telework

“Tele” means distance. Therefore, strictly speaking, the term “telework”, means “distant working”. In practice, however, it refers to a specific mode of working whereby employees or freelancers offer their services, using telematics, at a site which is geographically separated from the main office. “Telematics” refers to a combination of information and technologies, which connect the computers of employees or freelancers to the computers of the main employing organization. In the language of the emerging information society, teleworking involves working from distant premises online.

The term “teleworking” is thus often used interchangeably with “telecommuting”. As it opens up the possibility of moving the sites of work away from high rent city centers. This form of work is often assessed from the point of view of the corporate sector, urban planners and employees.

Telecommuting has the potential to improve resource efficiency. It does so by decreasing the number of hours required for commuting, leading to less road congestion, fuel consumption and pollution. Data from a teleworking center in the United Kingdom and Northern Ireland found that “users reduced the length of their commute journey on average by 19%, and its duration by 36%, reflecting the effect of congestion on their normal journey to the base office”¹. Another case study of a German-based insurance company with 400 teleworkers found that the total number of kilometers traveled to and from work was reduced by 800,000 km per year². The city of Atlanta implemented mandatory cutbacks in road traffic to reduce congestion during the 1996 Olympic Games. Many workers took advantage to work remotely. The city measured a 44% drop in visits to medical facilities by the local population for respiratory problems³. The state of Virginia is offering tax credits to companies for hiring telecommuters. Such initiatives will result in better community life and cause lower harm to the environment; and it will eventually yield dividends. According to a stakeholder in India, tele/e-commuting saves a lot of time, especially in Indian cities like Mumbai and Bangalore, where a commuter spends an average of two-three hours in daily travel. Citing a study, he adds that a 30-minute drive to work equates to about six working weeks a year.⁴

However, terms such as telework and teletrade are still fairly unfamiliar in India, even in mega cities. It remains a needs-based option in Indian firms. Furthermore, in the Indian context, a few important factors need to be considered:

- € **Maturity of processes:** Processes within BPO companies (broadly including those related to operations and people) are still maturing in India. Many Indian companies are still grappling with an understanding and implementation of basic systems, checks and balances within their own central work places. Metric orientation is still evolving. Issues like career paths, promotions, salary raises, and incentives will need to be worked out. Performance measurement and improvement systems need to be instituted. A separate set of SLA's may need to be evolved for telecommuters/e-workers.
- € **Maturity of employees:** Telecommuters need to have a level of discipline and competency that may not

¹ Flexibility, “Telecommuting 2000: Transport Substitution”, at <http://www.flexibility.co.uk/telecommuting2000/tc2006.htm>

² See: Wuppertal Institute and Forum for the Future “Digital Europe: Telework Case Study 2003” at <http://www.forumforthefuture.org.uk>

³ <http://www.iamontrac.com/iOps/September2004/iOps-Newsletter.htm>

⁴ Article: E-Commuting fast catching up in India – Business Standard, 13 June 2007.

necessarily be available as yet. The workforce in India is fairly young and requires constant supervision.

- € **Technology:** Availability of reliable broadband and telecommunications infrastructure at the telecommuter's residence is an important factor. It is not known who will bear the set-up and running costs at present (the company or the employee) and this will be a determining factor in the success of a telecommuting program. Voice-based processes may require more expensive set-ups than non-voice based processes. Again, the type of work will also determine technology.
- € **Type of work:** The type of work is also a determining factor. Companies in India are already implementing telecommuting programs for basic level work such as data entry and word processing. Telecommuters only require a computer, a UPS (uninterrupted power supply), a telephone and an internet connection.
- € **Technology help desk:** Companies will need to have a mobile tech help desk to assist agents with technical problems. They may even need to train telecommuters to do some amount of basic trouble shooting themselves.
- € **Miscellaneous expenditure:** Companies may need to spend on other miscellaneous items to sustain remote agents. Such expenditure may involve courier services, mobile phones, concierge services, etc.

An exploratory study in the future could help to provide insights to Indian companies about timing and scope of launching e-work/telecommuting programs; at present such information is lacking.

The ability to control attrition, the benefits of increased productivity, and the reduction in infrastructure cost per employee through e-work is hard to resist. Internationally, the trend is visible within the ITAC (International Telework Association and Council) which predicted that about 30 million workers would be telecommuters by the end of 2004. Another survey by the ITAC showed that 25% of employees would change companies if the new company offered telecommuting alternatives; some would even accept lower salaries in the place of no travel. It is not difficult to envision a scenario where employees in Indian cities who travel between one and three hours each way to work in various industries opt to work with BPO companies offering telecommuting facilities⁷. There are companies in Mumbai and Bangalore that are already experimenting with remote agents in some non-voice based

⁷ See: <http://www.iamontrac.com/iOps/September2004/iOps-Newsletter.htm>

processes. For example, Datamatics Technologies in Mumbai already employs people to do data entry work out of their homes¹. Healthscribe in Bangalore has employed over 100 people to work out of their homes². While MNCs like Accenture, Cisco Systems, Gartner, IBM, Intel, Microsoft, and Texas Instruments have been doing this globally; they are now beginning to investigate the possibility of implementing such systems in their Indian operations. Indian software house Wipro has now put telecommuting on a war footing. In some offices like IBM India and Wipro, there are telecommuting zones, where there are workstations reserved for telecommuters who only come in on certain days.³

The case study attempted to investigate the prevalence of telework in Bangalore. It is an ideal city for a study of the opportunities and challenges that cities in India face in attracting and retaining new service sector jobs. IBM in Bangalore allows employees (project managers and above) to work from home. Accenture is more democratic; all employees in functional areas like human resources (HR), finance, marketing and information technology (IT) can telecommute. By 2006, Bangalore-based IT firm Yodlee Infotech Pvt Ltd planned to make telecommuting available to all its 150 employees. "All employees will be provided a computer, telephone and broadband connection at home as part of their salary component," said the vice-president of Yodlee Infotech.⁴

Despite the success of software firms in Bangalore, the city's teletrade future is far from certain. A lingering lack of trust in the quality of services, as well as the inadequacy of infrastructure, still limit the scope of offshore outsourcing to Bangalore from the US and Europe. The major portion of outsourced work requires the on-site presence of Indian consultants, and contributes comparatively little to capacity building in India. The ratio of offshore to on-site work for companies in Bangalore is changing, particularly in response to technological changes that make transnational communication cheap and reliable. Yet, with a current ratio of 40% or more of services being delivered on-site, most Indian companies have a long way to go to move up the value chain⁵.

1 (Economic Times Intelligence Group) – See:

<http://www.iamontrac.com/iOps/September2004/iOps-Newsletter.htm>

2 (Times of India Aug 26th, 2004) - See:

<http://www.iamontrac.com/iOps/September2004/iOps-Newsletter.htm>

3 Article: Now, do 'homework' and get paid too – The Times of India 13 March 2006.

4 Article: In office at home – The Telegraph 11 October 2005.

5 See: <http://www.sacw.net/Labour/SMitter.pdf> (Article: Teleworking and Teletrade in India Combining Diverse Perspectives and Visions – Swasti Mitter – Economic and Political Weekly - 24 June 2000.

The sustainable success of Bangalore will also depend on its ability to withstand competition from newcomer cities in India. In this respect, the image of the city is important. Bangalore is often selected over other cities for three main reasons: it provides a “Silicon Valley” style competitive environment that is centered on technology; a high-quality skills base; and an attractive location which helps recruitment. Yet, despite these advantages, there are causes for concern. Overcrowding, soaring property prices, environmental pollution and a rise in salaries paid to programmers have recently contributed to concerns surrounding Bangalore’s future.¹

The Infosys case study²:

At Infosys Technologies Ltd in Bangalore mobility and e-work are viewed from a needs perspective. The company initiated a gender policy in 2003, motivated by the firm belief that “young mothers” and “mothers to be” need to stay close to home, and that infrastructure issues in Bangalore should not disrupt their normal lives. Hence, Infosys set up satellite offices in Bangalore under its “e-mobility program” (operational since February 2007), in a location close to most of the residential areas. The satellite office is a 50-seater facility, and is currently (as of 12 September 2007) used by twelve women employees of Infosys. Patterns of use vary month on month, depending on availability of the new mothers or mothers to be. Although the numbers may not seem large, it nonetheless covers 100% of the female employees for which it was designed. The satellite office has an atmosphere similar to the development center, and provides connectivity to ensure continuity of project work. This arrangement provides opportunities for young mothers to be both close to their infants and to the office. At present, the company has not implemented any other e-work policies in India, because of the nature of business, which requires a certain amount of specialized infrastructure and secure networks. To enable e-work in IT, it may be necessary to switch from regular project management work that requires customer connectivity/secured networks/regular timetables to an alternative role to enable out-of-office work. Working mothers are ideal candidates for such positions because they need to be strike a work/life balance while still managing priorities in the home. As a result, they are given jobs that allow them to do this, all the while on the understanding that they could, when ready, resume their regular IT work. The company informed TERI that it had not encountered any particular challenges or obstacles from senior management when implementing its e-mobility program through the satellite offices. It believed that it had build up sufficient awareness and communication capacity at all levels of management to enable such a set up. Although the company confirmed that the e-mobility program had helped women employees to travel less, it was not able to provide any data to TERI to confirm that there had been reductions in the number of trips made or in the distances traveled.

During the stakeholder forum, Infosys Technologies presented its views on the feasibility of e-work in India. According to the company, senior management in India still favors office-based work over e-work. Changes in cultural mindsets will be required to ensure effective use of technology and formalize home work on a large scale. This does not mean that the average Indian employee ceases to use technology after leaving the office at the end of the working day. Many employees continue to work from home, taking calls or using home-based computers. However, available technology is

¹ Article: **Teleworking and Teletrade in India Combining Diverse Perspectives and Visions: Swasti Mitter – Economic and Political Weekly 24 June 2000**

² Source: **Infosys Technologies email interviews and M4D Stakeholder Dialogue discussion forum**

seen as an enabler which ensures accessibility outside of working hours. Finally, internet and telecommunication network congestion remains an issue in India, which may prevent e-work on a large scale.

In summary, there is some evidence that e-working can reduce travel time and the number/distance of trips required. However more research is needed to quantify the benefits of e-working in reducing overall transport demand.

There is much research to be done. But in the meantime, individuals, organizations and policy makers should feel confident that there is value in using telework to save travel.

5.4 Intelligent Transport Systems (ITS)

There is far greater and more frequent movement of people today than twenty years ago because of stronger functional linkages. Quick, reliable, efficient and safe transportation is one of the greatest needs today. Intelligent Transportation Systems (ITS) have been identified as one possible means of achieving sustainable and environmentally friendly transport. They are a holistic concept that use advances in technology to transport human beings and goods from one place to another in an efficient, effective and safe manner. Efficient because they help reduce resource use while facilitating maximized outcome; effective because they transport people and goods to destinations thereby responding to the needs of commuters; and safe because they use technology to eliminate some of the risks involved in transportation.

Advanced ICT are required for ITS. ITS can be used for collecting and processing of real-time data, generating and utilizing information for diverse purposes such as control and traffic management, handling fleet operations, emergency management, and assisting users with travel-related decisions. Institutional and market factors play an important role in the successful deployment of ITS. Many governments are beginning to appreciate the benefits of ITS and deploying them in their regions¹.

Of the five functional groups of ITS, i.e., Advanced Public Transport Systems (APTS), Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Electronic Toll Collection and Traffic Management (ETTM), and Commercial Vehicle Operations (CVO), APTS is most important. The implementation of APTS technologies is

¹ See: http://www.location.net.in/magazine/2007/march-april/46_1.htm

transforming the way public transportation systems operate and changing the nature of the transport services that can be offered by public transport systems. Their goal is to provide public transport decision makers more information to enable them to make effective decisions on systems and operations; and to increase traveler convenience and use¹.

5.4.1 Advanced Public Transportation Systems in India:

The implementation of APTS technologies is transforming the way public transport systems operate, and changing the nature of the services that can be offered by the public transport sector. Their goal is to provide public transport decision makers more information to enable them to make effective decisions on systems and operations; and to increase traveler convenience and use. The public sector is, by far, the largest player in the public transport system, particularly the long distance movement of passengers in India. But most state road transport corporations run at a loss. The single most important cause of this is poor time-keeping. Other factors include absence of intelligent decisions regarding passenger pick-up points, and poor route planning, scheduling, manpower management, etc. APTS can help with all of these. In fact, evidence has shown that wherever it has been implemented it has helped public sector transport organizations to procure accurate information about items such as traffic conditions, the number of people using its buses, and the time taken to cover a route. The system can track the direction of vehicles, duration of halts, and keep a tab on over-speeding to ensure the safety of the vehicles, goods and passengers. Recently, there was an incident in Bangalore where thieves stole a Bangalore Metropolitan Transport Corporation (BMTC) bus. Thanks to the GPS receiver located in the vehicle, BMTC officials were able to recover it the very next day. This is just one example of how GPS technology can help tackle problems facing the transport sector.²

In the following section an attempt has been made to illustrate the application of APTS technologies in the public road transport sector in Bangalore, Karnataka.

5.4.2 ITS and Bangalore Metropolitan Transport Corporation (BMTC)

In 2000, BMTC installed satellite-tracking technology in its vehicles. It was the first public transport corporation in the country to install this technology. Initially, BMTC installed off-line GPS technology in 200 vehicles; the benefits from this system were immediate. As part of the expansion of this

¹ See: http://www.location.net.in/magazine/2007/march-april/46_1.htm
² http://www.location.net.in/magazine/2007/march-april/46_1.htm

program, BMTC has introduced an online GPS system in all its vehicles on a “Build, Own, Operate & Transfer” (BOOT) basis. In January 2007 the corporation placed orders for the supply and operation of electronic display boards for Passenger Information Systems (PIS) with a Bangalore-based information technology firm on a BOOT basis. According to BMTC officials, the first orders were fulfilled in February of the same year.

As part of efforts to begin the deployment of GPS and GIS for a real-time passenger information system (RPIS), the corporation has set up on a trial basis electronic display boards on two platforms at Kempe Gowda Bus Station – platform 3 (Chandra Layout, Nagarbhavi, etc.) and platform 11 (Banashankari, J.P. Nagar, etc.) – and one each at Shivajinagar Bus Station (platform 3) and Shanthinagar Bus Station (platform 11).

At present, information on arrival and departure of buses is stored in the display board itself, which contains the necessary memory space. The information is displayed every 10 seconds thanks to the presence of a processor, the necessary software and a real-time clock. Once real-time GPS is in place, the BMTC will be able to announce the departure and arrival of buses accurately.

BMTC has fitted GPS equipment in 700 of its own buses and 350 hired buses. This technology is now being used to track the movement of hired vehicles and the data is retrieved every four hours. Shortly, 1,500 more BMTC buses would also be fitted with GPS equipment.

The BMTC is also integrating its PIS and IVRS (Interactive Voice Response System) services to cater to the increase in passenger inflow since it hopes to increase its passenger capacity by 10%. In the future, a commuter will be able to obtain information about bus arrivals and departures by mobile phone. The corporation and its chosen service provider are currently working on the modalities for providing information about arrivals by SMS and the new system will be in place soon. Thanks to such technology commuters will no longer have to spend long hours at bus stops. In addition to reducing road congestion by private vehicles (thanks to detailed and accurate information about bus arrivals/departures), the PIS will also help to increase use of public transport through the provision of reliable information.

The section below describes ITS initiatives by the Bangalore Traffic Police that focus on the use of new technology for managing traffic. The case study looked specifically at the "Bangalore Traffic Improvement Project - BTRAC 2010", which sets out to address traffic congestion caused by spiraling vehicle

growth in the city and to tackle safety-related problems. It is a joint initiative of the Bangalore City Police and the Urban Development Department.

5.4.3 ITS and Bangalore Traffic Police

The Bangalore traffic police are responsible for managing the city's traffic. With ever-increasing traffic, growing congestion, increases in the number of road accidents, increasing number of vehicles, traffic management is taking on a greater urgency. To ease its operations and make the system more efficient, the Bangalore Traffic Police has adopted a few measures that focus on the use of new technology to manage traffic. Some of these include:

- € Using the Blackberry system to track violators and their past history
- € Using Alco sensors to detect drunken drivers
- € Using speed detection cameras

(Source: Traffic Police, Bangalore)

The traffic police have been focusing on policies at several levels. These include:

- € Traffic Management – through regulation and restructure
- € Traffic Infrastructure – including grade separators and subways
- € Intelligent Transportation Systems (ITS) – use of Automated Traffic Control Systems
- € Synchronized Signal Systems
- € Automated Enforcement – through PDAs'

The traffic police's focus on Intelligent Transport Systems represents an important step in the use of technology for traffic management. Studies and surveys of technology implementation are ongoing.

The department is also running public awareness campaigns and programs, including:

- € SARS (Student Association for Road Safety) to educate school children on road safety
- € Traffic Warden Organization
- € Citizen Committee Meeting

(Source: Traffic Police, Bangalore)

There is an ongoing effort to modernize traffic signals. Bharath Electronic Ltd. has been assigned the job. The police are also using CCTVs in several places, including: (1) Airport Road, near Manipal Hospital, (2) Airport Road, near the Airport exit gate,

(3) Airport Road, near ISRO, and (4) Hosur Road, near Bammanahally.

To address traffic congestion caused by spiraling vehicle growth in the city and tackle safety-related problems, Bangalore city police, in collaboration with the Urban Development Department, have put together the "Bangalore Traffic Improvement Project - BTRAC 2010."

Said to be first of its kind in the country, BTRAC 2010 will use the latest traffic management technology and techniques. The project has the twin objectives of easing congestion and preventing road accidents¹.

- € **The operational objectives:** Reduce traffic congestion by 30% in the central area of the city, bring down accidents by 30%, achieve a significant reduction in pollution, achieve substantial compliance with traffic laws and rules, and set up an effective trauma care system.
- € **The institutional objectives:** Coordinated traffic management through the development of a traffic task force, a road safety committee and a traffic action committee; a robust revenue model (traffic funds to pay for traffic management infrastructure and maintenance); legal and institutional reforms; capacity building (modernizing and upgrading of the traffic training institute); strengthening of traffic police by increasing the number of officers and staff; construction of buildings and provision of modern communications and mobility.

Strategy – Under BTRAC 2010, the city's roads will be categorized into concentric zones starting with a central area, and moving outwards to a core ring-road, radial corridors, intermediate ring-road, outer ring-road and peripheral ring-road. The central area will have traffic control systems, one-way streets, dedicated bus lanes, "no-auto rickshaw" zones, "no on-street parking" zones, restricted access roads, and toll roads. The core ring-road will feature 30 steel overpasses (small flyovers), while the intermediate ring-road will have grade separators similar to those on the outer ring-road.

The cost of the project is estimated to be about Rs. 350 crores (note: a crore is the equivalent of Rs. 10 million). This will include Rs. 30 crores for junction improvements, Rs. 100 crores for street furniture and road marking, Rs. 150 crores for an intelligent transport system including Area Traffic Controls

¹ See: <http://www.thehindu.com/2006/01/12/stories/2006011222730300.htm>

(ATCs) at 250 intersections, Rs. 50 crores for surveillance, monitoring and enforcement cameras, and Rs. 20 crores for education and training¹.

Some important benefits envisaged by the project include: ²

Smart signals: Over 1,000 modern and smart traffic signals to be installed at important locations

Smart enforcement: Effective, transparent and automated enforcement, computerized *challans* backed by actual evidence from violations

Smart information: Information about congestion/traffic jams and travel times. Information will be communicated through Variable Message Signs, FM Radio, SMS, websites and call centers

Smart helpline: 24/7 traffic helpline (call center) to receive and address public complaints

Smart response: Faster response by traffic police in case of emergencies, incidents, accidents, etc

Smart public transport: Dedicated bus lanes and signal priority for public transport

Smart traffic signs/markings: Thousands of new traffic signs and tubular cones to be installed for better traffic management along with 100 km of world-class thermoplastic road markings

Smart safety plans/campaigns: To educate the public about traffic rules and road safety and to reduce accidents and improve school area safety

Easy auto: A web-based call center to assist with making auto travel hassle-free.

IT can also be used to manage traffic accident records. The department is currently using a package called MAAP (Micro Accident Analysis Package) and is also organizing a Road Traffic Injury Surveillance program under the aegis of NIMHANS (National Institute of Mental Health & Neuro Sciences, Bangalore) and with guidance from the WHO. IT is also being used to monitor traffic violations through the Blackberry system; and the application of the Electronic Variable Message System is currently being studied and considered. In the near future, the department plans to focus on:

- § Total internal computerization
- § Online traffic complaint redressal
- § Online registration/issue of 110 forms, etc.³

¹ See:

<http://www.thehindu.com/2006/01/12/stories/2006011222730300.htm>

² <http://www.btrac.in/benefits.htm>

³

<http://www.bcp.gov.in/english/trafficpolice/AboutCity/OBJECTIVES.htm>

5.4.4 Future scenario of ITS in India

The intelligent transportation system is still in its infancy in India. However, a start has been made and the initial results have been very encouraging. The possibilities are huge. What remains is to tap this huge potential using vision and total commitment. This will be a real test of the country's modern technology preparedness. But the biggest challenge to the success of ITS in India is likely to be an inherent opposition to any change.

In summary, India has made huge advances in communications and information technology; the potential exists to build an ITS infrastructure that could provide significant ongoing benefits to the country's economy. However, to achieve this it will be necessary to bring together stakeholders from the government, the private sector and academia to work in partnership to ensure that India seizes the opportunities presented by this potentially lucrative global market.

5.5 Internet-based carpooling

Carpooling is a well-known practice in Europe and the US but is still nascent in India with most users unaware of the concept. Moreover, the government is unaware of the concept carpooling and of ways to promote it. The Society of Indian Automobile Manufacturers claims that just over a million cars, including multi-purpose vehicles, were sold in the country during the 2005-06 financial year, equating to a carrying capacity of at least four million people. Often, these cars carry single commuters, thereby worsening gridlock in many cities¹. Hence, in a country with over a million cars, carpooling presents significant opportunities.

Although informal car-sharing is nothing new, the advent of the internet and trip-matching software has made it possible for employers, communities, and indeed all interested participants with web access, to plan shared journeys. The web has many officially-endorsed sites offering such services and users simply enter their travel plans online. The software then generates matches with others seeking to travel to the same destination at the same time. The website www.carpoolworld.com carries several requests from Mumbai-based commuters. If this is any indicator of interest in India generally, the possibilities are considerable. Congestion-hit Bangalore has seen the development of a volunteer effort that is well on its way to attaining critical mass. Members of Carpool-Bangalore offer and seek rides through an email-based discussion group on Yahoo.

¹ <http://www.hindu.com/2005/09/27/stories/2005092704511100.htm>

Although the concept of “carpooling” has yet to catch on among traffic-weary Indians¹, with a lot of people heading in the same general direction from the suburbs to the city during the working day, carpooling would make sense from an environmental point of view. One NGO (non-governmental organization), Mumbai Environmental Social Organization (MESO), has launched similar a concept with the creation of Koolpool², an organized and secure carpooling system that runs via SMS. This is simply one attempt to facilitate carpooling in Mumbai and other large metro cities of the country. The founders of this initiative claim that it is a global first; it is currently being tested and members/volunteers are being sought.

In Bangalore, IT professionals are increasingly using carpooling websites. One IT professional, who uses a pool every morning from Basaveshwaranagar to his office on Airport Road, has started an online city carpool forum at www.commuteasy.com. Users simply need to specify the location of their residence, the location of their office, and their timetable and a carpool will contact the subscriber. This initiative has 1,285 registered users, with at least 120 registered pools. At least 85% of the users are IT professionals, while the remaining are students from colleges like R.V. College of Engineering and B.M.S. College of Engineering, according to Kasera. Little wonder then that most carpools are headed to the IT hubs, Electronics City, Marathahalli, Whitefield and Airport Road. Women too seem to have taken to the pool as the site numbers around 300 registered women. According to one woman user, most women prefer a pool with at least one more woman or an all-woman pool.

The flexibility of the carpool is its USP. All users can either take turns with their cars or hitch a ride with one person and split the fuel cost on a weekly basis. Some even hire a city cab and divide the cost incurred among them. Some companies offer to foot half the bill by way of incentive.

It has been suggested that one of the reasons people in India do not take the initiative to travel together in carpools is because they seem to be too shy to network. Furthermore, it seems to be a status issue; a study by CASUMM (Collaborative for the Advancement of the Study of Urbanism through Mixed Media) found that levels of Indian social interaction have gone down over the last 10 years and people find it tedious or status-lowering to drive with someone.

¹ <http://www.phoneyworld.com/newspage.aspx?n=2117>

² <http://www.koolpool.co.in/>

Interaction with stakeholders in Bangalore indicated that the solution to the city's traffic woes may well lie in carpooling lanes, toll taxes, higher parking fees for single-driver cars and better parking areas for carpooling vehicles. It was further highlighted that even though the government has not initiated measures to encourage carpooling, it will have to contend with petrol and automobile lobbies that are opposed to toll fees, parking fees, and the like. The CIVIC (Citizen's Voluntary Initiative for the City), a civil society organization in Bangalore, is of the opinion that the transport department needs to get film stars and other celebrities to endorse public transport, cycling and walking if it is to make a difference to the city's traffic problems¹.

Stakeholder interactions also suggested that not only does carpooling result in disciplined time-management; in addition it encourages social networking for lonely Bangaloreans who want to make friends.

5.6 Summing-up

ICT acts as a complement rather than a substitute for physical mobility. While mobile phones may reduce the need for some journeys to meet people, make enquiries or conduct transactions, they can increase opportunities for others, as people are able to stay connected to larger social and trading networks.

The findings of this study suggest that ICT could have a role to play in both social and transport policy, creating access to activities where it has previously been denied. Based on their analysis of this study, the research team firmly believes that ICT could and should provide a useful tool in both social and transport policy. As a tool to supplement access to participation, where it has previously been denied, the value of virtual mobility, which allows virtual interaction, learning, information and opportunity, should be recognized.

¹
<http://www.thehindu.com/mp/2007/10/08/stories/2007100850490100.htm>

CHAPTER 6 Summary of the Stakeholder Dialogue

6.1 Introduction

The Stakeholder Dialogue on the Bangalore case study took place on 12 September 2007 at the TERI Southern Regional Center in Bangalore. The objectives of the dialogue were:

1. To raise awareness of the importance of mobility as a driver for economic development in Bangalore
2. To examine opportunities to narrow the mobility divide in Bangalore (between rich-poor and urban-rural)
3. To discuss sustainable mobility solutions (including physical and virtual mobility) for the rapidly growing city of Bangalore, including active participation of businesses, governments, civil society and policy makers.

In all 62 participants, including representatives from automobile organizations, IT companies, academic and research institutes, government bodies, NGOs, etc. attended the dialogue (a list of participants is attached in Annex 6.1).

6.2 Opening session

The Dialogue started with a welcome address by Dr. A Ramachandran, Chairman TERI, who started by giving an overview of the activities of WBCSD, particularly in the area of sustainable mobility, with an explanation of the seven sustainable mobility goals highlighted in the Mobility 2030 Report; and a brief background of the Mobility for Development project. He went on to discuss the deteriorating state of transport facilities in growing Indian cities and the need for these cities to look at ways and means to make mobility sustainable.

This was followed by an introductory speech by Mr. Atsushi Toyoshima, Managing Director, Toyota Kirloskar Motor Pvt. Ltd. (TKM), who began by expressing Toyota's interest and concern for addressing sustainable mobility in developing cities and finding solutions as a part of their corporate social responsibility efforts. As an example, he described the Toyota Safety Education Program (TSEP) launched in Bangalore in July 2007, with the objective of creating road safety awareness among 20,000 school children in 20 schools in Bangalore, by March 2008. Mr. Toyoshima described the various modules through which children are being taught road safety; these include playing computer games, manning informative traffic booths, interactive traffic safety sessions, animation films and a mobile traffic park, etc.

Next, Dr. Shona Grant, Director, Development Focus Area, WBCSD, introduced the mobility for development theme. She started by discussing the interlinkages between transport services, economy and the environment, and how the very mobility systems that facilitate economic growth, can inhibit it, if the impacts of mobility are not checked. Following this, she gave an overview of each of the goals and indicators of sustainable mobility as highlighted in the Mobility 2030 Report. She concluded by highlighting the significance of this study and particularly of the Stakeholder Dialogue.

Following Dr. Grant's presentation, which also provided an overview of sustainable mobility and the relevance of mobility to development, Ms. Chhavi Dhingra, Area Convenor, Transport and Urban Development Area, TERI made a brief presentation on why Bangalore was chosen for this study. Reasons include the fact that Bangalore has become a magnet for job opportunities, its growing population and sprawl, its increasing attractiveness to foreign investors, and amidst all this, the tremendous pressure currently being exerted on urban infrastructure, especially transport. She highlighted that Bangalore had the largest rich-poor income divide in the country, and that this made it an interesting case, especially for addressing the second objective of the Dialogue. Ms. Dhingra concluded by describing briefly the approach and methodology adopted by TERI in order to conduct this study.

The next presentation was the keynote address made by the Chief Guest Professor Yoshitsugu Hayashi, Dean of the Graduate School of Environmental Studies, Nagoya University, Japan and Chair of Scientific Committee, World Conference on Transport Research Society, who gave an international perspective on sustainable mobility. His presentation focused on how urbanization and motorization with proper spatial development could play a role in creating better mobility and quality of life. Prof. Hayashi in his presentation discussed experiences (issues and best practices) with mobility in various countries of the world, and the findings of some of his research such as CUTE (Comparative Study on Urban Transport and the Environment) and Sustainability and Quality of Life (QOL). He concluded by listing a few proposals to make mobility more sustainable in Bangalore.

Finally, Dr. Ranjan K. Bose, Director, Regulatory Studies and Governance Division, TERI delivered the Vote of Thanks on TERI's behalf to WBCSD, Toyota Motor Corporation, Toyota Kirloskar Motor Pvt. Ltd, Renault, Prof. Hayashi, Dr. A. Ramachandran, the media and all the other stakeholders who participated in the Dialogue. Dr. Bose also thanked Mr. S. Sundar, Distinguished Fellow, TERI, for his guidance and

advice throughout the project. Dr. Bose concluded his vote of thanks with the hope that this study would make a substantial contribution and that WBCSD and auto companies would support TERI in researching further the areas identified in this study.

The following sections discuss in detail each of the plenary sessions. Each of the three sessions began with the presentation of a background theme by TERI, and provided TERI's assessment of the various themes and critical issues raised (these were drawn essentially from TERI's analysis given in Chapters 4&5 of this report). Each presentation concluded with a set of questions that acted as pointers for further discussion. These questions however were not binding, and the panelists and other stakeholders present in the room were encouraged to go beyond those questions or address other issues that were more pressing or demanded higher priority.

6.3 Session 1: The mobility challenge in Bangalore

Session Chair: Mr. S. Sundar, Distinguished Fellow, TERI

Panelists:

1. Mr. D. Thangaraj, Principal Secretary, Department of Transport, Government of Karnataka
2. Ms. K. Chamaraj, Executive Trustee, CIVIC, Bangalore
3. Mr. N.A. Khan, Asst. Traffic Manager, Bangalore Metropolitan Transport Corporation (BMTC)
4. Dr. Ranjan K. Bose, Director, Regulatory Studies and Governance Division, TERI

This session focused on the mobility challenges facing the city in terms of access, pollution, congestion, safety, etc. It also focused on the associated institutional challenges, raised critical issues and discussed possible policy directions for innovative solutions to make mobility more sustainable in the city.

Mr. Sundar initiated the first session of the Stakeholder Dialogue by emphasizing why sustainable mobility is critical from the view point of Bangalore's growth and development. This was followed by TERI's presentation of its diagnosis of the mobility situation in Bangalore and the various mobility challenges that exist in the city. Some of the questions that this presentation raised for discussion were:

- € How can uptake of public transport be increased in the city?
- € Can most companies in the city make arrangements for their employees to travel by comfortable and reliable public buses?

- € How can economic instruments like congestion charging and higher parking fees be brought into effect in Bangalore?
- € How best can the upcoming metro be made most effective in tackling problems of access and congestion?
- € How can the metro be best integrated with the existing public and intermediate means of transport?
- € Given the limited road space, and increasing number of personal vehicles on the roads, how can road space be utilized equitably and efficiently?
- € What role can various policies and existing institutions play in making mobility more sustainable in the city?
- € What are the advantages of road based investments vs. public transport investments for the city
- € Could computerized vehicle inspection and maintenance centers be set up in the city for proper monitoring of vehicles?
- € How can the issue of fuel and air quality for the city be addressed?

The presentation was followed by presentations by each of the panelists and followed by contributions from participants in the audience. A summary of the key observations and issues raised during Session 1 is given below:

- € The “garden” character of Bangalore is changing rapidly and trees are being felled in the name of transport development, especially where roads are being widened. It was felt that Bangalore may lose its charm as a “garden city” by the time the mobility situation improves, and the governments are not paying adequate attention to this threat.
- € Planning and decision making on transport development for the city was felt to be an ad hoc process, where the needs of different sections of society and issues of social equity and environmental concern are being largely overlooked.
- € There is lack of clarity in the planning processes and approaches adopted; how new transport measures would be integrated with other aspects such as building regulations and bye-laws in the city, was unclear.
- € With so many transport projects in the pipeline such as road widening, Bangalore metro, construction of flyovers, etc., the level of people’s participation and awareness raising regarding these projects was felt to be very low.
- € It was also felt that the developments taking place in the city were not truly in the spirit of the NUTP guidelines, as one of the NUTP measures is to provide equitable allocation of road space, which is not being practiced. Stakeholders still felt that more space was again being

created for personal motor vehicles and the rich, while the needs of the poor, non-motorized vehicle users and pedestrians were not being adequately addressed. There are no separate lanes for cyclists, pedestrians and even motorized two-wheeler users, who happen to constitute the greatest number of accident victims.

- € In the absence of policies to regulate use of personal vehicles (congestion charging, higher parking fees, etc.) and incentivize public transport, carpooling, and other such activities, achieving decongestion and effective public transport uptake would be difficult.
- € It was acknowledged that the city needs to improve current levels of uptake of public transport by taking various steps. To start with, the mindset of the people towards using public transport has to be changed by making the latter an attractive travel option.
- € Public transport in Bangalore is now being made more comfortable and attractive to encourage travelers out of cars and into buses. Fifty new Volvo buses were introduced by BMTC recently and similar luxury services were in the pipeline. There are plans to introduce 10,000 buses in a phased manner over the next 5 years to cater to the needs of all sections of society.
- € BMTC emphasized the fact that accessibility to public transport could be improved by increasing and upgrading public transport infrastructure facilities – bus bays, bus shelters, etc. – which are needed for the smooth operation of public transport. For this continuous support from the government is needed.
- € BMTC also highlighted the need to develop dedicated corridors for buses, and submitted that unless given priority on the roads, no matter how good the quality of service, buses may not be able to compete with personal vehicles.
- € In terms of efforts to increase uptake of public transport and narrow the mobility divides, BMTC explained that it provides subsidized fares for various sections of society in the form of bus passes, and close to 0.5 million people used the pass system daily.
- € Integration between various means of transport in the city was found to be inadequate. The example of Delhi, where only personal vehicle users whose point of departure and destination fall within 1-1.5 km of a metro station, shift to the metro because of a lack of adequate feeder services of equally good quality, was cited as an indicator of the need for good overall connectivity in the city, especially in light of the soon to be inaugurated Bangalore metro.

- € **BMTC was identified as having great potential to take over the traffic-generated by BPOs and the IT industries by offering customized services to their employees, thereby discouraging them from using their personal vehicles.**
- € **It was felt that public transport has not received due importance in policy matters and even with the NUTP in place there was lack of adherence to the NUTP guidelines during transport improvement planning in the city.**
- € **However, implementing the NUTP guidelines requires necessary institutional arrangements and coordination mechanisms between various departments within the government. Other than Delhi, no other state in India has taken measures yet to consciously follow the NUTP guidelines and what is missing is a unified metropolitan transport authority to bring the various functions related to transport under one umbrella.**
- € **The large number of different institutions working in silos on different aspects of transport and land use in the city was identified as a key deterrent by the Transport Department, which is responsible for transport policy in the state of Karnataka.**
- € **Also, the various departments working on transport and related issues lack the requisite capacities to handle the nature of planning and solutions required by today's mobility challenges.**
- € **Planning itself was raised as major issue. Lack of integrated land use and transport planning, along with integration at state and city levels were highlighted. Inadequate attention is given to social, economic and environmental consideration in the preparation of plans.**
- € **It was emphasized that no proper circulation plan exists for the city, and the buses work on a destination-based rather than a direction-based model, and that this needs to be revisited in order to ensure smoother traffic flows in the city.**
- € **In terms of fuel issues, it was recognized that diesel-fuelled passenger vehicles were fast penetrating the market, with resulting deteriorating air quality, particularly with PM and NOx emissions. Another issue raised was the increasing share of four-stroke technologies, which while resulting in greater fuel efficiency, contribute to increasing NOx levels.**
- € **Given that vehicle idling time is high in Bangalore due to choked traffic in most places, it was emphasized that good fuel quality was not enough, and the city needs to look at proper inspection and maintenance of vehicles. Bangalore will not be a modern city able to offer its**

- citizens several different vehicle brands, unless those vehicles are regularly inspected and maintained.
- € It was recognized that the government's efforts so far on promoting the use of alternative fuels have been limited.

Some interesting comments made during Session I of the Dialogue included:

"God created a garden and devil created a city."

Quoted by Mr. S. Sundar, TERI

"The knee jerk reaction to solving the congestion problem in the city is to widen all the roads in the central core area. This will destroy the soul of the garden city, and the city will lose its sobriquet by the time we decongest it."

Ms. K. Chamaraj, CIVIC, Bangalore

"Earlier people thought it was below their dignity to travel by public transport. Public transport in Bangalore had no room to carry people's ego, but now we are focussing on making public transport more attractive, fashionable and comfortable. Introduction of Volvo buses is a step in that direction."

Mr.N.A.Khan, Bangalore Metropolitan Transport Corporation

"BMTC should consider taking over the entire software traffic in the city, especially that of call centers and BPOs. I am going to be the biggest loser if this happens, as I am making a lot of money from that right now. But I don't mind forsaking it for the sake of posterity and the future of my grandchildren."

Mr. Prithvi Pani, Bangalore Tourist Taxi Association

"We need to recognize the substitutability and complementarity between private and public transport rather than looking at the age old issues of incentivization or subsidization. People today care more about the quality element not the cost element."

Mr. M.R. Narayana, Institute for Social and Economic Change, Bangalore

6.4 Session 2: Addressing the mobility divide in the city

Session Chair: Dr. Vinod Tewari, Advisor, Transport & Urban Development Area, TERI

Panelists:

1. Mr. K. Jairaj, Principal Secretary, Rural Development and Panchayati Raj Department, Government of Karnataka
2. Mr. M. Lakshminarayana, Commissioner for Transport & Road Safety, Government of Karnataka

3. Dr. G. Gururaj, Professor and HOD, Dept. of Epidemiology, National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore
4. Mr. Abhijit Mukherjee, Asst. Director, Association of People with Disability, Bangalore
5. Mr. M.A. Saleem, Director (Security & Vigilance), Karnataka State Road Transport Corporation (KSRTC)
6. Mr. Jean Grebert, Transport Research Manager, Renault

The second session focused on the various kinds of “mobility divide” existing within and around the city. The thematic presentation made by TERI emphasized widening income divides in the city and how these have resulted in various kinds of mobility divides at spatial, temporal, financial and personal levels between the rich and poor. Also aspects of the mobility divide between the urban and rural populations were discussed. TERI also presented its findings from the mobility assessments it carried out in five slum areas in the city, in light of the mobility divides. The presentation raised the following points for discussion:

- € How can public transport be made more accessible and attractive both in and around the city?
- € How can frequent and affordable public transport be provided to the poor?
- € How can existing city roads be made safer for pedestrians and the disabled?
- € How can urban rural connectivity be strengthened?
- € What scientific ways need to be adopted to collect accident data?
- € What steps are needed to promote collective means of transport?
- € Are our public transport vehicles suitable for the traffic conditions and road space?
- € The need for a new institutional structure/centralized agency to improve provision and management of transport systems
- € The need for better regulation.

The following key observations and issues were raised in Session 2 of the Stakeholder Dialogue:

- € It was acknowledged that the response of the three actors: the state, the City Corporation and civil society, to the mobility divide in the city had been miniscule and little has been done so far by the state to bridge this gap. The only state initiative so far is the Bangalore metro, which is a highly capital intensive initiative. Who would be the real beneficiaries? The middle and affluent classes who switch from personal vehicles? Or would the benefits reach the poor? Would the poor be able to

- afford the metro? All these questions remain mere speculation and there are as yet no clear answers.
- € There was a lack of effort on the part of the state to ensure enforcement and regulation, to protect vulnerable road users as the first commitment of the civic bodies was to create more infrastructure: flyovers, roads, bus bays, parking spaces, etc.
 - € Apathy among the citizens of Bangalore and an acceptance of the way of life as it is, with a blind eye to this divide, was identified as another reality in the city. It was felt by the government that society had not served as a good partner in enforcement with civic bodies, and Bangalore being a cosmopolitan and intellectual hub, could do with more enthused and participative citizens.
 - € In terms of safety, it was emphasized that the impact on health was not a part of policy making in transport. Health and its interlinkages with transport were neither adequately understood nor examined by the policy makers. Things like no speed breakers on highways in rural areas, no facilities for non-motorized transport and pedestrians to cross safely, alcohol shops on highways, etc. were evidence of this.
 - € Socio-economic impacts of road traffic injuries were found to severest among the poor.
 - € Recently, NIMHANS, the Bangalore City Police, BMTC, NGOs have started a road safety surveillance program in 30 major hospitals.
 - € Vital information about prevention, management and rehabilitation of road crashes is usually available in FIRs recorded with the police authorities etc., however accessing this information is a challenge as there is no system to extract it and make it available for public policy formulation.
 - € One of the key problems is that there is no one body accountable or responsible for road safety. There is lack of clarity as to who is responsible for road safety – urban departments, traffic police, health department, transport department, etc. and this has led to a lack of serious action on the part of any agency to address the problem.
 - € In other countries like Sweden and USA, there is a strong political commitment to road safety, targets are set to reduce the number of deaths from road accidents, along with structured programs backed by dedicated funds. Institutional arrangements and scientific research are in place to achieve these targets. However, in India there are no such political commitments or road safety targets.

- € A civilized society and a cosmopolitan city like Bangalore should not accept such levels of mortality and morbidity caused by road crashes.
- € In a study carried out by NIMHANS on social determinants of health in exposed communities of Bangalore, it was found that slum dwellers, people living on the city outskirts, homeless people and the migratory population constituted nearly 40% of the total population of the city. Unofficially there were almost 800 slums, and transport was one of their most fundamental needs.
- € Typically the means used by the poor were walking, public transport and second-hand scooters. When they had to spend more money they preferred to walk and, the unorganized labor community in particular, had to walk long distances, largely because they could not afford bus services regularly. As a result their, exposure to accidents risks, health problems, etc. increased.
- € If public transport could not meet the affordability and time requirements for the poor, it was of no use.
- € The “mobility served” population in the city was very small as the entire design, development, infrastructure, etc. of transport is more geared to facilitate travel of rich rather than the poor.
- € No individual decisions could be policies and therefore decisions need to be backed by science and evidence and credible research, which are missing.
- € Countless projects have been running in the slum areas of the city – infrastructure development, housing, electricity, water supply, social welfare, job creation, but on ground they are not being implemented because this needs constant coordination, dedication, monitoring and evaluation, and public participation which are not as yet part of the larger policy framework.
- € Better and more customized transport services, which could play a very vital role in improving the productivity and quality of life for the disabled in the city, are not present. At peak hours, due to crowding, certain kinds of disabled people find it difficult/uncomfortable to travel in buses, especially the rural segments.
- € Intercity buses congest the city center, as all the major bus terminals are located around the city center. Now new intermodal transit centers around the outer ring-road for transfers between intercity buses and intermediate transit modes, are being planned.
- € KSRTC recognized the need to be more competitive and upgrade its service quality and make its services more user-friendly and is taking steps to do so.
- € Transport infrastructure, its management and proper operation, with a focus on inclusiveness for the poor

were identified as a few of the key solutions to bridge the rich-poor divide.

- € Micro level planning processes following the master plan with emphasis on social developments and their linkages with transport were identified as missing.
- € Interaction of civic authority bodies with the government is presently inadequate.

Some interesting remarks made during Session 2 of the Dialogue included:

"From a civic body point of view, I must confess that thinking about the mobility problems of the poor living in the slums does not come under our radar, so the poor are more or less left to fend for themselves when it comes to organizing their mobility from their home to workplace."

K. Jairaj, Rural Development & Panchayati Raj Dept., Government of Karnataka

"Finding solutions like building more roads and flyovers to tackle challenges of rapid motorization, will not work from the viewpoint of making mobility sustainable for the whole city. The only thing that can make a difference and which has been proven worldwide, is investing in mass transport that works."

Dr G. Gururaj, NIMHANS, Bangalore

"There are structured programs in the country to combat diseases like malaria, tuberculosis, etc. The number of deaths yearly in road crashes far exceed the deaths caused by these diseases. However, there are no such structured and dedicated programs or a strong political commitment to address road safety in India yet."

S Sundar, TERII

6.5 Session 3: Use of technology to achieve sustainable mobility

Session Chair: Mr. S. Sundar, Distinguished Fellow, TERI

Panelists:

1. Dr. Hiroyuki Watanabe, Senior Technical Executive, Toyota Motor Corporation, Japan
2. Mr. Chetan Maini, Deputy Chairman & Chief Technical Officer, REVA Electric Car Company Private Limited
3. Dr. George Eads, Vice President, Charles River Associates International (CRAI)
4. Ms. N.S. Rama, Head, Bangalore Development Center & Product Engineering Business Unit, Infosys Technologies Limited
5. Mr. Madhukar Shetty, Deputy Commissioner of Police, Bangalore Traffic Police

The session looked at three possible options for using technology to achieve sustainable mobility in Bangalore – firstly, how could improved vehicle and fuel technologies make mobility sustainable? Secondly, how could application of

Information and Communication Technology (ICT), in the form of “virtual mobility” act as a complement to physical mobility, minimize travel demand and reduce trip lengths? Thirdly, to what extent can Intelligent Transportation Systems (ITS) and other technological tools be used to manage traffic better? The session considered the use of facilities like e-governance and the concept of e-work to reduce the number of trips, and Intelligent Transport Systems (ITS) for better traffic management. The potential of virtual mobility and associated challenges was discussed in this session along with various other technological means to improve physical mobility within the city.

TERI's background presentation on this theme raised the following questions for discussion:

- € How can improvements in fuel and vehicle technologies be expedited to promote sustainable transport?
- € Can e-governance be encouraged to reduce journeys and journey lengths?
- € What are the barriers IT companies face to encouraging more e-work initiatives among their staff?
- € How could congestion problems in the city of Bangalore be reduced through the use of ICT by the traffic police?
- € How could shared traveling like carpooling, ride sharing etc. be made effective in Bangalore and how could technology be use to facilitate this?

The key observations/issues raised during this session were:

- € The need for a council for sustainable mobility consisting of different stakeholders like government, car manufacturers, academics and citizens.
- € The need to increase awareness on the use of electric vehicles and their long-term advantages/disadvantages, and other technology interventions like GPS and GPRS.
- € E-work applications require a change in mindsets, and efficient communications infrastructure at residential levels to make it effective. Infosys Technologies in Bangalore has been experimenting with e-work practices and has found that cultural issues act as constraints preventing e-work from fulfilling its full potential. Similarly, the availability of infrastructure in the home, continuous power supply, privacy, etc. were all challenges that were discussed. Also, in projects requiring more team-based work managers are not comfortable with team members working in isolation, and it was felt that visibility is increased through office work as it leads to greater recognition. Also communication is more effective face-to-face than between individuals sitting remotely.
- € Though technology is available and can be used conveniently, it cannot be a substitute for people.

Therefore, achieving social acceptance for technology is crucial.

- € Infosys also highlighted that it was already using BMTC services to provide transport services for its employees. Close to 12,000 out of 18,000 employees travel by bus including senior level staff in the company.
- € In terms of the city's mobility problems, it was again stressed that the last twenty years has seen shrinking mobility spaces and shrinking public spaces; land use planning has been the major problem.
- € Congestion was mentioned not as a problem but merely a symptom of a bigger problem, which had to do with how the larger urban spaces were planned and how people moved and behaved in that space.
- € The problem of traffic law infringements in the city was raised. Poorly educated traffic police spend 80% of their time monitoring the behavior of so called "intelligent Bangaloreans" while their main functions are to ensure safety and security of all road users. There is an erroneous belief that existing traffic signals are sufficient to ensure smooth traffic flows.
- € Mobility is a personal right of *every* individual and should be practiced with awareness. It was felt that this was not understood properly by the citizens of the city and was not translated in the government's plans and projects.
- € New roads, widening of older roads, etc. are eating into the pedestrian walking spaces and this is a matter of concern.

Some interesting remarks made during Session 3 of the Dialogue were:

"Technology by itself is not a solution to the problem, it is an enabler giving us more options that may still be difficult to realize in practice. For example congestion pricing today is not technologically constrained, but limited by political and/or social constraints."

Dr. G. Eads, Charles River Associates International

"Mobility cannot be understood merely as right to unhindered access. It has to do with the larger array of spaces wherein we have designed spaces for various use. An old man's right to cross the road is just as valid as the company executive who wants to drive to work."

Mr M. Shetty, Bangalore Traffic Police

"If thousands of people start working from their homes, traffic jams that happen on the roads can happen on the telecommunication networks"

Ms. N. S. Rama, Infosys Technologies Ltd.

"Congestion is not the problem; it is how the urban space is managed and how people behave in that space that is the problem."

Mr M. Shetty, Bangalore Traffic Police

6.6 Summing-up

In the final session, TERI presented a summary of the issues and recommendations discussed during each of the sessions of the Dialogue. It concluded that there were a host of issues that needed to be addressed in order to tackle the challenges of making mobility sustainable in Bangalore. From the planning to the implementation stages, priority in investments, credible databases, good institutional coordination, adequate capacities, finances, etc. were needed.

It was felt that there is a need to increase the awareness of people in India to use technology and to choose the most appropriate means of transport. Hence education and environmental awareness are increasingly important. Education and environmental awareness needs were summarized as follows:

- ∄ Improving traffic efficiency through education and the promotion of Eco Drive¹ (also see Annex 5.2 for explanation)
- ∄ Education to promote the most appropriate choice of transport
- ∄ Provision of information to enable the most appropriate choice of transport (transfer, fare, time distance, etc.)
- ∄ Necessity of providing incentives to promote the most appropriate choice of transport (reduction in public transport fares, traffic congestion charges, etc.).

Specific recommendations from the Dialogue along with TERI's recommendations for this study are presented in the next chapter.

¹ Eco driving, as defined by the Japan Automobile Manufacturers' Association, is a way to drive in a more careful and environmentally responsible way by following certain driving rules.

7.1 Introduction

Given the rapidly increasing economic progress of Bangalore, demand for mobility in the city is expected to increase continually. This has huge implications for the economic, environmental and social sustainability of the city. There is increasing awareness among planners and policy makers of this and they recognize the challenges that rapid the economic boom and unprecedented levels of personal motorization pose for mobility in the city. However, as in many Indian cities, the existing emphasis of development efforts and “finding mobility solutions” continues to be on infrastructure development and the creation of space for more personal means of travel, rather than on diverting a larger set of resources to planning for more sustainable solutions like better and more public transport and non-motorized transport.

This report has highlighted a number of issues and challenges to sustainable mobility in Bangalore. This chapter presents a summary of the key challenges highlighted by TERI and the participants in the Stakeholder Dialogue and offers some insights into how these could be addressed. Many of these are already universally acknowledged policy prescriptions. Others, for example, addressing the various mobility divides between rich and poor, looking at various “non-travel” mobility solutions, enhancing urban-rural connectivity, making public transport more attractive and creating interfaces between businesses, knowledge institutions and the government, are particularly valuable in the context of a city like Bangalore. This is largely due to the fact that Bangalore has established itself as a “magnet” city in India, offering a package of attractions like good employment opportunities, education, clement climate, quality of life, etc., thereby increasing the levels of economic activities and consequently, mobility. In this context it becomes imperative to ensure that the city continues to offer these while not losing sight of overall objective of sustainable development.

This study raised a number of issues, which ranged from planning and implementation to institutional and enforcement issues. It should be noted that the directions for solutions identified in this report need to be addressed from different perspectives and levels. Also, the role of different stakeholders needs to be clarified when looking for effective solutions.

7.2 TERI’s recommendations in the light of sustainable mobility goals

7.2.1 Improving air quality and reducing GHG emissions (Goals 1 and 2)

The environmental problem resulting from road transportation in Bangalore is severe, particularly where air quality is concerned (see section 4.2.3). There are various options for addressing this including, improvements in fuel quality, improvements in emission norm standards, increased use of public transport in the place of personal vehicles, increasing fuel efficiency of vehicles, etc. In Delhi, for example, in 2001 diesel was banned for all public vehicles and the Supreme Court ordered all buses, auto-rickshaws and taxis to convert to CNG. Public transport has been dealt with in the later sections; the current recommendations focus on fuel quality, emission norms and vehicle certification. Since fuel quality and emission norms are key topics that come under the remit and jurisdiction of the central government rather the state or city governments, these recommendations apply to other similar cities as well.

TERI's recommendations:

- Stricter conventional emission norms need to be adopted.
- Efficient and cleaner fuel technologies need to be introduced as quickly as possible.
- Central government needs to lay down a fuel quality roadmap beyond 2010 (which does not currently exist) in order to help oil and auto manufacturers to leapfrog and adhere to stringent air quality norms, especially in large cities like Bangalore.
- The state should offer alternative fuels and technologies and provide the suitable visibility, concessions and benefits that they need in order to compete with existing technologies.
- Bangalore should take the lead in establishing a network of good quality and state-of-the-art vehicle inspection and maintenance centers in the city and make it mandatory for all categories of vehicles to get periodically checked.
- The Pollution Control Board should simulate models on traffic flow and air pollution in the city and enhance the database on air quality.

7.2.2 Improving road safety (Goal 3)

Motorized two-wheeler users, cyclists and pedestrians are most at risk from serious injury or death on the roads of Bangalore. In 2001, Bangalore ranked fifth among India's fourteen major cities in terms of RTI deaths per 100,000 people with an annual rate of 13 deaths per 100,000 (see section 4.2.2). It was also established that in terms of long-term economic and social damage, the urban poor and rural folk suffer more than their urban rich and urban counterparts, respectively.

Some key causes of RTIs identified in and around Bangalore include:

- € Poor road design and structural issues
- € Poor visibility
- € Driving under the influence of alcohol
- € Not wearing helmets
- € Speeding and overtaking
- € Lack of speed regulation devices on highways in rural areas.

Some general issues surrounding road safety in Bangalore, include:

- § Inequitable allocation of road space. Most road space is allocated to and occupied by personal means of transport leaving very little room for non-motorized road users like cyclists, pedestrians, hawkers, etc.
- § Several different authorities deal with road safety and none has full authority or responsibility for safety.
- § The absence of a clearly defined and well integrated road safety policy at the state level.
- § No scientific crash investigations, proper accident reporting and data collection.
- § Lack of good trauma care and pre-hospital care.
- § Inadequate capacity building to deal with the various aspects of pre, during and post-crash situations.
- § Lack of enforcement of seemingly simple rules like wearing helmets and seatbelts.

TERI's recommendations:

Since road safety is a multi-disciplinary area requiring involvement of a variety of bodies such as the traffic police, hospitals, insurance companies, car companies, scientific institutions, etc., it would be worth consolidating all individual efforts and forming unified bodies at the state level dedicated to road safety issues and building capacity. There needs to be a structured program to deal with road safety in the state which should have the necessary finances, political support,

institutional structures, etc. to back it up¹. The roles of transport planners and traffic police are critical to ensuring the success of measures like lane segregation to separate the different forms of transport.

In addition to this, the automobile industry also needs to play an active role in contributing to road safety in cities. As an example, Toyota Kirloskar Motors Pvt. Ltd. launched a Toyota Safety Education Program (TSEP) in Bangalore in July 2007, with the objective of creating road safety awareness among 20,000 school children in 20 schools in Bangalore, by March 2008. This program includes various modules such as playing computer games, manning informative traffic booths, interactive traffic safety sessions, animation films and a mobile traffic park, to educate children about road safety in an interactive and participatory way.

Specific recommendations include:

- Establish a clear policy on road safety for the state on the lines of the Sundar Committee Report²; raise it as a serious public health issue; put it on the political radar; and develop a structured and dedicated program to combat RTIs just like the structured programs in the state to combat diseases like AIDS, malaria, tuberculosis, etc.
- Give adequate care and attention to safety in rural areas, especially on high-speed rural highways passing through villages.
- Encourage the use of ITS in order to facilitate safe vehicle movement in the city.
- Make it mandatory to account for and include the non-motorized traffic in the city in all future mobility-related projects and plans.
- Ease pedestrian movement by creating dedicated and pedestrian friendly (clean, safe and usable by all kinds of vulnerable groups) infrastructure like uninterrupted and well-protected sidewalks, over-bridges, etc. To ensure that vehicles stick to their lanes and that this is enforced, make suitable provisions wherever necessary in the Motor Vehicles Act and other instruments.

¹ Recommended by the “Sundar Committee Report on Road Safety and Traffic Management”; available on http://morth.nic.in/writereaddata/sublinkimages/Road_Safety_sundar_report4006852610.pdf

²The “Sundar Committee Report on Road Safety and Traffic Management” is available at http://www.dorth.gov.in/writereaddata/sublinkimages/Road_Safety_sundar_report4006852610.pdf

- The State government should set targets to reduce RTIs by a certain percentage and develop a program to achieve this.
- Standardize and establish a mechanism to collect and report crash-related data properly and scientifically in a uniform format from all possible sources.
- Vehicle driving tests could also be improved.
- Raise awareness about road safety as a public health issue in education institutes, workplaces, etc. and invite more public participation in finding solutions to road safety problems.
- Ensure compliance and regulation, especially of simple rules like wearing helmets and seat belts.
- Initiatives should be taken to reduce corruption in both the licensing process and in the enforcement of traffic violations.
- Provide speed control mechanisms and safe crossing zones on highways passing through villages and rural belts.
- Develop a policy to deal with paratransit solutions and regulate their use in order to ensure accountability and better safety in their operations.

7.2.3 Reducing noise (Goal 4)

The noise level in the city is much higher than the limits set by the Pollution Control Board. See section 4.2.3.4

TERI's recommendations:

The State Pollution Control Board should work closely with the city authorities and project planners and consultants to ensure noise levels remain within accepted limits:

- Introduction of latest vehicle and bus technology helps to reduce noise levels.
- Different materials can be used for road construction in order to reduce the noise level or barriers can be constructed alongside the road to contain the noise.
- Eliminating choke points allows smoother traffic operation and helps reduce noise.
- Regular maintenance obligations should be introduced and noise regulation enforced.
- Databases on noise levels should be strengthened.

7.2.4 Reducing congestion (Goal 5)

Congestion was identified not as a problem but a symptom of a bigger problem of improper urban mobility planning and unchecked rates of personal motorization in the city.

TERI's recommendations:

Reducing congestion would require a number of players to act together. The planning authorities responsible for urban development; the consultants who estimate traffic forecasts, allocate road capacities and prepare traffic circulation plans; the agencies that construct roads and carry out roadside works; the traffic police who manage the traffic flows; the citizens who drive and are expected to obey the rules and properly maintain their vehicles to prevent break-downs. Each player has a very important role to play in helping to reduce congestion. To achieve this, an effective institutional arrangement needs to be in place that addresses the aspects of congestion and its various causes. The traffic police take the lead on this by building capacity in certain areas and expanding their resources.

- In order to enhance road capacity in Bangalore emphasis needs to be given to managing traffic effectively on existing roads through innovative traffic management (including ITS) schemes, better signal synchronization and separation of motorized and non-motorized vehicles, in addition to building more road infrastructure (where necessary). Amid all this, the needs of vulnerable road users should not be overlooked.
- Reduce excess trips and trip lengths using effective integrated land use and transport planning, situating residences closer to workplaces and education centers, etc. Reduce or replace excess trips through the use of technologies like e-governance, e-work, ITS, etc.
- In order to influence excessive use of personal transport in Bangalore and curb the increasing congestion and parking problems in the city, policy instruments like congestion charging, area licensing schemes, high parking fees, etc. need to be introduced. However it should be noted that personal transport users should only be charged for driving once they are given an alternative option of traveling in good and efficient public transport systems. Therefore making the existing public transport systems more attractive and finding ways to shift more and more traffic to public transport systems can significantly improve road performance. Dedicated lanes for public buses would be a big incentive for many people to use public transport.
- Carpooling schemes or shared means of commuting and increases in parking fees need to be encouraged in order to ease congestion levels in the city, especially among the IT companies, etc. A network has to be developed with

carpooling along predefined routes. The routes can be mapped in order that small routes become a subset of larger routes to facilitate more matching. Incentives should be found to make the service more attractive. For example, drivers and passengers should be able to collect points which could later be redeemed for fuel or other consumer goods with selected retailers.

- Government and companies in the city need to explore the options of e-work, e-governance, etc. wherein the need to make trips is reduced significantly.
- Appropriate measures to address on-road parking and other parking related problems adding to congestion in the city should be addressed.
- Credible databases on traffic movement should be maintained and updated regularly.
- Last but not the least, as mentioned earlier, since congestion is merely a symptom of a bigger urban planning problem, policies prescribing integrated land use and mobility for the city should be encouraged.

7.2.5 Closing the mobility divide (Goal 6)

Bangalore not only exhibits a large income divide but there is also a mobility divide between the rich and poor populations.

In terms of access, the challenge lies in the ease and quality of access and mobility in the city, rather than in the availability of transport itself. Ease and quality of access varies drastically among different travel groups. This can be explained by the fact that until recently, efforts to address mobility and accessibility challenges, focused on driving and favored users of personal vehicles. Several mobility divides were identified in the city:

Spatial and temporal divide: Bus network coverage was deemed satisfactory. However, issues identified included the infrequency of buses and longer travel times.

Financial divide: Not only did the poor surveyed spend a greater amount of time traveling, but also a significant part of their income went to pay for transport (15-25%).

Personal divides: These included: (1) overcrowding and lack of security in buses, (2) no special provisions to meet the needs of the disabled and other disadvantaged groups in the city, (3) safety concerns mainly for pedestrians, two-wheeler users and public transport users.

TERI's recommendations:

Improving uptake and quality of public transport and other shared modes in the city is one of best ways of bridging the mobility divide, as it addresses most of the concerns of each of the above-mentioned divides.

Public transport in Bangalore could be made more effective and attractive by:

- Basing it on comprehensive city mobility plans, where the thrust is on direction and not destination-oriented travel, and where proper trunk and feeder networks facilitate good integration with other means of transport. For this the city needs to develop a comprehensive mobility plan with inputs from different stakeholders.
- Introducing common ticketing services between the bus and metro (once it takes off).
- Creating better infrastructure facilities like bus bays, waiting areas, etc. in order to improve accessibility.
- Ensuring that access to public transport stations, etc. is safe and convenient especially for pedestrians and other vulnerable groups. This can be done by creating footpaths, improving design of existing sidewalks, clearing obstructions, improving lighting in streets, etc.
- Promoting further the concept of running differentiated services for different income-category users in order to increase share of personal vehicle users switching to buses.
- Strongly pushing for allocating dedicated road space and priority to public transport, as no matter how comfortable the service may be, its speed and timeliness will be an equally important factor.
- Providing extra services during peak hours.
- BMTC capturing industrial and corporate (workforce) traffic through customized/exclusive services, thereby shifting more work trips from personalized to public means. As an example, BMTC is running exclusive Volvo services for employees of Infosys Technologies Ltd. More companies should adopt measures on similar lines.
- Integrating buses with paratransit modes, which could serve low-demand routes and off-peak hours.
- Making provisions for suitable subsidies for the disabled and taking initiatives like reserving a fixed number of seats for them in public vehicles, running special small capacity services during peak hours, and designing more disabled-friendly vehicles.
- Carrying out a detailed evaluation of the upcoming metro rail, especially in terms of accessibility, affordability, equity, social benefits, etc. for users of various income groups in the city.
- With the soon to be inaugurated metro, there is a need to ensure that both BMTC and Bangalore Metro Rail Corporation Ltd. (BMRCL) work in tandem and ensure

seamless transfers and travel between the two means of transport. A regulatory authority at the state level should also be set up to regulate the fares to be charged for different types of public transport services.

Effects of increasing share of buses in Bangalore: A 2020 perspective

Two transport scenarios for Bangalore were analyzed for a timeframe of 2000–2020: (a) Business as usual (BAU), where vehicle growth, etc. was expected to continue as per present trends; (b) More buses (MB), where the share of travel demand (billion passenger km) by public buses in the city was increased to 80% as compared to 62% in the BAU. Analysis revealed that increasing travel share by buses in Bangalore to 80% led to:

- Fuel savings of 765,320 tons of oil equivalent (21% of fuel used in BAU)
- A drop in emission loadings: 40% CO, 46% HC, 6% NOx & 29% PM as compared to BAU
- A cumulative CO₂ mitigation potential of 13% from 2005-2020
- A 23% reduction in total vehicle numbers in 2020 and creation of road space equivalent to 642,328 vehicles.

Source: Bose, R.K., 2007

7.2.6 Improving mobility opportunities (Goal 7)

In order to improve overall mobility opportunities for people in the city and in turn address all of the above-mentioned goals, there are some fundamental and key issues that need to be addressed which will form the foundation of any successful mobility solution.

TERI's recommendations:

One of the key aspects underlying sustainable mobility is integrated and inclusive urban planning. As also indicated in the NUTP, there is a need to develop integrated land use and transport plans that enable the city to develop in a manner which:

- o **Takes into account all the unique city-specific features; it also needs to support the key social and economic activities of its residents.**
- o **That serves the entire population (including vulnerable groups and people living in peripheral areas) and yet minimizes travel needs.**
- o **Formulates a ground design for urban transportation with deployment of appropriate transport infrastructure and the most suitable technological choice for public transport modes.**
- o **Features an integrated master plan that internalizes the features of sustainable transport systems focusing on increased use of public transport systems, pedestrian-**

friendly designs and facilities and better inter-modal integration between various means of transport in the city.

- Channels the future growth of a city around a pre-planned transport network rather than developing a transport system after uncontrolled sprawl has taken place; corridors need to be set aside for this starting from now.
- Adopts an integrated approach that focuses on micro to macro-planning and emphasizes compact city development.

Today, the databases of information related to most of the issues discussed so far (air quality, noise, safety, accessibility, incomes, travel times and costs, traffic, uptake of various transport modes, etc.) are inadequate; this is true for almost all cities. In order to make effective policies, research based on credible and detailed datasets is necessary. Therefore there is a need to develop a reliable and consistent database of information to help guide the planning process and ensure optimum mobility solutions.

The NUTP sets out guidelines which, if implemented properly, would help to achieve most sustainable mobility goals. However, in reality, these are not being implemented properly (see section 4.2.6.7); state and city authorities should initiate measures to implement these guidelines and make them a part of the integrated planning framework for the city.

The present structures of urban transport-related institutions in cities, which were established long ago, are not equipped to handle the challenges presented by sustainable mobility. In order to facilitate integrated urban planning and related aspects, a single unified body to facilitate more coordinated planning and implementation of urban transport programs and projects and an integrated management of urban transport systems, is needed. The NUTP also prescribes setting up an umbrella body, a Unified Metropolitan Transport Authority (UMTA's), in all Indian cities of one million-plus people. These bodies should have the statutory backing and requisite powers to manage the various aspects of urban transport (fuel quality, emission norms, public transport, land use planning, safety, etc.) in order to make mobility more sustainable. They also need to be backed by research institutions/academia/consultants who should provide technical inputs like travel demand assessments, travel behavior analysis, etc. The state government should consider creating a unified transport authority.

To facilitate this, capacity building and training at both the institutional and individual levels in various government

departments needs to be undertaken based on a thorough training needs assessment. All urban development and planning bodies in the state should have a team of transport planners in-house as well as representation from the transport authorities in their management.

Also a network across various sectors (government, academia, auto manufacturers, research institutes, NGOs, etc.) should be developed to discuss mobility challenges and research opportunities (on the lines of SIMBA, see box item) in Bangalore from time to time.

7.3 Use of ICT for sustainable mobility

Chapter 5 examined the potential role of Information and Communications Technologies (ICT) in achieving sustainable mobility. After consulting with experts and mobility-related stakeholders, we concluded that ICT-based applications (virtual mobility and ITS) can contribute to providing effective solutions to sustainable mobility in the city provided they are integrated with other technologies and approaches.

SIMBA Project

SIMBA brings together the EU and the nations of Brazil, China, India and South Africa to create an international cooperation network that aims to increase road safety, improve mobility and enhance transport efficiency through the use of ITS, automotive technological development and enhancements to road infrastructure. Its objectives are to increase road safety, improve mobility and enhance transport efficiency through the exchange of technological know-how and best practices. The project reflects the recommendation of the European Road Transport Research Advisory Committee (ERTRAC) to increase international road transport research in order to maximize the effectiveness of public and private research in this field.

The idea behind SIMBA is that stakeholders from the four regions can design and implement better and more efficient road transport solutions for the future by pooling their expertise and years of experience. With this goal in mind, SIMBA will map national and regional RTD activities, policies and future requirements as well as propose demonstration cases and organize seminars, business meetings and industry visits in order to maintain close contact between all key players in the four regions.

Source: http://www.simbaproject.org/en/about_simba/

Table 7.1 Possible ITS services in India

Advanced Traveler Information System (ATIS)	Pre-trip information, On-trip Driver Information, On-trip Public Transport Information, Personal Information Services, Route Guidance and Navigation
Advanced Traffic Management System (ATMS)	Transportation Planning Support, Traffic Control Incident Management, Demand Management, Policing/Enforcing Traffic Regulations, Infrastructure Maintenance, Vehicle Management
Advanced Vehicle Control System (AVCS)	Vision Enhancement, Automated Vehicle Operations, Longitudinal Collision Avoidance, Lateral Collision Avoidance, Safety Readiness, Pre-crash Restraint Deployment
Commercial Vehicle Operations (CVO)	Commercial Vehicle Pre-clearance, Commercial Vehicle Administrative Processes, Automated Roadside Safety Inspection, Commercial Vehicle On-board Safety Monitoring, Commercial Vehicle Fleet Management
Electronic Payment	Electronic Financial Transactions
Safety	Public Travel Security, Safety Enhancement for VRU Intelligent Junctions, Collision Avoidance and Early Warning Systems, Speed Control and Regulation
Public Transport	Public Transport Management, Demand Responsive Transport Management, Shared Transport Management
Emergency Management	Emergency Notification and Personal Security Emergency Vehicle Management, Hazardous Materials and Incident Notification

(SOURCE – Courtesy presentation on “Intelligent Transport Systems (ITS) for Traffic Information and Management” by Dr.K. Ravinder & Dr.S. Velmurugan, CRRI, New Delhi at SIMBA India National Event, 21-22 November 2007, New Delhi, http://www.simbaproject.org/en/simba_regions/india/india_events/india_national_event_-_21-22_november_2007.htm)

TERI’s recommendations:

- **Parking management: Information on reservations and availability of parking spaces could be provided to drivers in the streets. This would optimize use of parking capacity and help to alleviate traffic congestion. Advanced parking management systems could be used to collect data, indicate the number of vehicles parked, provide transaction details, calculate residual value in order to increase parking lot efficiency (for example, Palika Bazaar parking lot in Delhi).**

- Toll systems based on a scheme similar to that used to finance road infrastructure could be established.
- Road traffic information systems like incident detection systems and variable message signs could help with detection of congested conditions, incidents, accidents, etc.
- Mobility services based on the massive use of cell phones and SMS could be encouraged. For example, taxis and rickshaw reservation processes could be optimized much more, particularly during peak hours by an SMS-based system. This could increase responsiveness and improve inter-modality around railway stations.
- In carpooling (discussed in section 7.2.4), user security is a major concern. Security features can be ensured through a system linking the membership ID of carpoolers with their mobile phones, where members should not be able to access the service from another cell phone number, and the ID shown on the member card must match the ID sent to the ride seeker, thereby avoiding fraud.

References

ADB. 2006

Energy Efficiency and Climate Change Considerations for on-road Transport in Asia

Philippines: Asian Development Bank, 68pp.

BDA. 2007

Revised master plan – 2015, vision document Bangalore, I

Bangalore: Bangalore Development Authority, 73pp.

Bose, R K. 2007

Urban Transport Scenarios in South Asia: Energy and environmental impact of enhanced public transport system

Journal of Transportation Research Board, Volume no. 2011: 116-126

Census of India. 2006

Population projection for India and States 2001-2026

New Delhi: Registrar General and Census Commissioner, Government of India.

CPCB. 1997

Ambient Air Quality - Status & Statistics 1995, NAAQMS/8/1996-97

New Delhi: Central Pollution Control Board, CPCB, 144 pp

CPCB. 1999

Ambient Air Quality - Status & Statistics 1997, National Ambient Air Quality Monitoring Series: NAAQMS/11/1999-00

New Delhi: Central Pollution Control Board. 130 pp.

CPCB. 2000

National Ambient Air Quality - Status & Statistics 1998, National Ambient Air Quality Monitoring Series: NAAQMS/15/2000-2001

New Delhi: Central Pollution Control Board, 120 pp.

CPCB. 2001

National Ambient Air Quality - Status & Statistics 1999, National Ambient Air Quality Monitoring Series

NAAQMS/21/2001-2002, New Delhi, Central Pollution Control Board, 148 pp.

CPCB. 2002

National Ambient Air Quality - Status & Statistics 2000, National Ambient Air Quality Monitoring Series: NAAQMS/22/2001-2002

New Delhi: Central Pollution Control Board, 161 pp.

CPCB. 2003

National Ambient Air Quality- Status 2001, National Ambient Air Quality Monitoring Series: NAAQMS/23/2003-2004

New Delhi: Central Pollution Control Board, 157 pp.

CPCB. 2004a

National Ambient Air Quality- Status 2002, National Ambient Air Quality Monitoring Series: NAAQMS/24/2003-2004

New Delhi: Central Pollution Control Board, 167 pp.

CPCB. 2004b

National Ambient air quality status 2003, NAAQMS/26/2004-05

New Delhi: Central Pollution Control Board

CPCB. 98

Ambient Air Quality- Status & Statistics 1996, NAAQMS/10/1998-99

New Delhi: Central Pollution Control Board New Delhi: CPCB, 115 pp

CPCB.2006.

National air quality status 2004, Central Pollution Control Board (CPCB), National Ambient Air Quality Monitoring Series

New Delhi: Central Pollution Control Board

CRRI. 1999

CRRI in association with Transport Operations Planning and Informatics Center, Bangalore; and Center for Transpiration Engineering, Bangalore University, "Traffic and Transportation Improvement Priorities for Road Corridors of Bangalore, Final Report"

Karnataka Urban Infrastructure Development and Finance Corporation

DoT. 2006

Annual Report 2006-07

New Delhi: Department of Telecommunications, Government of India

GoI. 1991

Census Handbook

Registrar General and Census Commissioner
Government of India, New Delhi

GoI. 2001

Census Handbook

Registrar General and Census Commissioner, Government of India.

GoK.2005

Karnataka Human Development Report

Planning and Statistics Department

Government of Karnataka

GoK. 2005^a

Karnataka at a glance 2005-06

Directorate of Economics and Statistics, Bangalore

Government of Karnataka

GoK 2005^b

Karnataka State Highways Improvement Project

Feasibility report study: Chapter 2- Karnataka state profile 'Feasibility study for state roads for proposed KSHIP II'

Government of Karnataka

GoK. 2007

Draft Eleventh Year Plan (2007-2012) & Annual Plan (2007-08): Volume II

Planning and statistics department: February 2007-08-16

Government of Karnataka

Group SCE India Pvt. Ltd., 2006

Bangalore Urban Atlas

Bangalore

Gururaj, G., Kolluri, S.V.R, Chandramouli, B.A., Subbakrishna, D.K. and Kraus, J.F.2005

Traumatic Brain Injury

National Institute of Mental Health & Neuro Sciences

Publication no. 61, Bangalore - 560029, India

Gururaj, G. 2006

Road traffic injury prevention in India

National Institute of Mental Health & Neuro Sciences

Bangalore: India

IEA. 2002

Bus Systems for the Future - Achieving sustainable transport worldwide

International Energy Agency

Paris

JNURM. 2006

City development plan for Bangalore

Jawaharlal Nehru National Renewal Mission, 168 pp.

Kundu, A. 2006

Trends and patterns of urbanization and their economic implications

In: India Infrastructure Report 2006, Urban Infrastructure, pp. 27-41,

New Delhi: Oxford University Press, 257 pp.

MoCA. 2006

Report of the working group on Civil Aviation for the 11th Five Year Plan

New Delhi: Ministry of Civil Aviation, Government of India

MoEF. 2004

India's Initial National Communication to the United Nations Framework Convention on Climate Change

Ministry of Environment and Forests, Government of India, New Delhi

MoF. 2007

Economic Survey 2006-07

New Delhi: Ministry of Finance, Government of India

MoPNG. 2002

Report of the Expert Committee on Auto Fuel Policy

New Delhi: Ministry of Petroleum and Natural Gas, Government of India

MoR. 2007

Report of the working group on Railways for the 11th Five Year Plan

New Delhi: Ministry of Railways, Government of India

MoRD. 2006

Report of the working group on Rural Roads in the 11th Five-Year Plan

New Delhi: Planning commission, Government of India

MOSRTH. 2005b

Basic port statistics of India 2004/05

New Delhi: Research Wing, Ministry of Shipping, Road Transport and Highways, Government of India

MoSRTH. 2006

Indian Highways: Emerging Opportunities for Profitable Partnership

Ministry of Shipping Road Transport and Highways, Government of India

MOSRTH. 2007

Report of the working group on Roads (2007-2012) for the 11th Five Year Plan

New Delhi: Department of Road Transport and Highways; Ministry of Shipping, Road Transport and Highways
Government of India

MoSRTH. 2007 ^a

Motor Transport Statistics of India, 2004-05

Ministry of Road Transport and Highways
Transport Research Wing, Government of India, New Delhi.

MOSRTH. 2007 ^b

Report of the working group on Ports (2007-2012) for the 11th Five Year Plan

Ministry of Shipping, Road Transport and Highways, Government of India

MoUD. 2007

India USP 2007: India Urban Space

Ministry of Urban development, Government of India

NIPFP. 2007

India Urban Report - A Summary Assessment

New Delhi: National Institute of Public Finance and Policy

Planning Commission. 2007

Report of the working group on Road Transport for the 11th Five Year Plan

Planning commission
Government of India

Rastogi, A. 2007

The Infrastructure Sector In India 2006.

In: India Infrastructure Report 2007, Urban Infrastructure
New Delhi: Oxford University Press, pp.1-27

Ravindra, A. 1989

Urban Land Policy for an Indian Metropolitan City (A Case Study of Bangalore)

RDPRD. 2005

Annual Report 2005-06

Rural Development & Panchayati Raj Department
Government of Karnataka

Madhavan, S.

Rural Transport in Karnataka with special reference to Kanakapura (Bangalore district), India

Research working Paper No.7

London: School of Social Sciences and business Studies, Polytechnic of Central London,
32-38 Wells Street, London WIP3FG

Sundar, S. 2007 a

Paper on Infrastructure

New Delhi: The Energy and Resources Institute
Unpublished

Sundar, S. and Jaswal. P. 2007

Policy brief - bottlenecks in the growth of coastal shipping

New Delhi, India: Asian Development Bank, 8 pp.

TERI. 2001

Issues, strategies, and challenges for sustainable urban transport: modelling the impact on the local and global environment – case of Delhi

Pacific and Asian Journal of Energy, Number 1 Volume 11

New Delhi: The Energy and Resources Institute

TERI. 2004

Urban Clean Fuel Project TA No. 4182 – IND

New Delhi: The Energy and Resources Institute

TERI. 2006

Responding to India's Complex Transport Problems: Challenges and Opportunities

New Delhi: The Energy and Resources Institute

TERI. 2007

The Energy Data Directory & Yearbook (TEDDY2005/06)

New Delhi: The Energy and Resources Institute

TRL. 2004

The involvement and impact of road crashes on the poor: Bangladesh and India case studies

Submitted to: Global Road Safety Partnership (GRSP)

UK: TRL Limited. 34 pp. [TRL Job No. CRIN]

WBCSD. 2004

Mobility 2030: Meeting the challenges to sustainability

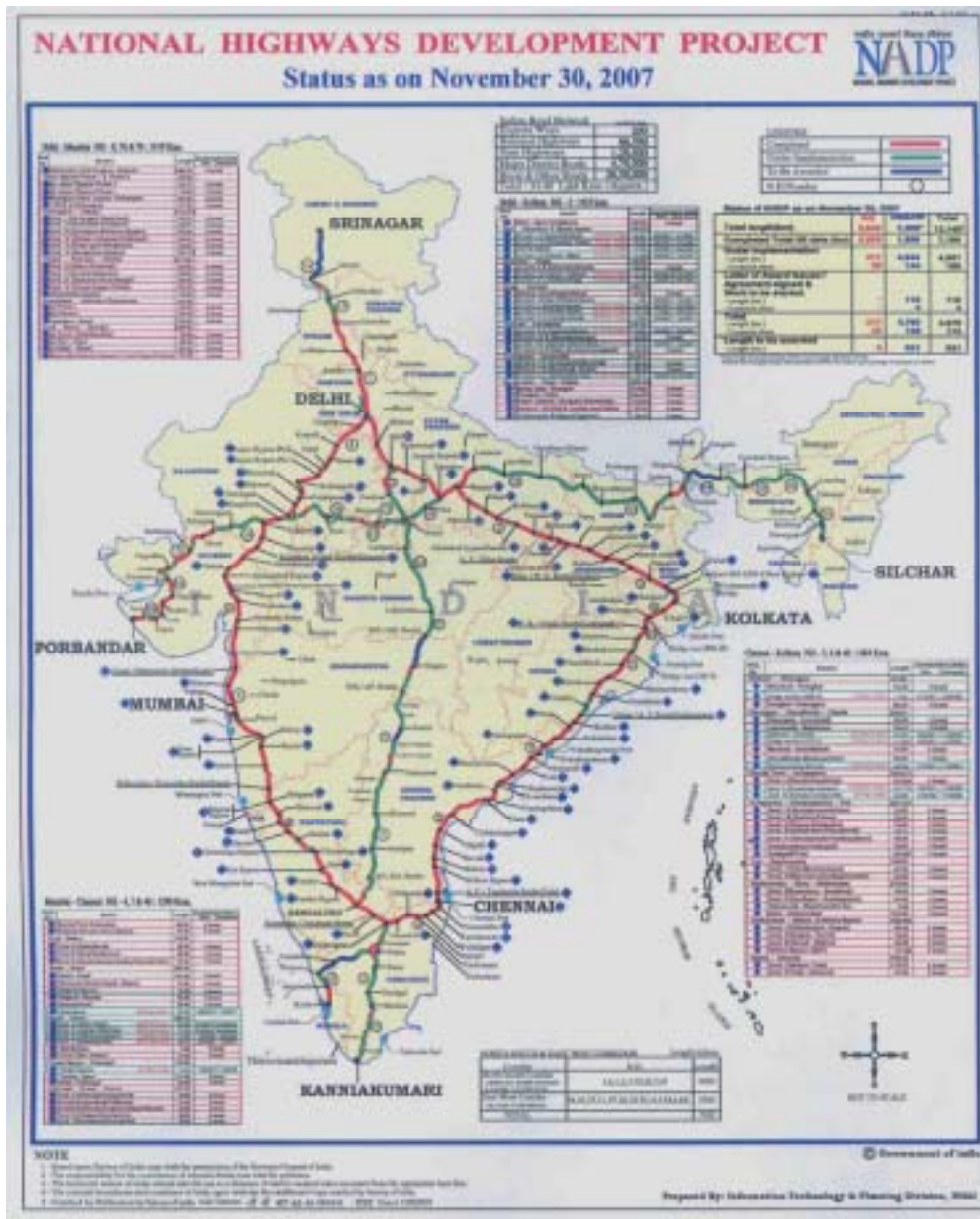
Switzerland: World Business Council for Sustainable Development, 178 pp.

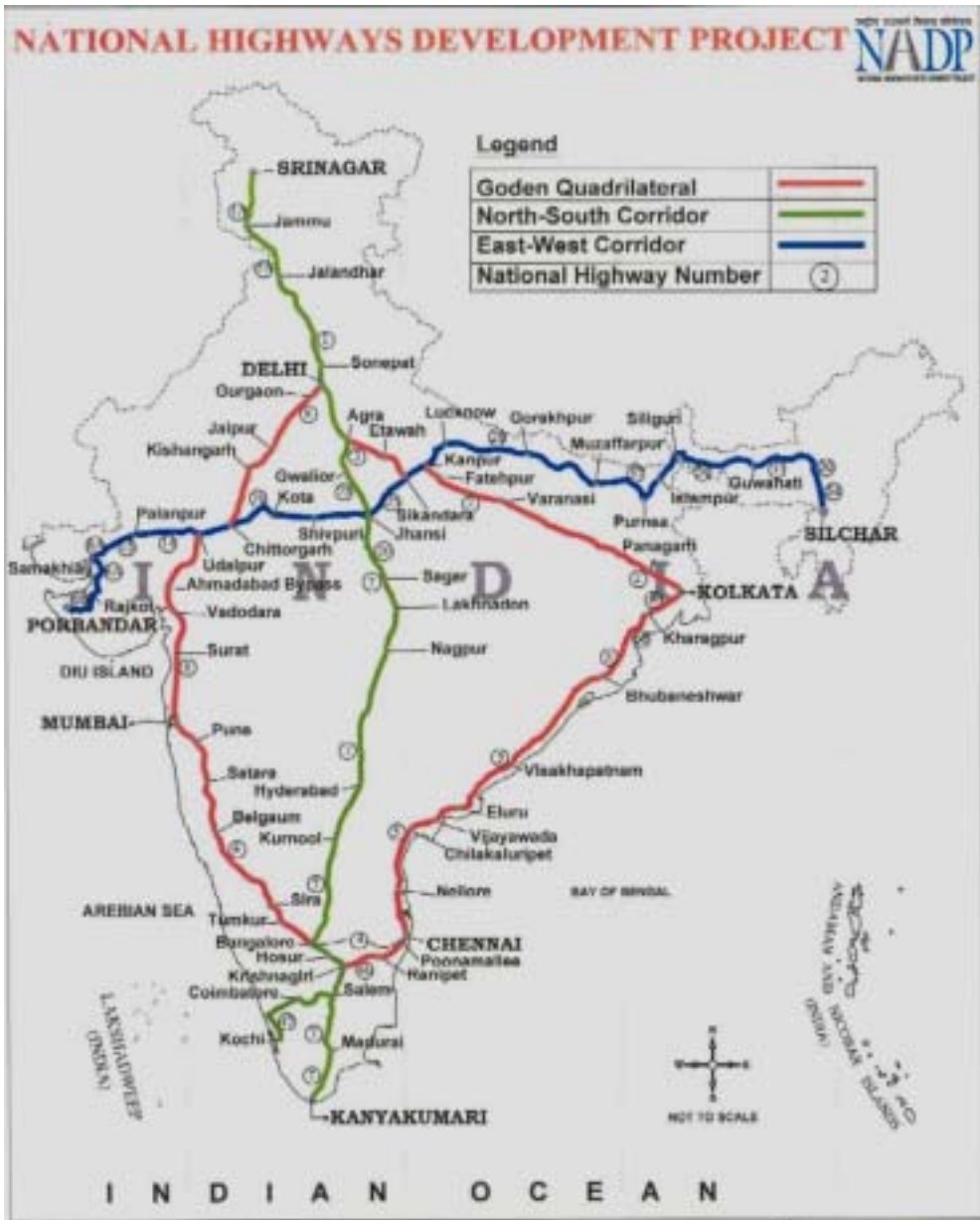
WBCSD. 2007

Mobility for Development – Facts and Trends

Switzerland: World Business Council for Sustainable Development, 17 pp.

Annex 2.1 National Highways Development Project





Source: <http://www.nhai.org>

Annex 4.1 Motor vehicles and traffic data

Table 1 Number of vehicles registered and kept for use in Bangalore and their variation over time

Vehicle category	as on 31-03-2004	as on 31-03-2005	as on 31-03-2006	as on 31-01-2007	Share of total in 2007
Motor cycle up to 50 CC	359065	385718	430221	432719	
Motor cycle 76 to 300 CC	1064737	1232235	1443397	1644399	
Motor cycle above 300 CC	20644	21829	23289	24056	
Total two-wheelers	1444446	1639782	1896907	2101174	73.1%
Motor car	276536	326803	400476	430206	
Jeeps	7517	8043	5147	7593	
Total personal four-wheelers	284053	334846	405623	437799	15.2%
Auto-rickshaws	75539	80810	81502	91899	
Motor cab	9413	13137	18428	23492	
Maxi cabs	7699	10974	13942	16356	
Total IPT	92651	104921	113872	131747	4.6%
Omni bus	17044	20787	22132	27543	
Stage carriage	9257	10429	11836	13290	
Private bus	2409	2479	1994	9518	
Contract carriage	265	326	255	278	
Total buses (public + private)	28975	34021	36217	50629	1.76%
Goods vehicle	60719	69024	97801	86246	
Delivery van	16207	21039	27951	33156	
Total goods vehicles	76926	90063	125752	119402	4.15%
Total invalid carriage	93	100	162	204	-
Total others	17730	23848	33577	33312	1.6%
Total	1944874	2227581	2612110	2874267	

Source: GoK, 2007

Table 2: Comparison of traffic composition on select roads during peak hours

Location	% Cars		% Buses		% Trucks		% Two-wheelers		% Auto rickshaws		% Cycles		% Others	
	1998	2006	1998	2006	1998	2006	1998	2006	1998	2006	1998	2006	1998	2006
Hosur Road	16	26.6	5	9	10	1.6	43	47	13	9.3	6	NA	7	3
Old Madras Road	18	22	7	3.7	9	2.3	42	53.6	8	10.14	6	NA	10	9
Bellary Road	21	28	5	2.9	8	-	47	50.7	7	15.07	4	NA	8	3
Airport Road	21	33	4	7	2	-	50	48	9	8.8	8	NA	-	NA
Lal Bagh Road	16	20	4	1.3	2	-	49	54.8	20	21	4	NA	5	2.5

NA= not available

Source: CRRI, 1999 & RITES, 2006

Annex 4.2 Circulation plan for Bangalore City



Source: BDA, 2007

Annex 5.1 About BangaloreOne or B1 Project

About BangaloreOne or B1 Project¹

The descriptions of the various government departments that have integrated their services with BangaloreOne are as follows:

Bangalore Electricity Supply Company (BESCOM)

BESCOM is responsible for power distribution in the six districts of Karnataka. BESCOM covers an area of 41,092 km² with a population of over 168 lakhs (note: a lakh is Rs. 100,000). In order to facilitate use by the citizens of Bangalore of the different services provided by BESCOM, the department has integrated the following citizen-specific services with BangaloreOne.

BESCOM services available in BangaloreOne centers:

- € **Viewing and payment of bills:** Citizens can obtain details of their electricity bills and pay their bills through any of the BangaloreOne centers. Bills can be settled in cash, by check or by direct debit.
- € **Filing of grievances:** This service will shortly be available through all BangaloreOne centers. A citizen can submit an application in any of the BangaloreOne centers and the details will be transferred to the department immediately. Citizens will be given a unique grievance tracing ID. This is a free service to citizens.
- € **Account statements:** This service enables citizens to see their account statements for the previous 12 months, excluding the current month, for any account identified by RR number. Details will be printed and given to requestors.

Services available through the BangaloreOne web portal:

- € **Viewing and payment of bills:** Citizens can pay their electricity bills through the BangaloreOne web portal. Payments are secure. They can be made using credit cards including VISA and MASTER CARD. A receipt is generated for each successful transaction. The receipt includes BangaloreOne's unique transaction ID and other details of the invoice.
- € **Filing of grievances:** This service is also available through the web portal. This is a free service through which citizens can file grievances against BESCOM.

¹See: <http://www.bangaloreone.gov.in>

Bangalore Mahanagar Palike (BMP)

BMP's major task is civic development within the Greater Bangalore Metropolitan area. This is an area of 224.66 km², divided into more than 100 wards, with a population of 6.8 million, and an additional floating population of +/- another 20%. Civic development in the BMP's case includes the orderly development of the city (including zoning and building regulations), health, hygiene, licensing, trade, and education through its network of schools and junior colleges. In order to provide the citizens of Bangalore with its different services, the department has integrated certain citizen-specific services with BangaloreOne.

BMP Services available through BangaloreOne centers:

- € **Issue of birth certificates:** A birth certificate is issued to every citizen to certify that the birth has been registered with the municipal corporation. Citizens require birth certificates for various reasons, including as a proof of date of birth. BMP issues copies of birth certificates to citizens against payment. Birth certificates can now be obtained through BangaloreOne centers.
- € **Issue of death certificates:** Death certificates are issued to certify that the death of an individual has been registered with the municipal corporation. Citizens need death certificates for various reasons, including as a proof of date of death or to settle property inheritance issues. BMP issues copies of death certificates to citizens against payment. Death certificates can now be obtained through BangaloreOne centers.
- € **Payment of property tax:** Citizens can now pay the tax due on their property, which is registered with BMP, through BangaloreOne centers. Previous property tax receipts are required before new payments can be settled.
- € **Filing of grievances:** This particular service will be shortly available in all BangaloreOne centers. Citizens can visit any BangaloreOne center and submit an application specifying that they wish to file a complaint against Bangalore Mahanagar Palike. The application specifies the department and the cause of the complaint.

Bangalore Police Service (BPS)

BPS is responsible for maintaining law and order, traffic management, and the implementation of social legislation. In order to facilitate law enforcement and provide citizens

of Bangalore with the different services offered by BPS, the department has integrated certain citizen-specific services with BangaloreOne.

BPS services available through BangaloreOne centers:

- € **Fine collection:** The Bangalore Police Service has integrated its "Police Fine Payment Service" with BangaloreOne. Citizens fined for violating traffic regulations can now pay their fine at any one of the BangaloreOne centers.

This service will shortly be available through the BangaloreOne web portal.

Bharat Sanchar Nigam Limited (BSNL)

In order to provide the citizens of Bangalore with its different services, BSNL – the telecom service provider –has integrated certain citizen-specific services with BangaloreOne.

BSNL services available through BangaloreOne centers:

- € **Payment of landline telephone bills:** Citizens can obtain details of their BSNL telephone bills and pay them in any of the BangaloreOne centers. Invoices can be settled in cash, by check or direct debit.
- € **Payment of CellOne bills:** CellOne is the pre-paid mobile phone service of BSNL. CellOne pre-payments can be made through BangaloreOne centers and the BangaloreOne web portal.

Services available through the BangaloreOne portal:

- € **Payment of landline telephone bills:** Citizens can now pay their BSNL telephone bills by internet should they choose to. Telephone bill payments through the BangaloreOne portal (www.bangaloreone.gov.in) are secure. Payments can be made by credit card including VISA and MASTER CARD. A receipt is generated for each successful transaction which includes BangaloreOne's unique transaction ID and any other details that may be required for future reference.

Regional Transport Office (RTO)

The Transport Department is one of the largest revenue earners in the state of Karnataka. It deals with various

transport-related matters including driving licenses, motor vehicle registration, granting and renewal of permits, and other regulatory and enforcement functions. In order to facilitate access to its various services, the department has integrated certain citizen-specific services with BangaloreOne.

RTO Services available through BangaloreOne centers:

- € **Renewal of learner's license:** Citizens of Bangalore can now renew their learner's license through any of the BangaloreOne centers. All that is required is the learner's license number. Renewal is for six months from the date of payment.
- € **Collection of road tax for transport vehicles:** Citizens of Bangalore can submit their road tax payment for transport vehicles from any of the BangaloreOne centers.
- € **Issue of B-extract of vehicles:** Citizens of Bangalore can now obtain information about vehicle ownership from any of the BangaloreOne centers, against payment.
- € **Payments against *challans*:** Citizens can pay their *challan* fines at any of the BangaloreOne centers.

Regional Passport Office (RPO)

The Regional Passport Authority is the Passport Issuing Authority. Currently it has a server-based network for collecting application forms from the different offices. In order to facilitate access by the citizens of Bangalore to its different services, the RPO has integrated certain citizen-specific services with BangaloreOne.

RPO services available through BangaloreOne centers:

- € **Application for a new passport:** Passport application forms are available in all BangaloreOne centers. Citizens can purchase these forms from operators at all BangaloreOne counters.
- € **Acceptance of passport applications:** BangaloreOne, with the government of Karnataka in association with the Ministry of External Affairs, and the Government of India, launched a new service in June 2006: "Acceptance of applications for a new Passport", through its Integrated Citizen Service Centers. Citizens can apply for new passports at these centers. Citizen-friendly executives in the centers can assist with filing an application for a new passport.

The Department of Labor, Government of Karnataka

This department is responsible for the registration and compliance with labor laws of all shops and commercial establishments, which come under the jurisdiction of the Government of Karnataka. The Department of Labor also looks after the renewal, amendment and surrender of these registrations. Registrations with the Department of Labor can be made through BangaloreOne centers.

Bangalore Water Supply and Sewerage Board (BWSSB)

The BWSSB is responsible for providing drinking water to the city and draining out sewerage. It maintains about 6,000 km of existing water distribution lines and 4,000 km of underground sewerage lines. Its aim is to ensure 24-hour water supplies. In order to facilitate access by the citizens of Bangalore to the different services provided by BWSSB, the department has integrated certain citizen-specific services with BangaloreOne.

BWSSB services available through BangaloreOne centers:

- € **Viewing and payment of monthly bills:**
Citizens can obtain details of their water bills and pay them through any of the BangaloreOne centers. Bills can be settled by cash, check or direct debit.
- € **Application for new connection:**
BangaloreOne centers can accept applications for new water connections. Applications are forwarded to the BWSSB authorities and a receipt provided to the consumer as proof of application.
- € **Statement of account:** Account statements can be obtained for the previous six months, but excluding the current month, for any account identified by the RR number.

Services available through the BangaloreOne web portal:

- € **Viewing and payment of monthly bills:**
Citizens can pay their water bills through the BangaloreOne portal (www.bangaloreone.gov.in). Payments are secure. They can be made by credit card, including VISA and MASTER CARD. A receipt is generated for each successful transaction and includes BangaloreOne's unique transaction ID and any other details contained in the invoice.

In addition to the services outlined above, it is possible to book railway tickets, airline tickets, obtain BMTC monthly bus passes, etc. Before the advent of these facilities, it was necessary to pass by several different offices in different parts of the city. BangaloreOne services help citizens to use all these services either from their homes or from the nearest citizen center.

Annex 5.2 Eco driving as defined by the Japan Automobile Manufacturer's Association



Source: Toyota Motor Corporation

Annex 6.1 List of Stakeholder Dialogue participants

S.No.	Name	Company
1	Abhijit Mukherjee	Association of People with Disability, Bangalore
2	B.V. Raghavendra	Auto-rickshaw Driver's Union, Bangalore
3	H.G. Srinivasmurthi	Auto-rickshaw Driver's Union, Bangalore
4	T. Ramppa	Bangalore Chamber of Industry and Commerce
5	Hemaraju	Bangalore Metropolitan Transport Corporation
6	N.A. Khan	Bangalore Metropolitan Transport Corporation
7	T.R. Naveen	Bangalore Metropolitan Transport Corporation
8	P.R. Dasgupta	Bangalore International Center
9	Madhukar Shetty	Bangalore Traffic Police
10	Duncan Eggar	British Petroleum
11	D. Mukhopadhyaya	Central Road Research Institute, New Delhi
12	George Eads	Charles River Associates International
13	K. Chamaraj	Citizen's Voluntary Initiative for the City (CIVIC), Bangalore
14	M. Lakshminarayana	Commissioner for Transport and Road Safety, Government of Karnataka
15	K. Jairaj	Department of Rural Development & Panchayati Raj, Karnataka
16	V.V. Bhaskar	Former Director General of Police, Karnataka
17	B.H. Sanjeev Kumar	Global Road Safety Partnership, India
18	T.R. Champaka	Group SCE India Pvt. Ltd.
19	Jeremy Grasset	GSF
20	T.V. Ramanayne	Indian Institute of Management, Bangalore
21	Santosh	Indian Institute of Science, Bangalore
22	N.S. Rama	Infosys, Bangalore
23	S. Abhijith	Infrastructure Development Corporation (Karnataka) Limited
24	Sushma Nirmal	Infrastructure Development Corporation (Karnataka) Limited
25	M.R. Narayana	Institute for Social and Economic Change, Bangalore
26	D.C. Prakash	International Association of Public Transport, Bangalore
27	Ananda Rao	Karnataka State Road Transport Corporation
28	M.A. Saleem	Karnataka State Road Transport Corporation
29	Prithvi Pani	Metro Travel Group, Bangalore
30	Alexandra Charnelet	MICHELIN, France
31	Jacques Toraille	MICHELIN, France
32	Kirti Bhandari	Nagoya University
33	Pelin Alpkokin	Nagoya University
34	Yoshitsugu Hayashi	Nagoya University
35	G. Gururaj	National Institute of Mental Health and Neurosciences, Bangalore
36	J. Gururaja	REAF, Bangalore
37	Jean Grebert	Renault, France
38	Chetan Maini	REVA Electric Car Company, Bangalore
39	U.R. Madhyasta	REVA Electric Car Company, Bangalore
40	Atsushi Toyoshima	Toyota Kirloskar Motor Pvt. Ltd, Bangalore
41	Makoto Ono	Toyota Kirloskar Motor Pvt. Ltd, Bangalore
42	Pankaj Gupta	Toyota Kirloskar Motor Pvt. Ltd, Bangalore

43	Prem Motwani	Toyota Kirloskar Motor Pvt. Ltd, Bangalore
44	Stephan Herbst	Toyota Motor Corporation, Europe
45	Hiroyuki Watanabe	Toyota Motor Corporation, Japan
46	Masayo Hasegawa	Toyota Motor Corporation, Japan
47	Satomi Tomomitsu	Toyota Motor Corporation, Japan
48	Satoshi Kato	Toyota Motor Corporation, Japan
49	D. Thangaraju	Transport Department, Government of Karnataka
50	Akshima Dogra	TERI
51	Annapurna Vancheswaran	TERI
52	Arcot Ramachandran	TERI
53	Chhavi Dhingra	TERI
54	Pratik Ghosh	TERI
55	Rakesh Hooda	TERI
56	Ranjan K. Bose	TERI
57	Sanjivi Sundar	TERI
58	Shikha Gandhi	TERI
59	Vinod Tewari	TERI
60	Lucy M. Mbome	University of Dar es Salaam, Tanzania
61	Mihoko Kimura	WBCSD
62	Shona Grant	WBCSD

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) brings together some 200 international companies in a shared commitment to sustainable development through economic growth, ecological balance and social progress. Our members are drawn from more than 30 countries and 20 major industrial sectors. We also benefit from a global network of about 60 national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues.

Our objectives include:

Business Leadership – to be a leading business advocate on sustainable development;

Policy Development – to help develop policies that create framework conditions for the business contribution to sustainable development;

The Business Case – to develop and promote the business case for sustainable development;

Best Practice – to demonstrate the business contribution to sustainable development and share best practices among members;

Global Outreach – to contribute to a sustainable future for developing nations and nations in transition.

www.wbcds.org

Development Focus Area

Through its Development Focus Area, the World Business Council for Sustainable Development is seeking to:

Raise awareness of the business contribution to development, helping business and non-business stakeholders understand what is possible by providing case studies, guides and tools that advance our understanding of development challenges and opportunities;

Advocate for change by working collaboratively with multiple stakeholders to create a more enabling business environment and seek synergies between official development assistance (ODA) and foreign direct investment (FDI);

Act by working with our members, Regional Network partners and other stakeholders to broker new business ventures that are both good business and good for development. A key element in this work is a partnership agreement with SNV Netherlands Development Organization to broker inclusive business in the Andean and Central American regions of Latin America.

Development Focus Area

Co-chairs: Paul Hanrahan (AES Corporation), Roberto Salas (GrupoNueva)

Focus Area Core Team: AES Corporation, Anglo American, BP, ERM, GE, GrupoNueva, Toyota

www.wbcds.org/web/development.htm



Secretariat
4, chemin de Conches
CH-1231 Conches-Geneva
Switzerland

Tel: +41 (0)22 839 31 00
Fax: +41 (0)22 839 31 31

E-mail: info@wbcsd.org
Web: www.wbcsd.org

WBCSD North America Office
1744 R Street NW
Washington, DC 20009

Tel: +1 202 420 77 45
Fax: +1 202 265 16 62

E-mail: washington@wbcsd.org