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PROMOTING LOW-CARBON TRANSPORT IN INDIA

Low-Carbon Mobility in India and the Challenges of Social Inclusion:

Bus Rapid Transit (BRT) Case Studies in India

CEPT UNIVERSITY

ज्ञानं विज्ञान महितम्

Centre for Urban Equity

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Low-Carbon Mobility in India and the Challenges of Social Inclusion

Bus Rapid Transit (BRT) Case Studies in India

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Abbreviations

AC	Air-Conditioned
ACA	Additional Central Allocation
AICTSL	Atal Indore City Transport Services Limited
AJL	Ahmedabad Janmarg Ltd.
AMC	Ahmedabad Municipal Corporation
AMTS	Ahmedabad Municipal Transport Services
AUA	Ahmedabad Urban Agglomeration
AUDA	Ahmedabad Urban Development Authority
BEST	Bombay Electric Supply and Transport
BPL	Below Poverty Line
BRT	Bus Rapid Transit
BRTS	Bus Rapid Transit System
BSUP	Basic Services for the Urban Poor
CAGR	Compound Annual Growth Rate
CBD	Central Business District
CDP	City Development Plan
CEC	Commission of the European Communities
CEPT	Centre for Environment and Planning Technology
CMP	Comprehensive Mobility Plan
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon-dioxide
CP	Connaught Place
CPCB	Central Pollution Control Board
CPWD	Central Public Works Department
CS&MC	Central Sanctioning & Monitoring Committee
CSOs	Civil Society Organizations
DDA	Delhi Development Authority
DIMTS	Delhi Integrated Multi-Model Transit System

DMRC	Delhi Metro Rail Corporation
DNA	Daily News Analysis
DPR	Detailed Project Report
DTC	Delhi Transport Corporation
DTS	Delhi Transport Service
ECMT	European Conference of Ministers of Transport
GIS	Geographic Information System
GNCTD	Government of National Capital Territory of Delhi
GoG	Government of Gujarat
GoI	Government of India
GPS	Global Positioning Systems
GVK EMRI	GVK Emergency Management and Research Institute
HCBS	High Capacity Bus Systems
HOV	High Occupancy Vehicle
HPEC	High Powered Expert Committee
HR	Hour
ICTSL	Indore City Transport Services Limited
IDA	Indore Development Authority
IDFC	Infrastructure Development Finance Corporation
IEA	International Energy Agency
IIT	Indian Institute of Technology
IMC	Indore Municipal Corporation
IPT	Intermediate Para-Transit
IPTS	Integrated Public Transport System
ISRO	Indian Space Research Organization
IT	Information Technology
ITDP	Institute of Transport Development and Policy
ITS	Intelligent Transportation Systems
JCTSL	Jaipur City Transport Services Limited
JDA	Jaipur Development Authority
JMC	Jaipur Municipal Corporation
JnNURM	Jwaharlal Nehru National Urban Renewal Mission
km	Kilo Meter

LB-IPTS	Louie Berger-Integrated Public Transport System
LRT	Light Rail Transit
M2W	Motorised Two Wheelers
MCD	Municipal Corporation of Delhi
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoUD	Ministry of Urban Development
MPCE	Monthly Per capita Consumption Expenditure
MPD	Master Plan of Delhi
MRP	Mixed Reference Period
MRT	Metro Rail Transit
NGO	Non Government Organization
NHAI	National Highway Authority of India
NIUA	National Institute of Urban Affairs
NMT	Non-Motorised Transport
NSS	National Sample Survey
NSSO	National Sample Survey Organization
NUTP	National Urban Transport Policy
PCMC	Pimpri Chinchwad Municipal Corporation
PCU	Passenger Car Unit
PMA	Pune Metropolitan Area
PMC	Pune Municipal Corporation
PMPML	Pune Mahanagar Parivahan Mahamandal Limited
PMT	Personal Motorised Transport
PMT	Pune Municipal Transport
ppH	Persons per Hectare
PT	Public Transport
PWD	Public Works Department
RITES	Rail India Technical and Economic Services
ROWs	Rights of Way
RSRTC	Rajasthan State Road Transport Corporation
RTO	Regional Transport Office
SEWA	Self-Employed Women Association
SGA	Sandeep Gandhi and Associates

SIAM	Society for Indian Automobile Manufacturers
SOR	Schedule of Rate
SPV	Special Purpose Vehicle
ST	State Transport
STA	State Transport Authority
TERI	The Energy and Resources Institute
TOD	Transit Oriented Development
TRIPP	Transportation Research and Injury Prevention Programme
UIG	Urban Infrastructure and Governance
UK	United Kingdom
UNDP	United Nations Development Programme
USA	United States of America
USD	United States Dollar
UTTIPEC	Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre
VVIP	Very Very Important Persons
WPR	Work Participation Rate

1. Introduction–Sustainability, Equity and Accessibility Issues in Urban Transport

1.1 Background to the study

Conventional development paradigm considers 'cities as engines of growth', urban development as supporting this goal, and transport as providing support to the 'required level of economic activity'. The first and major urban development initiative in India, the Jawaharlal Nehru National Urban Renewal Mission (JnNURM), also has the same paradigm. Such a development paradigm inadvertently supports approaches to urban transport that focuses on the efficiency of transport systems, through focussing on speed and infrastructure that meets this objective. However, there is now an increasing body of literature that analyses the issue of equitable and sustainable growth in the cities through the development of transport systems that provide accessibility to opportunities in life to the wider population in an affordable way. In this literature, the Bus Rapid Transit System (BRTS) figures centrally as a solution to meeting the needs of equity and sustainability. This is more so because the BRTS is conceived as an integrated system, which includes affordable transport along with infrastructure for pedestrians and cyclists and changes in land use planning, housing policy, road design approach and road space use, and pricing of parking and public transport. Learnings from different approaches to BRTS in different countries carried forward to policy dialogues has resulted in its acceptance as the main public transport mode in many countries, including in India through the JnNURM. Launched in December 2005, the JnNURM covered 63 cities with funds worth USD 11 billion of central assistance with matching grants coming from the state and city governments. The JnNURM was followed by the National Urban Transport Policy (NUTP), 2006, which emphasised safe, affordable, quick, comfortable, reliable, and sustainable accessibility for India's growing number of city residents to jobs, education, and recreation within cities[1]. Since the beginning, about ten Indian cities have shown interest in the idea of the Bus Rapid Transit (BRT) and many of these cities are in various phases of either planning or implementing the system.

Studies available point out BRTS as an important transport option for equitable and sustainable urban growth (Pai & Hidalgo, 2009). Research is available presenting the status of the BRTS and its characteristics in the Indian context (Kishore, 2009) (Pai & Hidalgo, 2009) (Tiwari & Jain, 2010), its technological, institutional, operational and management issues (Pai & Hidalgo, 2009) (Tiwari & Jain, 2010) (Ponnaluri, 2010), its financing (Pai & Hidalgo, 2009) (Tiwari & Jain, 2010), and its contribution to improving mobility (Agrawal, Agrawal, & Chakravarti, 2010). Tiwari and Jain's research (2010) has also paid attention to the integration of the BRT with other modes of transport such as walking, Intermediate Para-Transit (IPT) and Non-Motorised Transport (NMT) modes. The studies looking into the technology and operation of the BRTS have also discussed the designing of the system. However, there are no studies of the BRTS, which have looked at the BRTS's accessibility by different social groups and in particular the urban poor communities. This report attempts to fill this gap by holistically assessing the BRTS in the Indian context and then taking up an in-depth research of the BRTS in Ahmedabad, which is currently the largest network among the BRTSs in India. The research focuses on Ahmedabad BRTS's accessibility for the urban poor on one hand, the modal shift from Personal Motorised Transport (PMT) to the BRTS, (an agenda of great significance for reducing carbon footprint in cities), on the

[1] Source: urbanindia.nic.in/moud/quickaccess/imp_links/nutp.pdf , (accessed in July 2008). The JnNURM (Jawaharlal Nehru Urban Renewal Mission) is a flagship national program for urban development of the Government of India.

other. The study also analyses the urban poor's travel pattern in the city and assesses whether the BRTS addresses their accessibility needs. Before these objectives are embarked upon, the study also contextualises Ahmedabad BRTS within the overall public transport paradigm in urban India. Hence, this report addresses the assessment of the BRTS in India at two levels: at the macro level in terms of assessing the sincerity of different cities and their respective state governments in implementing planned BRTS projects, and at the micro level in terms of the urban poor's accessibility (and that of women amongst them) to the largest BRTS network in India, that is in Ahmedabad. Before that, in this chapter we discuss some of the key concepts on sustainability, accessibility, and travel behaviour of the urban poor and their transport expenditures in Indian cities, and we also discuss the methodological framework adopted.

1.2 Sustainability concept in urban transport

Transport systems are very important for a city's functioning; they provide people access to daily needs and most importantly to work. With increasing incomes and a continuous change in technology, cities have started to rely more on the PMT than public transit due to a lack of development of the latter. Ironically, the idea of movement using PMT is promoted as an idea of 'freedom', borrowing from the American idea of freedom post the Second World War. This idea of 'freedom' being tied to mobility through PMT has inadvertently slipped into the idea of development in the developing countries, including India. The PMT promotion is also driven by an idea of economic growth that promotes consumption, including that of personlised vehicles on one hand, and associated investments - related infrastructure on the other. Many developing countries are looking for high growth through investments in infrastructure and an important example is highways, something that the United States of America (USA) did post Second World War to promote economic growth and something that China has done in the last two decades. However, growing numbers of vehicles cause stress on the existing road and parking infrastructure, increase air pollution, and increase political demand to expand road widths causing demolitions and displacement. Furthermore, the use of modes like walking, cycling and other NMT decreases due to various reasons such as lack of infrastructure for the same and reduction in the sense of safety and security. The automobile-dependent cities experience sprawling structures with development led through land speculation on the periphery. With more investment in transport infrastructure, more and more people choose private motor vehicles and prefer to stay further away from the job-centres. It has been widely realised that dealing with transportation by increasing supply (speeds, road widths, advanced traffic systems etc.) and not regulating the demand is not sustainable.

Such a development paradigm also contributes to climate change through increased burning of fossil fuels and emissions of carbon-dioxide (CO_2). Transport has contributed to 23 per cent of global CO_2 emissions in the year 2006 as per data provided by the International Energy Agency (IEA) (Schipper, Fabian, & Leather, 2009). This situation calls for the need to reduce transport emissions by strengthening the use of public transport and making cities more reliant on modes like walking and cycling. Litman (2011) argues that there has been a paradigm shift in transportation planning from mobility-oriented analysis (which evaluates transport system performance based on quantity and quality of physical travel) to accessibility-based analysis (which considers a broader range of impacts and options with regards to choice of travel mode and time). Conventional mobility-based planning places automobiles (or PMT) at the centre whereas the accessibility-based planning places people at the centre.

The structure of Indian cities is particularly different from that in the West because of their dense and mixed land use. These dense Indian cities do not follow a simplistic structure of central and suburban development but are unique multi-nuclei structures with organically evolved road network patterns. In

most Indian non-metro cities, the average trip lengths are less than 5 km. Thus, the traditional city form in the Indian context has been sustainable, something that is now changing on account of a high-cost, energy-intensive and skewed urban development paradigm that supports only economic growth as against overall well-being. To support such a development paradigm, cities are moving towards a physical sprawl, which is low-density housing development. Providing mobility in this situation requires establishing capital-intensive transport infrastructure, which is pricing out the poor from the transport system as well as from the land market, and in short reducing the accessibility of the poor to urban opportunities. Women of low-income households are the worst affected in this paradigm change.

Inclusive sustainable cities, argues Mahadevia (2001), are the ones which have an 'Inclusive Approach', with the vision of the urban poor and marginal sections at the centre of urban policymaking and which is multidimensional in nature. This is also necessary with regards to looking at transport systems. The mainstream idea of sustainable cities exists only from the environmental/ecological perspective, and has missed out on synergy among the various programmes and certainly on building a people-centred approach to sustainable urban development, argues Mahadevia (2001). This author then goes on to define sustainable cities as 'inclusive' in two senses: inclusive of all sections of people and inclusive of all dimensions of development. It suggests convergence of thinking and actions and convergence of different aspects of development. Only such a development process would address the prime concerns of the poor in a sustainable manner. In other words, development and empowerment of the poor has to take place in such a manner that the environment is protected. If the urban environment deteriorates, it is the poor that are adversely affected first and foremost.

The role of the government, especially the local government, is to see that synergies are built between various development programmes and various actors in the process of development (government and civil society, micro- and macro) level institutions and so on. Hence, the concept of 'Sustainable Cities' rests on four pillars, argues this author: (i) environmental sustainability, (ii) economic growth with redistribution, (iii) social justice (for women and all other excluded sections) and (iv) political empowerment. These have to be simultaneously addressed in the development process, programmes and projects, including in transport projects.

In the case of transport, a sustainable approach will bring forth the voices of groups excluded and marginalised through the dominant transport paradigm of high-speed movement symbolised by PMT. High-speed transport using personal modes marginalises the poor, as they are unable to afford personal vehicles. Another approach to sustainable transport is high-speed public transport, which also forces the poor to spend large amounts on transit. Thus, the poor tend to depend on the NMT modes. This is an important context within which many developing cities are struggling with their transportation paradigm. Their infrastructure having failed to keep up with the ever increasing demand of private motor vehicles, they are now looking at options of providing public transit and regulating the use of PMT. The BRT system emerges therefore in this context of developing countries.

To summarise, sustainability in developing countries can only be achieved by addressing the equity concerns. Equitable distribution of resources in developing societies is essential to make sure that the vulnerable groups continue their low-carbon or sustainable activities instead of switching to high-carbon emitting practices, and to ensure the improvement of their well-being. At the same time, sustainability requires that those dependent on the PMT shift to public transit and NMT. The BRTS has the potential to provide equitable and sustainable urban public transit on account of its low cost relative to the metro, its integrated approach as already discussed, and the possibility of having an extensive over-ground network.

1.3 Concept of accessibility and its various dimensions

Accessibility is a key element in ensuring the social sustainability of the transport sector (ECMT, 2006). Accessibility (or just access) refers to the ease of reaching goods, services, activities and destinations, which together are called opportunities. It can be defined as the potential for interaction and exchange (Hansen 1959; Engwicht 1993).The European Commission's Green Paper on Urban Mobility focused on particularly the vulnerable and their easy access to urban transport infrastructure. In this context, accessibility is defined as that which concerns people with reduced mobility, disabled, elderly, families with young children, and young children themselves (Commission of the European Communities (CEC), 2007).

Accessibility to opportunities such as employment, education, networking, etc., plays an important role in the well-being of urban populations, making transport a very important network infrastructure. This is more crucial for populations that are naturally and socially disadvantaged, such as low-income groups, women, the physically challenged, and the marginal and minority population groups. The disadvantaged populations require access to opportunities much more than the advantaged groups who, by their class, gender and through belonging to a majority group, gain access to all opportunities in life. Transport studies and transportation planning have hardly reflected upon these bi-focal perspectives and hence have failed to understand that transport is as much a social issue as it is technical. Accessible transport opens up opportunities for disadvantaged and marginal populations as well as contributes to their capabilities, both of which are important for the purposes of equity as well as poverty alleviation.

1.3.1 Accessibility as reaching

Litman (2011:1) defines accessibility as people's ability to reach goods, services and activities. "Accessibility can be defined as 'ease of reaching', and the accessibility objective is concerned with increasing the ability with which people in different locations, and with differing availability of transport ('mobility'), can reach different types of facility". (Stantchev & Merat, 2010). Accessibility concept is 'situated', meaning, its definition is location specific, group specific, and activity specific. The groups can be distinguished by gender, class, ethnic affiliation, etc. The notion of 'situatedness' brings in the complementary aspect of equity. Hence, it has to be defined as the ease of reaching the desired destinations at the desired time by the desired mode.

1.3.2 Accessibility as better quality of transit services

There is a concept of improving transit system's accessibility. This concept would cover areas such as: design of vehicles, rolling stock, inter-modal stations, linking residential areas to central trip-attracting activities such as work places, shopping, leisure activities, and serving rural and peripheral areas. Increasingly, concerns for mobility of the differently-abled has brought focus to the definition of 'accessibility' as linked with concerns of people with reduced or constrained mobility. In the context of public transit, the European Commission's Green paper stated that: "In order to be attractive, public transport has to be not only accessible but also frequent, quick, reliable, and comfortable. European experience shows that an obstacle to modal shift from private to public transport is often the low quality of service, slowness and unreliability of public transport" (Commission of the European Communities (CEC), 2007).

1.3.3 Accessibility as affordability

Accessibility means affordability for a large section of developing economies. This is the most crucial aspect of success or failure of a public transit system in developing economies. Stantchev & Merat (2010) also say that there is a need to provide access to transport for lower income residents without cars (in

India without motorised transport) and living in deprived areas and in recent years living in peripheral/ distant locations.

Researchers have suggested that the existing system can be critically assessed by considering accessibility needs separately for those with and without private vehicles or those travelling by PMT and those by public transport. In the same vein, accessibility of the existing system can also be separately assessed from the point of view of special social groups, such as minorities, the poor, women, women from poor households, migrants, etc.

1.3.4 Accessibility and equity links – social inclusion

Our view is that accessibility is also important as an equity concern, that is, for universal access to desired activities at the desired time. The equity objective in transport is concerned with ensuring that the benefits of transport strategies are reasonably equally distributed, or focused particularly on those with special needs. Among the latter may be included lower income residents, those without private vehicles, elderly and disabled people, and those living in deprived areas. The equity objective is also concerned with avoiding a deterioration in accessibility, safety and the travel environment.

There is another concept of 'social inclusion' which largely discusses the equity issues in transport. Social inclusion issues in transport are concerned primarily with accessibility or lack of it for those without a car in the Western context (Stantchev & Merat 2010: 11). In a wider context, social inclusion in transport has to be pegged with broader social inclusion policies which deal with inclusion of specific social groups in the process of development. Hence, social inclusion discussions in general, and now even in the transport sector in particular, focus on the processes of exclusion of certain urban population segments from the benefits of urban growth. However, the Western concept of social inclusion may not explain the Indian situation fully as the nature of barriers are different in Indian cities, which is discussed further in the following section.

To summarise, if any transport system is to achieve equity or social inclusion by increasing its accessibility universally, then it needs to meet the following objectives:

1. Cost effectiveness – affordable pricing of the systems
2. Safety – against physical accidents, against personal violence
3. Minimised environmental impacts
4. Improve well-being through reducing drudgery, increasing leisure time and comfort during travel through low or no crowding
5. Linkage with livelihood
6. Route frequency and passenger stops to board or alight within certain distance or time of walking
7. Reliability in times of bad weather, for example monsoons in India
8. Disabled-friendly

1.4 Evidences of transport expenditure from Indian cities

In order to further understand the accessibility and equity issues of transport in Indian cities, the National Sample Survey (NSS) data has been analysed to understand the consumption and expenditure pattern of the urban poor. Affordability for transport is very low in urban India. First, the average monthly expenditure of an urban household is only ₹ 7,686 (USD 171) (in 2009-10) an increase from ₹ 5,136 in 2004-05 (USD 114) (NSSO 2006 and 2011). Of this, 39.2 per cent in 2009-10 is spent on food items (Table 1.1). This is a decline from 42.5 per cent in 2004-05. Items that have registered increase in expenditure in this five-year period in terms of percentage share are clothes & footwear, education, consumer durables and rent. In fact the share of education in total expenditure has increased from 5.0 per cent in 2004-05 to 8.7 per cent in 2009-10, a significant increase on account of privatisation of education in the urban areas. An increase in consumerism can be observed from the increased share of clothes & footwear and consumer durables. There is only a marginal increase in the share of medical expenditure and a slight decrease in the share of conveyance expenditure. The latter may be on account of households deciding to spend more income on the education of children rather than on transport and hence the earning members probably shifting to low-cost or no-cost transit options. This low share of conveyance in total household expenditure is maintainable only if there is a close relationship between the residence and place of work.

Table 1.1 Monthly per capita consumption expenditure (MPCE) (MRP[2]) distribution (2004-05 & 2009-10)

Item	2004-05			2009-10		
	Value (₹) (per capita)	Value per hh.*	%age	Value (₹) (per capita)	Value per hh.**	%age
Food	447.4	2183.4	42.5	727.49	3012.64	39.2
Non food	605.0	2952.2	57.5	1128.52	4673.36	60.8
- Fuel & light	104.6	510.5	9.9	142.76	591.19	7.7
- Clothing & footwear	49.3	240.4	4.7	118.34	490.06	6.4
- Education	52.7	257.1	5.0	162.19	671.65	8.7
- Medical	54.6	266.4	5.2	98.79	409.10	5.3
- Durables	42.8	208.9	4.1	92.61	383.51	5.0
- Conveyance	68.6	334.7	6.5	115.21	477.10	6.2
- Rent	59.5	290.1	5.7	117.81	487.87	6.3
- Taxes & cesses	8.5	41.5	0.8	15.98	66.18	0.9
- Other items	164.4	802.5	15.6	264.83	1096.70	14.3
Total	**1052.4**	**5135.5**	**100.0**	**1856.01**	**7686.00**	**100.0**

* Average Household size is taken as 4.88 persons (NSSO 2006)

** Average Household size taken is 4.14 persons (NSSO 2011)

Source: NSSO (2006 and 2011).

[2] It is also referred to as Mixed Reference Period (MRP). Two schedules were canvassed for soliciting information on consumption expenditure, one that asked data for the reference period of last 30 days and one that asked for last 365 days. The MRP is the measure of MPCE obtained by the Consumption Expenditure Survey (CES) when household consumer expenditure on items of clothing and bedding, footwear, education, institutional medical care, and durable goods is recorded for a reference period of "last 365 days", and expenditure on all other items is recorded with reference period of "last 30 days". (NSSO 2011).

Table 1.2 Expenditure pattern of bottom 40% and top 20% of urban population, 2004-05 and 2009-10

Item	2004-05				2009-10			
	Value of bottom 40% (₹)	Value of top 20% (₹)	Bottom 40% (%age)	Top 20% (%age)	Value of bottom 40% (₹)	Value of top 20% (₹)	Bottom 40% (%age)	Top 20% (%age)
Food	281	762	58.4	31.9	446	1254	53.6	29.6
Non food	200	1627	41.6	68.1	387	2979	46.4	70.4
- Fuel & light	62	186	12.9	7.8	89	250	10.7	5.9
- Clothing & footwear	13	136	2.7	5.7	61	243	7.3	5.7
- Education	12	153	2.5	6.4	31	511	3.8	12.1
- Medical	0	57	0.0	2.4	33	261	3.9	6.2
- Durables	3	184	0.6	7.7	15	336	1.8	7.9
- Conveyance	14	208	2.9	8.7	25	336	3.0	7.9
- Rent	12	174	2.5	7.3	20	365	2.5	8.6
- Taxes & cesses	3	19	0.6	0.8	6	40	0.7	0.9
- Other items	81	510	16.8	21.3	107	638	12.9	15.1
Total	481	2389	100.0	100.0	833	4233	100.0	100.0

Source: NSSO (2006 and 2011).

A disaggregated analysis of consumption expenditures by percentiles tells us the problems of poverty. While the share of food in the total expenditure has reduced to 39 per cent in 2009-10 for the whole urban population, for the bottom 40 per cent of the urban population, it still remains above 50 per cent (Table 1.2). The bottom 40 per cent households can be considered as poor. For the top 20 per cent, share of food in total expenditure is just 30 per cent. For the poor, the food share in the expenditure has declined by 4.9 percentage points. Clothing & footwear (4.6 percentage points increase), medical expenses (3.9 percentage point increase), education (just 1.3 percentage point increase) and consumer durables (1.2 percentage point increase) have registered a fast increase in the expenditure budget of the poor. There is very little change in the share of conveyance in the total household expenditure of the poor households. Share of fuel and light and other items has declined for the poor. Noteworthy is a significant increase in the share of medical expenses, and that this item and increased consumerism have crowded out the education and transport expenditures. Also of note is that the overall urban population has registered a very high increase in education expenditure share, a phenomenon which is not observed among poor households.

In contrast, the top 20 per cent, or the rich households, have registered the largest increase in the share of education expenditure (an increase by 5.7 percentage points). Transport expenditure has registered a decline of 0.8 percentage points and medical expense has registered an increase of 3.8 percentage points. It seems that the rich have made full use of privatisation of education while the poor continue to remain with low-cost public education in the urban areas. The rising healthcare costs have impacted both the poor and the rich, and among the former, transport and education expenditures have been pushed out along with other expenses.

The transport demand thus is determined by more factors such as healthcare and education expenditures, than merely transport costs and the urban poor are unable to increase their transport demand on account of a rise in healthcare expenditure and an increasing culture of consumerism. This implies that the poor would continue to prefer to stay near their place of employment, send their children to nearby schools so that the transport costs are minimised and consult private doctors in the vicinity to cut transport costs rather than visit public hospitals at a distance.

The poor are caught in a vicious cycle of poverty. Low shelter security and a denial of citizenship add to the problems of accessing basic facilities. This leads to low education and skills and hence consequently poor quality employment. They are pushed out of the city and forced to incur high costs of access, mostly in cases where squatting within the city is not permitted (which is the situation in metro cities now). This also leads to poor access to water and sanitation affecting their health. They are paying for shelter security (protection money), water access, education and health at a much high percentage of their income than the non-poor. One severe illness to a member of the household and they are pushed into a debt trap (which is also due to lack of institutional finance). These adjustments are made while spending about 50 per cent on food (Table 1.2).

The 2001 population census of India also collected data on urban assets, including on vehicle ownership. The data showed that 46.0 per cent of urban households in India owned a cycle; 24.7 per cent owned a motorised two-wheeler, 5.6 per cent owned motorised four-wheelers and 19.0 per cent of urban households did not own any vehicle[3]. Those not owning any vehicle would be either walking or depending on public transport/para-transit. In all, just 30.3 per cent of all households in India owned motorised vehicles.

Any new technology brings with it higher costs for travel. For example, Tiwari (2001, p. 8) says that: "Phasing out of older buses and introduction of compressed natural gas buses may reduce pollution levels in the city initially, however, new clean technology buses would be more expensive which may force many bus commuters to shift to using two-wheelers which is more polluting and less safe". The new BRTS introduced in Ahmedabad has a 150 per cent higher fare than the older Ahmedabad Municipal Transport Services (AMTS) buses, making the BRTS beyond the reach of certain households as we will see in subsequent sections.

1.5 Travel behaviour of the poor in Indian cities

The urban poor form a substantial proportion of Indian urban populations, and they are often dependent on low-cost (and low-carbon) mobility involving human-powered transport or public transport (when affordable), to access their livelihood and other needs in the city (Badami, Tiwari, & Mohan, 2007). But, in case the public transport is not affordable or available, then the urban poor depend on whatever services are available or trade their time for lack of affordability or availability. They can afford fewer

[3] http://www.censusindia.gov.in/Tables_Published/H-Series/H-Series_link/S00-020.pdf

trips and most of these are necessary ones for the purpose of maintaining livelihoods. Since they depend on human-powered transport, they prefer work and other facilities within walking distance and choose informal housing options for work accessibility. Informal housing causes considerable hardships, which they are willing to bear in the absence of accessibility options. This is truer for women among these groups, and also children and elders cutting across all social groups.

The studies conducted amongst low-income residents of Pune (Astrop, 1996) and Delhi (Anand & Tiwari, 2006) illustrate that considerable differences exist between males and females in terms of access to, and the use of, the various travel modes on offer. Females are much more likely to walk or take the bus, and this may be linked to the types of journeys they make, e.g., local shopping trips and escorting children to school.

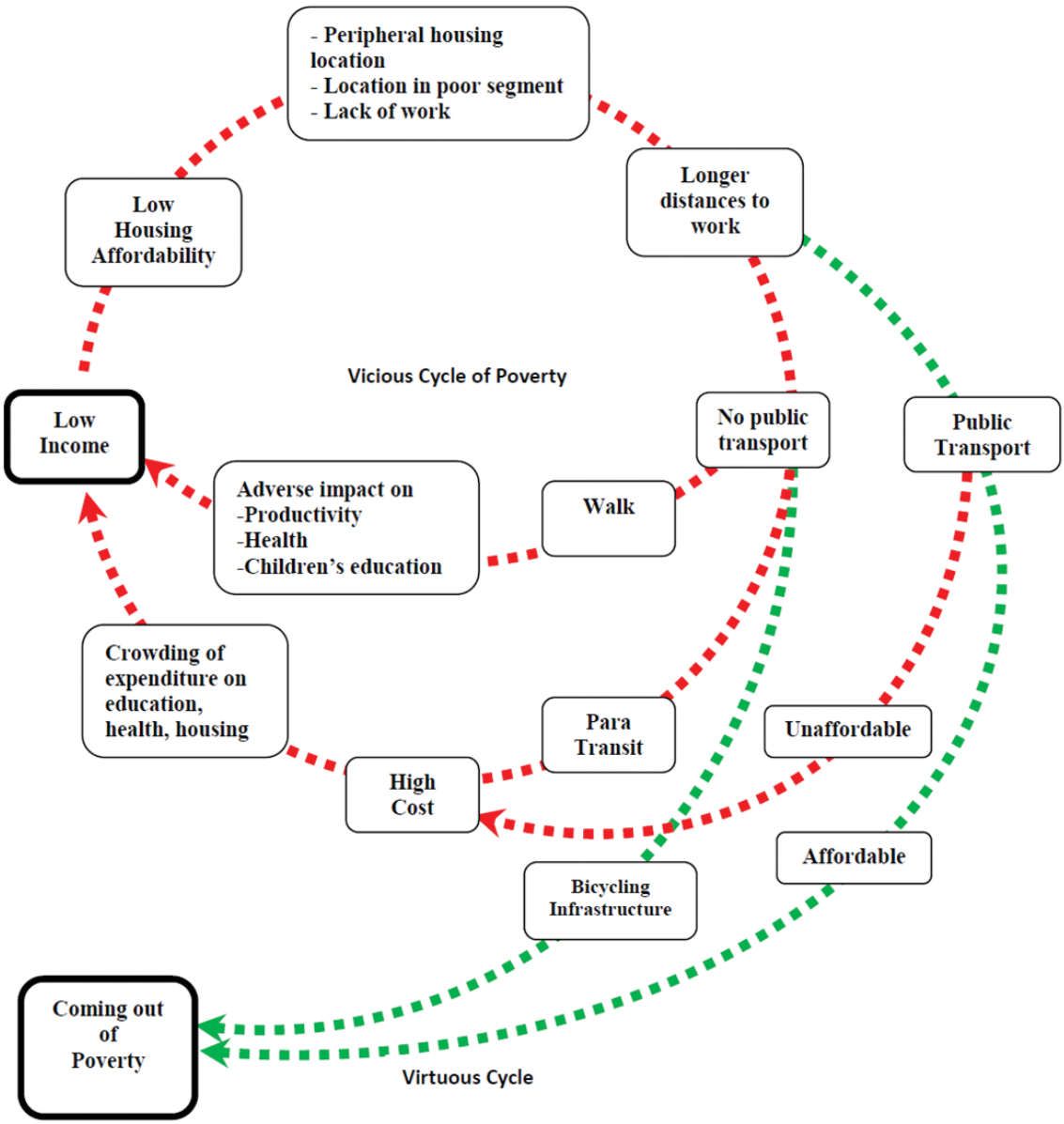
The urban poor households tend to trade various items of the consumption basket against each other to balance their budgets. First, they prefer to stay within or near the city centre or places of employment such as industrial areas to access work, which is the first priority in deciding housing location. In such locations, basic services may or may not be available. They then start upgrading their housing and improving their lives if they are not uprooted on account of evictions. In cases where they are uprooted and pushed to marginal areas, their lives begin afresh. These marginal areas are devoid of basic services, and thus their struggle to improve their lives restarts. Without basic services there are higher chances of falling ill, and owing to a lack of access to public healthcare services their health costs rise, which was observed in the previous section. They would then trade-off other costs. They do not trade education expenditures. In fact, in cases of displacement to marginal areas, household education costs increase as they have to send their children to private rather than public schools.

Mahadevia and Gogoi (2010) find these trade-offs in the public housing sites for the urban poor located on the city's periphery in the case of Hyderabad. This could be true for other cities as well. The poor, when relocated on peripheral sites, reduce their expenditure on travel by the men taking to cycling and women dropping out of the labour market. This reduces family income and pushes the family back into poverty. Consequently, in case of illness in the family, if healthcare costs are not affordable (which is the case in India on account of the lack of affordable healthcare), then the family pays attention to selective ailments for selective members of the family, and the ailments of women and girls are often not in the selected category. As a consequence also, women drop out of the labour market. Since public transport is not available in the marginal areas, men may also use paratransit, which pushes up the travel costs and some other substitutions occur in the family's consumption basket. The other scenario is that the poor choose to live in informal settlements near their place of work. In that case they trade-off their shelter security, which then prohibits access to social security schemes, and this in turn reduces their access to associated subsidised healthcare and other schemes.

As mentioned above, given that the bottom 40 per cent spent only 3.0 per cent of their total expenditure on transport, walking and cycling remain the only options. For those who experience the inconvenience of displacement, further inconvenience awaits due to the non-availability of safe cycling and walking infrastructure. Hence, they are also more prone to accidents, more often than not fatal. When the poor households are forced to expend large proportions of their incomes on transport, they enter into a vicious cycle of poverty. Their access to employment declines, which keeps their incomes low.

Women's mobility and accessibility needs have to be specially considered. Women's responsibility of the social reproduction sector means that they need their workplaces close to their place of residence. They also need flexible work timings, which requires work-travel at off-peak hours. Very poor women, such as those engaged in domestic work, often work in multiple places. They may have to make trips that are off the main routes. Furthermore, social reproduction sector responsibility means engaging in multiple activities and hence multi-leg trips, which requires travel mode options that are affordable for multiple journeys. This leaves no other option but NMT. In the Indian cultural context, which is mainly walking.

Figure 1.1 Schematic links of accessibility and poverty



Source: Prepared by the authors

The journey to work may be long, as the poor may opt for low-cost and hence often slow transport modes when they cannot walk to work. Then they tend to spend large amounts of time travelling to work. When the slow transport modes do not have good frequency, which is often the case, they tend to spend time waiting. The poor therefore are also "time-poor". Needless to mention, women are more time-poor than men. Their time-poverty demands that they look for work at shorter distances from home. Their ability to contribute to the alleviation of their standard of living and their status in society is severely curtailed by their limited mobility and the constrained accessibility to the transport system of the city (Anand & Tiwari, 2006).

Srinivasan & Rogers (2005) analyse the differences in travel behaviour between two low-income settlements in Chennai in contrastingly different locations – one near the city centre and the other on the periphery. Residents in the centrally located settlement were more likely to use NMTs for travel (walk or bicycle) than the peripherally located residents who were dependent on the irregular and crowed bus-based public transit. Location appears to be significant in travel behaviour for the low-income residents of Chennai who have few transportation choices. Interestingly, the women in both the locations had the highest modal share of walking. The poor depend heavily on NMT like walking and cycling as their primary mode of travel (Srinivasan & Rogers, 2005). Lastly, they also found that residents in both the locations expressed equal concern about the quality of public transportation and its cost. While they appeared not to be concerned about pollution due to buses, they were concerned about safe pedestrian and bicycle facilities" (p. 266).

1.6 Summarising transport and equity issues

As seen in the previous section, the disadvantaged groups face many mobility barriers in Indian cities (as in other developing countries) and there are severe consequences. These barriers emanate from (i) the structures of the cities, which tend to be segmented, (segregating populations along class, caste and religious basis in Indian cities), (ii) city morphology in the sense of the location of activities and their relationships, (iii) paradigm of transport, consequent modes chosen and their governance mechanisms, and costs of transport, (iv) costs of other goods and services emanating from the macroeconomic situations and (v) cultural factors that determine gender, caste and class relations. The canvas is full of complex relationships and consequently the analysis of mobility requirements of different social groups also have to respond to this complexity.

1.6.1 Planning barriers

Influenced by the paradigm of modernisation, city planning has segregated work places and residential places, increased travelling distances and facilitated high-resource use. The stress is on preparing the land use plans (as master plans) instead of integrating land use and transport plans or preparing integrated plans. It is assumed that modernisation means inevitable motorisation (domination of motorised modes over cityscapes) while viewing the NMT modes as pre-modern and thus not futuristic. Modernisation has also led to specialisations and hence the mobility concerns, viewed as technical, have been assigned to the domain of planners and engineers and poverty concerns assigned to public affairs and social policy (Clifton, 2003). Physical access to transport infrastructure for the success of the social policy is rarely seen as a concern of the transport planners. Transportation is neither linked with the land use plans or social policies in Indian cities.

1.6.2 Cost barriers

The other barrier to improving accessibility is that of the costs, which is very important in the context of developing economies in general and the poor in both developing and developed economies. The costing depends on fiscal instruments such as taxes and subsidies on fuel used, taxes on other components of motorised vehicles and the costs of using transport infrastructure such as tolls on roads and parking.

Furthermore, the costs of public transit in particular, which in essence is a lower carbon option than the PMT modes, are dependent on who is funding it and the extent of subsidies, if at all, in the system. For example, the national government funds are larger than those of local governments, and hence the former is able to give larger subsidies than the latter. The source of funding of public transit, namely land given as equity (as in Chinese cities), public investments, low-interest public loans, commercial borrowings and private equity, decide the pricing of public transit. Among the array of financial instruments, public investments require the least whereas the private ones require the highest returns. The financial model determines the pricing of a public transit, which in turn determines the target population for a public transit. Or the other way around; the affordability of a target group should define the fare structure and by that the financing model for a public transit. In turn, the financial model should decide whether the public transit would be rail based or bus-based, as each transit system option has a specific cost structure. If the public transit is unaffordable, which is the case with regards to the poor, then they will continue to walk or cycle or use informal transport.

Transport affordability affects travel demand and accessibility as well as mobility. The poor in Indian cities have low affordability for transport and hence poor women are 'no choice pedestrians' and poor men are both 'no choice pedestrians and/or no choice cyclists'. Any increase in travel costs often leads to the poor households in general, and women in particular, pushing out other essential expenditures such as healthcare expenditures. If that is not possible, the working members drop out of the labour market. Women certainly do, as we find from now large number of studies on displacements which indicate that women drop out of the labour market if pushed to the city's periphery. This in turn induces poverty in the household. Men shift to cycling long distances to avoid transport costs, which has an adverse impact on their health.

The implications of affordability on transport planning are:

1. Affordability affects accessibility.
2. Affordability is especially a problem for lower-income workers.
3. Affordability can be improved by reducing user costs (vehicle purchase costs, fuel prices, transit fares, etc.), by improving infrastructure for more affordable modes (such as walking, cycling and public transit), and by increasing land use accessibility.
4. Location affects transport affordability. Lower-income residents in automobile-dependent locations tend to spend an excessive portion of their income on transport.

1.6.3 Socio-cultural barriers

Socio-cultural barriers are also important in determining accessibility. In general, in all cultures, women are the home-makers and care givers and they therefore have the dual responsibilities of taking care of the home (social reproduction sector) and bringing income into the family in the cases of low income

households (production sector). Even if 'feminist services' such as crèches or care-givers for the older family members are available, the very fact that it is typically women who nurture infants and hence have to be close to their homes, decides their choice of work locations.

In most cultures, women hold an inferior status and also lower education levels than their male counterparts. Hence, women tend to work in low-wage or low-paid jobs leading to less control over financial resources. This also means they have lower affordability for transport than their male counterparts. Some cultures do not permit women to move out independently, restricting their accessibility to employment as well other opportunities, and also decide on their dress code which makes them use only certain transport modes. Hence women may then use public buses if available or motorised or non-motorised para-transit modes for their mobility. Lack of affordability for any of the above modes can force them to walk with either severe implications on their mobility and accessibility or their health.

Lastly, the transport paradigm itself determines the level of accessibility. For example, a transport paradigm that only looks at mobility and speed would invest in infrastructure that is motorised, thereby discouraging investments in infrastructure for NMT modes that are predominantly used by the poor. Providing infrastructure for NMT modes, in situations of narrow roads, can reduce road space available for motorised transport creating a situation of conflict for road-space access. If the transport paradigm decides in favour of mobility, it would stress expansion of space for motorised transport, thus pushing out the NMT. Then, the accessibility to various opportunities gets reduced for the urban poor. The equity concerns in transport therefore look at these various barriers in greater detail than is normally done in conventional transport planning.

The above sections of this chapter outline how concepts such as sustainability, accessibility and equity are interlinked in the transport sector in particular, and urban development sector in general. The national government in India, through its urban mission and the new transport policy, is promoting comprehensive transportation planning and funding mass rapid transit systems. These policy initiatives need to be seen from the perspective of sustainability, accessibility and equity. Based on these over-arching concepts the following section of this chapter discusses the research framework to assess various BRT projects in Indian cities.

1.7 Research framework and approach

The overarching concepts of sustainability, accessibility and equity need to be translated into the framework of assessing various BRT projects. From the perspective of accessibility and equity, it is important to find out who are the users of the BRT, who can afford the BRT services and how inclusive it is as a system. From the perspective of sustainability, it will be important to know the shifts from the PMT to the BRTS and the quality of NMT infrastructure built as part of the BRT system.

The research first contextualises the development of the BRTS in Indian cities against the global discussions on BRTS as a more affordable public transit system than the capital-intensive and high-cost metro systems, and the preference of BRTS in comparison to the normal bus-based public transport system. This brings us to the public policy context in India and a discussion on the National Urban Transport Policy (NUTP) of 2006 as an outcome of these debates. Nationally, the JnNURM has been the key trigger for cities to start preparing the BRTS proposals for funding under the JnNURM. A number of cities have proposed BRTS and are in various stages of development.

The first major component of the study is the assessment of the BRT system in various Indian cities. The cities of Pune, Delhi, Jaipur and Indore, where the BRT efforts have started since 2005, have been selected for brief assessment of the BRT system in India. These have therefore been discussed briefly as a context of assessment of BRTS. This macro analysis indicates the government's sincerity in pursuing the low-cost and low-carbon public transit system in India. It also points out the bottlenecks in the system. The following issues are discussed in the rapid assessment of the BRT projects in different Indian cities:

1. The urban planning context of the BRT project
2. Transport characteristics of the city
3. The status of the BRT project in terms of implementation and operations
4. User opinion
5. Systems bottlenecks and policy barriers

The second major component of the study is the detailed assessment of the Ahmedabad BRT system, which is the most extensive network in India today. The assessment of the BRTS is from the perspective of inclusiveness and a modal shift towards public transport from the PMT. The inclusiveness here is defined as how accessible the BRT system is to various income groups, what are the preferences for transport or demand patterns of the poor in particular, and what is the quality of the walking and cycling infrastructure along with the BRT corridors. The research attempts to answer two key questions: (i) is the BRTS accessible to the urban poor and has it improved the overall accessibility to the city for the urban poor as a consequence, and (ii) has the BRTS led to a modal shift in favour of public transport that addresses climate change objectives?

To answer the two research questions, the following objectives were laid out:

1. To find the profile of the BRTS users in terms of their sex, income, occupation and age
2. To find out the distances traversed and mode used to access the BRTS
3. To observe whether modal shift has occurred in the case of BRTS users and the extent and direction of this shift
4. To assess the quality and usability of the NMT infrastructure along the BRTS corridor
5. To assess the travel demand and pattern of the urban poor in Ahmedabad city and their reflection on the demand for the BRTS in this group

As the objectives clearly reflect, the focus of the assessment is the social inclusiveness and sustainability of the system. This assessment would not limit itself to the technology selected or design options of the BRTS, although both would impact the cost of BRTS travel and accessibility. These issues have been covered in the general discussions of the BRTS in India.

The term 'urban poor' can be quite vague if not properly defined. We have selected slum locations as a proxy of urban poor and surveys were canvassed in the slum communities of Ahmedabad to fulfil objective number five. This objective answers research question one. The BRTS user survey answers

both the research questions and is met through the first three objectives of the study. To cover research objective four, a separate assessment of the NMT infrastructure was carried out.

1.7.1 Methodology for the BRT users survey for Ahmedabad BRTS

Ahmedabad BRTS is managed by an entity called 'Ahmedabad Janmarg Ltd (AJL) and the system is also called the Janmarg. At the time of our survey, this system had 61 operational stations spread over a 39 km-long stretch. The first route is from the Regional Transport Office (RTO) to Maninagar and the other is from RTO to Naroda (Figure 1.2). The two routes have a common carriageway until the Danilimda Crossroads. The first route is a one-sided loop which starts from Kankaria Telephone Exchange, and ends there, after taking a full round around the Maninagar area, connecting the Maninagar Railway Station.

Three major criteria were used for selecting stations for survey. These were: (i) boarding data, (ii) urban poor households in the catchment area and (iii) importance of the station with regard to its connections with other transport nodes like the Ahmedabad Municipal Transport Services (AMTS), which is the public transport authority of the city, Railway Station and State Transport (ST) stations. Samples were selected from both the major as well as the minor stations. Stations were also selected from even the loop service which has stations for buses going in one direction. The boarding data published by Janmarg as well as from our quick surveys were used to decide the distribution of the total sample.

A total of 18 stations were selected for the primary survey (Table 1.3), where 1,040 questionnaires were canvassed, of which 624 (60 per cent) were taken at peak hours (8.30 am to 11.30 am and 5.30 pm to 8.30 pm) and 416 (40 per cent) at non-peak hours (the rest of the time). The survey process was spread over two weeks. More than one day was required for surveys at stations with large sample sizes. The surveys were not carried out during the weekends, which would have a very different composition of users. A short one-page questionnaire was devised so that it could be filled in during the waiting time of a passenger. A round of pilot surveys were conducted to correct the sequence of questions, and calculate if the form could be completed in the waiting time.

Figure 1.2 Janmarg's operational route and bus stations

Source: Prepared by the authors

Table 1.3 Station selection for survey and sample distribution

Station Name	No. of Samples	Peak Hour	Non Peak Hour	Urban poor households in catchment area	Major Station	Interchange station
RTO Office	224	134	90			S.T., IPT, AMTS to BRTS
Akhbarnagar	135	81	54	Yes	Yes	Interchange to AMTS
Memnagar	101	61	40		Yes	
Shivranjini	84	51	33		Yes	
Nehru nagar	24	14	10		Yes	
Anjali Crossroads	55	33	22	Yes		
Danilimda Char-Rasta	82	49	33	Yes	Yes	BRTS Interchange to Naroda Route
Chandola Lake	10	6	4	Yes		
Narol	14	33	22	Yes	Yes	
Isanpur	41	25	16	Yes		
CTM Cross Road	19	12	7	Yes		
Rabari Colony	7	4	3	Yes		
Sonini Chali	12	7	5	Yes		
Hirawadi	17	10	7	Yes		
Swaminarayan College	43	24	17		Yes	
Kankaria Lake	41	25	16		Yes	City-Level Park
Maninagar Railway Station	101	61	40		Yes	Interchange to Maninagar Railway Station
Meera Cinema Char-rasta	7	5	3	Yes		
	1040	624	416			

Source: By authors

The user survey questionnaire (see Annex A) solicited information on the sex, income, age, occupational details and vehicle ownership of the users, distance travelled, cost incurred and mode selected to reach BRTS and to reach the destination from BRTS, distance travelled on the BRTS, mode used prior to the BRTS and whether the users undertook the journey at all prior to the BRTS. Information on the suggestions for the system were also solicited. The data would make us analyse not only the user profile and the modal shift but also how important the BRTS was to the current users in terms of the share of this new system in their total travel cost and distance.

1.7.2 Methodology for the non-motorised transport (NMT) infrastructure survey

The NMT survey was carried out through physically moving along the corridor and recording the observations through mapping, photographs and videos. Observations with regard to width of the cycle lanes and footpaths, their quality, ease of navigating through them and obstructions were made. The obstructions were divided into two categories,

1. Permanent obstructions (tree, stall, temple, poles, structure for electric lines, transmitter box, building encroachment, sewerage cap)
2. Moving obstructions (parking, moving cart, group of people, cows, temporary structure)

The first level of analysis was to observe whether width of the footpath or the cycle track was as per the provision in the Detailed Project Report (DPR). It was realised at the onset that the actual infrastructure varied from what was stated in the DPRs In many places, it was observed that the footpaths were less than half a metre or even narrower in width. We did not consider these to be adequate footpaths. Similarly, the cycle tracks of less than 2.2m width were considered inadequate. The data thus collected were transferred to a Geographic Information System (GIS) map, from which the following were calculated:

1. The total length of the bicycle lane and footpaths provided along the BRTS corridor
2. Length of the footpath suitable for walking
3. Length of the bicycle lane suitable for cycling
4. Length lost due to obstructions mapped on the bicycle tracks and footpaths

1.7.3 Methodology for the survey of travel demand and pattern of the urban poor

The survey of the travel demand and pattern of the urban poor was carried out to assess the travel demand and pattern of the urban poor in Ahmedabad City and their reflection on the demand for the BRTS and other city-level transport initiatives. This was an important component to determine the inclusiveness of the BRT services in particular and the transport system of the city in general.

The city of Ahmedabad has about 710 slum settlements with varying population size, land ownership (public or private) and years of existence within the municipal limits. The population in these slum settlements is about one million people. Two important tasks of sampling were involved here: first, selecting the slum settlements, and second, selecting the households as samples within the given settlement.

Selecting the slum settlement – Three criteria

Based on a hypothesis that 'slums located in differing distances from the city centre would have different characteristics', the slum settlements were categorised as the core city[4] and peripheral settlements. It

[4] Here the 'core city slums' category would be broad enough to include the central city slums and the intermediate slums. In the case of Ahmedabad, the 'central city' means the historical walled city and the 'intermediate slums' means the slums developed in the periphery of historical walled city after industrial expansion in the city. Today, there are blurring boundaries between the two.

was also decided to select the settlements based on varying distance from the city centre in different directions to ensure unbiased spatial representation.

The Ahmedabad Municipal Corporation (AMC) has carried out surveys of the 'Below Poverty Line[5]' (BPL) households in all the slums distributed in different zones and wards (sub-set of zones) in the year 2009-10. This database includes a listing of households (as BPL or otherwise) in different slums for each of the city wards. This was the latest database available and it was used for sampling. Moreover, taking settlements from different municipal zones would ensure spatial distribution of the settlements in different directions (in addition to the core, intermediate, peripheral categories), given that Ahmedabad has geographically distributed inequities.

Beyond the spatial distribution and distance from the city centres, slum settlements in Ahmedabad can also be categorised as established slums, industrial suburbs' slums, walled city slums and rehabilitation sites. While selecting the settlements, it was ensured that these categories were covered. Inclusion of the rehabilitation sites was important as many poor people were displaced by various development projects, some of which are not rehabilitated fully but many of them were given public housing in recent years.

To summarise, the slum settlements in Ahmedabad were selected representing three criteria:

1. Distance from the city centre (core or peripheral)
2. Spatial distribution determined by municipal zones (north, south, east, west, etc.)
3. Slum typologies (established slums, industrial suburbs' slums, walled city slums, rehabilitation sites)

Selecting households within the slum settlements

The first step of conducting the survey was to make a profile of each settlement. This profile would map the settlement in spatial segments (based on a satellite image) such as lanes, bylanes, open space, etc. On the satellite image, social groupings within the settlement (based on caste, sub-caste or religion) and housing conditions (temporary, semi-permanent and permanent structures) were marked. For the overall settlement, stratified random sampling was employed which represents unbiased spatial representation by including every 'nth' house in the survey covering all the streets or clusters of the selected settlement.

While selecting the samples, the permanent structure houses were proactively avoided assuming that housing conditions are a proxy of income and poverty levels. Practically, only about 5-10 per cent of houses were permanent structures in the selected slums of Ahmedabad. It was also ensured that all the social groups were represented in the given settlement. Samples varied between 5 and 10 per cent of households depending upon the size of the settlement. However, a minimum of 30 households were

[5] There are many controversies and debates around identifying and estimating numbers of poor people in the Indian public policy and social sciences. A recent example has been the planning commission of India filing an affidavit in the supreme court that the official 'poverty line' should be the income of ₹ 32 /person/day for the urban areas. The BPL (below poverty line) surveys are based on poverty line as per the year 2009 at ₹ 20 /person/day.

selected in each settlement (including the smaller settlements) to arrive at statistically significant samples (Table 1.4).

Table 1.4: Sample for transport demand survey of urban poor

	Name of Major Settlements surveyed	Slum settlement type/location	Ward	Zone	No of BPL hh in settlement	Sample
Core City Slums						
1	Municipal quarters	Central core	Shahpur	Central	310	29
2	Khanpur darwaja	Central core	Khanpur	Central	500	47
3	Baba Lavlavi Nagar, Ramjimandir ni chali	Southern Core city	Baherampura	South	750	64
4	Lalluram na chhapara, Damodar ni chali, Rami ni Chali	Eastern Core city	Rakhial	East	1,097	98
					Total	**238**
Periphery/intermediate slums						
5	Hanuman Nagar, CTM	Industrial suburban South-Eastern Periphery	Bagefirdos	South	320	29
6	Santoshinagar n-a chhapara	Industrial suburban Northern Periphery	Naroda-muthiya	North	1040	52
7	Yogeshwar nagar-1	Western periphery	Vasana	West	450	29
8	Sanjay Nagar Na Chhapara	Western intermediate	Naranpura	West	975	59
					Total	**169**
Relocation-Rehabilitation sites						
9	Ajit Mill Ni Chali, Rakhial	Core city Rehabilitation	Rakhial	East	704	30
10	Balol Nagar BSUP	Western Rehabilitation	Near Akbar Nagar	West	640	35
11	BSUP Housing, Trikampura	Eastern Rehabilitation	Jasodanagar	South east	672	54
12	Ganesh Nagar, Piplaj	Temporary rehabilitation site (south)	Piplaj	South	600	54
					Total	**173**
					Grand Total	**580**

Source: BPL data from http://www.egovamc.com/bpl/SUMMARY_REPORTS/ZONEWISE.pdf (accessed on March 31, 2011)

2. Global Debates on BRT

2.1 The advent of BRT

Interestingly, almost all the cities which took to Bus Rapid Transit (BRT) as a mass transit option before the last decade started their thinking of Public Transport with metro trains, and in the long run found that the investments required for constructing a metro rail system were too large to afford and hence this system was an unaffordable prescription for cities of the world. It was also realised that the metro train-based public transport has been possible in cities receiving especially large funding from their respective federal governments, who tend to have vast financial resources as compared to local governments.

Almost all the cities in the world have relied on one or the other kind of bus system due to its lower investment requirements and greater flexibility in operations. Hence, public transport systems everywhere have begun with bus systems owned by private and/or government organisations meeting the public transport needs of the city. Looking at this reality, cities began to reserve spaces on roads for the bus system and that idea has taken root in the form of dedicated bus lanes. The idea has been to ensure uninterrupted bus movement on the road to decrease the travel time for this mode of public transport users. The idea seemed attractive in situations where road congestion had become a way of existence. The new system thus created is called the BRT system. Now the BRT system, which is reserving road space for buses, has been replicated in many cities across the world with various local variations.

The idea of BRTS has come to India after successful experience of the system in two Latin American cities, Bogotá and Curitiba, whose BRT systems have been referred to as 'full BRT systems' by the Institute of Transport Development and Policy (ITDP) (Institute for Transport Development and Policy (ITDP), 2007, pp. 13-14). The BRT system was a hope for cities like Curitiba, where mayors found investment for a mass rail transit system too expensive. The BRT system has been described as "probably the most important innovation in public urban transport since the invention of the trolley car in the 1870s" (Gakenheimer, 2008). There is a realisation now that buses offer mass-transit, and an effective system design of a city's bus system can give similar comfort and efficiency as a metro rail system.

2.2 A history of bus rapid transit systems

The basic philosophy behind the BRT system is giving priority to the buses on the road, which are otherwise stuck in the mixed traffic on account of congestion, so that large numbers of people are transported in the city in one go in the fastest possible way. This could be done by giving a dedicated lane to the buses on the road. This, it is believed, would inconvenience commuters using PMT, who would then shift to the public transit system. Causing inconvenience to PMT users is a good way to shift regular commuters to public transit option.

The history of the BRT system started with giving buses separate lanes on highways. In 1966, the first dedicated busway was constructed in St. Louis, United States of America (USA) and in Liege in Belgium. These busways were a result of converting existing tramways to bus ways. In 1969, the first high-speed busway of 6.5 km length was constructed on the Shirley highway busway in North Virginia, USA. In 1971, the first busway of the United Kingdom (UK) was opened in the city of Runcorn. The first busway in a

Latin American country was opened in Lima, the capital of Peru, in 2006 and was called 'Via Expresa' that covered a distance of 7.5 km. In 1972, London's Oxford Street was converted to a bus-only street. (Institute for Transport Development and Policy (ITDP), 2007, p. 22). In 1973, the 11 km El Monte Busway was developed in Los Angeles. The first promising project citywide BRT system was that of Curitiba's, which features 65 km of exclusive busways and 340 km of feeder service buses. Curitiba also made subsequent changes in the land use along the BRT corridors to trigger Transit Oriented Development (TOD) with the logic of getting sustained ridership for the BRT system. Many other Brazilian cities also followed Curitiba's example and developed and constructed basic systems; for example in, Sao Paulo (1975), Goiania (1976), Porto Alegre (1977), and Belo Horizonte (1981). Sao Paulo's BRTS is currently the longest in Latin America with 142 km of exclusive busways serving over 2 million passenger trips each day (Institute for Transport Development and Policy (ITDP), 2007, p. 23). Globally, Jakarta (Indonesia) has the longest BRT network in the world with 172 kms of exclusive network[6].

In 1980, Essen city in Germany opened the first guided busway, as an alternative to the Light Rail Transit (LRT) system. It was a technological innovation which used slide guide wheels to control vehicle movement within a track roughly the width of the bus. In 1986, Adelaide in Australia also tried to replicate the BRT system with guided buses on segregated corridors, and then the cities of Ipswich and Leeds in the UK followed suit with similar kind of systems in the year 1995. Bradford, another city in the UK, opened up a guided busway in 2002 (Institute for Transport Development and Policy (ITDP), 2007, pp. 22-24).

The ITDP has propagated many BRT systems in the world. After the success of the BRT project in Bogotá, called the Transmilenio, it started promoting the Bogotá model as a 'full and ideal BRT System'. Opened in the year 2000, Transmilenio is one of the most comprehensive BRTSs in the world today, which looks at the BRT corridor as an urban design project integrating footpaths, cycle tracks and parking provisions. The idea is to improve the mobility of people as a whole rather than certain social sections. In the year 2007, Transmilenio had 6 trunk corridors of a length of 84 km, with 107 stations. The average distance between stations is 500 m., total number of passenger trips per day account to 1,450,000 and peak hour ridership is 45,000 people per hour per direction, which is as good as any metro rail system. (Institute for Transport Development and Policy (ITDP), 2007).

Cities in Asia also followed suit and started planning and construction of dedicated busways and BRTSs. In 1999, Kunming developed the first median busway system in China as well as in Asia. Nagoya in Japan also promoted an advanced bus system in the early days. Since 1980, it has been running a BRT-like bus system. It has introduced coloured lanes in the Central Business District (CBD) as bus-only lanes in the peak hours. In 2001, the city started its first guided busway system which is 6.8 km long and is elevated above the road in order to reduce the traffic congestion on the existing parallel road (Ieda, 2010, pp. 135-138). Thirteen major cities in China namely, Beijing, Changzhou, Chongqing, Dalian, Guangzhou, Hangzhou, Hefei, Jinan, Kunming, Yancheng, Xiamen, Zaozhuang, Zhengzhou have developed BRTSs in the last years of this decade (Table 2.1). In the year 2010, 120 cities in the world had BRTS and bus corridors. The total number of BRT corridors in the world was 280, with a total length of 4,335 km (Hidalgo et al., 2010).

[6] Source: http://esci-ksp.org/?project=transjakarta-bus-rapid-transit, (accessed on October 2, 2012).

Table 2.1 BRTS projects added in the year 2010

Name	Corridors	Km.	Stations	Buses	Passengers/ Weekday
Guangzhou BRT, China	1	22.5	26	800	800,000
Hefei BRT, China	2	12.7	14	65	65,250
Yancheng BRT, China	1	8.0	21	20	20,000
Zaozhuang BRT, China	1	33.0	24	20	20,000
Jaipur Bus, India	1	7.1	10	20	6,200
Trans Hulonthanlangi, Indonesia	3	90.0	84	15	1,920
Tans Musim, Indonesia	2	60.0	69	15	1,920
Batik Solo Trans, Indonesia	1	30.0	35	15	1,920
Bangkok BRT, Thailand	1	15.9	12	20	10,000
East London Transit, UK	1	20.0	40	18	9,000
Corredor de Ônibus de João Pessoa, Brasil	1	2.5	5	111	100,000
Transmetro, Barranquilla, Colombia	1	13.4	15	92	32,000
Metrolinea, Bucaramanga, Colombia	1	8.9	24	131	75,000
Mexibus, Estado Mexico, Mexico	1	16.0	32	63	63,000
Metropolitano, Lima, Perú	2	27.0	35	627	160,000
Züm, Bradford, Canada	1	28.5	17	15	7,500

Source: Hidalgo, Gutierrez, & Lindau, Status of the BRT Industry, 2010

2.3 Types of BRTS

From the available literature, the BRTS can be categorised into two major types: (i) Full BRTS and (ii) High Capacity Bus Systems (HCBS). In other words, these systems can also be called Closed Systems and Open Systems of BRT.

2.3.1. Full bus rapid transit system

There is a section of researchers and policymakers who prefer metro rail-like infrastructure and service quality in bus systems, i.e strongly dedicated central median lanes with centralised on-station ticketing and systems following a trunk route, fed by other feeder networks and smooth interchanges. They project BRTS as a 'closed' and exclusive system. After the success of Transmilenio in Bogotá, this model of BRT is being increasingly placed on the centre stage as one of the most effective ways to improve the public transport systems of cities. The ITDP has called such systems 'Full BRT systems', which provide exemplary levels of public transport service and incorporate the most critical characteristics of BRT, which, at the minimum are:

1. Segregated busways or bus-only roadways over the majority of the length of the system's trunk/ city centre corridors
2. Location of the busways in the median of the roadway (rather than in the kerbline)

3. Existence of an integrated network of routes and corridors
4. Enhanced stations that are convenient, comfortable, secure and weather-protected and provide level access between the platform and the vehicle floor
5. Special stations and terminals to facilitate physical integration between trunk route feeder services and other mass transit systems, if available
6. Pre-board fare collection and fare verification
7. Fare and physical integration between routes, corridors and feeder services
8. Entry to the system restricted to the prescribed operators under a reformed business and administrative structure (closed system)
9. Distinctive marketing identity for the system

Source: Institute for Transport Development and Policy (ITDP), 2007, p. 14

According to ITDP (2007), there are only two truly full BRTSs in the world, one in Bogotá, Columbia, and other in Curitiba, Brazil.

2.3.2. The "Transmilenio"

The story of Transmilenio Bogotá's initial success lies not in it being a public transport system but in the inclusive planning approach taken to address the real requirements of the city. The origin of "Transmilenio" was rooted in the idea of social change, which Mayor Enriquè Penalosa called a "Demarginalisation Mega project", whose investment thrust was on urban infrastructure inclusive of transport, land use and housing in such a way that those outside the formal development and living in marginalised neighbourhoods and social groups gained equitable access to all infrastructure including housing. Bogotá spent a budget of US$ 800 million in three years to construct 110 km of local roads, 2,300 km of drainage, 6 hospitals, 51 schools, 51 parks, 4 major public libraries, legalising 32 informal neighbourhoods by 2000 and extending basic services in all recognised informal settlements. Petrol taxes were increased to 20 per cent from 14 per cent, to fund the infrastructure. On-street parking was discouraged by non-provision of parking spaces and removing the existing ones. Car-free evenings and car-free days were promoted as a celebration of walking and cycling in public spaces. Exclusive streets for walking and cycling were planned. NMT modes were promoted and connected with the bus system by providing Ciclorutas that are dedicated bicycle roads, and by providing cycle parking at BRT stations (Cox, 2010). It is evident that the root of success of Transmilenio were pro-people and inclusive policies and not the transport system alone.

Transmilenio has become a cornerstone in the history of urban public transport in Colombia. In its origin, Transmilenio itself mimicked the experiences of Curitiba and Quito, but it introduced some novelties that have become its trademark (Echeverry, Ibanez, & Hillon, 2004), about which there is not much reflection in others imitating it. Currently, at least five Colombian cities above 500,000 population have applied for central government resources in order to replicate the system implemented by Bogotá. Other cities in Latin America too are planning to follow suit. The idea of BRTS is being pushed in other countries by showcasing the success of Transmilenio, which has become a path-bearer to other cities in the developing world for implementation of BRTS. Despite the inclusive genesis of Transmilenio, promoted as a 'Full BRTS', the definition of 'Full BRT' available now stays silent on the necessary inclusion of NMT facilities into the system.

Detailed studies have been conducted to assess the functioning of the Transmilenio in Bogotá and the benefits provided by the system. There are problems of overcrowding in the system and people have to queue outside the stations for up to 15 minutes during peak hours, alleging that the buses have been turning into 'sardine cans'. On 9 March 2004, the users of the Transmilenio walked out of the stations and sat on the busways complaining about the low level of service. More recent surveys however record low levels of dissatisfaction on account of system improvements through increasing the numbers of buses operation. Nevertheless, 89 per cent of those consulted in 2007 thought that the main weakness of Transmilenio was overcrowding (Gilbert, 2008).

The low level of services of Transmilenio is being attributed to the then Mayor's office not taking interest in promoting and upgrading the system. The subsequent mayors after Penelosa have not been particularly favourable to Transmilenio and have been interested in developing a metro rail system and hence deliberately scuttling the functioning of Transmilenio. However, strong citizens' pressure groups and civil society organisations (CSOs) have constantly demanded infrastructure for sustainable modes. Their efforts have not only made certain projects happen but they have also created a political constituency whose support the local politicians seek. The Transmilenio example also shows that a transport system is built and sustained by continuous efforts and improvements triggered by institutional arrangements. Although individual leadership matters in bringing about the first big change, the subsequent developmental process needs stronger institutional procedures.

Currently, there are doubts about the Transmilenio system being socially equitable. The main problem is that the fare for the combined Transmilenio journey is higher than that for a single journey on regular buses, and in July 2007, the difference amounted to 300 pesos or 27 per cent during a normal working day. The transportation often takes a considerable share of the household budget for low-income families of Bogotá. In July 2007, when the fare was raised to 1400 pesos (USD 0.73), 20 return journeys a month cost 12.9 per cent of the minimum wage in Bogotá. Today, the combined cost of these 20 journeys exceeds the transport subsidy added to the minimum wage of formal sector workers by 10 per cent. The latest rise means that Transmilenio fares have risen by 27 per cent in 30 months, a period during which the minimum wage (plus the transport subsidy) has risen by less than 14 per cent. If rising fares are discouraging people from using the new system, the number of passengers per bus km will fall, and automatically trigger new fare hikes. This could easily turn into a vicious downward circle for Transmilenio (Gilbert, 2008).

2.3.3. High capacity bus systems (HCBS) or open BRT

Another idea for a bus-based rapid transit is to be found in High Capacity Bus Systems (HCBS). It is an 'open system' characteristically defined as a fully integrated, bus-based 'rapid' transit system utilising a highly flexible service and advanced technologies to improve customer convenience and reduce delays. It combines most of the qualities of light rail transit with the flexibility and lower operating, maintenance, and capital cost of buses. HCBS vehicles can operate on exclusive travelways, high occupancy vehicle (HOV) lanes, expressways, or ordinary roadways in almost any dense urban environment. In addition, HCBSs can combine Intelligent Transportation Systems (ITS) technology, traffic signal priority; rapid, limited stop service; clean, quiet, and aesthetically pleasing vehicles; enhanced shelters and stops; rapid and convenient fare collection; and facilitated integration with existing and future land use policy.

The HCBS provides a wide array of options for integrating various systems. High-speed express buses can operate on the same route as regular buses. To enable this, overtaking facilities have to be provided only at those stops which are to be skipped by the express buses. Buses entering the HCBS route from

other routes can also provide faster travel on this section (TRIPP, 2002). The following features typically characterise a HCBS system:

1. Exclusive travelways
2. Modern stations
3. Modern buses
4. Rapid service
5. Automated fare collection
6. ITS technologies
7. Lower costs

HCBS can contribute to a city's complete bus system rather than creating an exclusive entity which runs buses on a dedicated corridor. The basic concept behind HCBS is to take buses out of the mixed traffic so that public transport (PT) can enjoy speeds equal to a mixed traffic. This means an exclusive feeder system is not required and buses can use high capacity corridors in one part of the route and mixed traffic in the other. Roads that have a higher concentration of parallel-running bus routes can be provided with bus lanes to make bus movement swifter. The bus lanes then become a corridor. Even if a corridor is created, the HCBS can offer more flexibility in terms of vehicles used on them. So the approach here is to work with 'what is given' and not build an exclusive bus system from scratch. One improvement that can be thought of in the future is to introduce buses that have wide doors like a suburban train coach, so that several passengers can alight or board simultaneously, thus decreasing dwell time.

HCBS planners in India stress the inclusion of dedicated bicycle tracks, pedestrian facilities and spaces for vendors on the roads, as without these the concept of public transit is incomplete. The system should be able to improve not just the ease of commuting but also road edges, which are often ignored for the sake of private transport ease. A relatively small investment in bicycle tracks would increase the road space for motorised traffic by 50 per cent on 3-lane roads, resulting in better space utilisation, as the same sized lane can carry more cycles than cars per hour (Tiwari, 2002).

The key to the success of the BRT is a wholehearted commitment. To make it a successful system, it should be implemented with the same efficiency that characterises a rail system, with no compromise regarding the right of way, or Very Very Important Persons (VVIP) vehicles or taxis (Patel, 2006). In the case of the 'HCBS' model, the design of junctions and infrastructure is very crucial as the openness of the system adds complexities to the design elements. Meeting the transport needs of the poor requires more attention to the roles of the informal sector and of NMT as these are employment-generating sectors as well and would fulfil the goal of poverty alleviation.

2.4 Conclusion

This chapter traces the history of the emergence of the idea of the BRT in the context of the existing transit problems in different cities of developing countries. It has a long history of about 50 years. But, the idea caught on in the developing countries because of the cities having limited budgets and the national governments having limited financial capacity to fund capital intensive metro systems. They begun experimenting with the BRTS in their specific context, which has resulted in 120 cities all over the

world opting for this system, of which 13 are in China and about 8 are in India. This has not meant that the attraction to metro systems has declined, as illustrated by the experience of Bogotá's world famous system Transmilenio, where the politicians continue to prefer metro over the BRTS. This relates more to the preference of politicians worldwide for capital intensive projects over systems that are incremental and less capital intensive.

There is a raging debate between the Full BRTS (Exclusive BRT) v/s HCBS (Open BRT), with both sides extolling their respective virtues. The full BRT gives complete control to the managing agencies to regulate the bus stops, corridors, junctions, etc., whereas the HCBS model requires better coordination between various agencies, better implementation capacity and regular operational maintenance of the system elements. It is possible that the governing bodies find the exclusive BRT model easier to deal with given its control points are well-defined. The challenge for the exclusive model is its integration with the existing and regular bus (or other transit) services in a city. Conversely, the HCBS model is required to give a better level of service to public transit users as compared to their regular bus experience in terms of access, timings, comforts, safety, etc. The other difference between the two systems is cost in terms of the total project as well as to the individual commuter. The Full BRTS is more expensive than HCBS and this itself can be a determining factor in system selection.

Looking at the global experience, it is important to understand that no single PT system can cater to all the needs of transit in any city. Further, different existing and proposed transport systems need to be integrated with each other in terms of physical access, fares/ticketing, institutions and social marketing in a city. BRTS therefore should not be seen as one pre-fixed system, and cities should be given a chance to adapt it according to their own needs. The BRTS should also be developed after a total public transportation plan of the city is worked out, integrated with land use and housing plans and not as a standalone system. The BRTS should provide easy access to commuters and should also remain affordable for the economically disadvantaged, as they are most dedicated users of bus systems in the cities. BRTSs have to be developed as inclusive systems accommodating the concerns of NMT users and the informal sector, as that is the need of many cities in developing countries. Only then will these cities have a dependable and affordable public transit system.

3. BRTS in the Indian Context

3.1 The urban transport situation in India

While the population of India's six major metro cities went up by 1.9 times during the period 1981 to 2001, the number of vehicles multiplied by over 7.75 times during the same period (Ministry of Urban Development, 2007). The total number of registered motor vehicles increased from about 0.3 million as on March 1951 to about 142 million as on 31 March 2011. The total registered vehicles in the country grew at a Compound Annual Growth Rate (CAGR) of 9.9 per cent between 2001 and 2011. In the last decade the growth rate of registered motor vehicles was almost three times the growth rate of the road network in India. The share of buses including omni-buses in total registered vehicles declined to just 1.1 per cent in 2011 (Transport Research Wing, 2012). This poses a great challenge for India's transport sector and existing infrastructure to cope with the ever-increasing number of motor vehicles on Indian roads.

The modal split across different categories of cities in India is given in Table 3.1. It is quite evident that walking and cycling still constitutes 42 per cent of the trips in Indian cities, and the public transport share is 16 per cent, which is higher in cities above 4 million. Walking, cycling and public transport constitute 74 per cent of all trips in cities with population above 8 million, and 57 per cent in cities above 4 million. It is quite important to note that a large number of people are already using low-carbon transport modes, and the challenge is to retain them by properly facilitating these modes on roads in urban India.

Table 3.1: Modal share in cities of India (2007)

City Category according to Population	Walk	Cycle	2W*	Public Transport	Car	IPT
Category 1a (< 0.5 million, Plain Terrain)	34	3	26	5	27	5
Category 1b (< 0.5 million, Hilly Terrain)	57	1	6	8	28	0
Category 2 (0.5-1.0 million)	32	20	24	9	12	3
Category 3 (1.0-2.0 million)	24	19	24	13	12	8
Category 4 (2.0-4.0 million)	25	18	29	10	12	6
Category 5 (4.0-8.0 million)	25	11	26	21	10	7
Category 6 (Above 8 million)	22	8	9	44	10	7
Total	**31**	**11**	**21**	**16**	**16**	**5**

*2W= 2-Wheelers like Scooters and Motorcycles.
Source: (Wilbur Smith Associates and Ministry of Urban Development, 2008), pp. v.

In spite of the fact that Indian cities have been dominated by the low-carbon transport modes traditionally, the number of private motor vehicles are growing day by day. With increasing household incomes and escalating industrial-commercial activities, there has been a rapid growth in motor vehicles in Indian cities (12 percent per annum in the past two decades), turning more and more people to personalised modes (Wilbur Smith Associates and Ministry of Urban Development, 2008). The rising number of private

motorised vehicles poses obvious challenges to conventional bus-based public transport as the former slow down the latter on the roads.

3.2 Public transport in India

The public transport situation in India is like that of many other developing countries in the world. A study by the Ministry of Urban Development (2008) confirms that public transport systems in Indian cities have not been able to keep pace with the rapid and substantial increases in demand over the past few decades. Bus services in particular have deteriorated and their modal share has further reduced as passengers have turned to personalised modes and intermediate public transport (such as three-wheelers and taxis), adding to traffic congestion, which in turn has adversely impacted bus operations (Wilbur Smith Associates and Ministry of Urban Development, 2008). Moreover, urban transport improvements were perceived as road and flyover construction only, which did little to improve the mobility of all and instead, have brought more personal motorized transport vehicles on the roads, leading to clogging of streets.

Metropolitan cities in India like Mumbai, Delhi and Kolkata run PT services borrowed from the British legacy. Trams were one of the low-carbon public transport modes running in the cities that were closed down due to various reasons. Mumbai's tramways were closed in 1964 after the advent of a suburban railway system, while Kolkata's Calcutta Tramways Company Ltd. still runs trams in the city but in a completely fragmented manner. Mumbai's suburban rail system is one of the biggest in India and carries about 6.2 million passengers every day, and the buses of Bombay Electric Supply and Transport (BEST) carry a further 4.6 million passengers. Together they account for 88 per cent of the total passengers in the city. It is reflected in over-crowded suburban trains that carry around 4,000-5,000 people per train when compared to their design capacity of 1,800 to 2,200 persons (Nallathiga, 2010).

In 2007, the average modal share of PT in 21 Indian cities with populations of 0.05 million to 8 million was found out to be just 27 per cent. PT share in Indian cities with populations above 8 million was 44 per cent, and in cities with populations of 4 million to 8 million was just 21 per cent in the same year (Wilbur Smith Associates and Ministry of Urban Development, 2008). Most cities do not have the financial and technical capabilities to fund and develop mass rapid transit projects on their own. With low per capita income and 27 percent of its urban population living in poverty, India has been forced to keep its PT fares extremely low. This has sharply restricted the operating revenues of all public transport systems, making it difficult to afford even routine maintenance and vehicle replacement, let alone system modernisation and expansion (Pucher, Korattyswaroopam, & Ittyerah, 2004).

3.3 The national policy context for low-carbon mobility

The transport sector in India consumes about 16.9 per cent of total energy, and 80 per cent of the total emissions from this sector are from road transport (The Energy and Resources Institute (TERI), 2006). Another study states that the road transport sector has contributed 94.5 per cent and 53.3 per cent of total transport sector's carbon dioxide (CO_2) and carbon monoxide (CO) emissions, respectively (Ramachandra & Shwetmala, 2009). It is therefore important to understand that investments in transport in India require an insight into low-carbon transport initiatives. The Government of India, through the JnNURM, which is a 7 year mission, has embarked on large investments in metro and capital cities of India from 2005 to change their face through infrastructure development, governance improvement and housing and basic services for the urban poor. The mission had two components handled by two different ministries of the Central Government: the Ministry of Urban Development (MoUD) handling the

Urban Infrastructure and Governance (UIG) component and the Ministry of Housing and Urban Poverty Alleviation (MoHUPA) handling the Basic Services for the Urban Poor (BSUP) component. The mission is in its last months, and up to the end of 2011 it had committed an Additional Central Allocation (ACA) of ₹ 280.34 billion (USD 6.2 billion) in 537 projects across 31 states and union territories, out of which ₹ 153.39 billion (USD 3.4 billion) (54 per cent) have been released (MoUD, 2011).

In 2010, 24.2 per cent of funds under the UIG component of the JnNURM were given for transport-related projects, out of which 13.3 per cent was for roads, 8.66 per cent for mass transit and the rest for parking and other small transport projects. Yet this outlay of funds was considered grossly insufficient by the High Powered Expert Committee (HPEC) on Urban Development, which suggested an outlay of at least 56 per cent, given the transport infrastructure deficiency of Indian cities. But investments in road infrastructure without taking into account the needs of pedestrians and cyclists, which are low-carbon transport modes, could make roads the exclusive domain of those with private motorised vehicles, particularly four-wheelers. Cities have remained uninterested in laying the infrastructure for pedestrians, cyclists and users of NMT (Mahadevia, 2011).

India introduced a National Urban Transport Policy (NUTP) in 2006, which has promoted public transport and low-carbon mobility in India. The NUTP is a progressive policy in tune with international thinking about sustainable transportation and climate change concerns. Its objectives are to: (i) bring about a more equitable allocation of road space to various users with people, rather than vehicles, as its main focus; (ii) encourage greater use of public transport and NMT modes by offering central financial assistance for this purpose and (iii) enabling the establishment of multi-modal public transport systems that are well-integrated, providing seamless travel across modes (Ministry of Urban Development, 2007).

The public transit technologies are either rail-based (metro, tram, mono-rail) or road-based (bus systems). The idea of BRT was also one such way to induce equity in allocation of road space. Rail-based transport systems are too expensive to build. Hence, the NUTP has emphasised the BRTS because of its cost-effectiveness. In the Indian context, this can be shown by comparing the cost of the Delhi metro project with BRTS. The cost of the Delhi Metro Rail Corridor, Phases I and II, is ₹ 29,702 crore (USD 6.6 billion) (Singh, 2011), which is almost equal to the total central allocation of UIG for 64 cities in India, and has been utilised to develop a transit network of about 190 km at an approximate cost of ₹ 155 crore (USD 34.4 million)/km of metro network. With the same amount of money, about 2,900 km of BRT network could have been developed in many Indian cities. This was the reason why BRTSs have been promoted under the UIG component of the JnNURM as a low-cost solution for a better PT system.

BRT as an argument is also linked with NMT systems which are indeed zero-carbon and walking-cycling are the best access-egress modes for a public transit system. The success of Bogotá also lies in the fact that walking and cycling were given much more importance on roads compared to private vehicles like cars and two-wheelers. The whole right of way was treated like an urban design or street design project instead of just a traffic-based design, and this approach is suitable for Indian cities on account of the 42 per cent share of walking and cycling in 30 cities of various sizes studied as mentioned earlier (Wilbur Smith Associates and Ministry of Urban Development, 2008). World over, cities are investing more and more to increase the 'critical mass' of cycling and walking. The challenge in Indian cities is to retain the high share of walking and cycling. A good outcome expected out of these BRT corridors across various cities is the improvements in NMT infrastructure at least along BRT corridors, as it was mandatory for cities to build and integrate them if they were to apply for central funding for the BRTSs. In 2011, 10 cities in India had BRT corridors at various stages of development and operation.

3.4 BRT projects in India

The advent of JnNURM brought financial assistance to the cities for the implementation of BRTS projects. At least 50 per cent of the financial assistance has been provided by the Government of India, and the rest has to be managed by the cities and the states.

In 2011, 9 cities in India had received funds under JnNURM for construction of BRTS projects (Table 3.2) and there are operational BRT corridors of various sizes and types in the cities of Ahmedabad, Jaipur, Vizag, Pune and Delhi. Ahmedabad has the largest operational BRTS corridor to date and is growing. It is now seen as an example by other cities to learn from its preliminary success. Delhi's BRT corridor of 14.6 kilometres is not funded by the JnNURM, but by the Government of National Capital Territory of Delhi (GNCTD). BRT corridors across India also follow different designs of corridors, mainly following two models, the Bogotá model of exclusive BRT or a HCBS with a dedicated bus corridor allowing all kinds of buses inside it. BRTSs in India have a long way to go, adapting and improvising according to the context. An enquiry into the prevailing bottlenecks is therefore important.

Four BRT projects were selected by our research team to initiate an enquiry into their processes of planning and implementation, and the challenges before them. These were in Delhi, Pune, Jaipur and Indore. While the BRTS corridor in Indore is still under construction, the rest each had a different model. The study of Indore gave us an idea of the major bottlenecks faced by the cities in implementing the BRTS agenda. Delhi, Pune and Jaipur BRTSs are assessed and analysed on the basis of their planning context, operations and bottlenecks in planning. The fieldwork for this study was carried out in July, 2011.

Table 3.2 Approved BRTS projects under Jawaharlal Nehru National Urban Renewal Mission (JnNURM)

S.no.	City	Approved Km.	Sanctioned cost (in ₹ billions)	ACA (in ₹ billions)
1	Ahmedabad	88.50	9.82	3.44
2	Rajkot	29.00	1.10	0.56
3	Surat	29.90	4.69	2.34
4	Bhopal	21.71	2.37	1.18
5	Indore	11.45	0.98	0.49
6	Pune & Pimpri Chinchwad	124.77	13.64	6.82
7	Vijaywada	15.50	1.53	0.76
8	Vizag	42.80	4.53	2.26
9	Jaipur	26.10	2.19	1.10
	Total	389.73	40.84	18.95

Source: Ministry of Urban Development, 2008, p. 5

On the whole, we found that many of the cities that wanted to build BRTs were also those that already had an existing bus system like Pune Mahanagar Parivahan Mahamandal Limited (PMPNL) in Pune and Ahmedabad Municipal Transport System (AMTS) in Ahmedabad.

3.5 Delhi BRTS

Delhi is the capital city of the country and major regional hub of trade and commerce in Northern India. Delhi's morphology involves dispersed economic centres all over the city with surrounding residential areas, resulting in short trip lengths. The city-level transport system is a combination of bus transport, a suburban rail system and now a metro rail. Inspite of a large bus fleet, the PT is unable to serve the whole city and lacks reliability and comfort. Although the availability of cheap public mass transit has now increased, private vehicles have observed rapid growth leading to congestion on city roads. Delhi's population growth is still high at 2.4 per cent per annum, reaching 16.3 million in 2011[7]. In the previous decade the population growth rate was even higher and hence the demand for transport, private as well as public, has been increasing.

Delhi's public transport system came into existence in 1948 with the formation of the Delhi Transport Service (DTS) under the Ministry of Transport, Government of India (GoI), and then shifted under the Municipal Corporation of Delhi (MCD) in 1958. In 1971 the Central Government took over and the Delhi Transport Corporation (DTC) was formed under the Delhi Road Transport Laws Amendment Act to improve its performance. The DTC was then transferred to the GNCTD in 1997 with a fleet size of 2,636 buses and a total loss of ₹ 21,230 million so that it could obtain funds from financial institutes and improve its working. However, by 2003-04, DTC's accumulated loss increased to ₹ 24,200 million after its transfer to GNCTD (Gupta & Savant, 2010), contrary to expectations.

3.5.1 The planning context of BRT

The road network in Delhi is 28,500 km, which has increased from 8,380 km in 1971-72. The road network in Delhi is a ring and radial pattern, with all the radials converging at Connaught Place (CP), making it a focal point. These radial and ring roads are the major arterial roads and 50 per cent of these roads have speeds of less than 30 km during peak hour (DoUD and IL&FS Ecosmart Limited, 2006). Large signalised intersections on these roads create congestion and long travel time inspite of flyovers in many locations. The people of Delhi increasingly rely on the use of personal transport due to the lack of an integrated public transport system and inadequate and unsafe infrastructure for pedestrians and cyclists. The City Development Plan (CDP) of Delhi recommends banning parking on the arterial roads as this leads to road congestion and increased travel times.

The Master Plan of Delhi (MPD), 2021, states that the city's transport system is known for its traffic congestion, poor air quality and road accidents, which are expected to worsen. The Master Plan recommends therefore to improve the mass transportation system by integrating the different modes, mainly the road-based with rail-based transport, for the ease of the commuters. It also recommended to integrate IPT with the PT system, with the former acting as the feeder to the latter. It also recommended encouraging non-polluting modes by providing separate cycle and pedestrian lanes along with making rentable cycles available at different locations throughout the city (Certes Realty Limted, 2011).

The idea to improve the bus system was inspired by events way back in 1995, when the Central Pollution Control Board (CPCB) started a study to reduce the pollution in Delhi and a subsequent study by the transport department for the safety of cyclists, for GNCTD. In 2002, DTC along with the Infrastructure Development Finance Corporation (IDFC) and Society for Indian Automobile Manufacturers (SIAM) organised an international workshop in Delhi, which came to a consensus to build BRTS in Delhi.

[7] Source: Population Census of India, 2011, from http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural-UrbanDataSheets_paper2.pdf; (accessed on 31 August 2012).

A committee was formed to study the sustainable transport option for the city and this committee recommended a dedicated central lane on six corridors for BRTS. In 2004, the Rail India Technical and Economic Services (RITES) was given a contract to develop a DPR along with construction details for the first corridor. An order was also placed for the first six low-floor buses. In 2005, GNCTD organised another international conference to examine the design, and the suggestions of the experts were incorporated. The BRTS was first termed a 'High Capacity Bus System'. In 2006, the GNTCD established the Delhi Integrated Multi-Modal Transit System (DIMTS), a Special Purpose Vehicle (SPV) to oversee the establishment of public transport systems in Delhi. In 2006, the construction of the first corridor started (TRIPP, 2008). The planning for the Delhi metro system had already started in 1998. But, it was decided to go ahead with BRTS arguing that the most developed cities in the world, in spite of having well-developed metro networks, also have bus systems that cater to a large number of people as compared to metro (Kishore, 2009).

The DIMTS has the task of not just coordinating the entire public transport system of the city but also of attracting private bus operators. Towards this purpose, it has recently launched a scheme based on a cluster system, wherein the bus routes are divided into 17 clusters for both public and private operators in a ratio of 60:40 (DIMTS, 2009). DIMTS is taking care of the operation, maintenance, monitoring, specification and standards for the buses and the performance of the staff. Apart from these, RITES is the project management consultant, and Transport Research and Injury Prevention Programme (TRIPP) of the Indian Institute of Technology (IIT) Delhi is the technical and conceptual advisor. GNCTD and IDFC are the financiers with equities of 50:50.

The main agencies involved in managing the transport sector in Delhi are:

1. State Transport Authority, which does registration of vehicles and routing of public transport services
2. Public Works Department (PWD) of the Municipal Corporation of Delhi (MCD), which constructs and maintains roads
3. DTC, which is the operator of the public bus system
4. Delhi Development Authority (DDA), which constructs roads in newly planned areas
5. National Highway Authority of India (NHAI), which constructs and maintains National Highways
6. Delhi Metro Rail Corporation (DMRC), which is responsible for the Metro Rail
7. DIMTS, which is a joint venture by Delhi government transport department and IDFC, and has been created for operation and management of new BRTS corridors.

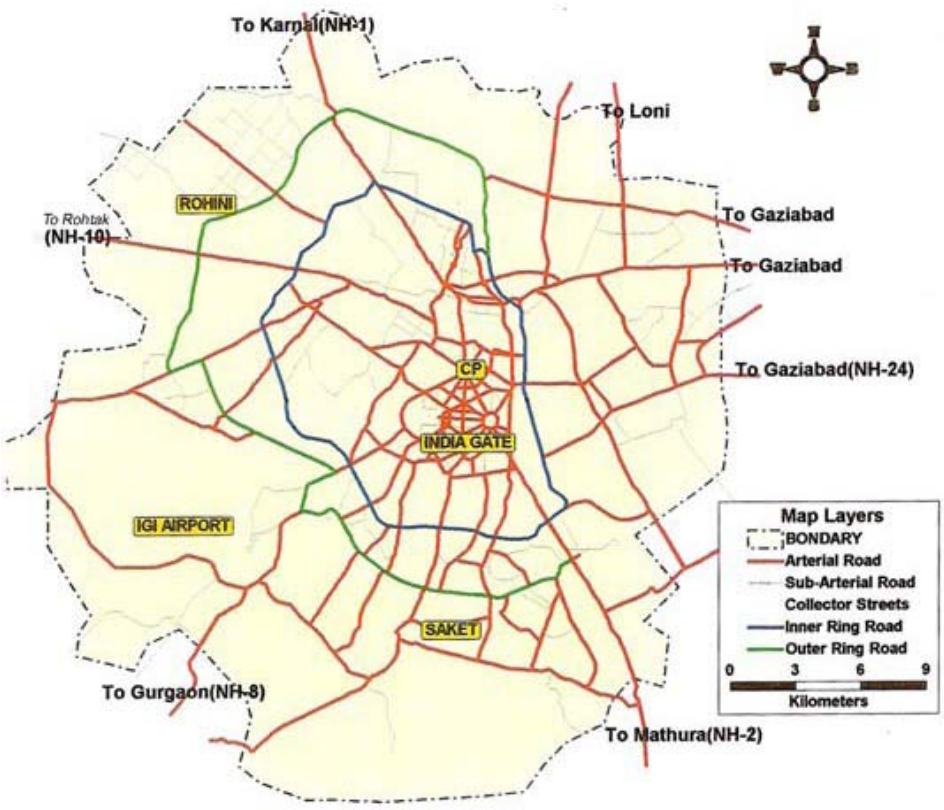
3.5.2 Transport characteristics

The roads in Delhi have different Rights of Way (ROWs) in different parts of the city. More than 500 km of roads in Delhi have 45 m or more as ROWs, which provides the possibility of creating a cycle lane and footpath; around 250 km of road length have a ROW of 30 m. The road network constitutes about 21 per cent of the total geographic area. In old Delhi, roads are very narrow and there is commercial development all along the major arterial roads. These roads have a large presence of cycles, cycle rickshaws and hand carts, in which now PMTs have also entered causing traffic jams. The cycle rickshaws are preferred as

distances required to be travelled are small. Otherwise cycles and walking are the other two preferred options.

In Lutyen's Delhi (New Delhi) the roads are 30 m wide with avenues defined by trees. There is a large space set back from these trees to the building and a cycle track is also provided, which often is used as a parking space and bunkers for the security, which discourages cyclists from using them. Many road junctions are roundabouts and have no provision for cyclists (Tiwari, 1999). The rest of the city has the same composition as that of Lutyen's, but the major difference is that the service roads have direct openings on to the arterial roads and the former consist of 2-way traffic. Due to the spread of the city, the road network is also increasing. To manage the traffic at junctions, traffic signals are installed at some 700 intersections and the traffic police of Delhi have also created the Area Traffic Control System in central Delhi for about 48 intersections for the smooth flow of traffic.

Figure 3.1 Road network map of Delhi



Source: DoUD and IL&FS Ecosmart Limited, 2006

In 2011, Delhi had 7.2 million registered vehicles, which is the largest amongst 35 million plus-population cities. The CAGR of registered vehicles in Delhi remained at 7.11 per cent in the last decade, which is quite high (Transport Research Wing, 2012). With this rapid growth in the number of vehicles, traffic problems are increasing day by day. The result can be seen as roads are jam-packed during peak hours with increased trip times. Due to the availability of cheap vehicles and financing schemes, many two-wheeler users have shifted to four-wheelers. The proportion of cars relative to total motor vehicles has

increased to 29.3 per cent in 2011 (Transport Research Wing, 2012) from 21 per cent in 1991 (DoUD and IL&FS Ecosmart Limited, 2006).

Consequently, the shares of IPT, namely, autorickshaws, cycle rickshaws, taxis, mini buses, phat-phat sewa, etc., have declined over time. The most preferred IPT was cycle rickshaw, which is also non-polluting, but is losing its demand due to many hindrances like road congestion and limiting of licences to rickshaw pullers. As per the data collected in 2007-08, 1.31 million trips were made by cycle rickshaw, which proves that it has potential to become a feeder to the Metro and BRT system (DIMTS, 2011, p. 9). In 1960, the Municipal Corporation of Delhi (MCD) passed special bylaws for rickshaws, which remained in force up to 1975. Many attempts were made to reduce the number of rickshaws by issuing only 600 licences. In 1976, the quota for licences was raised to 20,000 but the numbers continued to multiply. In 1993, the quota went up to 50,000. In December 1998, the licence quota was raised to 99,000 (Gurung, 2006). The number of rickshaws that ply on Delhi's roads is as high as 7,00,000 of which only 89,429 have licences (DIMTS, 2011, p. 2). These licences have been granted in 12 zones against different colour schemes (p.14). In 2007, MCD imposed a new scheme of scientific management of cycle rickshaws in which 80 per cent of the city roads were declared no entry zones (p. 18). In February 2010, the Delhi High Court lifted the cap on the total number of cycle rickshaws allowed in the city (p.17) and in April 2012 the Supreme Court of India also upheld the judgement that municipal authorities could not cap the number of licences to cycle rickshaws (Venkatesan, 2012). However, the demand for the cycle rickshaw is increasing after the increase in petrol and Compressed Natural Gas (CNG)[8] prices. They are also providing links to the residential areas from many metro stations. In 2007-08, a transport demand forecast study concluded that the modal share of person trips done by cycle rickshaw has doubled in the last 6 years, from 3.6 per cent in year 2000-01 to 7.9 per cent in year 2007-08[9] (DIMTS, 2011, p. 8). The autorickshaws are also slowly moving out of the city. The authorities are also planning to make these autos more traceable and want them to install Global Positioning Systems (GPS). The modal share of IPT (para-transit) is only 2.1 per cent but is an important part of the transport system (Table 3.3).

Table 3.3 Modal share of passenger trips in Delhi (2001)

S.no.	Mode	% Share
1	Bus	40.1
2	Car	6.9
3	2W	11.5
4	Autorickshaw	2.1
5	Bicycle	3.6
6	Train	0.5
7	Other	2.4
8	Walk	33.0

Source: DoUD and IL&FS Ecosmart Limited, 2006, pp. 11-16.

Apart from the motorised transport, there are a large number of people who are cycling or walking to the workplace. According to MPD, in 1962 almost 60 per cent of the trips were made by bicycles and there were proposals for cycle paths in this plan, but these were never constructed. In MPD 2001, the

[8] Discussion with Rajendra Ravi, New Delhi, 7 July 2011.

[9] In the RITES Transport demand forecast study of 2007-08, walking trips were not considered, therefore percentage distribution for other modes is on the higher side.

percentage share of cycle users went down to 9 per cent. MPD 2001 suggested the development of cycle tracks wherever feasible but later the idea was discarded on grounds of safety. A survey of passenger trips was also done by RITES in 2001, which recorded 33 per cent trips as walking trips and 3.6 per cent as cycling trips. In 2007-08, RITES did another Transport Demand Forecast Study, "without walk trips", which concluded that the share of bicycles in modal splits had increased from 5.3 per cent to 6.8 per cent (DIMTS, 2011, p. 8). The share of buses was 40.1 per cent. Cars and two-wheelers constituted just 18.4 per cent (Table 3.3). In 2007-08 the share of buses was 41.5 per cent (DIMTS, 2009, p. 8).

The NGO Sanjha Manch, along with IIT Delhi, conducted a survey of 3,000 households in slums and resettlement and unauthorised colonies, and found that 38.8 per cent of trips were made by cycle, 31.4 per cent by bus, and 22.1 per cent by walking (Tiwari, 2001). A UNDP-GoI survey of 3,000 households in resettlement colonies found that there were only 14 per cent of people using cycles, 45 per cent using buses, and 35 per cent who walked (Hazard Centre, 2007). All these facts show that people are either using public transport or non-motorised means of transport. It is also quite evident that resettlement of slums also decreases bicycle usage among households due to increased distances to workplaces. In such situations, they increasingly use public transport, especially buses.

Table 3.4 Modal shares of journey to work by low income households in Delhi (1999)

S.no.	Mode	Modal Share %
1	Cycle	38.9
2	Bus	31.4
3	Car	0.0
4	SC/MC	2.5
5	Three-wheeler taxi	1.0
6	Taxi	0.0
7	Rail	1.8
8	Others	2.3
9	Walk	22.1
10	Total	100.0

Source: Sanjha Manch & IIT Delhi (1999), quoted in Tiwari, 2001, p. 14

The DTC was the primary agency offering a bus service before 1992. Thereafter, the Delhi Government's transport department has also invited private operators. The total bus fleet as of now is 10,000, of which 4,000 are DTC-owned and 6,000 belong to different private operators. The DTC buses are all low-floor buses, green and red in colour. The latter are air-conditioned buses whereas the former are regular buses. The private buses have GPS systems and can be tracked anywhere. The 17 clusters planned comprise profitable and non-profitable routes. These clusters are not identified on the basis of origin and destination, but direction. At present only one cluster is operational and has only 50 buses, which are orange in colour, but there are plans to increase the bus fleet to 4,000[10]. The private bus operator is paid a fixed amount on the basis of kilometres/bus travelled.

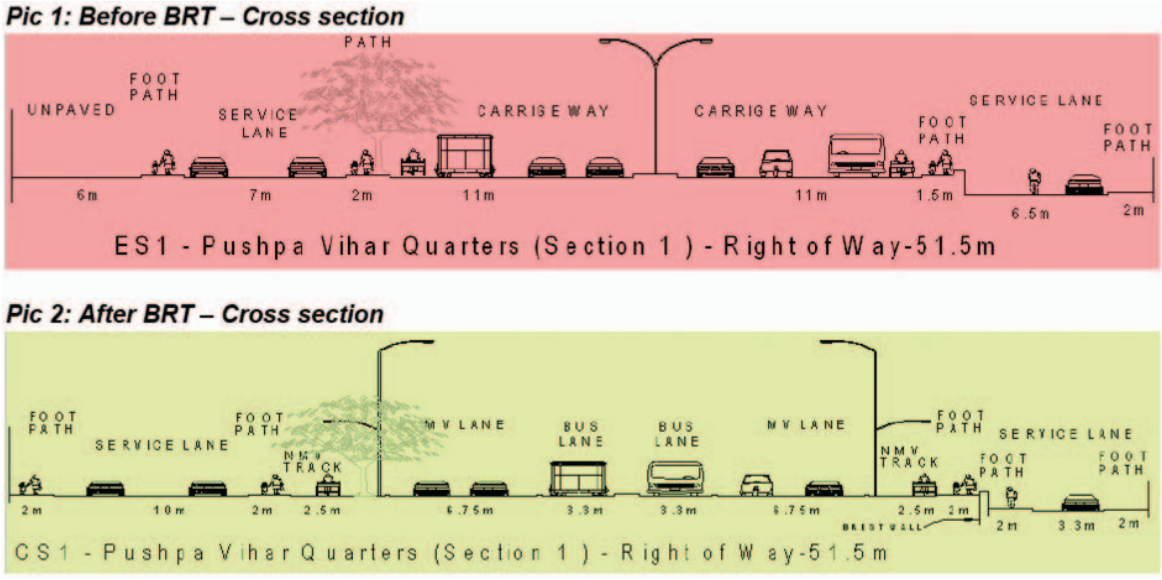
[10] Discussion with Mr. Samir Kumar Sharma, Asst. Vice President, Transport Planning, DIMTS, 6 July 2011.

3.5.3 The status of the BRT system

Delhi's BRT system is 'Open BRT', and is used by the existing bus services on upgraded dedicated lanes. Besides the DTC buses all others, such as chartered buses, are also allowed in the corridor. In the early part of the first phase, which was a 5.8 km corridor, the BRTS was designed as the central median. It took some time for people to accept this new concept. But now it is well accepted on account of its other benefits, despite negative media coverage. Over time, the BRTS design has changed from occupying the central lane to kerb-side lanes in some corridors. In the first phase itself, there is a mix of two types of corridors; from Ambedkar Nagar to Moolchand there is a central median, and from Moolchand to Delhi Gate there is a kerb-side lane. The kerb-side lane does not help much for what BRTS is supposed to deliver in terms of safety, reliability and operational speed, because the general traffic use the bus-only lane and there are more left turns which cannot be averted, and so the buses incur delays. The roads with higher road-width that carry heavy traffic volumes were identified as first corridors. Then, the areas with higher frequencies of buses, or from where the majority of commuters reside, were selected for identifying further corridors.

Figure 3.2: Different types of buses using the BRTS corridor

Figure 3.3 Cross-section of road – before and after the BRTS corridor



Source: DIMTS, 2010, p. 4

The first corridor of BRTS is from Ambedkar Nagar to Delhi Gate and is 14.5 km. Its ROWs vary from 28 m to 51.5 m. The width of the corridor is 3.3 metres separated with a 0.4 m wide kerb. After that is a motor vehicle lane of 6.75 m. Continuous separate lanes for NMT vehicles and pedestrians are provided along the corridor. But due to negligence of the built spaces, the footpath is unusable in many places. In some areas where there is not much road width, the pedestrian and the NMT lanes are merged. Wherever the road is wide, service lanes have also been provided.

Figure 3.4 (Left) Central median corridor Pilot – A. (Right) Kerb-side bus lane Pilot - B

Figure 3.5 Autorickshaw parking and four-wheeler parking along the road

The finishing of the footpath and cycle track has been done very diligently. The cycle track is segregated from the motorised lane by raising it 100 mm above the road level. But during peak hours, motorised two-wheelers try to use this lane. There is a clear segregation between the cycle track, footpath and motorised lane by a material difference. At junctions, priority for the cyclists is created by raising the section and changing its surface so that the motorised vehicles have to slow down, which in essence allows cyclists to pass first. For the cyclist, the raised portion matches their lane height. By constructing these separate lanes for both the pedestrians and cyclists, there is increased perception of security and hence an increase in the number of cycle users. During the peak hour, we have observed that about 1,200 cycles per hour used the cycle tracks. Inspite of the occasional incursion from motorised two-wheelers, the cycle tracks are heavily used by cyclists. To promote cycling, cycles are available for rent near the bus stops. The existing trees have been kept, around which the footpaths wind, creating shaded areas for pedestrians and cyclists.

Table 3.5 Phase-wise number and length of corridor

Phase	Corridor	Length (km)	Year
I	7	115.5	2005-2010
II	3	28.0	2011-2015
III	16	166.0	2016-2020
Total	**26**	**310.0**	

Source: Data gathered from DIMTS Office

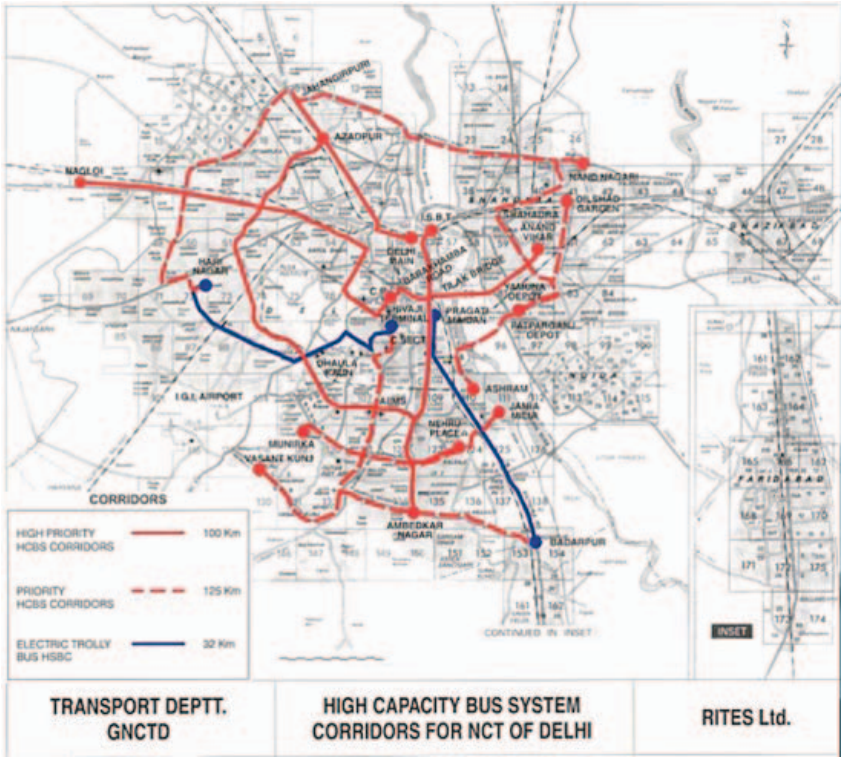
As per the original plan of DIMTS, the BRT is planned in 3 phases, with 26 corridors covering length of 310 km in addition to the Metro coverage of 400 km by 2020 (Table 3.5). The first corridor is from Ambedkar Nagar to Delhi Gate. This corridor is in two parts: Pilot A and Pilot B. Pilot A of 5.8 km is from Ambedkar Nagar to Moolchand as the central median, whereas Pilot B, of 8.7 km and operational from 2008, is from Moolchand to Delhi Gate is on the kerb-side. Pilot A is the central median and separated from the motorised vehicle lane by 0.4 m wide divider, on both sides of the corridor, whereas in Pilot B the bus lane is shifted to the left side and there is no physical barricade between the lanes. The lanes are segregated by a difference in surface material. The bus lane is painted blue which can be easily identified and written as BUS ONLY on the road.

Figure 3.6 (L) Bus stops with passenger information system (R) Kerb-side bus corridor

The DIMTS, working as the corridor manager, has to ensure smooth operation and efficient maintenance of the corridor. This also involves traffic management, bus operation, cleaning, safe and proper movement of people and vehicles and removal of buses that get stalled on the corridor. DIMTS has established an Operational Control Centre at two locations to keep track of daily progress. It has deployed road marshals on the corridor to guide passengers, help children and old people cross the roads, manage traffic and instruct people to follow the traffic rules. There are around 180 road marshals who are trained before deployment on the corridor. There are security guards on the corridor on a 24 hour basis. There are 8 lady guards on the corridor in shifts of two, which means four at one time. DIMTS has also organised training for bus drivers. Around 700 drivers are trained by the company, the traffic police, DTC, and the Institute of Driving Training & Research (DIMTS, 2010). The company is installing a passenger information system on all the bus shelters for people to know how long they have to wait for the next bus. Buses also are being installed with a GPS system. At present there are only 50 buses with GPS. The cleaning of the corridor and beautification is also conducted by the company.

Figure 3.7 Maintenance and cleaning of BRT corridor

Figure 3.8 Proposed BRT corridors of Delhi



Source: TRIPP, 2005, p. 6

The bus stops on the corridor are placed on both sides of each junction, along the left side kerb of the dedicated lane. This makes two bus stops per junction, one each for buses in each direction. The distance between any two bus stops is around 500-700 m, and there are 9 bus stops on the corridor from Ambedkar Nagar to Moolchand distributed over 5.8 km. The bus stops are before a junction or signal in each direction. There are two parallel sets of bus shelters before a junction. But, after the bus shelter, the buses have to get back into a single lane from the double lane of the shelter, creating some congestion at the junction itself. These two bus shelters are segregated by the route of the cluster system. The bus stops are very well designed with proper access for physically challenged people.

Figure 3.9 (L) Guards at junctions (R) PIS not working

Figure 3.10 (L) Crane removing bus from corridor (R) cycle track

Figure 3.11 Corridors at a junction

At the Siri Fort and Chirag Delhi stops, which are at junctions, traffic cycles at the junction are between 7-9 minutes during the peak hours and 2-5 minutes in the off-peak hours, creating a pile up of buses at the junction. Consequently, the journey time for bus commuters increases while there is a long pile up of vehicles in the mixed-traffic lanes.

Figure 3.12 (L) Dustbins and seating at a bus stop (R) NMT lane and public conveyance

The bus stops have proper lighting, passenger information system boards, benches for sitting and dustbins. Public conveniences/toilets are also provided near the bus stops.

Figure 3.13 (L) Bicycle track and footpath (R) Bicycle rental stand

Figure 3.14 & Figure 3.15 Segregation of bus lane on kerb-side lane

The ticketing in the BRTS is done on board but there are proposals of making it off-board in the near future. At the time of our survey, the fare for an ordinary bus ride was ₹ 5 up to 4 km, and ₹ 10 up to 10 km, whereas for AC buses it was ₹ 10 up to 4 km, and ₹ 15 up to 8 km. A penalty of ₹ 100 was levied on those travelling without a ticket. DTC also issues green cards for a full day of journey, costing ₹ 40 for an ordinary bus and ₹ 50 for an AC bus, which is valid for travel in any DTC city bus except the tourist services and Palam coach[11].

Figure 3.16 Types of buses

The frequency of buses planned in the stretch of 5.8 km is 120 buses/hr and the speed of buses during peak hour is expected to vary from 16 to 19 km/hr (Hidalgo & Pai, 2009, p.16), whereas the off-corridor speed of buses is 7-11 km/hr. In fact, we observed a speed of 30 km/hr on the corridor, but long waiting at the signals has reduced the average speed to 16 to 19 km/hr. The ridership during peak hour is 6,500 passengers/hr/direction (Hidalgo & Pai, 2009), but in peak hours we observed the riderships to sometimes reach 9,000-10,000 passengers/hr/direction. The frequency observed was just 80-90 buses/hr/direction with little difference in peak and non-peak frequencies. It was observed that during peak hours, the number of people carried by the bus corridor and cycle tracks combined is as much as the number of people being carried by the mixed-traffic corridor with the load factor of 1.4 (persons/vehicle). The off-peak speed is 23 km/hr. The time taken to board and de-board the bus is generally not more than 30 seconds. The level of boarding is not very precise and there is generally a gap between the platform and the bus level, which is sometimes of great concern for the safety of the passengers.

[11] Details of DTC fares are taken from the website of the Delhi Transport Corporation: http://dtc.nic.in/dt3.htm

The BRTS corridor was initially designed as a 'No Parking Zone', restricting private vehicle owners to park along the corridor (DIMTS, 2010). A parking facility around the bus stations or proper feeder services could have been provided to shift PMT owners, in particular car owners, to the BRTS. But, as parking facility is not provided, the footpaths are often encroached upon by private vehicles.

Figure 3.17 (L) Bus pile up at stations (R) Gap at platforms

3.5.4 Users' opinions

As a part of our study, a quick survey was conducted to get users' opinion on the Delhi BRTS. Users were randomly selected from different locations so that we could cover different segments of the population. The survey was conducted during both peak and non-peak hours. All users were covered in the survey: working people, students, retired people, women, etc. Our findings are as follows:

1. Most users of the BRTS were living or working within walkable distance, varying from 100 m to 1 km, from the bus station.
2. More than 50 per cent of people who were earlier using other means of transportation, i.e., private vehicles, have now shifted to buses. The major reason for the shift is disinterest in driving a private vehicle on congested roads, especially when the buses take less time.
3. Most of the people said that the corridor length (5.8 km) is too short that it does not give a sense of a bus rapid system. Furthermore, the BRTS does not get priority at traffic signals and the network is not complete, and hence the effect of a rapid transit is not felt. They want the corridor to be extended.
4. People were complaining about the frequency and the crowding of buses during peak hours. They want the number of buses to be increased during such hours.
5. Since there are two parallel lanes of bus stops for the buses to arrive before a junction, the buses do not stop at their designated bus stop but stop at the parallel lanes because of the pile up of buses in one lane. This causes chaos and mix-up at the bus stops.

6. They also said that the central median is a new concept they are not used to, and it is very difficult to adapt to the new technology. They want the same kerb-side bus lanes or underpasses at congested junctions.

7. Some people had also reported the incidences of pick-pocketing and eve-teasing in the buses.

8. Most people do not have to wait too long. They reported the waiting time to be between 5 and 10 minutes, but in some cases it was 30 minutes, which is very high; but still people are waiting and using the bus service.

9. People also recommended one kind of ticket system (or smart card), which can be used for various public transport modes.

3.5.5 System bottlenecks and policy barriers

The most significant bottleneck in the system is the traffic signalling system, which has created long waiting times for the BRTS buses at traffic junctions, and has thereby increased the trip time. Some innovations have to be done here. The long signal cycle is designed to favour the mixed traffic and not give priority to buses.

Figure 3.18 (L) Buses at junction (R) Buses stopping away from bus stops

The second bottleneck was the short length of the bus corridor. If the length is extended and the system made more bus-friendly than now, this would work well for the commuters. Since the corridor in Delhi is just 5.8 km so far, the rapid transit system fails to make any impact either on commuters or as a different public transport system.

The third bottleneck was the navigation of the buses at the junctions, where the buses experience a pile-up and instead of stopping at a designated place, they stop at other stops. There are mainly two issues here: (i) since there are two parallel sets of bus shelters before a junction in each direction and since the buses do not stop at the designated stops, there is chaos; (ii) from these two sets of parallel shelters, the buses will have to go into one single lane across the junction and there is not enough space for the buses to negotiate the distance. This causes further piling up of the buses at the junction. Because the signal cycle at the junction does not favour the buses, it further creates operational problems for the buses. Better junction management is required at places where there is such a pile up and chaos.

Figure 3.19 Bus pile up at green signal while changing lanes

The main reason for the mismanagement of the BRTS corridor is the lack of institutional coordination and also lack of consensus about the BRT operations amongst the governing agencies. DIMTS is acting as the corridor manager of the BRTS, while the Transport Department regulates the bus operations. The traffic police have their own ideas about how to 'run the traffic smoothly' on the corridor. DIMTS does not have a say in the junction design or signal cycling or bus operations. There has been an attempt to establish a dialogue between the transit agencies through the formation of the Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC) headed by the Lieutenant Governor, but the formation of a unified metropolitan transport authority has a long way to go.

3.6 Pune HCBS

Pune is a city with a population of 5.05 million as of 2011[12]. The city has registered a population growth of 3.0 per cent per annum during 2001-11. It is now emerging as an important centre for Information and Technology (IT) firms and educational institutes. The presence of an Army cantonment has given the city its own identity. It has been a city with large automobile companies and a manufacturing base since Independence. The city is well connected by roads to important cities in the state like Mumbai, Nashik, Satara, and Solapur. It is located on the main line of the railways that connects Mumbai to the southern states.

[12] Source: Population Census of India, 2011, from http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural-UrbanDataSheets_paper2.pdf; (accessed on 31 August 2012).

3.6.1 The planning context of BRT

The Development Plan of Pune, 1987, attempted to create a multi-nucleated structure for the city through planned dispersal of commercial and tertiary sector job centres. District centres were proposed at various locations, which were to be connected by major city roads (Pune Municipal Corporation, 2006). Nothing has been spelt out about the transport plan in this document. The city has only radial roads originating from, or close to, the old core connecting to various parts of the city. It has no ring roads to complete the network, and is consequently over dependent on the radials for reaching anywhere in the city.

Figure 3.20 Road network map of Pune

Source: Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008, p. 4.21

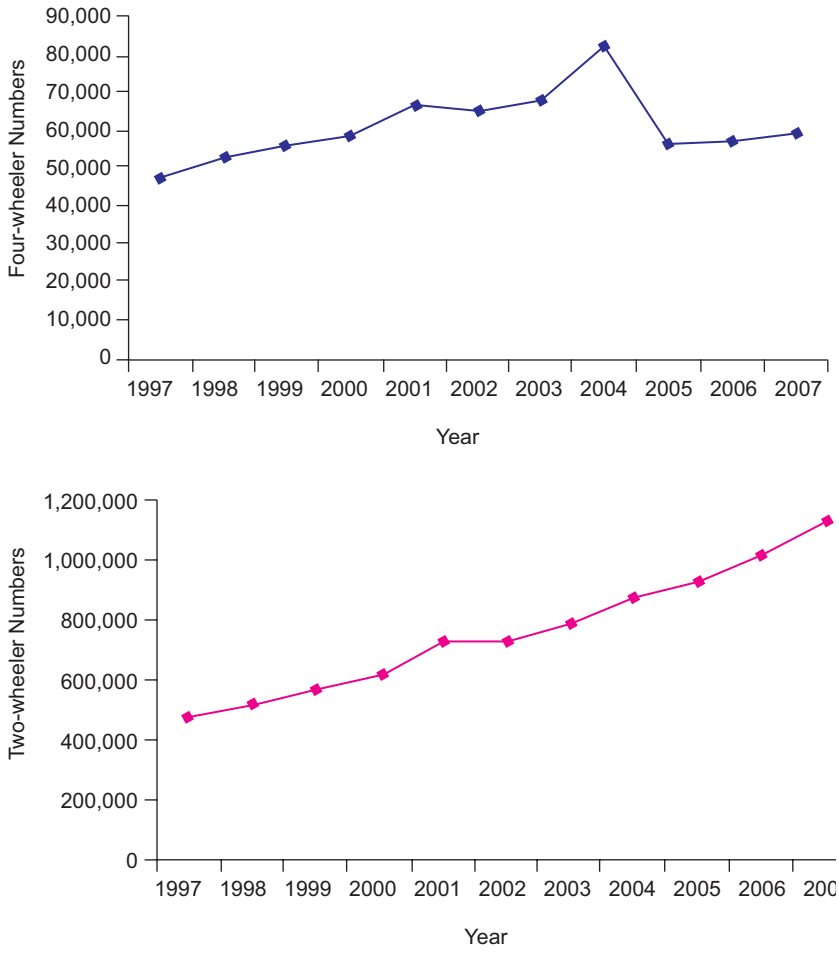
Road side interview surveys (Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008) revealed that 24 per cent of all trips entering Pune city are actually destined for places outside Pune. Also, many of the important arterial roads like Nagar Road and Satara Road are part of the national or state highways. This mixes heavy transport vehicles with the city traffic thereby affecting road safety and creating congestion. The truck terminals that were in the outskirts when they were planned are now in the heart of the city. Similar cases are to be found in the existing intercity bus terminals and the two railway stations within the Pune Municipal Corporation (PMC) limits.

3.6.2 Transport characteristics

The share of public transport in Pune is only 12.2 per cent. Another 7.2 per cent use IPT (autorickshaws). The modal share of walking and cycling is 22 per cent and 11.1 per cent, respectively (Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008). There are various reasons for the low share of public transport: availability, quality, frequency, efficiency, reliability, hygiene, and point-to-point

availability of services. The lack of an efficient public transport system along with increased incomes and easy availability of finance has increased the number of private vehicles over the years. The city had an estimated 1,445,364 vehicles registered in 2007, of which 1,123,898 (78 per cent) were two-wheelers (Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008).

Figure 3.21 Vehicle growth in Pune, 4-wheelers and 2-wheelers



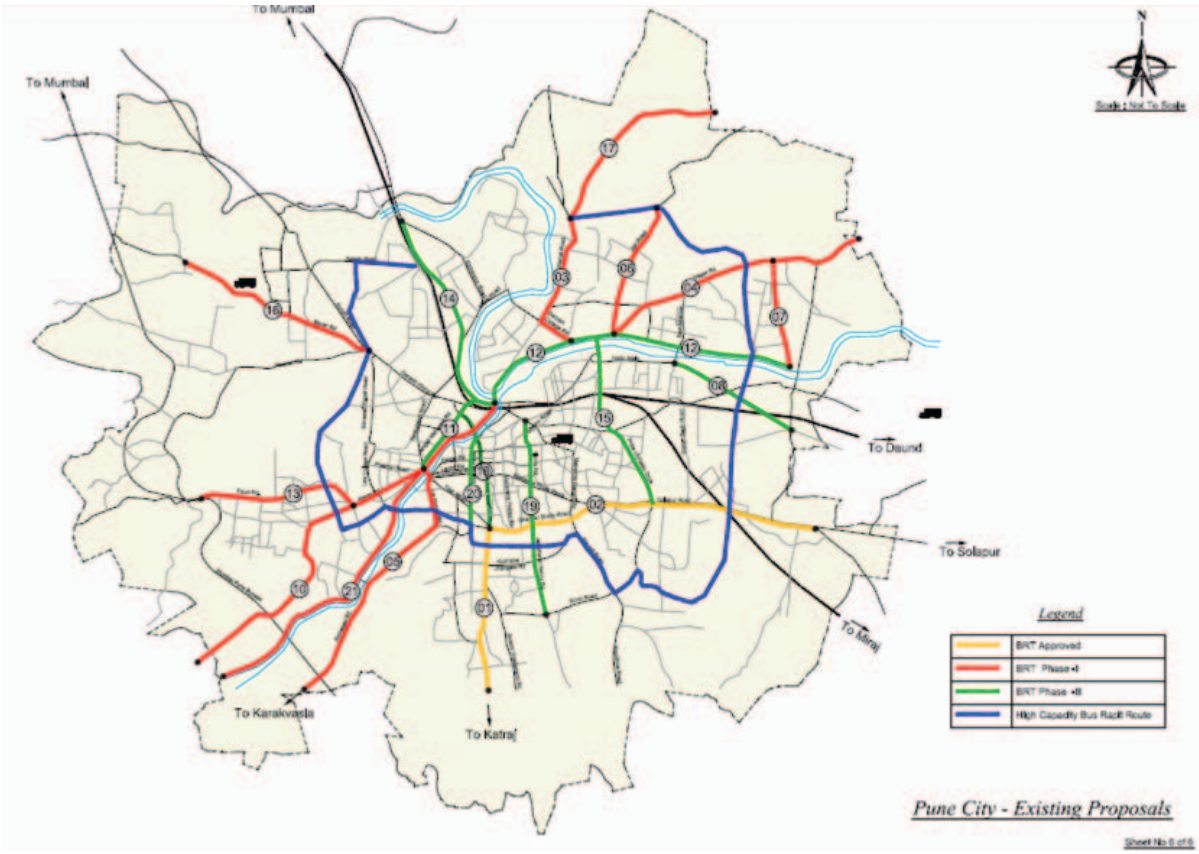
Source: Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008, p. 4.25

Pune Mahanagar Parivahan Mahamandal Ltd (PMPML), set up in October 2007, is the transport authority responsible for bus transport operations in the Pune Metropolitan Area (PMA). Pune has a twin city named Pimpri Chinchwad, which is governed by Pimpri Chinchwad Municipal Corporation (PCMC). The PMPML has a BRT division to handle the BRTS operations in the urban agglomeration area. PMC and PCMC are equal stakeholders in the PMPML and therefore have a mayor and chairman of the standing committee and a municipal commissioner from each in the board of directors of the PMPML, which has been created by merging the transport bodies of the PMC and PCMC, which has a fleet of 1,000 buses operating on 282 routes and is used daily by more than 0.8 million passengers.[13]

[13] http://www.pmpml.org/FactSheet.php accessed on 30 June 2011

The suburban trains (popularly called local trains), run by the Western Railways, also connect Pune to its twin city Pimpri Chinchwad. Currently, there are four local trains that shuttle 34 times (17 return trips) between Pune and Lonavala and 6 times (3 return trips) between Pune and Talegaon, catering to about 0.1 million commuters. The authorities have also drawn up a plan to run a local service every 15 minutes at least during peak hours (More, 2008). The rail and bus services operate within close proximity of each other. Both the suburban stations, viz., Shivajinagar and Pune, are also major stops for PMPML buses. The bus service also connects with the intercity bus stands at Shivajinagar, Pune station and Swargate.

Figure 3.22 Existing BRT proposals in Pune



Source: Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008, Sheet-6

The City Development Plan (CDP), prepared in 2006, states one of the goals as 'good connectivity for all citizens' as a part of the vision statement. However, it also states that the PMC will provide and develop the infrastructure required for public transport and facilitate BRTS or Metro Rail Transit (MRT). The city then submitted a DPR for a BRT system with a total length of 101.77 km, which was sanctioned at a total cost of ₹ 9.23 billion (USD 205 million). These routes radially connect the city core to the various centres in the city. The Comprehensive Mobility Plan (CMP) prepared to obtain BRTS funds hopes to achieve 80 per cent trips through PT, excluding IPT. The CMP scenarios for the share of public transport are given in Table 3.6. The CMP has included the approved BRT routes and has also proposed the MRT system to the centre, but it has not integrated the two systems.

Table 3.6 Scenarios and their effect on public transport share

Situation	PT share (%)
Do nothing	10
Augment PMPML	18
Augment PMPML + BRT	60
Augment PMPML + BRT + Ring Corridors	65
Augment PMPML + BRT + Ring Corridors + High capacity corridors	80

Source: Wilbur Smith & Associates and IL&FS Urban Infrastructure Services Ltd, 2008

The CMP puts the approximate cost of the entire mobility plan at ₹ 193 billion. Of this, it is estimated that 60 per cent would be required for the development of an MRT. It admits that the national and state governments will continue to be the major sources of funding, while also stressing the need for internal revenue generation and contributions from the private sector.

3.6.3 The status of the BRT system

Table 3.7, showing the current status of the BRT corridors funded under the JnNURM, clearly indicates that the PMC has not implemented the BRTS in the corridors for which they have received funds, and has instead utilised all the funds for paving the roads and widening them without making attempts to build infrastructure for the BRTS, like dedicated lanes or bus shelters. This puts a question mark on the central monitoring of city-level projects and their implementation as per the plans.

Table 3.7 BRT projects in Pune funded under JnNURM

Project	Approved cost (in ₹ millions)	Central funds committed (in ₹ millions)	Central funds released (in ₹ millions)	Amount utilised	Expected date of Completion	Current Status
BRT Pilot project for Pune city	1031.35	515.67	515.67	100%	Completed	In operation from Dec 2006
BRT (Phase 1) for Pune City	4766.22	2383.11	2144.54	100%	Dec-10	Road widened with no dedicated lane
BRTS (Infrastructure development for Commonwealth Youth Games, 2008)	3121.40	1560.70	1560.70	92%	Dec-11	Road widened with no dedicated lane or bus stops
Improvement of New Alandi Road for BRT (13.9 km from Vikrantwadi to Dighi-Octroi Naka)	370.30	185.15	92.57	100%	Dec-11	Concretisation work in progress

Source: http://www.JnNURM.nic.in/nurmudweb/Project/list-of-project.pdf accessed on 30 June 2011

The pilot project has two of the major routes connecting three major bus terminals. These are:

1. Swargate–Hadapsar (East-West Corridor), which was designed by the TRIPPS, IIT Delhi
2. Swargate–Katraj (North-South Corridor), which was designed by the PMC

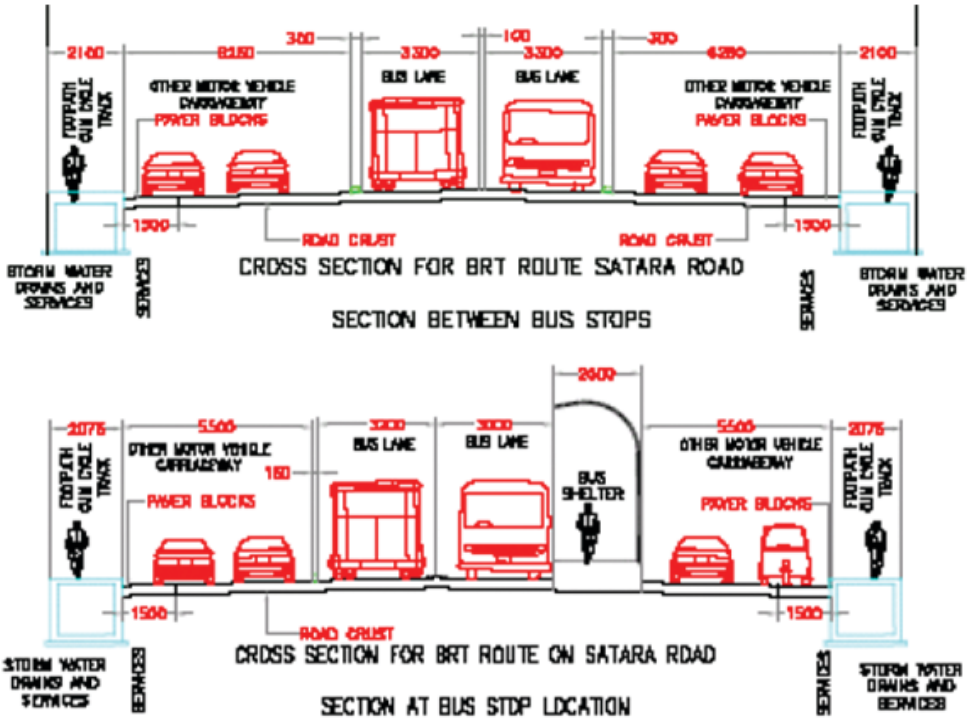
These two corridors were sanctioned by the MoUD at a total cost of ₹ 623.2 million (USD 13.84 million) for a total length of 12.6 km. The length excludes the 3.8 km length that passes through the Pune Cantonment area. The implementation began immediately after JnNURM approval was received and the corridors started their operation in December 2006, essentially providing central bus lanes. While implementing the pilot BRTS, the PMC realised that the entire road had to be redeveloped to take care of provision of underground infrastructure and services such as (i) footpaths and cycle tracks, (ii) municipal services like water supply and drainage lines, (iii) utility ducts for electrical and telecommunication cables and (iv) BRT elements like lane-segregators, bus stops, etc. Consequently, the costs were revised to ₹ 1,072.1 million (USD 23.82 million) for 13.20 km of BRTS corridor (excluding the stretch of the Cantonment area), which includes six bus stations, a footpath, cycle track, utility works, electric works, road furniture and other BRTS provisions. When the Central Public Works Department (CPWD) was able to secure land in the Cantonment area for the corridor, the project cost was increased to ₹ 1,139 million (USD 25.31 million). The MoUD however approved the project at the Schedule of Rate (SOR) of 2006, when the DPR was first submitted. Finally, the DPR approved was for ₹ 1,031.35 million (USD 22.91 million).

Figure 3.23 BRT pilot corridors

Source: Pune Municipal Corporation, 2008

At this stage, designers Sandeep Gandhi and Associates (SGA) of Delhi and architect Prasanna Desai of Pune were consulted for improving the design of the pilot project. There were several consultations between the design team, the authority (PMC) and civil society organisations (CSOs) such as Parisar, Alert, Janwani, etc., and concerned individuals to develop design ideas for the corridor, in particular for including quality NMT infrastructure.

Figure 3.24 Cross-sections of ROWs on Satara road



Source: Pune Municipal Corporation, 2008

Figure 3.25 BRT lane and bus station in Pune

The road design of the BRTS corridor is a continuous two-way 3.3 m dedicated lane in the centre, which was already constructed when the two designer firms previously mentioned took on the job. They designed the bus stops staggered across the signals. They also provided guidelines to adjust the width of median lanes at turns, etc., so as to maintain the speed of the buses. However, the existing central medians on the corridor were new and the municipal engineers refused to remove them. At some locations, the BRTS dedicated corridor itself is divided in both directions by the central medians as wide as 1 m. This has put an immense limitation on the BRT design. If there is a bus breakdown near such a location, it will completely stop the functioning of the corridor. Further, the bus lane and the mixed vehicle lane are segregated by reflecting and flexible studs, which would allow any motor vehicle to accidentally enter the bus lane. Over time, railings and kerbs have been constructed at the same place as the reflector rods and this has further reduced the quality of the infrastructure.

Figure 3.26 Inspection chambers on NMT lanes

The NMT facility and footpath are provided along the edge of the ROW and are segregated from the mixed vehicle lane by a hedge. The provision of a minimum 1.5 m wide footpath and a 2.4 m wide NMT corridor is observed. The DPR also gives details of where and how the two could be combined in case of inadequate ROW. Wherever possible, a service lane has also been provided. During the study, one found that there was no problem with the designs but the implementation has not been to standard, resulting in situations such as abrupt ending of NMT facilities and poor construction quality on NMT lanes.

The Pune BRTS corridor is an open system, and allows buses other than those of the PMPML to run on the corridor. Pune has a very large fleet of buses of about 17 different models[14] procured over a period of time. Many of them have different heights of bus-floor, necessitating the idea of an open corridor. There were 125 PMPML buses making 1,515 trips between Swargate and Hadapsar and 59 buses making 663 trips between Swargate and Katraj, using the two existing corridors. It was difficult to arrive at one kind of bus-shelter design to accommodate all types of buses, leaving no option but to make just a platform with a shed as a bus shelter. These buses connect Hadapsar and Katraj terminals to Kothrud, Shivajinagar, Pune Station, Corporation, Kalyaninagar, Chinchwad, Nigdi, Bhosari, etc.

Ten semi-low-floor buses, which can seat 38 passengers, fitted with a GPS, are operating between Hadapsar and Katraj as exclusive BRT buses. They have pneumatic doors at the front and in the centre on the left. The buses have a digital display board, a microphone facility for making announcements, and reserved seats for women, senior citizens and the physically challenged. The drivers were specially trained by the company and the PMT Training Institute.

[14] As per the PMPML authorities.

The bus stops are staggered across the junctions (before the junction) to take advantage of the signal cycle. They are designed for universal access and level-boarding for low-floor buses. Safe pedestrian crossings (3 m wide) are provided from the footpaths. The traffic signal cycle comprises of a dedicated time-slot for the passage of BRT buses.

Figure 3.27 (L) Bus stop on inauguration day (R) Current situation

However, pedestrians accessing the bus stops feel insecure due to honking vehicles on the zebra crossing. A free left turn at every junction is increasing the vulnerability of the pedestrians. The absence of tactile flooring at these stops makes it difficult for the visually challenged to access a bus. The quality of construction of the ramps and the details used also make access difficult for a wheelchair. And because of the variety of buses that use this corridor, one hardly finds a bus that stops in a way to make level-boarding possible. The buses drop/pick up passengers from the road. During the study it was observed that frequently the buses missed stops and stopped only at the signal where the commuters also boarded or alighted. At times when only a couple of passengers have to alight, the bus only slowed down instead of completely stopping. This compromises the safety of the commuters. Driver training in buses other than new semi-low-floor buses is completely missing in Pune BRT.

Initially, facilities like seating, digital display boards informing waiting time, drinking water, public telephones, etc., were also provided. However, at the time of our survey only seats could be found. The digital display boards have become defunct at a few stops. Where functional, they fail to display the waiting times of buses other than the BRTSs, as others are not fitted with GPS devices. The lighting fixtures can be seen but the tubes are missing. Further, the stops are poorly maintained. The ticketing is an on-board electronic system as this is an open corridor and integration of fare collection across various agencies has not been possible so far.

Figure 3.28 (L) Shoddy public works (R) People boarding from the road

Figure 3.29 (L) Distance of bus from the platform (R) State of stations

The frequency of buses on the current corridors is high. At the time of the survey, one bus was available every minute during peak hours on the Swargate and Hadpsar Corridor, and every two minutes during non-peak hours. The frequencies are similar on the Swargate to Katraj Corridor. The planned frequency of AC buses is one every 10 minutes, which was found at the point of origin but gets lumped with the earlier AC bus towards the point of destination.

3.6.4 Users' opinions

The users are happy with the introduction of AC buses and feel safe using the bus service. However, they have questioned the central dedicated lane as they do not feel safe crossing the road. Since the corridor has limited length, those wanting to travel to destinations beyond the corridor's last point, say Swargate, prefer to take a direct bus rather than change at Swargate and hence have to wait for their specific bus and not take the BRTS bus.

The NGO-CSOs are quite active in the city and constantly monitor the urban mobility and the operations of the PMPML and PMC. They had participated in a workshop to formulate the vision for urban transport in the city, as already mentioned. These NGOs consider the BRTS as the most appropriate public transit system for a city the size of Pune as it is cheaper and more flexible than the MRT system. In fact, some of the individuals involved have taken a step further and submitted proposals to the PMC to improve the service and extend it to areas that are ill-served now, such as the new IT Park at Hinjewadi where the daily commuters number approximately 0.2 million. The BRT division of the PMPML also has its own plans of expansion.

3.6.5 System bottlenecks and policy barriers

The first bottleneck is the lack of institutional coordination. Pune is a unique case as PMA comprises two municipal corporations and three cantonment boards that are well connected functionally. However, there is little coordination and cooperation between their governing bodies. Inspite of the formation of PMPML, the PMC and PCMC continue with the old routes and both have different BRT systems. PMPML has few powers in bringing both municipal corporations to the same page on unified transport plans for these twin cities. Also, the PMPML is only concerned with the operation of the bus service while the PMC and PCMC are responsible for constructing infrastructure like roads, bus stops and terminals, depots, etc. Moreover, the PMPML does not have financial autonomy and hence is fully dependent on the PMC and PCMC for providing the buses, operational funding and building the infrastructure.

The second bottleneck is the lack of administrative or political will to build the BRT. The PMC, for its part, has used all the JnNURM funds for road widening, re-paving etc., and hence BRTS services could not begin operations in most parts of the city. The BRTS was proposed to facilitate transport during the Commonwealth Youth Games of 2008, which it could not do on time. Overall, the PMC did not like the idea of a dedicated road space for public transit, perceiving it as an 'encroachment on space for motorised traffic' and hence it neglected and never owned the BRT project.

The third bottleneck was the complete lack of social marketing of the BRT system. The BRT system has faced public wrath right from the day its operations began. The public was unaware of the benefits of the system. The social media were not taken into confidence to promote the system. Instead, the system was in the media for all the wrong reasons like the accidents on the corridor. It is noteworthy that there is hardly any difference between the BRTS and other PMPML routes except for the dedicated bus lanes. Other things like dirty and poorly maintained stops, unreliable bus services, etc., is just like the regular bus services. So the BRT has not been able to make a good impression on commuters.

There have also been some operational mistakes. The project was completed in haste, resulting in poor quality construction in many places. The bus drivers of only the new (exclusive BRT) buses were trained, whereas those of the older ones were not trained or made aware of the use of the corridor. This created many operational problems on the corridor, some following signals and instructions but others not. The traffic police were not consulted before implementing the project and hence they have been reluctant to enforce the new traffic rules that would make the system run smoothly. Thus, vehicles other than the buses enter the dedicated lane, mixed vehicles do not respect the zebra crossing rules, vehicles park on the NMT corridors and two-wheelers use the NMT corridor in both directions. The PMC has placed garbage bins on the footpaths from where the garbage spreads. Thus, inspite of good design of footpaths and cycle lanes, these are not safe and convenient for the users.

3.7 Jaipur BRTS

3.7.1 The planning context and transport characteristics

Jaipur is the capital of the state of Rajasthan, and is a major tourist destination. The population of the city was 3.07 million in 2011[15], with a registered population growth rate of 2.8 per cent per annum during 2001-11. Like many other cities of India, Jaipur has a walled city and a new town. The city has a Municipal Corporation and a Development Authority, Jaipur Municipal Corporation (JMC) and Jaipur Development Authority (JDA) respectively, and the total area of the city is 2,939 sq km. The total road network of the city is 1,500 km, of which 34 per cent are two lane and 54 per cent four lane roads. In the year 2008, the number of vehicles registered in Jaipur district were 1,324,624, out of which 74 per cent were two-wheelers and 11 per cent four-wheelers. The average annual growth rate of vehicles in the city stands at 13 per cent (Jaipur Development Authority & Wilbur Smith Associates, 2010).

[15] Source: Population Census of India, 2011, from http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural-UrbanDataSheets_paper2.pdf; (accessed on August 31, 2012).

Table 3.8 Modal share, 2009

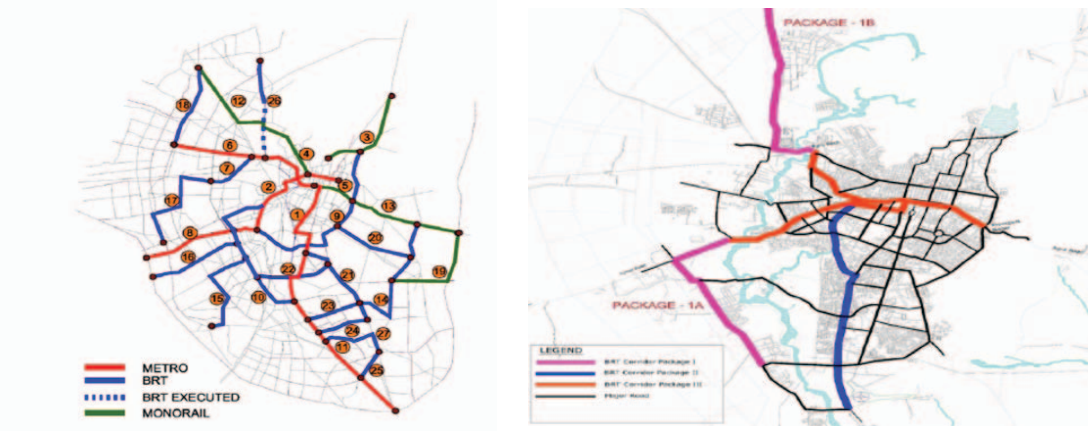
S.No.	Mode Used	No of Trips (2009)	% Share
1	4-Wheeler	29,380	8.8
2	2-Wheeler	82,300	24.7
3	Autorickshaw	19,340	5.8
4	Taxi	27,980	8.4
5	Public Transport	70,785	21.3
6	Walking	28,906	8.7
7	Cycling & Pedal Rickshaws	74,331	22.3
8	**Total**	**333,022**	**100.0**

Source: Jaipur Development Authority & Wilbur Smith Associates, 2010

The city's PT consists of both public and private bus operators. Rajasthan State Road Transport Corporation (RSRTC) runs the city-bus services. The city has a bus fleet of 220 buses, of which 190 are minibuses. The entire fleet of minibuses runs on 28 lucrative routes and the state transport buses run on 28 routes.

A modal split survey of peak trips was conducted in the year 2009 as part of the Comprehensive Mobility Plan (CMP). The data shows that two-wheelers had the largest modal share of 25 per cent, followed by cycles and pedal-rickshaws (22 per cent) and public transport (21 per cent) (Table 3.8). The share of NMT trips in the city is 31 per cent, which is the largest modal share. The total share of walking, cycling and PT is more than half. It would be important to retain this modal share, which is already quite low-carbon. The fatality rate in the city is 71 per 100,000 population. The city is planning for a BRT system as well as a metro system for solving its transport problems. The city's CMP also suggested a Mono-Rail system at a few corridors as well. There is already an operational BRTS Corridor in the city and work on the MRT has already started. However, there is not much clarity in official documents or amongst the officers about how all these different proposed systems would be integrated. The maps in Figure 3.32 show the delineation of various corridors in the city.

Figure 3.30 Public transport initiatives proposed by Comprehensive Mobility Plans in Jaipur



Source: Jaipur Development Authority & Wilbur Smith Associates, 2010

3.7.2 The status of the BRT system

It was decided that the BRTS will run along all the major road corridors where the intensity of travel demand is in the range of 2,000 persons per hour per day (pphpd) to 20,000 pphpd (projected). Jaipur Development Authority (JDA) is the nodal agency for planning and implementing BRTS infrastructure in Jaipur. The BRTS Project in Jaipur city has been developed and implemented through a SPV called Jaipur City Transport Services Limited (JCTSL). As per the Master Plan of the BRTS, a total of 138 km have been planned, which will be implemented in three phases. 'In-principle Approval' of ₹ 4,690 million (USD 104.22 million) was given by the GoI in August 2006 for implementation of 42 km of BRTS Phase-I corridor in the city.[16] The first phase consists of two main corridors, one goes from Sikar Road to Tonk Road (North-South Corridor), and the other is from Ajmer Road to Delhi Road (East-West Corridor). The North-South corridor of 26 km is currently under implementation. Phase-I is divided into three packages. The details are given in Table 3.9.

Table 3.9 Package-wise details of Jaipur BRTS

S. No.	Details	Route	Length (in km)	ROW (m)	Remarks
1	Package-I	C-Zone bypass-Pani Pench	7.1	40-50m	7.1 km of this Corridor has been in operation
2	Package-II A & B	Pani Pench-Sanganer Airport	18.0	20-40m	Under Implementation
3	Package-III	Transport Nagar-Amruth Nagar	13.4	18-35m	Under Implementation
		Total	**42.0**		**Added extra 2.7 km proposed to be extended till Sanganer Town**

An elevated BRTS has been proposed between Pani Pench and Khasa-kothi so as to facilitate connectivity to Sindhi Camp Bus Stand (which is the central bus stand for Jaipur city) and Railway Station, i.e., up to two major destinations. The elevated road at Durgapura is in progress with provision of a future metro on Tonk Road. Package-III has also been re-adjusted according the planning of a metro project. A junction on this phase will have a flyover which will have BRTS at Tier-I and metro at Tier-II. This is an unexplained overlap of different systems on the same corridor and there are contradicting stories about the planning decision.

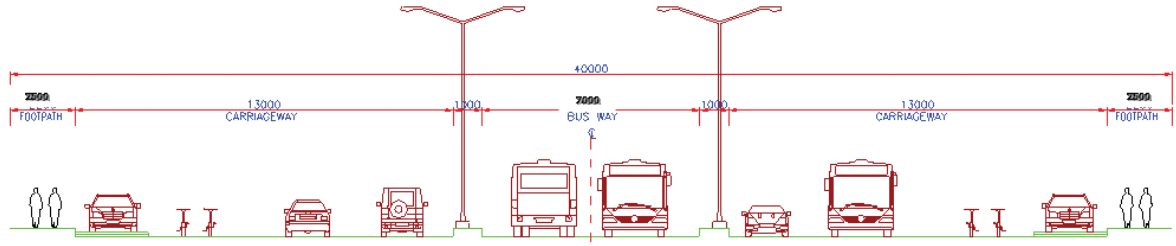
Figure 3.31 (Left) Design of the bus station with access ramp (Right) Station from inside

[16] http://www.jaipurjda.org/page.aspx?pid=69 (accesed on 21.09.2011)

A 7.1 km long corridor is in operation in Jaipur, and consists of 21 stations (both sides). It is planned as a closed system, but currently JCTSL has launched new buses with new routes. Currently the orange route from Harmada to Badi Chaopad uses the corridor. The bus remains in the BRT Corridor till Chomu-Puliya junction. There are also exclusive BRTS buses using the corridor.

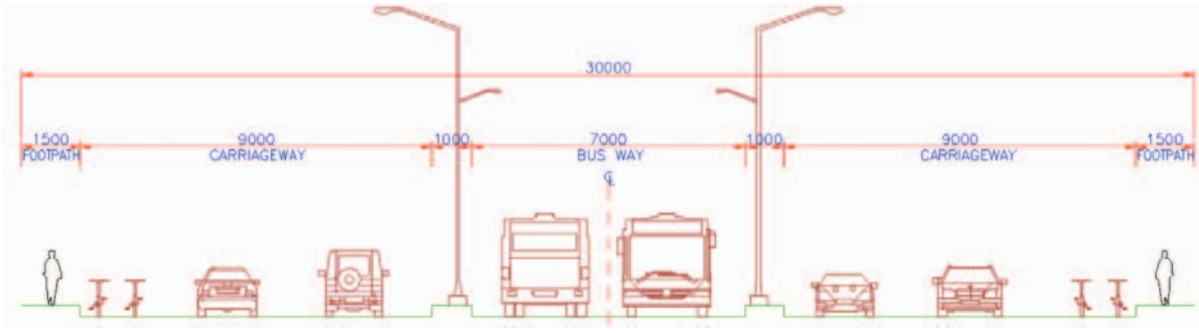
Kerb-side bus stations located before the junctions have been chosen for the system. Bus stops are open and airy, and are differently-abled friendly with the provision of ramps. The crossroads also have slopes and the bus stops are at the crossroads, allowing for easy wheelchair access to the bus stations. Bus stops allow for two buses to board at a time in the same direction.

Figure 3.32 Road Section at 40 m ROW



Source: Based on drawings from JDA

Figure 3.33 Road section at 30 m ROW



Source: Based on drawings from JDA

The section of the proposed ROW is given in Figures 32-33 and the details of the same are given in Table 3.10. The space for mixed traffic is much more in 40 m ROW. Footpaths in 30 m ROW are of inadequate width, as they should be at least 2 m. No dedicated space for bicycle tracks is given and cyclists use mixed-traffic lanes with the cycle lanes painted on the road.

Table 3.10 Distribution of road section at different ROWs

Road Section Type	Bus Lane Width (m)	Mixed-Traffic Lane width (m)	Bicycle Track width (m)	Footpath Width (m)	Others (Parking Kerb etc.)
40 m ROW	7.0	13.00+13.00	Non-segregated and ounted in Mixed-Traffic Carriageway	2.5+2.5	1.0+1.0
30 m ROW	7.0	9.0+9.0	Non-segregated and counted in Mixed-Traffic Carriageway	1.5+1.5	1.0+1.0

Source: Prepared by the authors from the data collected.

Figure 3.34 (1) Level-boarding problems (2) Bus distanced from the platform (3) Cycle track

3.7.3 System bottlenecks and policy barriers

Like many other BRT systems, work in Jaipur also started with much excitement and deliberation, but the project stalled midway after plans of the metro project were floated. The corridor had to be re-aligned at many places and the request is still pending with MoUD. The JDA also faced many problems related to land acquisition for achieving the ROWs. Furthermore, the bus drivers are not properly trained to facilitate level-boarding. People sometimes get down from the bus stand and then board the bus. There remains a wide gap between the bus and the station, which makes boarding uncomfortable for some people, and completely impossible for the physically challenged.

Facilitation of NMT modes also took a backseat in Jaipur BRTS. Bicycle lanes were not separately made and have been left as a painted white strip, on the road, causing hazards to cyclists. These lanes are increasingly used for unauthorised off-street parking, which completely defeats the purpose of the NMT infrastructure.

The city of Jaipur had elaborate plans of building BRTS, but the aspirations of building a metro project has derailed the momentum of the BRT project. The existing BRT ridership is so low that a full-fledged BRT is not justified on all the corridors. It would be even more illogical to plan the metro system given the road

network, densities, and travel demand along the arterial roads. There is a lack of comprehensive public transport planning in the city.

3.8 Indore BRTS

3.8.1 The planning context and transport characteristics

Indore is one of the major commercial cities of the state of Madhya Pradesh, with a population of 2.17 million in 2011 and compound growth rate of 3.6 per cent per annum during 2001-11. The city's population is growing rapidly and its stress can be observed on the roads. The city is also experiencing a very high rate of vehicle growth on its roads.

The PT system of Indore was initially completely privately owned and government-regulated. The system had 300 private mini buses which were run by many private operators forming one cartel called "Indore Nagar Sewa". Intercity bus operations to the nearby industrial towns of Dewas and Pithampura were also handled by the private operators. Indore also had 8-seater IPT modes, called tempos, running on the roads.

Indore started the Atal Indore City Transport Services Limited (AICTSL) in December 2005. The company was jointly formed by the Indore Municipal Corporation (IMC) and Indore Development Authority (IDA) with a seed fund of ₹ 2.5 million. The bus service has become increasingly successful due to colour coded routes, which were decided after adequate surveys. The system has six private operators that run the buses in the city. In April 2008, AICTSL carried 110,000 passengers every day. In 2009, the city also received ₹ 700 million (USD 15.55 million) from the Indian Government's stimulus package to purchase 170 new transit buses.[17] In December 2011, the fleet size was 107 buses. AICTSL now runs on 25 routes across the city.[18]

3.8.2 The status of the BRT project

The first BRTS corridor from Niranjanpur to Rajiv Gandhi Chauraha was sanctioned in 2006. It was a pilot corridor of 12 km. The Central Sanctioning & Monitoring Committee (CS&MC) of JnNURM also told the implementing agencies IMC and IDA that they should first implement the pilot corridor, and only then would the rest of the project be approved.

Figure 3.35 Overlapping of AICTSL routes on A.B. Road

Source: Traffic Mobility Solutions , 2008, p. 18

[17] The details have been taken from the Embarq India website http://embarqindia.org/node/65
[18] Discussion with Managing Director, AICTSL

It can be seen that many AICTSL routes merge on A.B. Road and therefore to free up the numerous bus routes the idea of the BRTS emerged. The first pilot corridor had two kinds of ROWs of 75 m and 30 m. The responsibility of construction was given to IDA while that of maintaining and operating the buses was given to the AICTSL.

3.8.3 System bottlenecks and policy barriers

BRTS in Indore is facing many problems in its implementation. The first major problem is land acquisition for the ROWs from the many religious authorities, as there are many religious structures present on the road margins. The research team observed 12 such structures that were obstructing the ROWs, specifically the footpaths and bicycle tracks.

Another problem being faced during the implementation is the lack of underground sewage and water lines on the sanctioned corridor. The water and sewerage projects on this corridor were simultaneously sanctioned with the BRT project. In many ways, Indore's BRT Project also became a big city digging exercise, in which all underground infrastructures were rebuilt. Black cotton soil also posed considerable difficulties in the construction of the corridor.

Figure 3.36 (Left) Footpath getting discontinued by a building obstruction (Right) Under construction

Construction on the pilot corridor is ongoing, and the project has been greatly delayed. Bicycle lanes and footpaths are also getting built along the sides according to specification, but remain discontinuous at many places due to many encroachments which are yet to be removed from the corridor. There is a fear that Indore's BRTS might become another road-widening exercise as in other Indian cities. Bus lanes have not been constructed yet. Wide roads are built in concrete, without a thought for bus station placement.

Kerb-side stations were initially planned, but after the success of the Ahmedabad BRTS and the perceived failures of Delhi and Pune, the authorities have increasingly pushed for central median bus stations and no decision was taken for a long time. Subsequently, in August 2011 it was decided to give up the idea of kerb-side bus stations and go for central median bus stations like those in Ahmedabad. Twenty new bus stations were getting constructed at the time of our visit to the corridor in July-August 2011.[19]

[19] http://www.indianexpress.com/news/ahmedabad-brts-success-takes-cept-to-indore/674299/1

3.9 Conclusion – The state of BRT projects in selected cities

Table 3.11 depicts the status of BRT projects in the selected Indian cities discussed earlier in this chapter. Ahmedabad BRTS will be discussed in the next chapter in detail. There are a few more Indian cities like Vijaywada, Vishakhapattanam, Surat and Rajkot where deliberations for constructing BRT systems are ongoing, but none of the projects are at the operational stage. Besides Ahmedabad (which will be discussed in detail), Delhi, Pune and Jaipur have a few of operational BRT corridors – not long enough to measure the impacts of the project or to assess using any performance indicators. The systems are different; Delhi and Pune have the open BRT system where all types of buses are allowed to run, whereas Jaipur and Indore have not yet reached sufficient functionality to support any assessment.

Table 3.11 Characteristics of the BRT systems of the selected cities

City	Stage of imple-mentation	Cons-truction started	Ope-ration started	Planned network (km)	Length of corridors approved by MoUD	Peak hour average speed (km/hr.)	Frequency of buses (sec/ direction)	Existing Ridership	Planned ridership
Delhi	5.6 km operational	Oct-06	Apr-08	426	NA	16-19	30-45	9000-10000	20,000-24,001
Pune	17 km operational	2003	Dec-06	117	117	16-18	45-60	3,600	10,000-15,000
Jaipur	10 km operational	Sep-07	Partly started	138	42	25	120-300	500-1,700	–
Indore	11.5 km under construction	Oct-07	Not yet started	106	11.5	20 (expected)	150 (planned)	1,000-6,000	10,000-20,000
Ahmedabad	45 km operational	2007	Jul-09	88.8	88.8	22-25	180-300	1500-2000	15,000-20,000

In spite of the fact that there are many adverse implementation, operational and institutional issues in Delhi, Pune and Jaipur, the experience of running buses in rapid transit have benefited the commuters in terms of the time saved. The BRT services are comparatively better than the regular bus services. On the BRT corridors of Pune and Delhi, the combined users of public transport and cycling-walking sometimes outnumbered the mixed-traffic users. It can be conjectured that the complete BRT network will not only benefit the commuters, but will also bring about positive changes like curbing air pollution and traffic congestion in these cities. In the end, it is very important to understand that they are the only hope for affordable PT in Indian cities. On the other hand, it is crucial to understand that every city cannot be Bogotá, and Indian cities will have to evolve and adopt their own concept of BRTS with dedicated bus lanes and good NMT infrastructure.

All the cities studied above started with much optimism for changing the transport system in their city and introducing the new BRT system. Our study observes that all the BRTS projects are struggling to cope with the challenges posed by various combinations of a lack of comprehensive planning and operational efficiency and implementation failures. In all the cities, there was a lack of clarity and consistency about giving due importance to the BRT system as the main mass rapid transit system. In Delhi, it was perceived as a secondary system and in other places, the BRT was seen merely as a few corridors instead of a comprehensive network. In Jaipur, the system has become an apology to the metro system. In many cities the administrators and politicians are not too convinced about the BRTS as the main PT system, which has caused planning failures. In Delhi, the BRTS initially attracted bad press, but subsequently social

marketing of the project helped. In Pune, social marketing efforts were not made at all and the project has received negative publicity. In Jaipur, the state chief minister is keen to implement a metro rail project, even when viability of the BRTS is under doubt.

The implementation of BRT systems in Indian cities has not been a smooth ride. These projects have turned into an immense exercise of managing land acquisition tussles along roadsides, displacing vendors and slum settlements, and improving and altering water and sewage infrastructure buried beneath. Moreover, implementation has become the subject of political struggles in many cities.

So the ideal of allocating dedicated lanes for buses and giving them priority over other vehicles did not quite translate into reality in many cities. Somewhere, there was a reluctance in giving more priority to buses over private motor vehicles, or somewhere the BRT system was compromised either by the junction or signalling cycle designs, or by not achieving operational efficiency. There was an immense pressure on political and bureaucratic classes from the local media and others about not taking away the share of private motor vehicles, and thus the systems were paralysed. Even after taking the funds for implementation, all the local governments have been unable to implement more than one or two isolated corridors in all four cities. Also, the city managers have found more interest in construction rather than ensuring smooth functioning of the corridors. In other words, there has been greater interest in the hardware than in the software of the BRT systems. This is, indeed, not a very optimistic picture for the future of low-carbon mobility in India. In spite of having funds under the JnNURM, having the right policy (NUTP) and after deliberation on the right solution (BRT), the city governments have not been able to take advantage of all these favourable circumstances to change the face of transport in their cities. The city of Ahmedabad has built about 44.5 km of BRT corridor already, and it is hailed as the 'most successful BRTS in India'. The next chapter discusses the case of Ahmedabad in detail.

4. Janmarg: Ahmedabad's Bus Rapid Transit System (BRTS)

4.1 The planning context

The Ahmedabad Urban Agglomeration[20] (AUA) had a population of 6.35 million in 2011[21], registering a growth rate of 3.5 per cent per annum, which was higher than Gujarat's and India's urban population growth rates of 3.1 and 2.8 per cent per annum, respectively in the decade of 2001-11. The fast population growth is partly attributed to an increase in the Ahmedabad Municipal Corporation's (AMC) jurisdiction from 198 sq km to 450 sq km in 2006, which was achieved through the amalgamation of seven municipalities and contiguous areas with the former city limits. This also has led to an increase in the number of wards from 43 to 58 (Mahadevia, 2012). The city has a wide variation in population density. On the east bank of the Sabarmati, the old city of Ahmedabad has a gross population density of 560 persons per hectare (ppH).In the west is the new city of Ahmedabad, which is now rapidly globalising with commercial real estate development and high-end residential areas. The overall density of the former AMC area is 189 ppH. The total area of the city, including the Ahmedabad Urban Development Authority (AUDA) area, is 1,330 sq km (AMC, AUDA and CEPT University, 2005).

The making of Ahmedabad from a small trade fort on the bank of the Sabarmati to a buzzing metropolis now situated on both banks of the river is a journey which has many layers of historical, political and socio-economic changes. Ahmedabad used to be an industrial city, with many cotton textile mills adjoining the old city on the eastern bank of the Sabarmati. The west is a high-income residential and institutional area, and hence it is prosperous and has better infrastructure as compared to its eastern counterpart (Mahadevia 2010). The city's economy is becoming increasingly tertiary sector-oriented in nature (Mahadevia, 2012). Although the Census of 2001 estimated the slum population of the city to be 439,000, which was 13.46 per cent of the city's population, a survey conducted by the Self-Employed Women Association (SEWA) in Ahmedabad estimated the slum population of the city to be 25.77 per cent.

The planning function was vested with the AMC. For the planning and development of peri-urban areas, the AUDA was created in 1976. However, the current development plan of the city for the period 1996–2011 was prepared by AUDA for both the peri-urban and AMC limits (Mahadevia, 2010). The city's CDP was prepared in 2005. The city has submitted multiple Detailed Project Reports (DPRs) and has received many grants for taking up urban projects in the area of water supply, sanitation, roads, housing for poor and public transport under the JnNURM. The city has received the second largest per capita grant for JnNURM projects among the metropolitan cities (Kundu & Samanta, 2011). Its housing component is being used for the rehabilitation programme for the project-affected persons (Mahadevia, 2012). Many of the city's projects, conceived to create an image of a "World Class" city, have caused evictions and the dumping of poor households on city peripheries, and transport projects are no different in this regard.

[20] Urban Agglomeration is a concept which takes into account the population of all the contiguous outgrowths of the main city and hence it is more a functional definition than an administrative definition.

[21] Census 2011 data from http://censusindia.gov.in/2011-prov-results/paper2/prov_results_paper2_indiavol2.html, (accessed on October 15, 2011)

The city has not yet made a CMP that considers the existing network of public transit and the proposed metro rail projects, etc. Ahmedabad was one of the first few cities to launch a public transport system, and was also much ahead in implementation of other transport initiatives like CNG conversion of public transport and the implementation of a BRT system.

The city's BRT system, known as "Janmarg", was started in the year 2009, and it has attracted global as well as national awards as a prime example of best practice in the field of public transport. Two years have passed since the opening of the first corridor, and Janmarg is now operating along a 44.5 km route and carrying about 0.15 million passengers with a daily revenue of about ₹ 0.75 million (Ahmedabad Municipal Corporation, 2011). It is expected to become a path-bearer for many other cities in India. Janmarg means 'People's Pathway', and this study will assess whether this definition of 'people' is inclusive and whether it has indeed become an important option for public transport in the city.

4.2 Transport characteristics

Ahmedabad started its Municipal Transport service (AMTS) in 1947, which is now one of the oldest urban transport organisations in the country. Its operations started with 112 buses (Central Institute of Road Transport, 1996, p. 1). AMTS is under the supervision and control of the AMC. A study by the Central Institute of Road Transportation in 1996 stated that at that time the AMTS had a bus fleet of 724, operating on 187 routes and carrying 0.62 million passengers daily with a yearly revenue of ₹ 475.93 million (USD 10.58 million). The fleet utilisation rate of the system was between 80 and 83 per cent (Central Institute of Road Transport, 1996).

The status of AMTS declined after the 1990s when the fleet and utilisation rate started falling. By 2005, the AMTS bus fleet had fallen to just 540 buses and more drastically its utilisation rate had fallen to 67.33 per cent. The number of passengers dropped to 0.35 millions per day, or a 44 per cent decline. The yearly revenues remained at ₹ 559.51 million (AMC, AUDA and CEPT University, 2007), which if adjusted for inflation would be a real decline in revenue of 27 per cent over the period. In 2005-06 the AMTS decided to hire private CNG buses and use them as public transport. In the end of 2009, there were a total of 728 buses run by AMTS on 157 routes, which consisted of its own fleet and a fleet of other private operators (Ahmedabad Municipal Corporation, 2010, p. 2). Evidently, the routes operated by the AMTS have declined since 1996. A report by NIUA (2010) shows that the AMTS bus fleet was around 1,000 buses carrying about 0.83 million passengers.

The AMTS is now a highly indebted agency. Its 2010-11 budget has shown an outstanding loan of ₹ 6,710.8 million (USD 149.13 million) borrowed from various sources such as the AMC, the Central Government, the state government and other finance institutions. There are also concerns regarding its increasing debt burden and imbalance of income and expenditure (Ahmedabad Municipal Corporation, 2010). The modal share of AMTS was just 7 per cent in 2005, which also shows its decreasing patronage. The average speed of an AMTS bus is 15km/hr and the average waiting time at bus stops is around 15 minutes (AMC, AUDA and CEPT University, 2007).

By 2011, after Janmarg became operational, the AMTS's situation had further deteriorated. The bus fleet in 2011, after adding 250 private buses, is just 600-650, and fleet utilisation is just 30 to 40 per cent (*Gujarat Samachar,* 2011). The JnNURM offers buses to cities to improve the state of their bus transport. The total fleet size of the AMTS also includes these new buses given under JnNURM. AMTS was supposed to get 550 new buses under the programme (*Ahmedabad Mirror,* 2011). The buses operated today by AMTS are a mix of old and new, but the number is still very low to cater to the growing public

transport demand. Minimum and maximum fares in AMTS used to be ₹ 1 and ₹ 14, which were increased to ₹ 2 and ₹ 21 in January 2012.

The other transport modes are autorickshaws, used as full-fare as well as shared, which together had a share of 5.76 per cent in 1996 (Central Institute of Road Transport, 1996). For many years now, shared autorickshaws have become substitutes for a public bus on account of low fares taken by the former in comparison to the latter. In 2005, 43,865 autorickshaws were registered with the Road Transport Office (RTO), Ahmedabad (Wilbur Smith Associates and Ministry of Urban Development, 2008). Until 2004, autorickshaws used diesel, but in July of that year a notification issued by Ahmedabad's police commissioner prohibited diesel-using autorickshaws from plying within the AMC limits, and since then diesel has been replaced by Compressed Natural Gas (CNG). Over time, the autorickshaws registered before the year 1991 have been scrapped and others have been converted to CNG. State authorities, district officials and local administrations helped autorickshaw drivers to procure loans to buy CNG vehicles (Rana, 2011). This notification also met with the recommendation of the Bhure Lal Committee formed by the Supreme Court to implement the conversion of the public transport system to CNG. Autorickshaws are important IPT mode in the city. A study by Louie Berger-Integrated Public Transport System (LB-IPTS) in 2000, estimated the modal share of shared autorickshaws to be 5.73 per cent, whereas that of full autorickshaws was 2.54 per cent, taking this mode's total share to 8.27 per cent of the city's trips (AMC, AUDA and CEPT University, 2007).

Ahmedabad has also experienced a great increase in the number of two and four-wheelers. There were 9 million vehicles in Ahmedabad in 2007, which is a rise by 170 times in 40 years (AMC, AUDA and CEPT University, 2008, p. 3.2). According to Road Transport Office (RTO), more than 0.133 million vehicles were registered in Ahmedabad district during 2011, of which 43,000 (32 per cent) are four-wheelers and 90,800 (68 per cent) are two-wheelers (Thakor, 2011). Up to now, a total of 2.7 million vehicles are registered in Ahmedabad district, including 477,000 four-wheelers and 2.2 million two-wheelers. And 80 per cent of these vehicles are registered in the city alone (Thakor, 2011). Increasing numbers of vehicle in the city and growing reliance on them for daily commuting has led to road congestion, specifically in old city areas (where road widths are already very narrow) causing high carbon emissions as well as pollution.

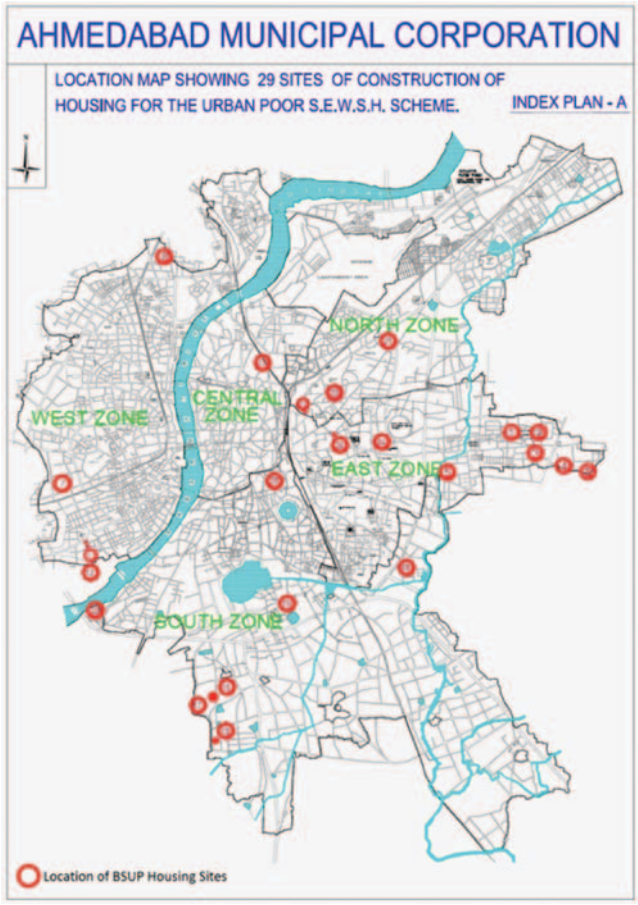
The city roads are in chaos with no space to walk or cycle on account of ever-increasing motorised traffic. Ahmedabad roads are unsafe and there are instances of increasing accidents. In 2007, 2,605 accidents occurred on Ahmedabad's roads, of which 248 (9.5 per cent) were fatal. A further enquiry into these accidents also indicated that in 42 per cent of cases, the victims were cyclists and 19 per cent were pedestrians (AMC, AUDA and CEPT University, 2008). This means that 61 per cent of those affected by accidents were the NMT mode users. Data released by the GVK-Emergency Medical Research Institute, which runs the 108 ambulance services, indicated that of the 96,669 vehicle accident emergencies reported in the country until 16 November 2010, Ahmedabad topped with 16 per cent (15,776), making it the city with the most unsafe roads in Gujarat (Shastri, 2010).

Ahmedabad has undoubtedly remained an example of deteriorating bus services, with increased numbers of accidents involving pedestrians and cyclists and a growing reliance on private vehicles. The city therefore needed positive interventions in public transport options and an equitable distribution of road space, with a proper delineation and demarcation of roads and footpaths with space for street vendors and bicycle tracks.

Recent changes in the city's growth and land use planning has not helped the cause of public transport. In May 2006, the city's area was expanded to 466 sq km from 190 sq km. Besides that, the city's peri-

urban planning authority, the AUDA, has laid out road infrastructure over a 10 km radius outside the AMC's new limits. This has caused significant urban sprawl, especially on the western periphery, with the development of low density, high income housing within gated communities. The outcome of the sprawl is increased land prices in the city. Housing for the poor has become unaffordable and now land is available for housing the poor at a distance of 15 to 20 km from the centre (Figure 4.1).

Figure 4.1 Location of low income housing schemes in Ahmedabad[22]



Source: Gautam, I.P. (2009) *Housing Project under JnNURM BSUP*, Presentation in Workshop on Shelter Security and Social Protection for the Urban Poor and the Migrants in Asia, 11-13 February 2009, Ahmedabad accessed on 12 March 2011 from: http://www.socialprotectionasia.org/pdfdoc/IPGautam.pdf

There is another observed phenomenon in the city. The former retail commercial areas, which were intermixed with residential activities, are now converting into pure commercial areas. The residential activities in the western part of the city have shifted towards the periphery and the older residential areas have moved closer to the Sabarmati river, making space for offices. Hence, the travel distance has increased, yet the exact impact of such a change in land use and sprawl has not been quantified. The older mixed land use areas closer to the river on the western bank of the Sabarmati get deserted during the weekends, while traffic jams are common on the western periphery on the weekends. The traffic jams are also prominent during peak hours. The new urban structure is emerging as a result of the way land markets have functioned, causing greater trip lengths. Traffic congestion and unaffordable housing have forced the low income groups to move further out and face accessibility crises.

[22] These schemes are under the JnNURM's Basic Services for the Urban Poor (BSUP) component.

There have been three major transport studies in the city in the last decade or so. The first was the 'Integrated Public Transport System' in 2000, and the second and third were detailed project reports for the metro rail and BRT in 2005 and 2006-07, respectively. As per the modal split described in these reports, motorised two-wheelers have dominated the city traffic and its share has increased over time. Walking has drastically reduced because of the lack of infrastructure, the perceived danger and sprawl. The bus-based public transport has not been significant but the situation has moderately improved over the years. The shared autorickshaw (called 'shuttle' rickshaw) has been a very popular option in place of public bus services amongst the lower middle class and urban poor. Overall, there has been a clear deficit in public transport, with the reduction in walking trips and domination of private motorised vehicles over the years.

Table 4.1 City-level modal split, Ahmedabad

Mode share in earlier studies	Walking	Cycle	Public bus	Shared auto rickshaw	M2W	Auto rickshaw	Car-van	Others	Total
LB-IPTS study 2000[1]	37.6	17.6	8.4	5.7	25.3	2.5	2.5	0.3	100.0
AMC-CEPT 2006[2]	13.2	18.8	15.0	–	35.0	8.8*	3.1	5.8	100.0

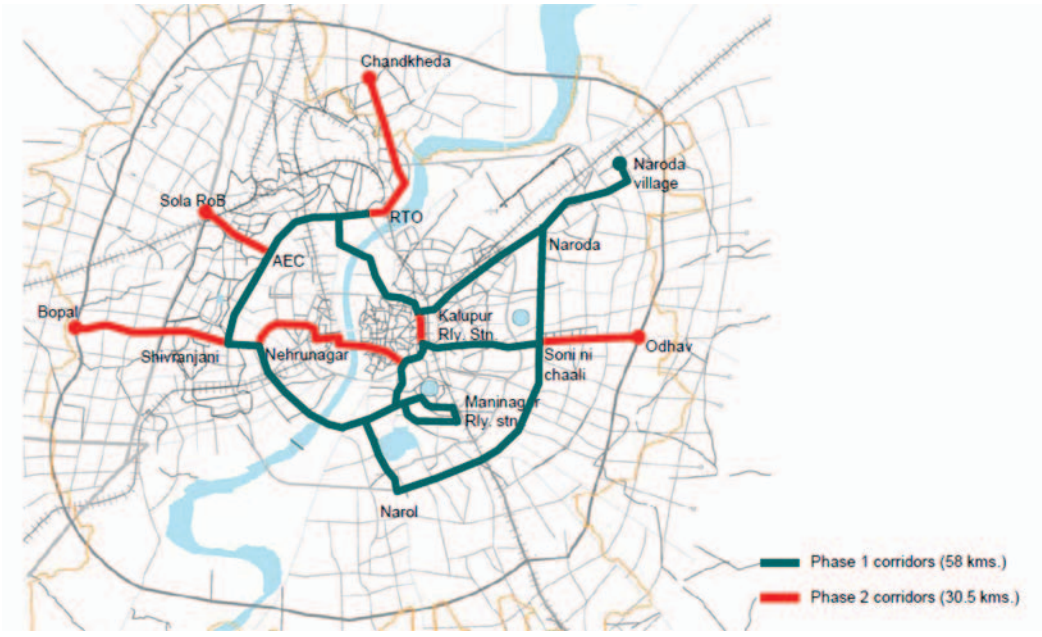
Notes: * Shared autorickshaw is assumed to be part of this as it is not mentioned separately.
1 As quoted by AMC et al., 2007 (Detailed Project report for BRTS Phase -1)
2 As quoted by AMC, 2008 (Detailed Project report for BRTS Phase -2)

4.3 Janmarg: The status of the BRT project

Gujarat celebrated an "Urban Year" in 2005, when AMC decided to construct a Bus Rapid Transit System (BRTS) in the city. It was an important decision, as it also increased expectations of getting properly laid out roads, the creation of proper road space for pedestrians, cyclists and vendors, management of on-street parking and mainly the provision of an efficient and reliable bus system. This coincided with the launching of the JnNURM and NUTP at the national level in 2006. The JnNURM and the NUTP had an important agenda of encouraging and supporting better public transport in the cities and showed willingness to support DPRs for the BRTSs in all the cities. Ahmedabad was among the first of the cities to grab this opportunity and submitted a DPR under the UIG component of the JnNURM. Under the UIG norms, 30 per cent contribution for the project is from the GoI, another 20 per cent from the state government, (Government of Gujarat – GoG) and another 20 per cent from the city government, the AMC. The project got approval in the year 2006 and the work started in 2007. The sanctioned length of the project is 88.8 km and it is divided into two phases. The first phase is of 58.3 km and the second phase is of 30.5 km. Figure 4.2 shows the BRTS corridors in the two phases.

Phase-II of the corridor also consists of an elevated BRTS corridor from Kalupur railway station to Sarangpur, connecting the city's BRTS network to the main railway station. The first corridor of length 12.5 km from RTO to Chandranagar was opened to the public in October 2009. This is entirely in west Ahmedabad. Until January 2012, 44.5 km of BRT corridor had become operational, including the newly opened RTO-Delhi Darwaza Corridor, which was made operational in the last quarter of 2011.

Figure 4.2 Janmarg: Phase-I and II route map



Source: http://www.indiatogether.org/2010/mar/eco-abadbrt.htm accessed on 10-01-2012

4.3.1 Janmarg: Ideology and system design

The BRTS corridor was designed by following the ideology of connecting busy places but avoiding busy roads. This ideology played a strong part in how the first corridor was selected for design and implementation by the AMC. The first implemented corridor of Phase-I from RTO to Chandranagar was laid out on the inner ring road in the western part of the city, which had an existing road width of 40 m and manageable traffic volumes of 3,000-6,000 PCU (Passenger Car Unit) on most of the stretch and 6,000-9,000 PCU elsewhere. This decision also facilitated the smooth arrival of the BRTS in Ahmedabad, unlike in other cities such as Delhi and Pune where the system had to bear severe criticism from personal motor vehicle users. The first corridor in Ahmedabad did not create problems for private vehicle users because it returned back a similar amount of road space, and also provided a good service to regular bus users. This was a good public relations exercise for the new system.

The other major points which planners of Janmarg had in mind were "Designing a Network and not a corridor". This mistake has been made by many cities that have visualised the projects in terms of corridors and not a network. Janmarg was the first BRT Project which aimed at creating a city-wide network within the first proposal, rather than delineating corridor by corridor. This approach also helped them to realise the project in the context of the city, rather than specific roads. It was decided to create a project on the lines of Bogotá's Transmilenio, with median bus lanes and NMT facilities along the BRT lanes.

In October 2011, the average speed of buses observed by our research team on the corridor was 25 km/h at peak hours and 29 km/h at off-peak periods. The frequency of buses during peak hours on the RTO-Maninagar Route was 3-4 minutes and on the RTO-Naroda route 7-8 minutes. After every two buses to Maninagar, one bus to Naroda was released from RTO. In the off-peak period, the frequency towards Maninagar was 8-10 minutes and towards Naroda it was 12-15 minutes. There are no buses to Naroda from RTO in the afternoon, and they start from Anjali Crossroads. Boarding/de-boarding time varied from 18 seconds to 25 seconds.

4.3.2 Bus lane and bus station design

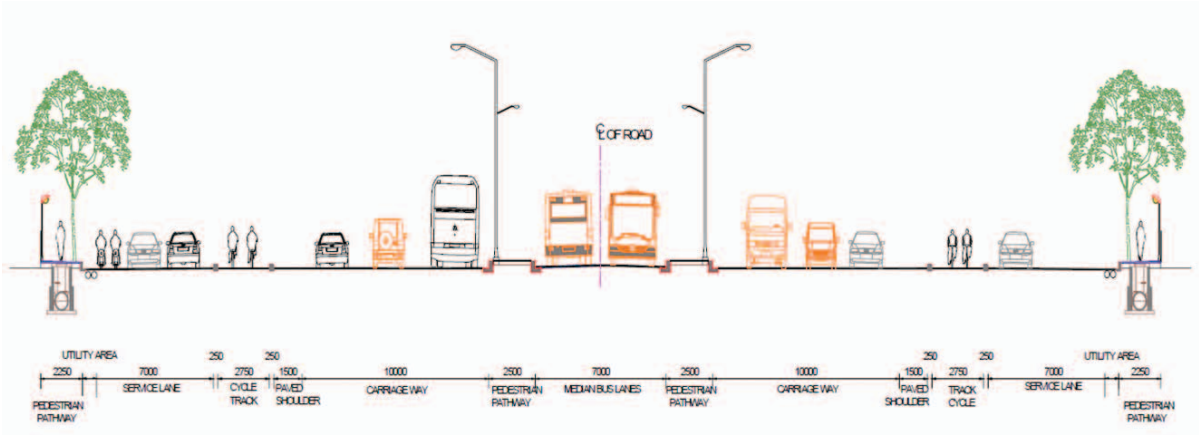
There were slight differences in road sections in Phase-I and Phase-II. The road sections of both phases are given in Table 4.2 and Table 4.3.

Table 4.2 Distribution of road section at different ROWs in BRT Phase-I

Road Section Type	Bus lane width (m)	Mixed-traffic lane width (m) LS+RS	Bicycle track width (m)LS+RS	Footpath width (m) LS+RS	Others (parking kerb service lane (SL) etc.)
60 m ROW	7.0	10.0+10.0	2.75+2.75 (Segregated)	2.25+2.25	14 (SL) + 9
40 m ROW	7.0	9.25+9.25	2.0+2.0 (Segregated)	2.0+2.0	3.25 + 3.25
36 m ROW	7.0	7.0+7.0	2.0+2.0 (Non-Segregated)	2.0+2.0	3.0+3.0
30 m ROW	7.0	6.5+6.5	2.0+2.0 (Segregated)	2.0+2.0	1.0+1.0

ROW = Right of Way
Source: Collected from BRT DPR, Phase-I

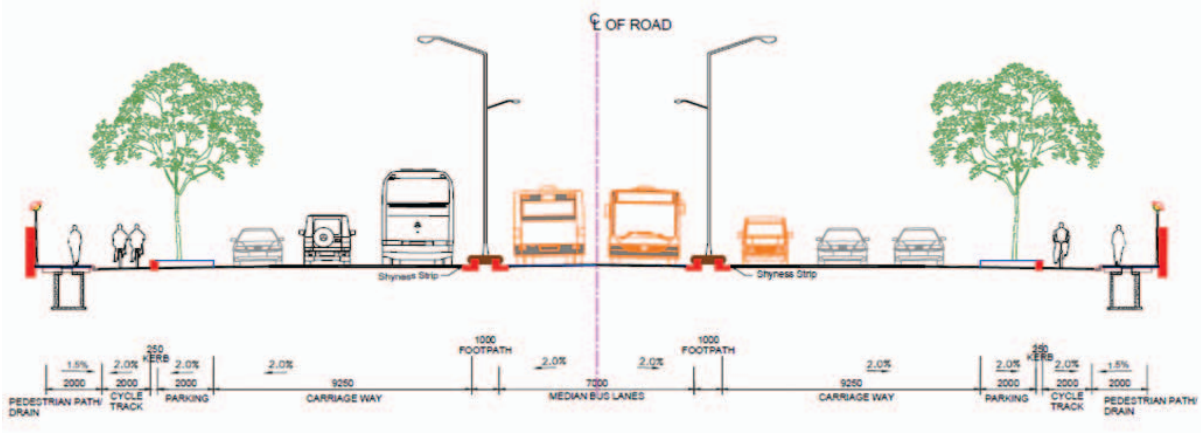
Figure 4.3 Road section at 60 m ROW



Source: AMC, AUDA and CEPT University, 2007

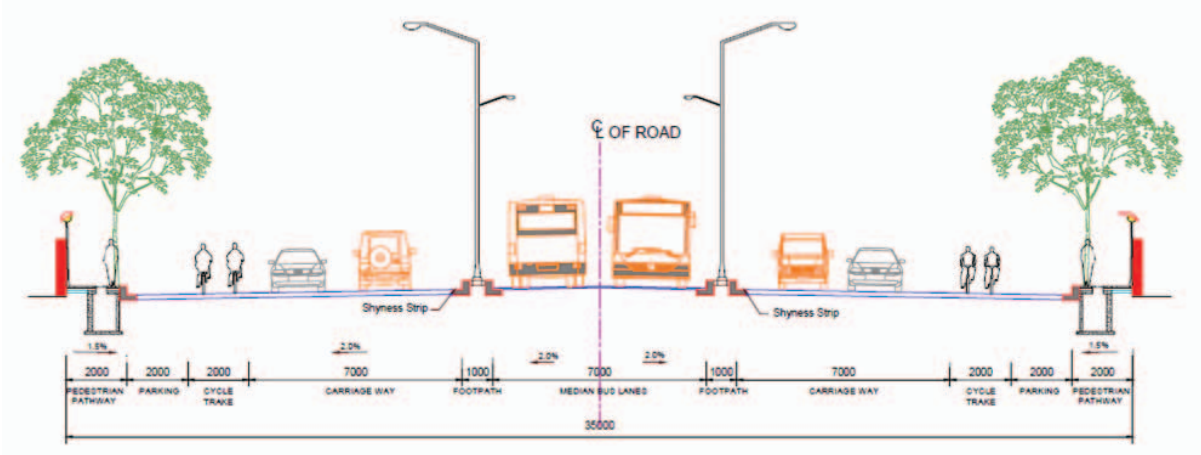
The BRT lanes in both phases have railings on two sides, and guide the pedestrians to crossroads only at specific locations where zebra crossing has been provided. The station is built in the middle of the bus lane. In Phase-I, the width of the bus lane is 7.0 m in all ROWs. Service lanes of 7.0 m width have been provided on the two sides, just after the bicycle track on the 60 m ROW. Parking space of minimum width of 2 m has also been provided at all ROWs except at the 30 m ROW. The width of the mixed-traffic lane decreases with the ROW. The width of the footpath varies from 2.0 m to 2.2 m and of bicycle tracks from 2.0 m to 2.25 m. Bicycle tracks are segregated on ROWs of 40 m and above as well as for ROW of 30 m, but non-segregated for ROW of 36 m (Table 4.2).

Figure 4.4 Road section at 40 m ROW



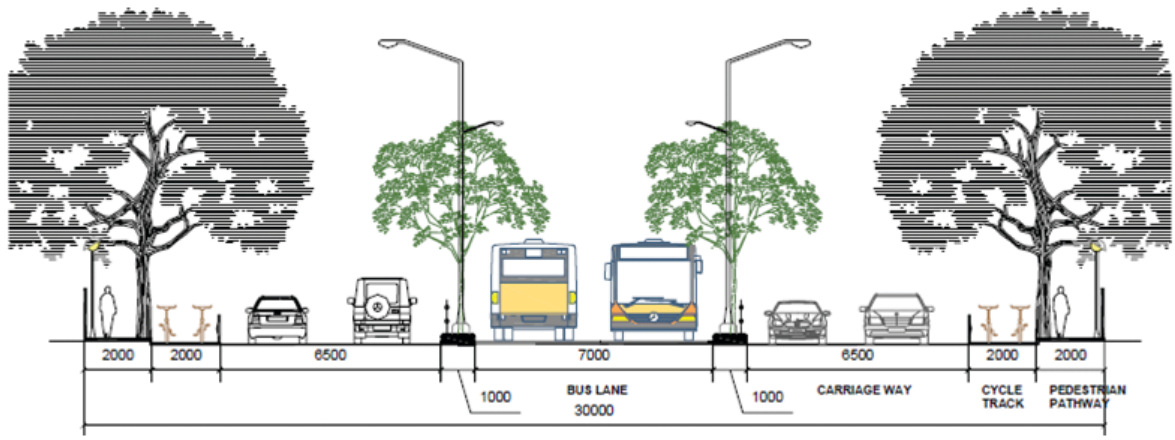
Source: AMC, AUDA and CEPT University, 2007

Figure 4.5 Road section proposed at 35 m ROW



Source: AMC, AUDA and CEPT University, 2007

Figure 4.6 Road section proposed at 30 m ROW



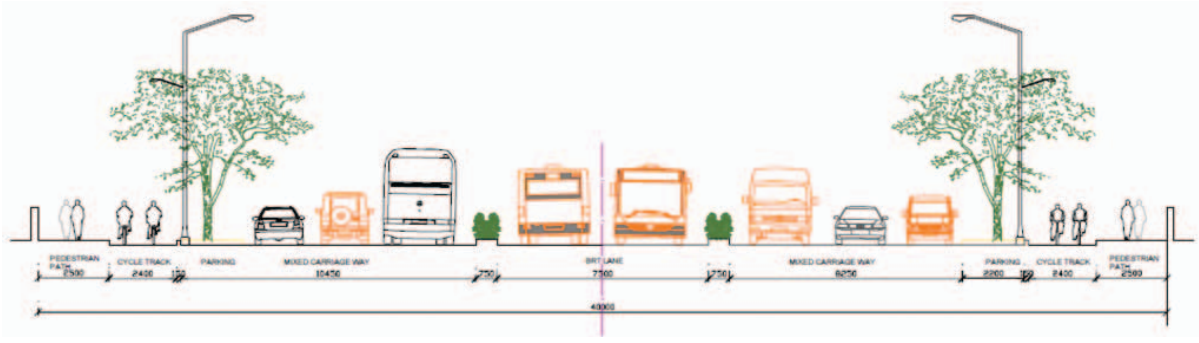
Source: AMC, AUDA and CEPT University, 2008

Table 4.3 Distribution of road section at different ROWs in BRT Phase-II

Road Section Type	Bus Lane Width (m)	Mixed-Traffic Lane width (m)	Bicycle Track width (m)	Footpath Width (m)	Others (Parking Kerb etc.)
40 m ROW	7.5	8.25+8.25	2.4+2.4 (Segregated)	2.5+2.5	3.1+3.1
36 m ROW	7.5	6.25+6.25	2.25 + 2.25 (Non-Segregated)	2.7+2.7	3.55+3.55
30 m ROW	7.3	6.0+6.0	Not Provided	2.5+2.5	2.85+2.85

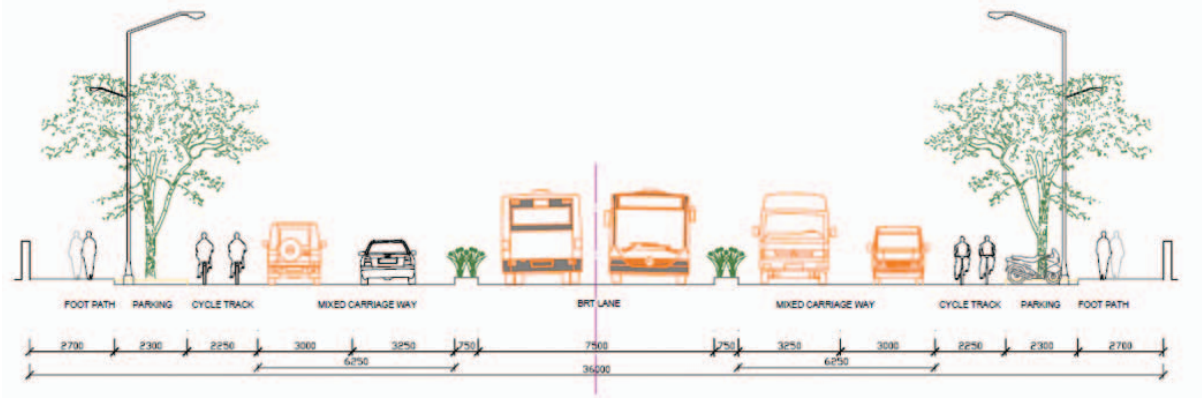
In Phase-II, bus lane width has been increased by 300-500 mm, and it is 7.3 m at the 30 m ROW and 7.5 m at the 36 m and 40 m ROWs. This was done mainly to leave more space between two buses when they pass each other on the corridor. The minimum width of mixed-traffic lane is 6.0 m on both sides at the 30 m ROW, and increases to 8.25 m at the 40 m ROW. Parking has been provided in all ROWs ranging from 2.1 m to 2.3 m, which is more in width as compared to Phase-I. Although segregated bicycle tracks of 2.4 m have been provided at the 40 m ROW, at the 36 m ROW they are not segregated and are of slightly lesser width. No separate bicycle track has been provided at the 30 m ROW. The width of the footpath has been improved in Phase-II and it ranges between 2.5 m to 2.7 m.

Figure 4.7 Road section proposed at 40 m ROW



Source: AMC, AUDA and CEPT University, 2008

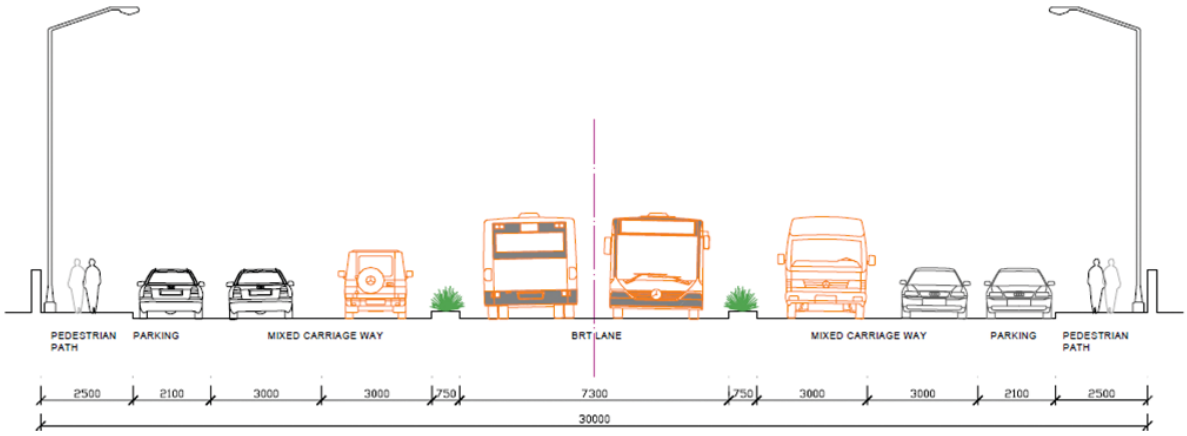
Figure 4.8 Road section proposed at 35 m ROW



Source: AMC, AUDA and CEPT University, 2008

Bus stops are planned roughly at every 700 m. There are two kinds of bus stops. The longer ones are made of concrete and look more like permanent structures. There are also smaller ones which are made of steel and look more temporary in nature. There is a stark difference between the two kinds of bus stations. Longer concrete bus stations can cater to two buses per direction at a time, and the steel bus stops can cater to one bus per direction at a time. Each bus stop is provided with a ramp to make it easier for the physically challenged and those in wheelchairs, to move. The bus stations are airy and well lit. A passenger information system is provided by digital display boards, which constantly updates the time and destination of the expected bus. Station doors are automated and open in sync with the bus door. Bus stops are 900 mm above the ground, and therefore level-boarding to the bus is smooth and easy for physically challenged and elderly people. The reasons for the deviation in bus stop design is not clear, but prima facie it seems that bus stations near slums and residential areas of low income groups in Eastern Ahmedabad were made of steel due to possible fear of vandalism.

Figure 4.9 Road section proposed at 30 m ROW



Source: AMC, AUDA and CEPT University, 2008

Figure 4.10 (Left) A concrete-made bus station, (Right) A steel-made bus station

4.3.3 Fares and fare collection system

Fares are collected at the bus stop itself, and tickets are collected at the end of the journey. The minimum and maximum fares on the BRT were ₹ 2 and ₹ 21 at the time of our survey, which were increased to ₹ 3 and ₹ 28 in January 2012. Travelling on the BRT for longer distances has become expensive now,

and it may deter low-income households from using it. The smart card system on the BRT was launched in January 2012 after 2 years of operation due to a few complications in selecting the agency for its implementation. The minimum recharge value has been kept at ₹ 50 and the maximum is ₹ 1500. The card has a cost of ₹ 25. Almost 2,000 cards were sold on the day it was launched.

Ahmedabad's BRT system is the only one in India in which fares are collected at the bus stops. This has obviously reduced chaos in buses, made the boarding-alighting easier and reduced the possibility of fare evasion, but on the other hand has rendered the collection of separate fares for air-conditioned (AC) and non-AC buses impossible. Still, there is just one fare for AC and non-AC buses, while AJL pays different charges per km to the operator for AC and non-AC buses. Display boards at bus stops also do not indicate if the arriving buses are AC or non-AC, which also makes the possibility of buying a separate ticket for AC buses at the ticket window impossible. There is no clarity regarding how a different fare for an AC bus would be deducted from a smart card while making an exit from the bus stop.

4.3.4 Buses

Janmarg's buses are privately owned and operated. Currently there is just one bus operator working with AJL, but more will be joining as soon as the system extends to its full length. Janmarg uses Euro III and Euro IV compliant diesel engines, high-floor (90 cm) buses, a decision which was taken due to the much higher cost of the low floor buses. CNG buses are now slowly being added to the fleet, and the new ones would all be CNG. There are 78 buses with the AJL right now, out of which 10 are AC buses. AJL has a gross cost contract designed to include incentives and penalties to govern operations. AJL is currently paying ₹ 43.11 per km to the private operator which was earlier ₹ 34.11 (*Indian Express,* 2012). The design of the buses is such that it has a door 900 mm above the ground level to match it with the Janmarg bus station on one side, and a low door on the other side. The bus has a seating capacity of just 36 people, and hence ensures more standing room.

4.3.5 Branding

The Janmarg team has remained very pro-active about the branding of the project. They have successfully given "Janmarg" a similar glamour quotient in Ahmedabad to that of the Metro in Delhi. The system has an identity of its own. The bus systems in India are always associated with poor services, and Janmarg has worked hard to remove this image from people's minds. Most stations are kept neat and clean, the frequency of buses is well maintained, and the staff is helpful to passengers.

Janmarg could be said to be one of the most highly advertised government projects in Ahmedabad. A lot of publicising was done to educate the people and get their approval. Special newspaper articles were published on its success during the festival and holiday seasons, such as Navaratri, Diwali, etc. For the first 2-3 months of the launching of the Janmarg first corridor in Western Ahmedabad, free rides were offered to all the citizens to make the system well-known to the people and create goodwill toward the new system. The system was also advertised well in all international forums. All details of system extension, and achieved landmarks in terms of daily fare collection and ridership are regularly reported in most local newspapers. Due care has been taken to educate people on every aspect of the system, and the strategy has worked so far.

4.4 Janmarg: An assessment

Although Janmarg is operating a very well-managed bus service, there are many components which are either missing or have not found enough attention in the system design. The justification of every BRT system has started with encouraging NMT modes and public transport, allowing universal access, and improving mobility for all, including the poor. All major successful case studies of BRTSs have included these components in their design. Janmarg has managed to attract worldwide attention without paying adequate consideration to these components.

Janmarg also received a Sustainable Transport award for the year 2010, which was given on the basis that it has reduced carbon emissions and has dramatically improved residents' access. It has made continued efforts to be a leader in sustainable transport, including incorporating high-quality pedestrian facilities in some corridors, as well as bicycle lanes. The parameters used to judge this dramatic improvement were not made available in the public domain. At that time Janmarg was just managing 18,000 passengers per day. The citation for the award mentions that:

> "Ahmedabad's Janmarg BRT is the first full-featured BRT in all of India, the first with stations in the median and where one buys tickets before entering system stations, to allow for quicker boarding of the buses, and fewer delays. The stations are well-designed, attractive spaces that provide shelter from rain and sun. The buses are boarded at-level, making them much more accessible to the elderly, handicapped and even parents with small children. It serves as a model for the future of transportation in India and the world. City residents have unilaterally embraced the BRT system—as of June 2011 there were 115,000 trips each day on Janmarg, carrying residents to work, to school and elsewhere. The system is projected to save 288,000 metric tons of CO2 each year, in part because it will prevent passengers from switching from bus to motorcycles or private cars in the years to come. The city is also making continued efforts to be a leader in sustainable transport, including incorporating high quality pedestrian facilities throughout the city as well as bicycle lanes."[23]

There is no debate on the fact that walking and cycling are the two major modes of the most sustainable transportation. Bogotá's BRTS success also had a big component of NMT like walking and cycling, which actually led to the betterment of the city's public transport scenario. In the case of Ahmedabad, planners did not meet the claims made in their own DPRs about creating facilities for walking and cycling. Furthermore, Janmarg is partly funded by the Central Government under condition of implementing the NUTP, which however has not been fully followed with respect to provisions on NMT. All cities getting funding under JnNURM for implementing BRT systems were asked to mandatorily build NMT facilities alongside.

4.4.1 Janmarg: BRT without NMT facilities

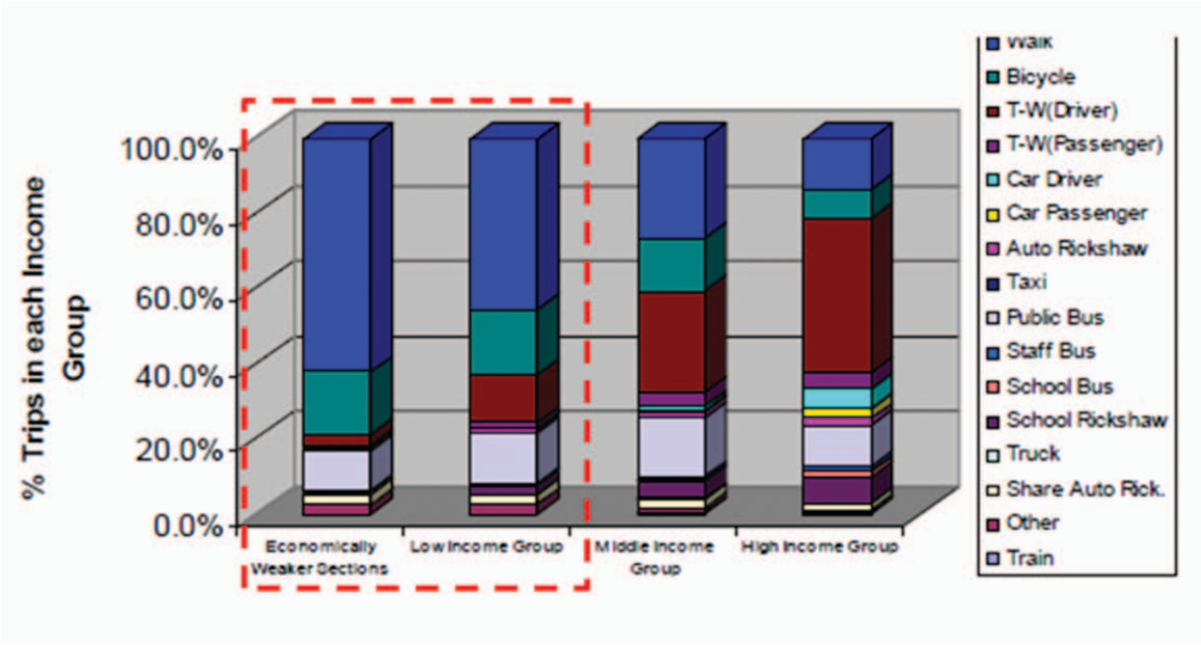
A comprehensive mapping of NMT facilities was done along the BRT corridor by our survey team, and the provision of footpaths and bicycle tracks was measured and compared with the proposal.

Walking and cycling are two major low-carbon modes of transport, and they are mainly used by low-income groups due to the zero cost of using them. The DPR for Phase-I realised that pedestrians and cyclists were the most accident prone, comprising 61 per cent of the total accidents when these modes comprised 55.21 per cent of the total trips in the city (AMC, AUDA and CEPT University, 2007). Thus, on

[23] http://www.itdp.org/get-involved/sustainable-transport-award/previous-award recipients/ahmedabad-india (accessed on 20 November 2011).

two counts–the share in the total modal split and in total accidents–the NMT infrastructure should have been better planned and implemented. A big expectation from Janmarg was that it will ensure a more equitable allocation of road space for people, rather than vehicles, as per the recommendations of NUTP. Table 4.4 shows the extent of provision and Table 4.5 shows the state of the NMT infrastructure along the BRT corridor. Detailed maps have been added as Annex-B.

Figure 4.11 Mode choice vs income



Source: Janmarg DPR Phase-I (pp. 5-9)

Table 4.4 Provision of footpaths and bicycle tracks along Janmarg corridor

	BRT length in km (L+R)	Bicycle track provided (L + R)		Footpath provided (L+R)	
		in km.	% of BRT	in km.	% of BRT
R.T.O. to Naroda	63	20.4	32.5	53.5	85.0
Danilimda C.R. to Kankaria T.E. (Loop)	15	0	0.00	11.7	78.0
Total	**78**	**20.4**	**26.2**	**65.3**	**83.7**

Source: Primary Survey

In the surveyed stretches, bicycle tracks were provided only on 26.2 per cent of the BRTS track and footpaths were provided on 83.7 per cent of the BRTS track. Even these were not obstruction free. Of the available bicycle tracks, 35 per cent were obstructed due to various reasons like unauthorised parking, open manholes, rainwater drainage, electricity poles, etc. The rest of the cycle track is also not very continuous and hence rendered unusable. Bicycle tracks are also badly designed and have high kerbs segregating them from the mixed-traffic lane. The effective usable width of the cycle track reduces as a

result. Due to the fear of their bicycle paddles hitting the kerb and causing accidents, the cyclists are often found in the mixed-traffic lane rather than the cycle track. Observing the usages of the walking and cycling facilities, the sizes of footpaths and bicycle tracks along the corridor raises the question of their adequacy. The widths of both the footpaths and bicycle tracks each varied between 2 m and 2.7 m from the DPR. The width of the cycle lane is not enough for cyclists to overtake others. Being stuck behind slower cyclists discourages the use of cycle lanes. Hence, instead, cyclists start using the mixed-traffic lanes.

Table 4.5 Percentage of obstructed bicycle tracks and footpaths along Janmarg corridor

	Availability of Bicycle Tracks			Availability of Footpaths		
	Provided (km)	Obstructed (km.)	% Obstructed	Provided (km)	Obstructed (km)	% Obstructed
RTO to Naroda	20.4	7.2	35.0	53.5	28.2	52.6
Danilimda C.R. to Kankaria T.E.	0	0.0	NA	11.7	6.1	52.0
Total	20.4	7.2	35.0	65.3	34.2	52.5

Source: Primary Survey

Figure 4.12 (Left) Autorickshaw parking planned at entry to bicycle track (Right) State of bicycle tracks after rains

The footpaths are obstructed due to various reasons like signboards, light posts, trees, post boxes, telephone boxes, entrances to buildings, and unauthorised two-wheeler parking. Thus 52.5 per cent of the footpaths are obstructed. The width of footpaths is also very narrow at certain places and they are mere road kerbs than footpaths. The NMT infrastructure along Janmarg has been given short shrift. Some strong steps are needed to improve this infrastructure for pedestrians and cyclists, and thereby encourage walking and cycling in the city to meet climate change goals. Yet walking and cycling as an everyday mode of transport has drastically reduced in the city over time as already mentioned, and the NMT infrastructure along the BRT corridor has not been able to stop this trend and has not delivered on its promises. It is clearly a case of lost opportunity. It would not be wrong to say that Janmarg has failed the urban poor households of the city.

Figure 4.13 (Left) An electric pole obstructing the bicycle track, (Right) A manhole opened up in the middle

Figure 4.14 (Left) 4-wheeler parked on foothpath, (Right) A JnNURM sign board obstructing the footpath

Figure 4.15 (Left) Unusable width of footpath as well as bicycle track, (Right) No footpath or cycle track

In the current implementation phase of all the newly planned Janmarg corridors, bicycle tracks are being discarded under the excuse of 'lack of space' and 'security concerns'. In a particular stretch passing next to the Indian Space Research Organisation's (ISRO) campus, the AMC has stated that cycle tracks would not be laid as they would cause a security threat to the establishment (*Times of India,* 2011). If such arguments are repeatedly forwarded, the Janmarg might ultimately discard the idea of bicycle tracks and thus fail to achieve the goals of sustainable and inclusive transport for Ahmedabad.

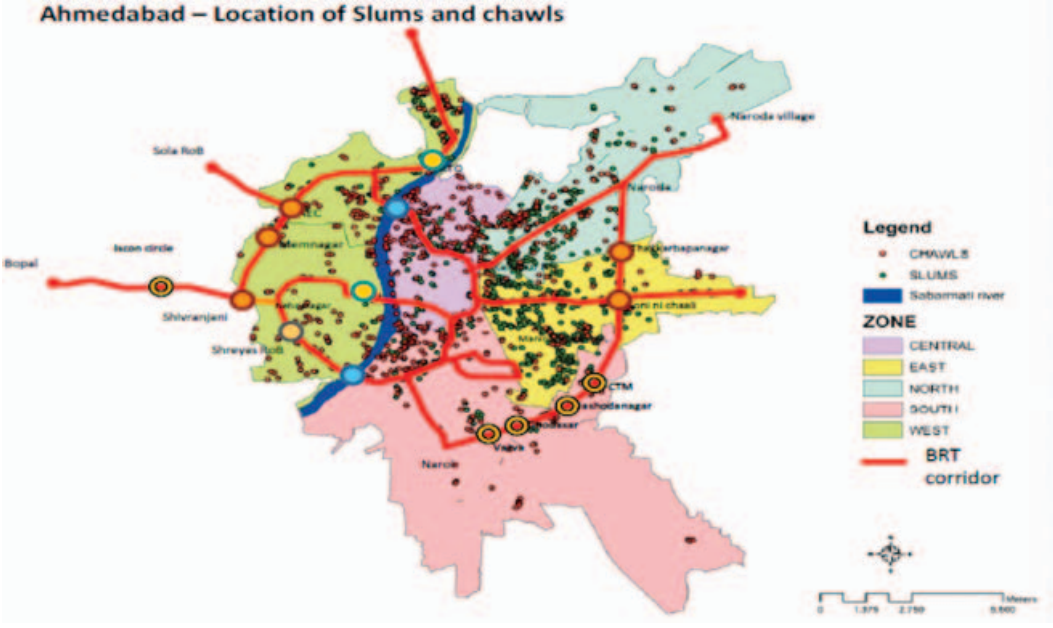
4.5 Janmarg: Scope of improvements

There are various other concerns which have not been addressed while implementing the BRTS Project. Janmarg BRTS boasts of being situated near the maximum number of slums and chawls[24] and therefore it is expected that these households would also benefit from the new system as per the DPRs The following two sections describe in detail whether the slum and chawl-dwellers have benefitted on account of the BRT.

The BRTS project has caused demolition of houses along the corridor and displacement of hawkers on these stretches. Hawkers have been displaced because there has been no attempt to integrate them into the main design. Janmarg's street design has not been sensitive to other street activities along the corridor either. Informal street activities are an important aspect of urban living in Indian cities, which should have been acknowledged and taken as a design challenge.

Figure 4.16 shows the BRTS network with respect to the location of slums and chawls. A public hearing held in December 2009 on the displacements in Ahmedabad stated that 7,500 households were expected to be displaced from one stretch of the BRTS corridor (Akhbarnagar to Vadaj bus stand) for road widening for Janmarg, of which just 1,050 families were resettled (Our Inclusive Ahmedabad, 2010, pp. 36-37).

Figure 4.16 Janmarg corridor vis-à-vis slums and chawls



Source: Prepared by the authors.

[24] Chawls are single room dwelling units laid in a row with personal or share bathroom and toilet. These were constructed to house industrial workers in the first half of the 20th Century. Now, any low income housing of single room dwelling units in a row is called a *chawl*.

Figure 4.17 (Left) Satellite image of Vadaj slums before BRT (Right) After BRT implementation

Figure 4.18 (Left) Satellite image of Vadaj slums before BRT (Right) After BRT implementation

4.5.1 Non-inclusion of street vendors in design

Janmarg's foray into the heart of the old city will further increase these problems if the street character is not taken into consideration in street design. Janmarg's new route construction near the main bus stand has already started displacing vendors and other markets along it. Nearly 500 vendors and residents around Geeta Mandir Bus terminus held a *dharna* (protest sit-in) in January 2012 against the decision of

the civic body to construct a double track of BRTS there, as the BRTS is supposedly going to demolish 300 shops (*Daily News Analysis (DNA)*, 2012).

Figure 4.19 Buzzing vendor's street along Janmarg in the eastern part of the city

4.5.2 Lack of integration with the AMTS

The advent of Janmarg has led to the negligence of the AMTS by the AMC. The AMTS network and fleet is much larger than that of the BRTS and therefore has much larger coverage and ridership. AMTS fares are also lower than that of the BRTS, which makes it affordable for low-income users. To create ridership for Janmarg, all the AMTS routes parallel to it have been closed down. This has brought exclusivity to Janmarg and the majority of Janmarg users (more than 50 per cent) are ex-AMTS users. The continuous AMTS routes have been disrupted as a result, necessitating now more interchanges than before and increasing trip time and inconvenience to the AMTS users. AMTS-BRTS commuter integration was never considered, due to which two bus services run in a completely segregated manner even if are they governed by the same AMC. The segregation between both bus services is complete in terms of physical infrastructure, ticketing and social marketing.

AMTS buses are not allowed in the Janmarg corridor. Instead of closing down the AMTS routes along the Janmarg and causing inconvenience to the users, the AMTS buses could have been allowed to run in the dedicated corridor for the BRTS. Instead, the BRTS is being run as an exclusive service. This could have led to an improvement of the whole bus service of the city, improved the mobility for many more

people than the few living along the corridor, reduced bus interchanges, and maintained point-to-point connectivity. Janmarg right now also has issues of last-mile connectivity due to bad walking and cycling infrastructure in the city, and a crippled AMTS service which is not used efficiently. Janmarg's image is of an exclusive bus system, expensive and express, which ignores the mobility of all in the city.

4.5.3 Problems of universal access

Janmarg has also remained unsuccessful in providing better access to the physically challenged. Although the bus stops have been designed in a way that they are wheel chair-friendly, access to bus stops is gated by concrete pillars, which makes it impossible for the blind, people with crutches and wheelchairs to reach the bus stations. Entry and exit into a BRTS station is difficult for everyone and discipline along the zebra crossings is not enforced.

The RTO station from where the Janmarg starts is the worst in terms of user access. The bus stop is a low platform, opening on the left side of the bus, which is the low floor section. There is no ramp for wheelchairs. The buses do not board at the platform provided. There is no display which tells the time of the next bus. Janmarg staff members resort to yelling the names of the buses, and guiding people towards the right bus. The practice completely defeats the purpose of the bus stop design, which is meant to smoothly board/de-board all passengers, including the physically challenged.

Figure 4.20 (Left) R.T.O. bus station: Low height, no ramp, no level boarding (Right) Concrete pillars at entry of station

4.6 Conclusion

The Ahmedabad BRTS stands out amongst the Indian cities for having built about 45 km of rapid transit network and it continues to expand the network. It is commendable that there is 'network' thinking involved in the planning of BRTS and not 'corridor' thinking. With the expansion of the BRTS, the ridership is increasing and the service is becoming increasingly popular amongst the people of the city. Since the system became operational, both ridership and revenue has grown impressively. The system is being seen as a trademark of the city and is also used for marketing the city. However, the recent fare hike will make it difficult for low-income households to travel by BRTS.

There is a lot of scope for improvement in planning, design and implementation of the Ahmedabad BRTS. The operational BRTS corridors so far have been on the roads above 30 m in width and in terms of its cross-sectional design, maximum spaces have been left for mixed traffic at the cost of cycle tracks and footpaths. In this process, the NMT infrastructure has not been paid the due attention promised in the DPRs Furthermore, there are also no official plans of either improving them or planning them

in a comprehensive manner in the city, irrespective of the BRT project. Second, integration with the regular bus service (AMTS) is another unaddressed concern and there are no official plans to do so as of now. Lastly, there are unaddressed social issues, such as the resettlement of those whose housing and livelihoods were displaced on account of corridor development. The following chapter delves more deeply into some of these issues relating to the Ahmedabad BRTS by discussing user characteristics and profiling their socio-demographic backgrounds, opinions and perceptions.

5. BRTS Users Survey - Ahmedabad

The study of the Ahmedabad BRT system was undertaken in 2011, when 44.5 km of the total planned 88.8 km was in use, suggesting that almost half of the proposed network was in operation, giving us a good idea about its effectiveness in the city. As mentioned earlier in Chapter 1, samples for the survey were drawn during both peak and off-peak hours based on the user data obtained from Ahmedabad Janmarg. The survey was canvassed at the BRT stops of passengers before they boarded the bus. This survey would give us an idea about the user profile, travel behaviour and perceptions, to assess how far the system has been successful as an inclusive low-carbon mobility system.

5.1 User profile

The BRTS users are comprised of 72.5 per cent males and 27.5 per cent females, making the system more male-centric than gender neutral. The sex ratio among the BRTS users in Ahmedabad is 379[25] (Table 5.1). This bias is seen in Ahmedabad in the overall transport system, as well as the fact that only 1/3 of trips in the city are being made by the women. The mobility of women is constrained by various factors resulting in low travel demand. The sex ratio is lower among the low income groups (up to a household income of ₹ 10,000 per month) and overall it increases in line with income (Table 5.1), indicating that the low income women are the least likely to use the BRTS.

Table 5.1 Income profile and sex ratio of BRT users, Ahmedabad

Income (₹)	Male	Female	Persons	Sex ratio
Up to 2,500	1.7	1.7	1.7	385
2,501-5,000	12.7	9.8	11.9	292
5,001-7,500	12.1	8.0	11.0	253
7,501-10,000	13.9	11.2	13.2	305
10,001-20,000	28.2	27.6	28.1	371
20,001- 30,000	12.5	16.4	13.6	500
30,001- 40,000	8.0	8.4	8.1	400
> 40,000	10.9	16.8	12.5	585
Total	**100.0**	**100.0**	**100.0**	**379**

Source: Primary survey.

At the same time, use of the BRTS by low-income groups is low. Of the total users, just 13.7 per cent belong to household incomes of up to ₹ 5,000. We could safely take this group as the poor. Just one-fourth of the users had monthly incomes of up to ₹ 7,500. 62.2 per cent of users had monthly household incomes of more than ₹ 10,000. Thus, BRTS is being used largely by middle-income groups, with monthly incomes between ₹ 10,000 and ₹ 40,000, wherein half the users fall. As per the National Sample Survey's

[25] Sex ratio is number of females per thousand males.

(NSS) Consumption Expenditure data of 2009-10, about 30 per cent of the urban households fall in the monthly household income category of up to ₹ 5,000 (NSSO, 2011). Hence, we can safely assume that households with incomes of ₹ 5,000 per month or less are the bottom 30 per cent of the urban spectrum and they do not use the BRTS in Ahmedabad to any great extent. Furthermore, as mentioned, women among them use BRTS even less. Another group that does not use the BRTS much is households with incomes of more than ₹ 40,000 per month.

Table 5.2 Age profile of BRT users, Ahmedabad

Age (Yrs)	Male	Female	Persons	Sex ratio
Up to 14	0.4	0.0	0.3	0
15 - 40	75.9	73.8	75.3	369
41 - 59	19.1	22.4	20.0	444
60 and above	4.6	3.8	4.4	314
Total	100.0	100.0	100.0	379

Source: Primary survey.

By age, the largest user group of the BRTS is the youth and adult working population, which is the age group of 15-40 years (Table 5.2). Three-fourths of the BRTS users fall in this age group. There is very little gender difference in this age group. The non-users of the BRTS are school-going children up to 14 years of age and girls in this group do not use the BRTS at all. Among the middle-age population (age 41-59 years), there is a slightly higher presence of women than in other age groups, although the sex ratio of the users in this group is only 444.

Table 5.3 Percentage of workers among BRT users by sex, Ahmedabad

	% Workers Among BRT Users
Male	71.8
Female	42.7
Persons	63.8
Sex ratio in workers among BRT users	226

Source: Primary survey.

Workers are the main BRTS users and they comprise 64 per cent of the BRTS users (Table 5.3). But the sex ratio in the workers among the BRTS users is just 226, indicating that among the women, main BRTS users are the non-workers. Just 42.7 per cent of the female BRTS users are workers. Among the males, it is just the contrary; 72 per cent of the male BRTS users are workers. The sex ratio in the non-workers category using the BRTS is 770, indicating that women are using the BRTS to a great extent for purposes other than work.

About two-thirds of the BRTS users who have identified themselves as workers are employed in the private sector on a regular salary (Table 5.4). This is true among males as well as females. Among males, the next largest user category by employment type is high wage self-employed, and among females it is public sector employees. The unemployed are those not having work now but are available for work if they get it. They are not non-workers. Use of the BRTS by the unemployed is very low. So, evidently, the BRTS is being used largely by workers in the case of males, and non-workers in the case of females.

But, among the males as well as females, those who have a regular job in either the private sector or the public sector use the BRTS. Their proportion together among the BRTS users is 75 per cent. Casual labour proportion among the BRTS users is low as compared to their proportion in the whole city (which is 10 per cent) (Mahadevia, 2012).

Table 5.4 Employment profile of BRT users by sex, Ahmedabad

	Male	Female	Persons	Sex ratio
Regular Salaried Public	8.1	18.0	10.0	500
Regular Salaried Private	63.8	65.6	64.1	232
Self Employed High Wage	13.7	9.8	13.0	162
Self Employed Low Wage	7.6	1.6	6.5	49
Casual Labour	6.1	3.3	5.6	121
Unemployed	0.7	1.6	0.9	500
Total	100.0	100.0	100.0	379

Source: Primary survey.

5.2 Trip purpose

Going to work is the single largest BRTS trip-generator among males; 55.4 per cent of male users said that was their trip purpose (Table 5.5). Among females, other purposes such as social, recreational, and religious visits was the largest purpose for their BRTS use at 38.5 per cent. Among those who use the BRTS to access healthcare services, the sex ratio was 722 indicating that women travelling for health purposes did take BRTS. For the purpose of shopping as well as other trips, the sex ratio was higher than the average, indicating a relatively large presence of women among these types of trip-makers.

Table 5.5 BRT trip purpose

Purpose	Male	Female	Persons	Sex ratio
Work	55.4	35.0	49.8	239
Education	15.8	19.6	16.8	471
Health	2.4	4.5	3.0	722
Shopping	1.7	2.4	1.9	538
Others*	24.7	38.5	28.5	591
Total	100.0	100.0	100.0	379

* Others include social, recreational, and visits to religious places.
Source: Primary survey.

Table 5.6 Trip purpose by household income, Ahmedabad

Income (₹)	Work	Education	Health	Shopping	Others	Total
Up to 5,000	60.6	5.6	3.5	2.1	28.2	100.0
5,000 to 10,000	55.0	11.2	3.2	1.6	29.1	100.0
10,001-40,000	45.5	20.1	2.9	2.3	29.2	100.0
> 40,000	45.4	26.9	2.3	0.8	24.6	100.0
Total	49.8	16.8	3.0	1.9	28.5	100.0

Source: Primary survey.

Different income groups use the BRTS for different purposes. The low income groups, up to an income of ₹ 10,000 per month, largely use it for going to work followed by other purposes, whereas the higher income groups use it for the purpose of going to educational institutions (Table 5.6). In fact, in the income groups above ₹ 10,000 per month, more than 20 per cent use the BRTS to go to educational institutions. Note that the low income groups do not send their children to schools which would require them to spend money on transport. Hence, the use of the BRTS for educational purposes is quite low among low income groups.

If children (up to the age of 14 years) are making a BRTS trip then they are doing so for the purpose of education (two-thirds) or social purposes (one-third) (Table 5.7), and probably with the elders of the family. As seen above, their share in the total trips is very small (just 0.3 per cent of the total trips). In the age group of 15-40, 49 per cent are for work and another 22 per cent are for education. The rest of the trips are for other purposes. As the age group advances, other purposes become the reason for using the BRTS. In the age group of 60 plus, about 57 per cent use BRTS for other purposes. Nonetheless, in the age above 14 years, significant proportions of trips are for work purposes.

Table 5.7 Distribution by trip purpose for each age group, Ahmedabad

Trip purpose	Age Group				Total
	Up to 14	15 - 40	41 - 59	60 and above	
Work	0.0	48.8	57.7	34.8	49.8
Education	66.7	21.7	1.4	0.0	16.8
Health	0.0	1.9	5.8	8.7	3.0
Shopping	0.0	1.9	2.4	0.0	1.9
Others	33.3	25.7	32.7	56.5	28.5
Total	100.0	100.0	100.0	100.0	100.0

Source: Primary survey.

5.3 Physical access to BRTS

This section deals with access to the BRTS from home, and access to the destination from the BRTS. First, we would look at the dynamics of access to the BRTS station. On the whole, 46 per cent of the BRTS users reached the station on foot (Table 5.8), meaning the station has to be within walking distance. Among female users, half of them walked to the station. The next largest mode used to reach the BRTS station was shared autorickshaws, as this is a cheaper mode than full-fare autorickshaw and is easily

available as compared to the public bus system run by the AMTS. Hence, 19 per cent of the BRTS users reached the BRTS station by shared autorickshaws and 13.4 per cent used the AMTS. The use of shared autorickshaws is larger in proportion among the females than males. About 4.9 per cent of the BRTS users stated that they reached the BRTS station by the ST bus and another 2.9 per cent stated that they used railways to reach the BRTS station. At several points on the BRTS route, there is a connection with the ST system and the intercity commuters are using the BRTS to reach their destination. Those coming by train are also intercity commuters who are now using the BRTS for intra-city travel.

Table 5.8 Mode used for reaching BRT by sex, Ahmedabad

Mode to BRTS station	Male	Female	Persons
Walking	44.8	50.0	46.3
AMTS	14.6	10.1	13.4
Autorickshaw (Shared)	17.9	22.0	19.0
Autorickshaw (Full-Fare)	5.4	7.0	5.9
Motorised 2-wheeler	6.8	6.3	6.6
Motorised 4-wheeler	1.1	1.0	1.1
State Transport Bus	5.7	2.8	4.9
Railways	3.7	0.7	2.9
Total	**100.0**	**100.0**	**100.0**

Source: Primary survey.

The BRTS station was within half a kilometre of their home for about half the BRTS users (Table 5.9). Hence, obviously, they walk. For another 15 per cent, the BRTS station was between half a kilometre and one kilometre. The average distance to the BRTS station comes to 1.92 km because of the outliers. The median distance is 0.38 km, meaning that half the population travel 0.38 km or less to reach the BRTS station, which is a walk of about 5 to 7 minutes.

Table 5.9 Frequency distribution of distance travelled to teach BRTS station, Ahmedabad

Distance travelled in km	Percent
Less than 0.50	50.5
0.51 - 1.00	15.3
More than 1	34.2
Total	100.0
Mean	1.92 km
Median	0.38 km

Source: Primary survey.

Further disaggregation by the mode used to traverse different distances to reach the BRTS station shows that 76 per cent of those who were walking lived within half a kilometre of the BRTS station. Another 23 per cent lived within half to one kilometre of the BRTS station. No one is cycling to the BRTS station, not for any other reason than the non-availability of cycle-parking facilities at the BRTS stations. AMTS is used to reach the BRTS station for distances of more than half a kilometre and shared or full-fare autorickshaws are used for distances exceeding 1 km.

While there is not much of a difference in terms of income group for travelling a distance of less than half a kilometre to the BRTS station, there is quite some difference among income groups of users travelling more than 1 km. The proportion traversing more than 1 km increases with the increase in income (Table 5.10).

Table 5.10 Distance travelled to reach BRTS station by income groups, Ahmedabad

Income (₹)	Distance travelled to reach BRT Station (in km)			Total
	Up to 0.50	0.51-1.00	> 1.00	
Up to 5,000	50.7	18.3	31.0	100.0
5,000 to 10,000	45.8	23.5	30.7	100.0
10,001-40,000	53.0	12.2	34.8	100.0
> 40,000	49.2	8.5	42.3	100.0

Source: Primary survey.

Table 5.11 Mode used to reach destination from the BRT station, Ahmedabad

Mode	Male	Female	Persons
Walking	64.3	63.6	64.1
Cycling	0.4	0.0	0.3
AMTS	7.7	7.7	7.7
Autorickshaw (Shared)	17.5	14.3	16.6
Autorickshaw (Full-Fare)	4.5	8.7	5.7
Motorised 2-wheeler	4.4	4.5	4.4
Motorised 4-wheeler	0.4	0.7	0.5
State Transport Bus	0.5	0.3	0.5
Railways	0.3	0.0	0.2
Total	100.0	100.0	100.0

Source: Primary survey.

Once again, walking dominates the mode to reach the destination from the BRTS station. 64 per cent of the users do so and there is hardly any gender difference here (Table 5.11). In fact, a much higher proportion of BRTS users walk to their destination from the BRTS station than the proportion of BRTS users walking to reach the station from home. This means that BRTS users are willing to go a longer distance to reach the BRTS station if their destination is closer to the stand. Hence, the average distance travelled to the destination from the BRTS stand is 1.62 km (less than the distance to reach the BRTS) and for about half the population it is 0.27 km (Table 5.12). About 58 per cent of the BRTS users traverse less than half a kilometre to reach their destination from the BRTS station. But, there is also a significant proportion of the BRTS users who travel more than a kilometre from the BRTS station to their destination.

Table 5.12 Frequency distribution of distance travelled to destination from BRTS station, Ahmedabad

Distance travelled in km	Percent
Less than 0.50	57.9
0.51 - 1.00	13.1
More than 1	29.0
Total	100.0
Mean	1.62 km
Median	0.27 km

Source: Primary survey.

Only a very small percentage of males cycle to their destination from the BRTS station. They keep their bicycle in a shop near the station to reach their destination. The second highest mode used to reach the destination is shared autorickshaws (16.7 per cent) followed by the AMTS (7.7 per cent). Four-fifths of those walking to their destination from the BRTS station are covering distances of up to half a kilometre. Another 19 per cent of them walk to a destination located between half and one kilometre from the station. Three-fourths of the AMTS-takers have to go more than 1 km to reach their destination. All those who use autorickshaws, shared or full-fare, traverse beyond 1 km to their destination.

Table 5.13 Distance travelled to reach destination from BRT station by income groups, Ahmedabad

Income (₹)	Distance travelled to reach destination from BRT Station (in km)			Total
	Up to 0.50	0.51-1.00	> 1.00	
Up to 5,000	55.6	18.3	26.1	100.0
5,000 to 10,000	53.8	17.1	29.1	100.0
10,001-40,000	60.7	11.2	28.0	100.0
> 40,000	56.9	6.9	36.2	100.0

Source: Primary survey.

There is, once again, very little difference in income groups for those who are traversing less than half a kilometre to their destination from the BRTS station (Table 5.13). But for distances exceeding a kilometre, the proportion traversing longer distances increases with income group. In other words, the higher income groups tend to take BRTS even if their destination is beyond 1 km of the BRTS station. They view a BRTS trip as cost saved from either taking a full-distance autorickshaw or a full-distance private motorised vehicle.

5.4 BRTS trip characteristics

The BRTS is being used in Ahmedabad for an average travel of 8.7 km. The median trip-length is 6.9 km on the system (Table 5.14). But, 23 per cent are travelling only up to 3 km on the system and another 22 per cent are travelling between 3 and 6 km. Just 26 per cent of users are travelling more than 12 km on the system. Thus, the cost of travel on the BRTS is also restricted to the minimum fare of ₹ 2 for 21 per

cent of users. Another 32 per cent are paying from ₹ 3 to ₹ 5. The ticket fare slabs of the BRTS at the time of our survey were ₹ 2, ₹ 5 and above. About half the BRTS users are going distances that require them to spend ₹ 5 per trip. The average trip cost on the BRTS has been ₹ 6.73 (Table 5.15). These fares were subsequently revised in December 2011, and the new fares are not reflected in our survey as it was completed before the fare increase.

Table 5.14 Frequency distribution of distance (in km) travelled by BRT, Ahmedabad

Distance in km	% users
Up to 3.00	22.9
3.01 - 6.00	22.4
6.01 - 9.00	18.8
9.01 - 12.00	9.5
More than 12.00	26.3
Total	**100.0**
Mean distance	8.7 km
Median distance	6.9 km

Source: Primary survey.

Table 5.15 Frequency distribution of per-trip BRT expenditure (₹), Ahmedabad

Per-BRT Trip Expenditure (₹)	% users
2.00	21.4
2.01 - 5.00	32.2
5.01 - 10.00	28.2
10.01 - 15.00	14.5
More than 15.00	3.7
Total	**100.0**
Average Cost	₹ 6.73
Median Cost	₹ 5.00

Note: These costs are prior to increase in the BRT fares in December 2011.
Source: Primary survey.

The average total trip length, which includes the trip by the BRTS and the access and egress modes (modes used for accessing BRTS and reaching destination from the BRTS), is 12.92 km. The median total trip length (including access and egress modes) is 10.84 km (Table 5.16). For around 40 per cent of all users, (39 per cent among males and 41 per cent among females), the total trip length when using the BRTS is up to 9 km (Table 5.18). For another 26 per cent, (20 per cent among females and 28 per cent among males), the total trip length is between 9 km and 15 km. For only one-third, the total trip length is more than 15 km (Table 5.18). On the whole, the average trip length increases with increase in income groups, indicating that the lower income groups travel shorter distances in general, and since most of the BRTS trips are for work, they travel shorter distances to work than higher income groups (Table 5.19).

Table 5.16 Frequency distribution of total trip length, Ahmedabad

Trip length (in km)	% users
Less than 3.0	8.4
3.1 - 6.0	15.9
6.1 - 9.0	15.6
9.1 - 12.0	15.9
12.1 - 15.0	10.4
15.1 - 21.0	17.7
More than 21.0	16.3
Total	**100.0**
Mean	12.92 km
Median	10.84 km

Source: Primary survey.

For the total trip, which includes access to the BRTS and to the destination from the BRTS, 27 per cent of users are incurring costs of less than ₹ 6 (Table 5.17). Another 29 per cent are incurring per trip expenditure of between ₹ 6 and ₹ 12. The average cost per total trip is ₹ 15.18, and half the users are incurring costs of ₹ 11 per trip. As a proportion of income, the transport costs come to a very small percentage for all the income groups except for those with monthly income of less than ₹ 5,000. So, for those income groups, taking this public transit option represents a substantial proportion of their income at 12.7 per cent (Table 5.20).This is higher than the average of 3 per cent at the all-urban level, because this is the average of those using the BRTS. But, there are many low income families who are not using the BRTS who, if included in the average cost calculation, would reduce the average proportion spent on conveyance.

Table 5.17 Frequency distribution of total trip cost (₹), Ahmedabad

Total trip cost (₹)	% users
Less than 6.00	27.1
6.01 - 12.00	29.2
12.01 - 18.00	17.3
18.01 - 30.00	16.6
More than 30.00	9.7
Total	**100.0**
Average Cost	₹ 11.18
Median Cost	₹ 11.00

Source: Primary survey.

Table 5.18 Distribution of households of different income groups by total trip length by sex, Ahmedabad

Income (₹)	Total trip length (in km)							Total
	Up to 3.0	3.1 - 6.0	6.1 - 9.0	9.1 - 12.0	12.1 - 15.0	15.1 - 21.0	>21.0	
Male								
Up to 5,000	10.1	12.8	21.1	21.1	9.2	11.9	13.8	100.0
5,000 to 10,000	6.6	15.8	20.9	18.9	11.2	18.9	7.7	100.0
10,001-40,000	7.1	15.0	13.6	17.2	10.9	16.3	19.9	100.0
> 40,000	8.5	18.3	13.4	15.9	7.3	20.7	15.9	100.0
All	7.6	15.3	16.6	18.0	10.3	16.8	15.4	100.0
Female								
Up to 5,000	9.1	24.2	30.3	9.1	15.2	9.1	3.0	100.0
5,000 to 10,000	20.0	18.2	3.6	5.5	5.5	25.5	21.8	100.0
10,001-40,000	10.7	20.0	12.0	10.7	11.3	18.0	17.3	100.0
> 40,000	0.0	4.2	14.6	14.6	10.4	27.1	29.2	100.0
All	10.5	17.5	12.9	10.1	10.5	19.9	18.5	100.0
Persons								
Up to 5,000	9.9	15.5	23.2	18.3	10.6	11.3	11.3	100.0
5,000 to 10,000	9.6	16.3	17.1	15.9	10.0	20.3	10.8	100.0
10,001-40,000	8.1	16.4	13.2	15.3	11.0	16.8	19.1	100.0
> 40,000	5.4	13.1	13.8	15.4	8.5	23.1	20.8	100.0
All	8.4	15.9	15.6	15.9	10.4	17.7	16.3	100.0

Source: Primary survey.

Table 5.19 Average trip length (km) by income groups, Ahmedabad

Income Group	Average Trip length (km)
Up to 5,000	10.9
5,000 to 10,000	11.8
10,001-40,000	13.6
> 40,000	14.6
All	12.9

Source: Primary survey.

Table 5.20 Percentage of income spent on transport for different income groups, Ahmedabad

Income Group (₹)	% income spent on travel
Up to 5,000	12.7
5,000 to 10,000	4.1
10,001-40,000	1.5
> 40,000	1.1
All	–

Note: The income data collected was by ranges, and the mid-point in the range has been taken as the average income for this calculation.
Source: Primary survey.

Since travel by the BRTS is an expensive option, low income users who use this mode prefer that a large proportion of their trip is by the BRTS. Hence, 47 per cent of users with household incomes of up to ₹ 5,000 cover more than 80 per cent of their total trip by the BRTS (Table 5.21). In contrast, in the high income group (with incomes above ₹ 40,000), BRTS comprises only one-third of their total trip. This is because, 50 per cent of the BRTS users with income up to ₹ 5,000 walk to the BRTS station, which for 70 per cent is up to 1 km distance. Among the high income groups, for 21.5 per cent of users, the BRTS comprises less than 40 per cent of their total trip expenditure. This could be because they are taking the BRTS for a matter of convenience or partial cost saving and would then be taking other para-transit options such as shared or full-fare autorickshaw from home to the BRTS or from the BRTS to their destination. In Table 5.21, the proportion of BRTS users with less than 40 per cent of the trip by the BRTS increases with an increase in income group and the proportion of BRTS users who cover more than 80 of their trip by BRTS reduces with increase in income group.

Table 5.21 Distribution of users by proportion of their total trip by BRTS for different income groups, Ahmedabad

Income (₹)	Proportion of the Total Trip by BRT (%)				Total
	Up to 40.00	40.01 - 60.00	60.01 - 80.00	More than 80.00	
Up to 5,000	10.6	15.5	27.5	46.5	100.0
5,000 to 10,000	11.6	22.7	24.3	41.4	100.0
10,001-40,000	13.5	19.9	25.7	40.8	100.0
> 40,000	21.5	25.4	20.0	33.1	100.0
Total	13.7	20.7	24.9	40.8	100.0

Source: Primary survey.

Table 5.22 Mode taken to reach BRTS by income groups, Ahmedabad

	Income group (₹)				Total
	Up to ₹ 5,000	₹ 5,000 to ₹10,000	₹10,000to ₹ 40,000	Above ₹ 40,000	
Walking	50.0	54.6	42.9	39.2	46.3
AMTS	13.4	14.3	12.6	14.6	13.4
Autorickshaw (Shared)	19.0	16.3	20.9	16.9	19.0
Autorickshaw (Full-Fare)	3.5	4.4	5.8	11.5	5.9
Motorised 2-Wheeler	2.8	5.2	7.5	10.0	6.6
Motorised 4-Wheeler	0.0	0.0	1.5	2.3	1.1
State Transport Bus	8.5	2.4	5.4	3.8	4.9
Railways	2.8	2.8	3.3	1.5	2.9
Total	100.0	100.0	100.0	100.0	100.0

Source: Primary survey.

About 40 per cent of the high income BRTS users take either autorickshaws (shared or full-fare) or PMT to reach the BRTS station (Table 5.22). Another 40 per cent among them walk. In the urban poor group, certainly no one uses a PMT, 32 per cent take the AMTS or a shared autorickshaw to reach the BRTS, and 11 per cent, who are long distance commuters, use either the railway or ST to reach the BRTS.

Table 5.23 Proportion of BRTS cost in the total trip cost, Ahmedabad

Income group (₹)	Proportion of trip cost by BRT to total trip cost (%)				Total
	Up to 25.0	25.0 - 50.0	50.01 - 99.0	More than 99.0	
Up to 5,000	9.9	31.0	20.4	38.7	100.0
5,000 to 10,000	9.2	28.7	23.5	38.6	100.0
10,001-40,000	15.3	29.4	23.8	31.5	100.0
> 40,000	27.7	33.8	17.7	20.8	100.0
Total	14.6	30.0	22.5	32.9	100.0

Source: Primary survey.

Table 5.24 Frequency of BRT use per month, Ahmedabad

Income group	No. of times BRT used per month						Total
	Infrequent	Up to 5	6 - 10	11 - 15	16 - 20	>21	
Up to 5,000	3.5	31.7	10.6	6.3	0.7	47.2	100.0
5,000 to 10,000	2.4	25.5	14.7	5.2	2.4	49.8	100.0
10,001-40,000	4.8	30.0	19.5	4.1	4.4	37.1	100.0
> 40,000	6.2	26.2	25.4	3.1	1.5	37.7	100.0
Total	4.2	28.7	17.9	4.5	3.1	41.6	100.0

Source: Primary survey.

On the whole, 33 per cent were incurring expenditure only on the BRTS in their total trip (Table 5.23). Among the urban poor, this proportion was slightly higher (39 per cent), whereas among the high income group, this proportion was only 21 per cent. For 60 per cent of the urban poor, the BRTS cost comprised more than 50 per cent of their total travel cost, whereas for 60 per cent of the high income group (above ₹ 40,000 income), the BRTS cost was less than 50 per cent of the total trip cost. This means that while the poor were not willing to take BRTS if they had to incur additional transport cost, members of the highest income group were taking the BRTS even though they had to incur additional costs on their trip. This issue has arisen because, as of now, the BRTS does not have a wide network.

The frequency of BRT use is not very high for any of the income groups. Just 42 per cent of the users were taking a BRTS for more than 21 days in a month (Table 5.24), that is, on a daily basis. A large proportion (45 per cent to 55 per cent) used the BRTS up to 15 times a month. This means, the BRTS still has a capacity utilisation issue. We however did not attempt to find out why the frequency of the BRTS use was so low in the city.

5.5 Impact of BRTS

Prior to the BRTS, a large proportion of the current users (47 per cent) were taking AMTS buses (Table 5.25). In that sense, the BRTS would not have impacted the carbon emission level as users have shifted from one public transport mode to another. As mentioned in the previous chapter, the AMTS services have deteriorated over time and the BRTS has come as a replacement for the earlier services. Another 13 per cent each have shifted to the BRTS from shared autorickshaw and full-fare autorickshaw. Just 12 per cent have shifted from PMT and 1 per cent from walking to the BRTS.

Table 5.25 Mode used prior to BRTS

Mode used prior to BRTS	Income group (₹)				Total
	Up to ₹ 5,000	₹ 5,001 to ₹ 10,000	₹ 10,000 to ₹ 40,000	Above ₹ 40,000	
Walking	2.1	1.6	0.4	0.0	0.9
Cycling	4.2	1.6	0.8	0.8	1.4
AMTS	52.1	46.2	48.5	35.4	46.8
Autorickshaw (Shared)	18.3	17.9	9.9	9.2	12.9
Autorickshaw (Full-Fare)	9.9	13.5	12.6	17.7	13.1
Motorised 2-Wheeler	4.2	6.4	12.0	16.9	10.2
Motorised 4-Wheeler	0.0	0.4	2.1	3.1	1.5
State Transport Bus	0.7	0.0	0.2	0.0	0.2
No Trip Before BRT	8.5	12.4	13.5	16.9	13.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Primary survey.

Among the poor, 52 per cent of the current BRTS users were taking AMTS and another 18 per cent were using shared rickshaws, which makes a total of 70 per cent. Just 2 per cent of former pedestrians in this income group have shifted to BRTS. Among the high income group, 35 per cent of the current users were using AMTS and another 9 per cent were using shared autorickshaws. Shifts from shared autorickshaws to the BRTS is an environmentally positive change. Also, 17 per cent used their personal two-wheelers,

18 per cent used full-fare autorickshaws and 3 per cent used their personal four-wheelers. In all, 38 per cent were using energy-consuming modes before the BRTS and have shifted to the BRTS, which would have had a positive environmental impact.

For those who have shifted to the BRTS, there is also some cost benefit. The benefit, as expected, is much higher for the former users of PMT and full autorickshaw. For those using the AMTS, the per trip cost has reduced by 7.9 per cent (Table 5.26), which is surprising as the AMTS fares are lower than the BRTS fares for the same distance. For the shared autorickshaw users, the cost has reduced by 42 per cent, for full-fare autorickshaw users by 83 per cent, for two-wheeler users by 66 per cent and for four-wheeler users by 89 per cent.

Table 5.26: Savings in trip cost due to BRTS, Ahmedabad

Mode used before BRTS	Average trip cost (₹)		% savings due to BRTS	Number who shifted
	Before BRTS	After BRTS		
AMTS	7.96	7.33	7.9	365
Shared Auto	6.95	4.03	42.1	109
Full Auto	39.16	6.63	83.1	113
Two-wheeler	23.75	7.98	66.4	55
Four-wheeler	71.76	7.80	89.1	5

Source: Primary survey.

The BRTS has also induced new trips. This means, those who were not taking a trip before have begun to do so, indicating that there is enhanced mobility of some people. This proportion is 13 per cent (Table 5.27). But, the enhanced mobility is experienced more for the higher income groups than for the poor; for the poor the BRTS-induced trips are for only 8.5 per cent of the current BRT users, whereas for the high income group the BRTS-induced trips is for 17 per cent of the current users. The purpose of the BRTS-induced trips is work for 47 per cent, education for 33 per cent and other purposes for 17 per cent.

Table 5.27: Details of BRT-induced trips, Ahmedabad

Income (₹)	Male	Female	Persons	% of current trips which are BRT-induced trips
Up to 5,000	8.0	11.4	8.9	8.5
5,000 to 10,000	26.0	14.3	23.0	12.4
10,000 to 40,000	55.0	42.9	51.9	13.5
> 40,000	11.0	31.4	16.3	16.9
Total	100.0	100.0	100.0	13.0

Source: Primary survey.

5.6 Conclusion

There were two important questions asked as part of the users survey: (i) is the BRT system accessible to everyone in the city (including the urban poor) and (ii) has it led to a modal shift in favour of public transport to address the goal of reducing greenhouse gas emissions? The study of the users of the BRT system of Ahmedabad found that:

5.6.1 Gender-related issues

1. The BRTS users comprise 72.5 per cent males and 27.5 per cent females, making the system more male-centric than gender neutral. The sex ratio among the BRTS users in Ahmedabad is 379. The sex ratio was the highest, at 444, among the middle age population (41-59 years) using the BRT system. The sex ratio of the working population using the BRT system was just 226, indicating that working women did not use this system. Among the working population, the sex ratio was the lowest among those in low-wage self-employed work (sex ratio of 49) followed by those engaged as casual labour (sex ratio of 121).

2. While males predominantly used the BRT system (55 per cent of them) for work, females used it for other purposes such as social, recreational, etc. (39 per cent) and for work (35 per cent). The BRTS has a challenge of becoming popular with women, especially working women and also low-income women.

5.6.2 Income-related issues

3. The use of the BRTS by low income groups is low. Of the total users, just 13.7 per cent have household incomes of up to ₹ 5,000. 62.2 per cent of users were with monthly household incomes of more than ₹ 10,000. As per the National Sample Survey's (NSS) Consumption Expenditure data of 2009-10, about 30 per cent of urban households have a monthly household income of ₹ 5,000. Hence, we can safely assume that households with income of ₹ 5,000 per month are the bottom 30 per cent of the urban spectrum and they do not use the BRTS in Ahmedabad to any great extent. This is inspite of the fact that a large number of low income households and slums are within less than 500 metres radius of the BRT network in the eastern part of Ahmedabad.

5.6.3 Travel behaviour issues

4. About 30 per cent of the BRTS trips are for purposes related to social, recreational and shopping trips. BRTS has made long-distance recreational facilities more accessible for the middle class from western Ahmedabad and has created new demand for transport. Only 42 per cent of the users were taking a BRTS for more than 21 days in a month, which means that the BRTS is still to find regular and sustained ridership in the city.

Prior to the BRTS, a large proportion (47 per cent) of the current users were taking AMTS (municipal) buses, and because the AMTS services were discontinued on the BRTS corridors they shifted to the BRTS. Another 13 per cent each have shifted from shared autorickshaw and full-fare autorickshaw IPT. In total, 70 per cent of the BRTS commuters were previously regular users of some form of public transport. This group can be termed as the 'captive users'. Only 12 per cent of commuters have shifted from PMT.

As mentioned in the previous chapter, the AMTS services have deteriorated over time and the BRTS has come as a replacement for the earlier services. In that sense, the BRTS would not have impacted carbon emission levels as users have shifted from one public transport mode to another. The BRTS has also induced new trips as 13 per cent of commuters were not making the trip before BRTS. This enhanced mobility, or the newly created demand, is experienced more by the higher income groups than by the poor for purposes such as recreational, social and shopping trips. In all, the BRT is mainly used by the middle-income groups, and many of them have been previous public transit users commuting longer distances.

This study showed that although the BRT system is promoted as low-cost public transport in Indian cities, it is not yet accessible to the urban poor and in particular women among them. The cost of the BRT system in Ahmedabad is prohibitive to improve the accessibility of low-income households and in particular poor urban women. The cost of the BRT is higher than the cost of the alternative public transport system, which is the AMTS. The provision of any public transport system may not bring gender equity if the costs of the new system are not kept in mind. The best option at the current level of incomes in Indian cities is to ensure accessibility to opportunities for the urban poor (especially women) through better land use planning, particularly that which provides work and social service locations in closer proximity to poorer residences, and through shelter policies that promote in-situ upgrades. Otherwise, improving access to public transport for low income groups would mean continued public transport subsidies for some years to come.

6. Travel Characteristics of the Urban Poor in Ahmedabad: Towards Inclusive Mobility

6.1 Introduction

This study on low-carbon mobility initiatives has two main components. One, to understand and document the profile of the users of low-carbon transport (here BRT), which has been discussed in the previous chapter. This chapter deals with the second component, namely, understanding the travel demands of the low-income and socially vulnerable groups in the city. This section of the study is essential to understand the dynamics of low-carbon transport in the following ways:

The urban poor either use zero-carbon transport modes (walk or cycle) or rely on public transport. As captive users of low-carbon mobility, it is important to get to know how their transport modes function in their life. Their efforts of using low-carbon mobility without compromising their quality of life needs to be sustained by policies and projects, especially when the developing societies are continuously motorising at a rapid pace due to rising incomes.

There have been massive investments in the public transport and road infrastructure in the cities of developing countries and it is a timely debate whether these investments are being used for the betterment of everyone in society. Specifically, this section of the study looks at whether the JnNURM funding for transport has helped the urban poor or not. This may lead to arguments about the inclusiveness of the low-carbon mobility goals.

There have been a few studies related to mobility and poverty in the Indian context (on Mumbai by Baker et al., 2005; on Chennai by Srinivasan and Rogers 2005; and on Delhi by Anand & Tiwari 2006), which show evidence of differences in the mode choice, time spent, cost and frequency of trips of the poor relative to the non-poor. This means that transportation planning has to take into account all income groups and cannot afford to attempt 'one size fits all' solutions. These studies have also suggested further research in this area in newer contexts. Transport needs and poverty linkages in developing cities are largely neglected (Booth et al., 2000; Barter, 1999; Cox, 2010) and there is clearly a gap in the academic literature on the dynamic relationships between living in poverty and transport needs.

A detailed household survey was conducted in Ahmedabad in October 2011 and the detailed methods and sampling process for the same is presented in Chapter 1. From each household, trip details were asked for at least four adult members and two children. The questionnaire was designed in such a way that weekly trips, multiple mode trips, trip chaining etc., are captured and quantified. The purpose of the household surveys was to quantify and analyse the urban travel characteristics of the poor people in the city of Ahmedabad. The travel characteristics included are frequency of travel for various purposes, mode use, destination, routes and costs, and time taken. The trips of the sample captured in the household survey are analysed by gender, income, employment and the location of various settlements.

6.2 Sample description

The survey covered 15 slum settlements (distributed in central city, periphery, rehabilitation sites in east and west Ahmedabad) as already mentioned in the methodology. The survey covered a sample of 580

households (3,002 people), with an average household size of 5.2 and sex ratio of 853. Their average monthly household income is ₹ 6,049,and 97 per cent of them had incomes of less than ₹ 5,684 per month. The monthly average income of Ahmedabad city is ₹ 8,728 (NIUA, 2010). The survey covered 3,419 trips, 1,253 by females and 2,166 by males. The surveyed population's literacy rate is 73.2 per cent, 65.6 per cent among females and 79.6 per cent among males (Table 6.1). Only 18.9 per cent of the sample had education beyond primary level. This also means that the majority of the workforce is engaged in low-skilled, low-wage employment.

Table 6.1 Sample description by age, sex and education level, Ahmedabad

Age group	% of sample	Sample count	Illiterate	Literate	Primary education	Other school years	up to 12th Std	Certificate Course	Graduation & above
Female	**46.5**	**1382**	**475**	**197**	**516**	**79**	**100**	**1**	**14**
Up to 14	13.0	380	34	81	180	79	5	1	
15-40	24.8	743	262	86	293		88		14
41-59	6.6	200	131	24	38		7		
60 & above	2.1	59	48	6	5				
Male	**53.5**	**1620**	**330**	**240**	**676**	**99**	**247**	**3**	**25**
Up to 14	15.6	463	36	102	216	97	10	2	
15-40	27.8	842	171	86	360	2	201	1	21
41-59	7.1	223	78	33	81		29		2
60 & above	3.0	92	45	19	19		7		2
Total	**100.0**	**3002**	**805**	**437**	**1192**	**178**	**347**	**4**	**39**

Source: Primary survey.

Table 6.2 Employment status by age and sex, Ahmedabad

	Regular employment (salaried)	Self employed	Casual employment (daily wage)	House manager	Pre-adults (attending education)	Pre-adults (not attending education)	Unemployed	Grand Total
Female	**178**	**89**	**54**	**618**	**319**	**104**	**20**	**1,382**
Up to 14	2	2	3	12	257	104	0	380
15-40	117	63	36	454	61	2	10	743
41-59	49	22	13	115	1	0	0	200
60 & above	10	2	2	37	0	0	8	59
Male	**322**	**283**	**328**	**21**	**426**	**123**	**117**	**1,620**
Up to 14	2	2	4	6	322	127	0	463
15-40	250	198	228	14	102	0	50	842
41-59	56	68	74	0	2	1	22	223
60 & above	14	15	22	1	0	0	40	92
Total	**500**	**372**	**382**	**639**	**745**	**227**	**137**	**3,002**

Source: Primary survey.

Table 6.2 shows the distribution of the main activities of the population. The work participation rate (WPR) of the population is 41.8 per cent, 23.2 per cent among females and 57.6 per cent among males. About 20.6 per cent of the sample population are women and engaged as house managers (domestic unpaid work) in their own households. There are 972 children in the sample population below 14 years of age, out of which 15 children have reported to be working already as child labourers. At the same time, 23.3 per cent of children (below 14 years) are not attending any educational activities and can be considered potential members of the child-labour force.

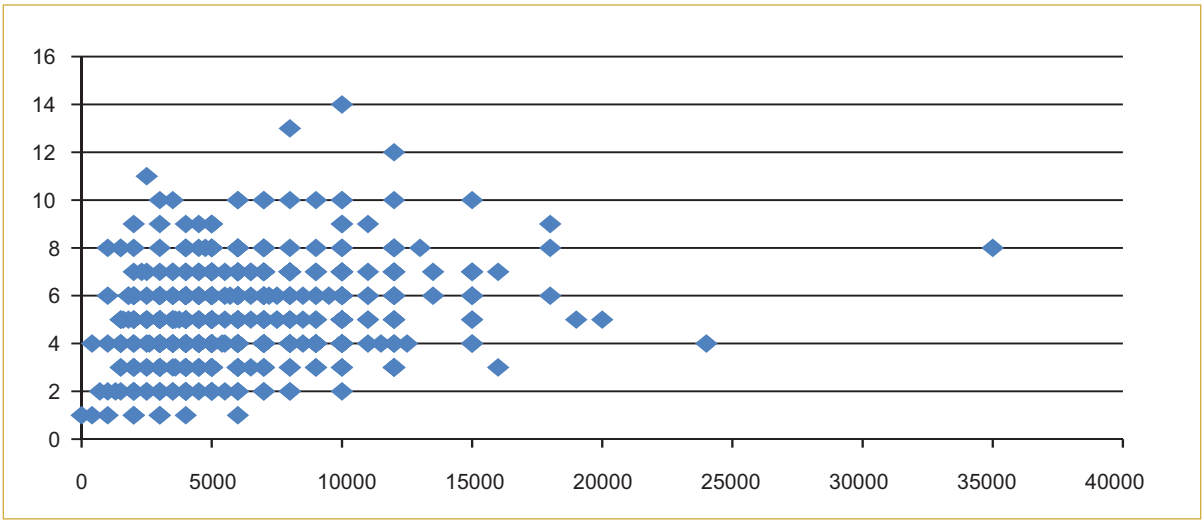
Table 6.3 Nature of employment, Ahmedabad (%)

	Regular Employment (salaried)	Self Employed	Casual employment (daily wage)	Total
Female	55.5	27.7	16.8	100.0
Male	34.5	30.3	35.2	100.0
Overall	**39.9**	**29.7**	**30.5**	**100.0**

Source: Primary survey.

Of the working females, 55.5 per cent are in regular employment (Table 6.3), of which 57 per cent are working as domestic help on a regular basis. 34.5 per cent of males have regular salaried employment, another 30.3 per cent are self-employed, out of which 63 per cent are working in home-based enterprises out of their homes. The remaining male workers are either mobile vendors (street vendors) or providing transport services (cycle rickshaw/hand cart pullers, autorickshaw drivers). A total of 30.5 per cent of the workforce is employed in casual or daily-wage based labour. It is observed that out of the total workforce, home-based workers and daily-wage earners are in lower skill-based work, and lower wage employment compared to those in regular salaried employment.

Figure 6.1 Monthly income (X) and household size (Y)



Source: Primary survey.

Looking at the education and employment level of the sample population, it is clear that most have a very low level of education (primary level) and possibly low-wage, low skill-based work involving hard labour or

manual work. 59.3 per cent of the population is dependent and non-working, out of which some children are being pushed into child-labour.

6.3 Travel characteristics of the urban poor

The analysis in this sub-section focuses on the urban poor's travel characteristics such as mode share, trip length, purpose, cost, time taken etc., disaggregated according to some key socio-demographic variables such as gender, age, and income distributed across various slum locations in the city.

Clearly, the majority of the trips of the poor population (55.4 per cent) are dependent upon NMT modes like walking and cycling (Table 6.4). The other important modes are public transport or shared autorickshaws. The shared autorickshaws outnumber the municipal bus services. Similarly, private modes (motorised two-wheelers) represent 3.5 per cent of the total trips. This indicates that unlike the middle classes in Ahmedabad, the process of motorisation (penetration of PMT) has not started in the urban poor groups.

Table 6.4 Modal split by sex, Ahmedabad

Sex	Walking	Cycle	Hand cart/ paddle rickshaw	Public bus	Shared auto rickshaw	BRTS	Multiple modes	M2W	Auto rickshaw	Grand total
Female	58.9	1.8	0.7	8.7	16.3	0.2	9.9	0.8	2.6	100.0
Male	29.7	19.5	2.7	11.8	15.6	0.5	11.7	5.0	3.6	100.0
Overall	**40.4**	**13.0**	**2.0**	**10.7**	**15.8**	**0.4**	**11.0**	**3.5**	**3.2**	**100.0**
	Non-motorised modes = 55.4			Public/ shared modes = 26.9			Private modes = 6.7			100.0

Source: Primary survey.

The trips by BRTS are negligible (0.4 per cent) (Table 6.4). It is rare that someone from the surveyed slum settlements uses BRTS although three settlements studied here are situated right next to the BRTS network and three more settlements fall within the 500 m radius of the network. The length of the BRTS network was about 47 km by the time this study was conducted in October 2011, which is quite substantial.

Table 6.5 City-level modal split, Ahmedabad

Mode share in earlier studies	Walking	Cycle	Public bus	Shared auto rickshaw	M2W	Auto rickshaw	Car-van	Others	Total
LB-IPTS study 2000 1	37.6	17.6	8.4	5.7	25.3	2.5	2.5	0.3	100.0
AMC-CEPT 2006 2	13.2	18.8	15.0	–	35.0	8.8*	3.1	5.8	100.0

Notes: * Shared autorickshaw is assumed to be part of this as it is not mentioned separately.
1 As quoted by AMC et al., 2007 (Detailed Project report for BRTS Phase -1)
2 As quoted by AMC, 2008 (Detailed Project report for BRTS Phase -2)
Source: Primary survey.

The DPRs of BRTS quote two different studies[26] to present the city-level mode share in Ahmedabad, both carried out with a time gap of six years. Both studies have strikingly a different mode share of walking; 37.62 per cent and 13.2 per cent, which can be interpreted as a decline in the share of walking by 24.4 percentage points over just 6 years (Table 6.5). Put together, these two studies also show substantial increase in the share of motorised two-wheelers (from 25.3 per cent to 35.0 per cent). Since the sample description and methodology of the second study is not clearly stated in AMC (2008), it would not be sufficient to analyse and critique the scientific rigour and validity of this database. The data of vehicular ownership and the increase in the fleet of municipal bus operations in the city between 2000-06 (as discussed in Chapter 3) may corroborate the increase in the share of both modes. The decrease in walking share is alarming, if this data is believed to be true.

Comparing the mode share of the urban poor with the city-level mode share, it is clear that poor people rely much more on walking and cycling followed by shared and public transport modes (with the exception of BRTS). It is also clear that the city-level trend of increase of private motorised two-wheeler trips is not seen among the urban poor as yet. It becomes much clearer in Table 6.6, where the multiple modes are further distributed into other categories based on the dominant mode in the full trip. The dominant mode is selected as the mode used in the longest leg of the journey. 62 per cent of the trips of poor people are by NMT mode and the remaining are by shared autorickshaws and municipal buses. The private mode share is merely 8 per cent and the share of BRTS trips is negligible.

Table 6.6 Modal split by sex (after distributing multiple mode trips), Ahmedabad

Sex	Mode Share (after distributing multi-modes) (%)								
	Walking	Cycle	Hand cart/ paddle rickshaw	Public bus	BRTS	Shared auto rickshaw	M2W	Auto Rickshaw	Grand Total
Female	65	2	1	10	0	18	1	3	100
Male	34	22	3	13	1	18	6	4	100
Overall	**45**	**15**	**2**	**12**	**0**	**18**	**4**	**4**	**100**
	Non-motorised modes = 62			Public modes = 30			Private modes = 8		100

Source: Primary survey.

There is a difference in the mobility of males and females. Female members tend to walk more than male members. In the case of male members, cycling has the next highest mode share. The NMT mode share amongst females is 68 per cent and amongst males is 59 per cent, which is comparable. In the case of male members, walking is replaced by cycling whereas the female members continue to walk. Cycling is not seen much in the case of female members, barring which the shared and public transport usage is comparable between the different genders. Higher use of motorised two-wheelers (M2W) and cycles amongst the male members indicates that whenever a household owns a private vehicle (cycle or M2W), the male members tend to use them more, whereas the female members either walk or use shared or public modes. This indicates a marginalisation of women and their mobility within a poor household, and that the mobility of the male members takes priority and privilege.

[26] Louis Berger on behalf of the Gujarat Industrial Development Board conducted the first city-level travel study in the year 2000. This study is widely quoted in various transport related reports on Ahmedabad such as metro rail feasibility studies (2005), the detailed project report of BRT (2007) and also in various international research papers etc. The second study was conducted by CEPT on behalf of Ahmedabad Municipal Corporation (and other state agencies).

Table 6.7 Trip distance distribution (%), Ahmedabad

Distance Travelled	Less than 1 km	1.1 to 3 km	3.1-5 km	5.1-7 km	7.1-9 km	9.1 and above	Grand Total
Female	42	30	10	7	3	7	100
Male	24	27	15	9	7	18	100
Overall	31	28	13	8	6	14	100
LB-IPTS study 2000 (City – level)	13.0	43.1	12.9	8.3	7.0	15.5	100

Source: Primary survey.

About 59 per cent of the urban poor travel less than 3 km for their daily activities, and their percentage drops progressively in each subsequent distance category (Table 6.7). This pattern resembles the LB-IPTS study conducted eleven years prior. In the last decade, not only have the municipal limits increased from 192 sq km to 466 sq km, but the urbanised (built) area has also expanded. The average trip length in Ahmedabad was about 4.6 km (as per LB-IPTS study, 2000) which has increased to 5.5 km (as per AMC-CEPT, 2006). This indicates that the travelling distances have increased in the city, but the poor people continue to travel short distances. In the case of the urban poor population, the average trip length is 4.5 km with 59 per cent of trips being less than 3 km. This indicates that the majority of the poor population do not travel beyond a 3 km radius of their residence.

Table 6.8 Mode-wise average trip length (km), Ahmedabad

All trips	Walking	Cycle	Hand cart/ paddle rickshaw	Public bus	Shared auto rickshaw	BRT	Multiple modes	M2W	Auto rickshaw	Average trip length
Female	1.36	2.83	3.33	5.56	4.75	5.17	8.83	6.10	4.86	3.20
Male	1.45	4.76	5.08	9.30	5.93	7.27	9.61	7.16	6.35	5.26
Overall	1.40	4.66	4.84	8.18	5.48	6.82	9.35	7.07	5.90	4.50
Trips occurring more than 4 days/week										
Female	1.36	2.90	3.33	5.24	4.77	1.50	7.98	6.88	3.39	2.88
Male	1.35	4.86	5.08	9.34	6.12	4.75	9.39	7.07	5.96	5.10
Overall	1.36	4.77	4.84	8.14	5.70	4.39	8.99	7.06	5.24	4.35
Mode wise trip lengths in city-level studies										
LB-IPTS study 2000	0.9	3.6	–	12	5.3	–	–	6.8	5.1	4.6
AMC-CEPT '06[1]	2	3	–	–	–	–	–	–	–	5.5

[1] – Only trips exceeding 1 km are considered as a 'trip' for this study.
Source: Primary survey.

Table 6.8 shows that among the poor population, the NMT mode users limit themselves to travelling distances of less than the average trip length of the sample. All motorised trips are above the average

trip length. Many of them commute longer trips (>8 km) by public bus followed by shared autorickshaws. City-level average trip lengths (in 2000) for shared autorickshaw, autorickshaw and motorised two-wheelers are comparable with the sample of the urban poor. However, the city-level public bus average is as high as 12, whereas the city-level walking and cycling averages are lower compared to the urban poor population.

Amongst the poor, the NMT mode users (the majority of the population) have a different pattern than the motorised mode users. The NMT mode users (especially pedestrians) tend to travel shorter distances for their daily activities. This suggests two interpretations. First, the NMT modes restrict their mobility. Or second, they have located themselves well in the city so they do not need to travel far in order to carry out their daily activities. The motorised mode users are travelling as much as the average motorised mode user in the city, who will have higher average incomes and more resources to spend on transport per month.

Table 6.9 Distribution of persons (%) by per trip expenses, by sex, Ahmedabad

Sex	Expense per trip (in ₹)						
	Nil	01-05	06-10	11-15	16-20	20+	Grand Total
Female	63	17	13	3	1	2	100
Male	54	15	17	5	2	6	100
Overall	58	16	15	5	2	4	100

Source: Primary survey.

Table 6.9 shows that 58 per cent of trips involved zero cost to the trip makers. Another 16 per cent of trips were managed with equal to or less than ₹ 5. The minimum fare for the BRTS is ₹ 5, and for the AMTS (public bus) is ₹ 2 for a distance between two bus stops. It is clear that for the majority of the urban poor, BRTS is an expensive option. AMC, AUDA and CEPT University (2008) mentions: "In Ahmedabad on an average households spend about ₹ 200 to 500 per month on transport". Our study states that about 30 to 35 per cent of poor households end up spending monthly ₹ 200 to 500 for their transport needs. Most of the poor households try to minimise the cost of the transport by using NMT modes and using motorised modes selectively.

Table 6.10 shows trip purpose by mode share where more regular trips in a week (trips occurring more than 4 days/week) are filtered and presented. The data of modal split by trip purpose gives interesting findings. Only 20 per cent of trips made by males are walking trips to work (avg. distance 2 km) whereas 55 per cent work trips of females (avg. distance 2 km) are walking trips (Table 6.10). 30 per cent of work trips (avg. distance 5 km) made by males are on cycles, 13 per cent of work trips are by public bus (avg. distance 8 km), and 19 per cent are by shared autorickshaw (avg. distance 6 km). Female members travel less by other modes and under all purposes compared to males and mostly by 'inferior' modes. 15 per cent of female work trips are made by public bus (avg. distance 6 km) and 20 per cent of female work trips are made by shared autorickshaw (avg. distance 5 km). Education and shopping trips amongst females (avg. distance 2 and 1 km respectively) are dominated by walking. Social and recreational trips by females are made by public and shared autorickshaws (avg. distance 5 and 6 km). Mobility is skewed between the genders. Within the poorer group in the city, the female members struggle more to access transport, and experience constrained mobility compared to males.

Table 6.10 Trip purpose by modal share, Ahmedabad (%)

Trips (more than 4 days/ week)	Walking	Cycle	Hand Cart/ Paddle Rickshaw	Public bus	Shared Auto Rickshaw	BRTS	M2W	Auto Rickshaw	Grand Total
Female	**70**	**2**	**1**	**9**	**15**	**0**	**1**	**2**	**100**
Work	55	4	3	15	20	0	2	1	100
Education	76	2	0	7	12	0	0	3	100
Health	33	0	0	0	33	0	0	33	100
Shopping	89	1	0	1	9	0	0	0	100
Social-recreational	0	0	0	0	100	0	0	0	100
Household work	67	0	0	0	33	0	0	0	100
Male	**35**	**23**	**3**	**12**	**17**	**0**	**6**	**3**	**100**
Work	20	30	5	13	19	1	8	4	100
Education	65	9	0	10	13	0	1	2	100
Shopping	46	21	0	7	11	0	11	4	100
Social-recreational	0	0	0	100	0	0	0	0	100
Health	0	0	0	0	0	0	0	0	0
Household work	0	100	0	0	0	0	0	0	100
Other	40	20	0	20	20	0	0	0	100
Overall	**47**	**16**	**3**	**11**	**16**	**0**	**4**	**3**	**100**

Source: Primary survey.

Table 6.11 Per capita income groups by modal share, Ahmedabad (%)

	Mode used								
Income (₹)	Walking	Cycle	Hand Cart/ Paddle Rickshaw	AMTS	Shared Auto Rickshaw	BRTS	M2W	Auto Rickshaw	Grand Total
<400	50	13	4	7	17	1	0	7	100
<800	51	11	3	11	18	0	3	2	100
<1200	45	13	2	15	18	0	3	3	100
<1600	38	18	2	12	20	1	4	5	100
<2000	41	18	1	14	15	1	5	6	100
2000+	41	19	0	10	18	0	10	3	100
Overall	45	15	2	12	18	0	4	4	100

Source: Primary survey.

Table 6.12 Per capita income groups by trip distance, Ahmedabad (%)

	Distance travelled (km)						
Income (₹)	<1	1.1-3	3.1-5	5.1-7	7.1-9	9.1 and above	Grand Total
<400	31	34	14	8	3	10	100
<800	34	31	13	6	4	13	100
<1200	29	32	13	10	5	12	100
<1600	31	23	13	8	6	18	100
<2000	30	23	16	6	8	16	100
2000+	27	24	12	14	6	18	100
Overall	31	28	13	8	6	14	100

Source: Primary survey.

Table 6.11 and Table 6.12 show the distribution of trips based on (per capita) income groups with the comparison of mode share and trip distance. It was assumed that there will be differences in the travel pattern of the 'bottom level' and 'top level' income groups within the urban poor group. There is no clear pattern emerging between the income groups. However, as the income level increases, the trips by walking and push cart/pedal rickshaw reduces. The share of cycling trips remains almost constant across income groups after an initial rise. There is a significant jump in the mode share of motorised two-wheelers with rising income. Households earning more than ₹ 2,000 per capita have 10 per cent of trips by motorised two-wheelers. Table 6.12 shows that with increasing income, the travel distances increase marginally and there are more long-distance trips but the difference is not significant between various income groups.

There is a dynamic relationship between purpose, distance and mode use. The trips made for work stand out clearly as motorised transport is more frequently used for work purpose compared to other purposes. For work trips, as the distance increases the mode use changes. In the absence of any private motorised modes, there is a strong dependence on public transport. For longer trips (more than 6 km), the municipal public bus becomes the suitable option, even if there are issues related to high waiting times and erratic service. Whenever there are motorised two-wheelers, they are being used for commuting longer distances. It is not surprising that with rising income and more affordability, motorised two-wheelers will become the most cost-effective option given the current state of public transport services in the city.

Poor people try to minimise the cost of travel by using the NMT modes for shorter distances and non-work purposes. In order to minimise cost, time and distance, poor people prefer services and jobs near their residential location by compromising on the quality of services or wages. This further pushes them into a cycle of poverty. Amongst the non-working population, the trip rate is really low, which means they don't go out of their own settlement very often. This amounts to mobility constraints and their possible exclusion from the rest of the city. The following section discusses the location aspects in detail.

6.4 Impact of relocations on travel patterns of the poor

There is a continuum between the travel pattern and the residential location for the poor. Based on their location, they either look for work in the nearby areas or they locate themselves near their workplace. Their location is crucial in minimising their travel distance and thus saving time and cost on transport. However, whenever poor households are not given the choice of their residential location, they incur greater costs in terms of longer commutes, higher expenditure on transport, more time spent waiting for public-shared modes and travelling long distances. The lack of choice in residential locations is very evident in the case of forced evictions. As part of the study, four rehabilitation sites were examined. Three of these were formal public housing areas built by the AMC, and the fourth was the 'transit camp' where project-affected people were housed, and in many cases the 'transit arrangement' lasted for more than a year.

As explained in Chapter 1, all the surveyed slum settlements are divided into core city, peripheral and rehabilitation sites. The rehabilitation sites are the BSUP housing under the JnNURM, and are located in various peripheral parts of the city. Looking at the modal split in different categories of slum settlements, it is clear that there is a marginal difference between the mode share in the core city and the peripheral slum. Even in the periphery slums, a majority of the poor people commute by NMT modes followed by shared and public transport. This scenario drastically changes in the case of rehabilitation sites. The share of shared autorickshaw and public bus increases to 44 per cent of total trips (Table 6.13). The NMT trips amount to 46 per cent. The outer-city locations of public housing are not very well connected with the rest of the city. Provision of transport services has not been part of the rehabilitation process, and hence the rehabilitated population has been forced to change their mode use.

Table 6.13 Modal split by different geographic locations of slums, Ahmedabad (%)

	Walking	Cycle	Hand Cart/ Paddle Rickshaw	AMTS	Shared Auto Rickshaw	BRT	M2W	Auto Rickshaw	Total
Core City Slums									
Female	66	3	1	10	16	0	1	3	100
Male	40	26	6	8	12	0	6	2	100
Overall	50	17	4	9	14	0	4	2	100
Peripheral Slums									
Female	77	1	0	6	12	1	1	2	100
Male	33	21	1	15	17	2	4	7	100
Overall	48	14	0	12	16	1	3	5	100
Rehabilitation Sites									
Female	52	2	1	13	27	0	1	4	100
Male	22	17	1	20	27	0	8	4	100
Overall	34	11	1	17	27	0	5	4	100

Source: Primary survey.

Table 6.14 Average distance travelled by different modes, by sex and geographic locations (km)

Trips <4 days/ week	Walking	Cycle	Hand Cart/ Paddle Rickshaw	AMTS	Shared Auto Rickshaw	BRTS	M2W	Auto Rickshaw
All settlements								
Female	1.4	2.9	3.3	5.2	4.8	1.5	6.9	3.4
Male	1.4	4.9	5.1	9.3	6.1	4.8	7.1	6.0
Overall	1.4	4.8	4.8	8.1	5.7	4.4	7.1	5.2
Rehabilitation Sites								
Female	1.1	2.8	2.0	6.6	6.5	0.0	10.0	4.3
Male	1.5	8.0	5.5	10.8	7.5	0.0	10.3	4.9
Overall	1.3	7.6	4.3	9.5	7.2	0.0	10.3	4.7

Source: Primary survey.

Regarding the rehabilitation sites, the average distances per trip have increased for each mode (Table 6.14). The average distance covered by the cyclists living in rehabilitation sites is 8 km. The average trip length for the public bus has increased to 9.5 km and for the shared autorickshaw to 7.2 km. The trips by M2W are more than 10 km. Out of the four rehabilitation sites surveyed, two settlements (Trikampura BSUP and Ganeshnagar) have distances of more than 7 km between the original settlement and the new settlement. The other two rehabilitation sites (Balolnagar and Ajit Mill compound) have distance of more than 4 km between the old settlement and the new one. In the process of relocation, many jobs have been lost and some jobs continue near the old settlements. This has led to long-distance commutes and higher expenditures on transport. The average trip length for cyclists is 8 km, which is physically straining, but in order to avoid transport costs the cyclists resign themselves to the long commute.

As per Table 6.15, 57.6 per cent of trips were zero-cost trips, which have reduced to 41.4 per cent of trips in the rehabilitations sites. In the rehabilitation sites, about 35 per cent of trips cost more than ₹ 6 per trip. The household expenditure on transport has increased ₹ 300 to 500 per month among many households after rehabilitation. This is likely to have an adverse impact on other expenditures.

Table 6.15 Distribution of persons by per trip expenditure, by sex and geographic location, Ahmedabad

	Expenditure per trip (in ₹)					
	Nil	01-05	06-10	11-15	16-20	20+
All settlements						
Female	63.1	17.4	12.9	3.3	1.0	2.5
Male	54.4	15.3	16.9	5.5	2.5	5.5
Grand Total	57.6	16.1	15.4	4.7	1.9	4.4
Rehabilitation Sites						
Female	51.0	19.1	17.5	7.8	1.1	3.6
Male	35.2	16.1	25.7	9.8	4.5	8.8
Grand Total	**41.4**	**17.3**	**22.5**	**9.0**	**3.2**	**6.7**

Source: Primary survey.

Table 6.16 Distribution of trips by distances, by sex and geographic location, Ahmedabad (km)

	<1	1.1-3	3.1-5	5.1- 7	7.1-9	9.1 and more	Grand Total
Core City Slums							
Female	41	39	10	4	1	5	100
Male	30	33	14	8	4	11	100
Grand Total	**34**	**35**	**13**	**6**	**3**	**9**	**100**
Periphery Slums							
Female	54	22	11	7	2	4	100
Male	24	27	20	7	8	14	100
Grand Total	**34**	**25**	**17**	**7**	**6**	**11**	**100**
Rehabilitation Site							
Female	35	24	8	12	7	14	100
Male	13	18	11	15	9	33	100
Grand Total	**22**	**20**	**10**	**14**	**9**	**26**	**100**

Source: Primary survey.

In the case of the core city slum settlements, about 70 per cent of trips are within a radius of 3 km from their locations (Table 6.16). In the case of the peripheral slums, about 60 per cent of trips are within a radius of 3 km from their location. However, there is a striking dissimilarity with the rehabilitation sites. About 60 per cent of trips are more than 3 km and 36 per cent of them are more than 7 km. This clearly shows the kind of transport burden created due to rehabilitation.

Three settlements surveyed as part of this study, namely, Santoshinagar na Chhapara (north, near Naroda), Hanumannagar (east, near CTM) and Sanjaynagar (west, near Sola housing) are located within a 200 m walking distance from a BRT bus stop. The use of the BRT was found negligible in these settlements, as it was for the overall sample (Table 6.17).

Table 6.17 Mode share in settlements located next to BRT corridor, Ahmedabad (%)

Settlements close to BRTS (Less than 200 m)	Walking	Cycle	Hand Cart/ Paddle Rickshaw	AMTS	Shared Auto Rickshaw	BRTS	M2W	Auto Rickshaw	Grand Total
Female	70	1	0	13	12	0	1	2	100
Male	28	21	1	19	16	1	7	6	100
Grand Total	**44**	**14**	**1**	**17**	**14**	**1**	**5**	**4**	**100**

Source: Primary survey.

6.5 Conclusion – Inclusive transport system?

The survey portrays that urban trips by the poor in Ahmedabad are generally fewer, take more time, traverse less distance, and rely on NMTs or public modes more than the non-poor. The consequences of this deficit mean fewer out-of-home activities, less ability to search for and maintain employment, and lower capacity to seek higher quality goods at a lower price. The time and money costs of public transit are higher for the poor (with a greater share of monthly household budgets) than for other income groups (Kwakye et al., 1997), which may indeed explain their short commutes or limited mobility.

Sometimes the poor manage to retain high levels of accessibility despite their low mobility by living in proximate locations to their destinations (Barter 1999 and Baker et al., 2005). Limited mobility becomes one of the reasons for squatting in slum quarters near job centres in the city to minimise their exclusion by trading off quality of life and security of tenure. Whenever there is a forced eviction (as seen in the case of rehabilitation sites in Ahmedabad), their access level reduces and they are pushed into the cycle of commuting longer distances, and spending more money and waiting time. Lower frequency and bad public transit services result in longer trip lengths and times for the poor compared to the non-poor (Gwilliam, 2002). This hampers their ability to make the most of employment opportunities in the cities.

The modes used by the poor, mainly the NMT ones of walking and cycling (especially in the case of Ahmedabad), makes them 'vulnerable road users' from the road safety point of view (MoUD, 2008). There is 'no choice' for the poor but to walk (or cycle) as a primary mode as they cannot afford motorised transport and hence, Tiwari (2001) calls the poor 'captive NMT mode users'. However, having an 'inferior' mode is only part of the problem for the poor. In the absence of reliable transport, they become more vulnerable as they depend more on the informal job market.

The burden of limited mobility is borne disproportionately by women and children. Besides what is seen in Ahmedabad, similar studies conducted amongst the low-income residents of Delhi (Anand et al., 2006) and Pune (Astrop et al., 1996), illustrate that considerable differences exist between males and females in terms of access to, and the use of, the various travel modes on offer. In household budgets, the cost of the main breadwinner's trip to work is prioritised, which sometimes means that trips made by women, the elderly or the young (for schooling or health services) may be sacrificed or rationed. Women's ability to contribute to the alleviation of their standard of living and their status in society is severely curtailed by their limited mobility and constrained accessibility.

However, transport provision on its own is only going to play a limited role in the lives of the urban poor. There is a need to expand the debate about the mobility of the urban poor from being 'the vulnerable road user' or 'the disadvantaged commuter' to 'the disadvantaged citizen'. The idea of citizenship brings in the political and governance context, including issues like provision of housing and basic services, employment, participation in urban processes and stakes of the poor in infrastructure investments.

The continuing hegemony of private motorisation over the rest of the public or NMT modes in the cities makes the poor stretch their budgets to own a M2W (Vasconcellos 2001, Pucher et al., 2005). In other words, low income families in the developing world are giving up their low cost, zero-carbon modes for more expensive, higher carbon emitting modes. However, the use of private motorised vehicles was negligible in Ahmedabad. Yet this does not mean it will never happen, and the need to reduce the likelihood of such an outcome provides further impetus to step up public and shared transport efforts in the city.

The biggest low-carbon mobility initiative in Ahmedabad (namely, BRTS) is not being used by the poor, and the reasons could be the cost of tickets, routing or the exclusivity of the system. The poor households are dedicated users of the public bus and shared autorickshaw. The AMTS services are depleting as the BRT is the main focus of the authorities. The shared autorickshaw is another reliable transport option for the poor, but it is viewed as a 'menace' by the traffic police and the municipal authorities. In spite of much rhetoric about providing for the NMT infrastructure (footpaths and cycle lanes), nothing much has been achieved (Chapter 4). It seems that all the modes favourable to the poor (walking, cycling, shared autorickshaw, public bus) are either not being planned for, or are not being implemented properly. It would only be fair to claim that allocation of billions of rupees from the JnNURM funds for transport projects in the city have not facilitated the transport needs of the poor.

7. Progress of Low-carbon Mobility and the Challenges of Social Inclusion

7.1 Public transport paradigm

This study has assessed the current status and processes of implementation of the BRTS in five cities, including Ahmedabad, where a detailed study has been undertaken. The purpose is to assess whether these cities in particular, and urban India in general, has an interest in transiting to this relatively low-cost and low-carbon form of transport. The detailed case of Ahmedabad not only presents the progress and challenges of the BRTS project, but also tries to understand its users' profiles. This study has aimed at putting together the goals of low-carbon mobility and social inclusion in the transport system. This concluding discussion separates the issues at the national (macro) level from the city (micro or local) level, as well as the policy issues from the implementation issues.

The study had two guiding principles; sustainable mobility and equity. Sustainable mobility (prioritising accessibility) describes all forms of transport that minimise fuel consumption and carbon emissions by minimising the need to travel itself (Knowflacher, 2007; Banister, 2008). Knowflacher argues that the hypothesis of traditional urban transport planning – 'growth of mobility' and 'travel time saving by increasing speed', end up creating more transport, environmental, and socio-economic problems all over the world. It also creates higher mobility-oriented infrastructure and urban form, which makes it difficult for more sustainable modes in cities to operate. There is a great danger of creating the situation of 'lock-in' for the cities with automobile-dependent infrastructure. The transport interventions across the world are attempting to achieve accessibility and reaching, rather than travelling. In the context of climate change, the notion of sustainability has more specific goals relating to carbon emissions. Low-carbon mobility is prioritised, involving zero-carbon modes like walking and cycling or any other shared and public modes of transport where the emissions can be distributed amongst commuters.

In the context of 'equity', Vasconcellos (2001) argues that transport is not an end in itself. The 'end' has to be the equitable appropriation of space and the corresponding access to social and economic life. There have been massive investments in urban infrastructure in developing cities and it is a timely debate in policy formation whether these investments are used for the betterment of everyone in society. The idea of equity is a paradigmatic approach to policy-making where everyone's share in the system is recognised and provided for. Since mobility practices are indicative of specific socio-economic situations, the transport system in a city should be inclusive and equitable.

The practice of transport planning in general focuses on the link between transport and economic growth. In fact, transport induces economic growth through investments in infrastructure, purchase of vehicles and employment generated through both. Neo-liberalism, which dominates economic policies (in the developing world and in India), perceives 'growth of mobility' and 'freedom of modal choice' as inseparable parts of economic growth and infrastructure building. Located in the neo-liberal approach, conventional transport planning assumes that infrastructure building and provision benefits everyone equally in the given transport system. However, such a growth-centred paradigm of transport does not necessarily address the human concerns of equitable development on the one hand, and environmental sustainability on the other.

In societies that are experiencing high economic growth, there is a latent demand for PMT because of newly achieved prosperity. In developing countries, increasing numbers of private vehicles, rising income levels and depleting air quality pose further challenges to sustainable transport. There is pressure on the city governments to invest in infrastructure to facilitate easy mobility of private vehicles, which the city governments are complying with after a long lag. Cox (2010) demonstrates how there remains a bias towards prestigious mega projects in market-based, top-down approaches to transport provision. Badami (2009) shows how this approach further facilitates motorisation by failing to be proactive in achieving the goals of sustainability. The outcome is now unmanageable congestion on city roads, which is a phenomenon that has trickled down to smaller metros as well.

Furthermore, capital-intensive transport options, which are also energy-intensive, exclude and more often than not displace low-income populations from the urban space. In such a context, issues of sustainability and equity are interwoven objectives of transport initiatives and not mutually exclusive entities, especially when what is sustainable is also equitable, and vice versa. However, now there is an overwhelming consensus within the urban transport debate that accepts the need for more public transport and a reduced reliance on private transport. However, the debate is ongoing with regard to the type of public transport that is equitable. A section of transport planners believe that a transport system that prioritises walking, cycling, shared and public transport is equitable as well as low-carbon.

An important question is: does the BRTS offer a low-cost and affordable transport option to low income groups (who are 'captive' users), and has it offered convenient public transport to ensure a modal shift from private two- and four-wheelers to public transport? These two questions have been answered through this research into the BRTSs of India, with a detailed case study on Ahmedabad City, which has the largest BRTS network among those existing in Indian cities. More often than not, in situations of latent demand for public transit, any system introduced works. But, the real issue is whether the two important questions raised above are answered by any new public transit system? This will be discussed further after discussing the planning and implementation issues related to the BRTS in various cities.

7.2 The Bus Rapid Transit debate

Public buses are more sustainable and offer low-carbon mobility, as they are efficient transport modes in the usage of road space and engine capacity. The flexibility in routing and wide area coverage makes it a more efficient mode in the urban context. Public buses are 'mass transit' as they carry millions of people around the globe in urban areas and elsewhere. The efficiency of public buses is compromised when increasing numbers of private vehicles on the roads slow them down. To make the 'mass transit' (buses) more 'rapid', the idea of the bus rapid transit system evolved, which is meant to give priority to the bus by creating dedicated lanes for it. In the words of Roberto Cervero, 'BRT is a key to absorb traffic displaced by road capacity losses'. Given the structure of world cities and budget constraints of city governments, BRT emerges as the most cost-effective and wide-ranging option for the mass rapid transit system. There have been many interesting examples from Latin American cities, where BRT has developed as a comprehensive and well-integrated system.

The global literature suggests that transport systems are continuously evolving and transport planning is a continuous process. Cities which have seen the BRT as a system integrating other modes and have committed to build comprehensive BRT networks have been successful in the long term in providing accessibility to its citizens. Here, the comprehensiveness of the BRT system includes well-integrated networks of walking and cycling facilities along with the BRT system, and effective parking policies. In some Latin American cities, the BRTS has been seen and planned in conjunction with land use planning

and housing policies, making the system efficient, sustainable and equitable. The crucial approach here has been to view BRTS projects more as exercises in appropriate road allocation for various uses rather than merely as road or traffic engineering projects. There is a tendency, and hence possibility, for engineers to overtake the social planners in transport projects, and this seems to have happened with BRTS in most cities in India, as we see in the next sub-section.

7.2.1 The national-level issues

In India, the National Urban Transport Policy (NUTP) places emphasis on public transport, and the national government has made funds available for the same through the Jawaharlal Nehru National Urban Renewal Mission (JnNURM). The NUTP aims to move away from 'roads for vehicles' to 'streets for people', and given the funding opportunities from the national government, it seemed possible to build infrastructure favouring low-carbon or zero-carbon modes of transport. Bus-based public transport dominates in Indian cities (Wilbur Smith Associates and Ministry of Urban Development, 2008), which face escalating costs, poor maintenance, high labour costs, ageing bus fleets and erratic service (Badami, Tiwari, & Mohan, 2007). In such a context, projects such as the BRTS provided new optimism for urban public transit.

Inspite of the NUTP, the debate on the best form of public transport continues and the BRTS is compared and contrasted with the metro rail system, the latter being more capital-intensive. The costs of establishing and maintaining the metro, and hence the costs of individual trips, are higher than those of the BRTS, and hence the latter is typically preferred. Furthermore, the BRTS has more flexibility in expanding the transit network and widening the coverage. Given the structure of the Indian cities that have organically evolved as an urban form around multi-nuclei economic centres, trips are distributed in multiple directions and it is difficult to find high ridership corridors to justify the metro rail system (i.e., 20,000 persons per hour per direction or more). Thus, bus rapid transit was positioned as the more cost-effective and relevant option. But there are those who remain unconvinced by the BRTS and are in favour of the metro, particularly those in decision-making positions and those who remain sold on the idea of 'global cities', that is, cities dominated by capital-intensive and real estate-led development. The consequences of such a metro lobby have undermined the implementation of the BRTS projects in many cities, although at least the projects have begun.

The first consequence is the unsettled debate on whether the BRTS should be an open system or a closed system. The closed system is very much an apology to the metro and hence preferred as a low-cost metro system, as the buses run on the dedicated or 'exclusive BRT bus reserved' corridors. The closed corridors work in conjunction with the Transit Oriented Development (TOD) option, yet for metros it is inflexible and may not be suitable for multi-nuclei cities. The open system is more flexible as it is in essence a High Capacity Bus System (HCBS), which is an upgrade of existing bus systems by providing them with a special corridor to take priority over PMT and other para-transit vehicles. The debate is ongoing but the city administrators and BRT planners have chosen the closed over the open system, and wherever the BRT projects had begun as open systems they are being converted into closed systems. For example, the systems in Jaipur and Indore started as open systems and are now being converted into closed systems. Delhi's open system is under severe criticism, firstly from the PMT users and now from transport planners and road research institutes. Ahmedabad is a fully closed system. But, to get ridership for it, the cheaper public transport system provided by the local government is being closed down on the BRTS routes. While the former public transport system was affordable, the BRTS is expensive for at the least bottom 30 per cent of the city's population.

Whichever system is accepted, a lot depends upon how meticulously the system is designed in terms of level-boarding, junction design, and operational planning. A system which allows easy and faster boarding-alighting (than regular buses), minimised waiting times, and prioritisation for BRT buses at junctions, is likely to get more support from the users. It is possible to achieve these three crucial components of the BRT in both the systems, provided it is planned and implemented for that purpose. From the urban governance point of view, building up a transit system like BRT requires a long-term vision and commitment of continuously investing into the system.

While the virtues of the BRTS have been extolled and the JnNURM has decided to fund these projects, it was decided that any road project could be funded if there were BRTS links to it and NMT infrastructure was also created. Some cities, interested in road projects, applied for the JnNURM funds meant for BRTS and then resurfaced the roads while not putting in the committed BRTS infrastructure. The case in point is Pune. This city has not been able to come out of the older transport paradigm on one hand and has subverted the BRTS on the other.

Looking at the inadequacies of all the existing BRTS projects in India, it is important to understand that no single PT system can cater to the needs of transit in any city. Further, different existing and proposed transport systems need to be integrated with each other in terms of physical access, fares/ticketing, institutions and social marketing. Some of the successful examples of cities with efficient public transport systems such as London, Paris, Beijing, Singapore or Hong Kong have well-integrated, multi-modal systems. BRTS therefore should not be seen as one pre-fixed system, and cities should be given a chance to adapt it according to their own needs and requirements. They should provide easy access to commuters and should also remain affordable for the economically disadvantaged as they are the most dedicated users of bus systems in cities. BRTSs have to be developed as inclusive systems accommodating the concerns of NMT users and the informal sector, as that is the need of many cities in developing countries. Only then will the cities have a dependable and affordable public transit system.

7.2.2 Planning issues

The Ministry of Urban Development (MoUD) in India has been a key promoter of low-carbon mobility projects such as the BRT in various cities. Cities that have shown interest in building BRTSs often lack the expertise and human resources in understanding the full implications of such a project and so need handholding and planning knowledge for projects as complex as BRTS. There is a need to develop planning guidelines for various models of BRTS for the Indian context endorsed (or commissioned) by the MoUD.

City officials and planners need to be systematically trained not only about the technical aspects of the BRTS but also about the social marketing of such projects. MoUD has conducted various training programmes and workshops with many bilateral and multilateral agencies. However, it has not resulted in creating a dedicated team of experts at the central level or at the city level to deal with the complexities of BRTS projects. As a result, the early enthusiasm for the BRTS projects has not been sustained in subsequent years.

Of the 63 cities eligible for national funds under JnNURM, only about 10 had decided to build the BRTS, out of which Ahmedabad, Delhi, Pune and Jaipur have buses running on continuous or discontinuous dedicated corridors. Given the challenge of transport infrastructure in Indian cities, many other cities have to come forward to upgrade their transport system. It is important that the national funds provide positive incentives for the cities to take up low-carbon mobility projects such as the BRT. The cities opting

for low-carbon mobility should be given encouragement through financial support for such projects. And such support should become exemplary for other cities to go on a similar path.

In spite of the objectives of JnNURM of mainstreaming the public participation process at the city level, the transport projects have not made clear attempts to seek participation in planning the BRTS projects at the city level. Participation of wider citizen groups would have also ensured ease in the implementation of projects. This has resulted in making the BRTS projects top-down in conception, planning and implementation. The MoUD should ensure public consultations for transport projects in future.

7.2.3 Implementation issues

The implementation of the BRT projects is mired by the lack of coordination amongst various government agencies, a lack of effective monitoring from the national government, and a lack of interest in the city administrations to implement such a complex project. The most crucial implementation aspect is to have a clear institutional set-up (a group of agencies or an agency) that is fully responsible for all aspects of the transport system, and has the ability to share the vision with other stakeholders (i.e., traffic police) and to take them along in the implementation process. The funding for the BRTS project should be linked with performance-based incentives. The cities opting for the low-carbon mobility option should be given priority over other infrastructure funds as well. National-level monitoring and handholding can also facilitate initiatives for local cooperation between other agencies. National-level monitoring should also make sure that the goals of the NUTP are not compromised and that all aspects of the project such as infrastructure for walking and cycling are also implemented efficiently. The national-level monitoring should be linked with the disbursement of funds and performance-based incentives.

7.3 The city-level issues

Internationally, the BRTS has a long history of 50 years. But, the idea caught on in the developing countries wherein the cities have limited budgets and the national governments have limited financial capacity to fund capital-intensive metro systems. They began experimenting with the BRTS in their specific context, which has resulted in 120 cities all over the world opting for this system, in which 40 are in China and about 10 are in India. This has not meant that the liking for metro systems has declined, as illustrated by the experience of Bogotá, which has established a world famous system named Transmilenio, but the politicians there continue to prefer metro to the BRTS. This preference has more to do with a preference for capital-intensive projects by politicians worldwide over systems that are incremental and less capital intensive. Even in cities where full-fledged BRT operations exist and further expansions are planned, there are aspirations to build the metro system, as in the cases of Ahmedabad and Jaipur. Sometimes, the metro corridors are the same as the existing BRT corridors (in the cases of Jaipur and Pune) creating duplicity of mass transit systems. Or, the city itself has subverted the BRTS by taking the JnNURM money and widened and resurfaced the roads rather than implementing the committed project (as in the case of Pune).

The major conflicts at the city level are the conflicts related to road space use between different users. Except in Ahmedabad, all other BRT systems have been criticised in the local popular media for 'taking away the road space from regular traffic'. This clearly shows that urban opinion-making is hijacked by the vocal middle classes who are also the owners of PMT vehicles and who resist more equitable distribution of road space. Except for Ahmedabad, it was not possible to carry out detailed surveys about either the operational efficiency of the system or the impact of the system, since the corridors did not have enough lengths to observe their wider impacts.

7.3.1 Policy issues

One of the major issues observed in the cities with regard to planning the BRT systems was the lack of long-term commitment to the idea of the BRTS. In some cases, the BRTS was threatened by proposals for metro rail, while in some other cities BRTS projects were threatened by a backlash in the media against the idea of this public transit mode. Except in Ahmedabad, there were no visible attempts to expand the BRTS network or to engage in proactive social marketing of the system. Ahmedabad BRTS has claimed to 'connect busy places and to have avoided busy roads', but it can also be interpreted as 'building BRT on the wider roads only'. Ahmedabad is expanding the BRT network and most of the roads have widths of more than 30 m.

There were no proactive attempts within any of the studied cities to integrate other transport modes with their BRT systems. The Delhi BRTS has provided cycle-renting schemes in some locations, but besides that there was no attempt to link the bus corridor with other modes. In Pune, Delhi and Jaipur, the BRTS networks were not comprehensive enough to plan any sort of integration with other transport modes.

Ahmedabad is the only city where an exclusive bus service was created for the BRT. In Pune, Delhi and Jaipur, the existing bus services are using the BRT corridors. In Delhi there is a clamour for removing even whatever BRTS infrastructure exists, and in Indore the open system is being converted into a closed system. In Ahmedabad, there was no attempt to integrate the BRTS with the existing municipal bus services. These two systems have been operating parallel to each other in terms of institutional mechanisms, fares and ticketing, and physical infrastructure. There was also no clear plan in the public domain to integrate them. Even worse, some of the existing bus routes were closed to get ridership for the BRTS.

Pune and Delhi could design and implement facilities for pedestrians and cyclists. Since, especially in Delhi, the cycle tracks were extensively used by cyclists. In contrast, in Ahmedabad, despite building the biggest BRT network with operational efficiency, there has been a total failure to design and implement facilities for walking and cycling. In fact, it was taken for granted that the new corridors would not have any cycle tracks.

7.3.2 Implementation issues

Each city has its unique situation regarding failure in implementation of the projects as planned. Various departments of the city governments are involved in implementing the BRTS projects, such as planning, construction and operations, etc. A dedicated coordinating committee/authority is required at the city level with representation of high-ranking officials from each of the concerned departments, such as the municipal corporation, traffic police and the state government. This committee should not only share the vision of 'what kind of BRTS' but also streamline the implementation procedures.

The most difficult implementation issues are related to sharing the road space amongst all users. Even if the system is designed to give priority to pedestrians and cyclists, it is often re-appropriated in favour of motorised vehicles. As in the case of Delhi, the traffic police control the signal cycle at the junctions, and they have designed it to favour the mixed traffic more than the BRTS. The traffic police have also refused to place a check on motorised two-wheelers encroaching the cycle tracks, and regulating this has been left to private security guards. Sometimes inappropriate design of infrastructure has led to a lack of usage. In other cases like Ahmedabad, footpaths and cycle tracks have not been designed and built for all the corridors, compromising the safety and access of pedestrians and cyclists. Wherever cycle tracks are built, the design is faulty and discourages cyclists from using them. It is not clear whether they have plans

to improve these facilities or not. In short, the most contested issue, both in planning and implementation, has been the appropriate sharing of road space amongst all users.

Another conflict seen consistently across the cities relates to on-street parking. The new facilities created, whether it is footpaths, cycle tracks or increased road width, were encroached by roadside parking. Parking is seen as a 'right' of the motorist instead of being seen as PMT owners privatising the public space. Much of this parking on the BRT corridors is long-term parking and not short-term and dynamic parking. All the parking on the BRTS corridors continues to be free and this has become the major obstruction in efficient street management. This means that the BRTS plans should include parking policy and plans in addition to an overall integrated approach.

7.4 The case of Ahmedabad – Users and non-users of the BRTS

The BRTS assessment in Ahmedabad is contextualised against the BRTS paradigm discussions at the global as well as national levels, against the progress of the BRTS in different cities in India, and against the physical structure and political economy of Ahmedabad City itself, with implications for poverty and the transport needs of the urban poor in the city.

7.4.1 The BRT users

The users survey in Ahmedabad shows that the system is dominated by males (72.5 per cent). Of the total users, just 13.7 per cent belong to households with incomes of up to ₹ 5,000. BRTS is being used largely by the middle-income groups, with monthly incomes between ₹ 10,000 and ₹ 40,000, within which half the users fall. Households with incomes of ₹ 5,000 per month or less are the bottom 30 per cent of the urban spectrum and they do not use the BRTS in Ahmedabad to any great extent. And, the women among them use BRTS even less than men, as the sex ratio (females per thousand males) amongst workers that use the BRTS is 226. The sex ratio in the non-workers category using the BRTS is 770, indicating that women are using the BRTS to a greater extent for purposes other than work. Among the males as well as females, those with regular jobs in either the private or public sectors constitute the largest category of BRTS users.

About 30 per cent of the BRTS trips are for purposes related to social, recreational and shopping trips. It is possible that many such trips have been induced by a new mode of transport in the city. For example, BRTS connects western Ahmedabad to the recreational facilities located at the Kankaria Lake in the southeast of the city. In other words, BRTS has made the distant recreational facilities more accessible for the middle-class from western Ahmedabad and created new demand for transport. Only 42 per cent of users were taking a BRTS for more than 21 days in a month, which means that the BRTS is still to find regular and sustained ridership in the city.

46 per cent of commuters have access to the BRTS by using other modes, and 50 per cent of commuters are located within 500 m of a BRT stop. BRTS users are willing to go a longer distance to reach the BRTS station if their destination is closer to the stand. This clearly suggests a public transport deficit in the city. Furthermore, the BRTS is being used in Ahmedabad for an average travel of 8.7 km and when the median trip distance is of 6.9 km on the system. This shows that the BRTS users are long-distance commuters given that the average trip length in the city, including all modes is 5.5 km. The average total BRTS trip length (including modes for access-egress) is 10.84 km for half of all BRTS users.

Prior to the BRTS, a large proportion (47 per cent) of the current users were taking the AMTS (municipal) buses, and because the AMTS services were discontinued on the BRTS corridors these commuters shifted to the BRTS. Another 13 per cent each have shifted from the intermediate public transport modes like shared autorickshaw and full-fare autorickshaw. In total, 70 per cent of BRTS commuters were previously regular users of public transport. Only 12 per cent of commuters have shifted from private motorised vehicles. As mentioned in the earlier chapter, the AMTS services have deteriorated over time, and the BRTS has come as a replacement for the AMTS services. In that sense, the BRTS would not have impacted the carbon emission level as users have shifted from one public transport mode to another. The BRTS has also induced new trips, as 13 per cent of commuters were not making the trip before BRTS. But the enhanced mobility is experienced more by the higher income groups than by the poor. And thus, it explains the new travel demand being created for purposes such as recreational, social and shopping trips. In all, BRT is mainly used by the middle-income groups and many of them have been previous public transit users commuting longer distances.

There is a great gender divide in the users of the BRT, and women continue to have constrained mobility in the city (as only one-third of the trips are made by women in Ahmedabad city as per IPTS, 2000). BRTS has induced new demand and enhanced the mobility of some people in the city, but it has failed to develop dedicated commuters who use the system for work purposes every day. BRTS is not very popular amongst the lower income groups. The higher fares of the BRTS compared to the AMTS (municipal) bus may be one reason, besides the coverage of the system. The Ahmedabad BRTS has made a positive impact in the Indian transport sector by building the longest and most complete network of corridors, but it has a long way to go in emerging as a successful and socially inclusive example of low-carbon mobility.

7.4.2 The urban poor and their travel demand

Since the urban poor in Ahmedabad do not really use the most important low-carbon mobility initiative in the city, the next question was how the mobility of the urban poor is determined in the city of Ahmedabad. The survey shows that the travels of the poor in Ahmedabad are mainly by walking or by public or shared transport modes. One major difference between males and females is in the use of cycles by the males, whereas these trips are replaced by walking among the females. Women are culturally restrained in using cycles. Poor people travel short distances with the most essential trip purpose being work or education. The urban poor make fewer trips per capita than the non-poor, and while the differences are not extreme it does imply that the poor work closer to home than do the non-poor. The relative time and money costs of public transits are higher for the poor than for other income groups, which may indeed explain their short commutes. Many of the urban poor suffer constrained mobility and consequently engage in fewer out-of-home activities, meaning less ability to search for and maintain employment, and lower capacity to seek higher quality goods at a lower price. There are a number of concerns related to the mobility of the urban poor. The modes used by the poor, mainly the non-motorised ones of walking and cycling, make them 'vulnerable road users' from the road-safety point of view (Wilbur Smith Associates and Ministry of Urban Development, 2008).

Having an 'inferior' mode is only a part of the overall problem for the poor. Cities in the developing world have complex urban structures with varying costs of living, services access and accessibility to workplace or public transit lines. Many poor workers take several part-time, low-paid jobs at different locations, simply to maintain the very basic level of household income. Labour market imperfections and working in the informal sector increase their vulnerability. Moreover, when poor households are displaced from their original location, they feel excluded from the city, losing their livelihoods and education for their children. The problem of access becomes more acute on account of their low affordability (which is less than 5

per cent of their household expenditure). The burden of limited mobility is borne disproportionately by women and children. The women of lower-income households experience greater transport deprivations as compared to men.

Transport can facilitate mobility and access and thereby enhance the livelihoods of the poor. Public transport represents a particularly important physical common property resource for the urban poor. Good provision can enhance livelihood profiles and enable the poor to develop and broaden their asset base. For low-income people in many Indian cities including Ahmedabad, public transport is either not affordable or constitutes a substantial financial burden. It is important for projects like BRTS to be more socially inclusive by expanding their reach to the urban poor. The lost opportunity of building walking and cycling facilities along the BRT corridors would have facilitated the travel of the urban poor. Ahmedabad BRTS is far from achieving low-carbon mobility and equitable development. The urban poor can be dedicated users of the BRTS system provided they are recognised and included in the system by innovating the fare system.

Overall, the top-down transportation planning approach has not really taken into account the needs of the urban poor in the city of Ahmedabad, in spite of all the rhetoric about including the low-income groups in the proposed project reports. It has also not achieved a significant shift away from the private motorised modes. Both the goals of low-carbon mobility and social inclusion still remain important challenges for the Ahmedabad BRTS project. Since the project is still in implementation phase, there is scope for reforming its key components and making it more inclusive, and thus sustainable.

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Annex-A

Questionnaire for users of Janmarg-Bus Rapid Transit System (BRTS) in Ahmedabad

Questionnaire for Users of Bus Rapid Transit System (BRTS) in Ahmedabad

Surveyor Code_____Form No._____Date:____/11/2011 Time: Peak/Non-Peak

1. **Where are you coming from?**
   - i. Home ( )
   - ii. School/College ( )
   - iii. Place of Work ( )
   - iv. Market ( )
   - v. Relatives ( )
   - vi. Hospital ( )
   - vii. Recreation Space like Park, Theatre, Restaurant etc. ( )
   - viii. Others (Please Specify)

2. **How did you reach the BRT Station from the above mentioned place? (Tick the Appropriate, Mention Time Taken/ Distance/Fare)**
   - a. Walking ( ) _____Minutes_____ Kms.
   - b. Cycling ( ) _____Minutes_____ Kms.
   - c. AMTS ( ) Fare Rs._____
   - d. Auto-Rickshaw ( ) Fare Rs._____
   - e. Motor Cycle/Scooter ( ) ____ Kms.

3. **Journey from** _____ Station to _____Station.

4. **Fare Paid for the BRTS Trip** (Rs.)_____

5. **Where will you go from the destination BRTS Station?**
   - i. Home ( )
   - ii. School/College ( )
   - iii. Place of Work ( )
   - iv. Market ( )
   - v. Relatives ( )
   - vi. Hospital ( )
   - vii. Recreation Space like Park, Theatre, Restaurant etc. ( )
   - viii. Others (Please Specify)_____

6. **How will you go to your destination from BRT Station? (Tick the Appropriate, Mention Distance/Fare)**
   - a. Walking ( ) _____Minutes_____ Kms.
   - b. Cycling ( ) _____Minutes_____ Kms.
   - c. AMTS ( ) Fare Rs._____
   - d. Auto-Rickshaw ( ) Fare Rs._____
   - e. Motor Cycle/Scooter ( ) _____ Kms.

7. **How frequently do you undertake this trip?** No. of times_____/Week.

8. **How did you undertake this trip when BRTS was not available?**
   - a. Walking ( ) _____Minutes_____ Kms.
   - b. Cycling ( ) _____Minutes_____ Kms.
   - c. AMTS ( ) Fare Rs._____
   - d. Auto-Rickshaw ( ) Fare Rs._____
   - e. Motor Cycle/Scooter ( ) _____ Kms.
   - f. Motorized 4 Wheeler ( ) _____ Kms.
   - g. Trip was not undertaken ( )

9. **Which vehicle(s) your household owns out of the list? (Tick the owned)**
   - a. Bicycle ( )
   - b. Motorcycle/Scooter ( )
   - c. Car ( )
   - d. Others ( ) _____
   - e. None ( )

10. **What is your monthly household income? (Tick the Appropriate)**

a. Below Rs. 2,500	( )	e. Rs. 10,000 – Rs. 20,000	( )
b. Rs. 2,500 – Rs. 5,000	( )	f. Rs. 20,000 – Rs. 30,000	( )
c. Rs. 5,000 – Rs.7, 500	( )	g. Rs. 30,000 – 40,000	( )
d. Rs. 7,500 – 10,000	( )	h. Above Rs. 40,000	( )

11. **Whether you could have undertaken this trip if BRTS was not available?**
    Yes/No _____

12. **Suggestions/Comments for Improving the BRTS Project**
    _____
    _____

13. **Respondent Age** _____

14. **Sex of the Respondent (M/F)**_____

15. **Occupation:**_____

Annex-B

Mapping of footpaths and bicycle tracks along the Janmarg corridor in Ahmedabad

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 1
R.T.O to Memnagar

N
W E
S

Legend

- BRT Stand

Footpath

- Walkable
- Non Walkable

0 0.5 1 2 km.

Key Map

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 2
Memnagar to Khodiyar Nagar

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 3
Khodiyar Nagar to Isanpur

N
W E
S

Legend

- BRT Stand

Footpath

- Walkable
- Non Walkable

0 0.5 1 2 km.

Key Map

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 4

Isanpur to Geeta gauri cinema

GEETA GAURI CINEMA

RAMESHWAR-PARK

RAMRAJYA NAGAR

RABARI COLONY

JOGESHWARI SOCIETY

PURVADEEP SOCIETY

CTM CROSS ROAD

EXPRESS HIGHWAY JUNCTION

JASHODA NAGAR

GHODASAR

ISANPUR

N

W

E

S

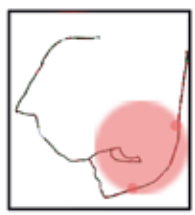
Legend

- BRT Stand

Footpath

- Walkable
- Non Walkable

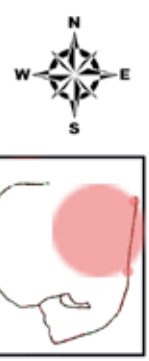
0 0.5 1 2 km.



Key Map

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 5
Geeta gauri cinema to Naroda



Key Map

Legend

- BRT Stand

Footpath

- Walkable
- Non Walkable

0 0.5 1 2 km.

Mapping of Footpath along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 6
Danilimda char rasta to Meera cinema

N
W E
S

Legend

- BRT Stand

Footpath

- Walkable
- Non Walkable

0 0.5 1 2 km.

Key Map

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 1
R.T.O to Memnagar

N
W E
S

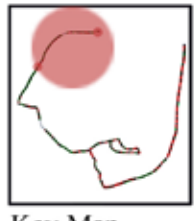
Legend

- BRT Stand

Cycle Track

- Cyclable
- Non Cyclable

0 0.5 1 2 km.



Key Map

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 2
Memnagar to Khodiyar Nagar

Key Map

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 3
Khodiyar Nagar to Isanpur

Legend

- BRT Stand

Cycle Track

- Cyclable
- Non Cyclable

0 0.5 1 2 km.

N W E S

Key Map

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 4
Isanpur to Geeta gauri cinema

GEETA GAURI CINEMA

RAMESHWAR-PARK

RAMRAJYA NAGAR

RABARI COLONY

JOGESHWARI SOCIETY

PURVADEEP SOCIETY

CTM CROSS ROAD

EXPRESS HIGHWAY JUNCTION

JASHODA NAGAR

GHODASAR

ISANPUR

N

W E

S

Legend

- BRT Stand

Cycle Track

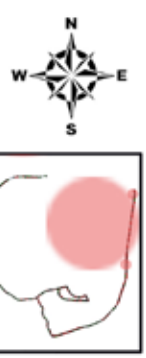
- Cyclable
- Non Cyclable

0 0.5 1 2 km.

Key Map

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 5
Geeta gauri cinema to Naroda



Key Map

Legend

- BRT Stand

Cycle Track

- Cyclable
- Non Cyclable

0 0.5 1 2 km.

Mapping of Cycle Track along Janmarg Corridor

Route - R.T.O. to Naroda S.T. Workshop Section - 6
Danilimda char rasta to Meera cinema

Note : NO Cycle Track on Section - 6

Legend

- BRT Stand

0 0.5 1 2 km.

Key Map

Information about the project:

UNEP Transport Unit in Kenya, UNEP Risø Centre in Denmark and partners in India have embarked on a new initiative to support a low carbon transport pathway in India. The three-year 2.49 million Euro project is funded under the International Climate Initiative of the German Government, and is designed in line with India's National Action Plan on Climate Change (NAPCC). This project aims to address transportation growth, development agenda and climate change issues in an integrated manner by catalyzing the development of a Transport Action Plan at national level and Low Carbon Mobility plans at cities level.

Key local partners include the Indian Institute of Management, Ahmedabad, the Indian Institute of Technology, Delhi and CEPT University, Ahmedabad. The cooperation between the Government of India, Indian institutions, UNEP, and the Government of Germany will assist in the development of a low carbon transport system and showcase best practices within India, and for other developing countries.

Homepage : www.unep.org/transport/lowcarbon

FOR MORE INFORMATION, CONTACT:

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