1.0 Background

Transportation is the backbone to the development of urban areas. It enables functioning of urban areas efficiently by providing access and mobility. Passenger transport has an overriding influence on the functioning of the city. With growth, the mobility needs increases. People's personal choices and freedom get expressed in increased ownership and use of personalized vehicles. As a result public transport becomes financially less viable, speeds reduce, congestion levels increase and the transportation becomes a source of environmental problem. According to a study (World Bank, 1996), 70% of the world's urban population breathes unsafe air. It is also estimated that more than one billion people live in cities with unhealthy levels of suspended particulate matter. Every year millions of people die or suffer serious health effects from air pollution. As per a WHO study (2000), an estimated 3 million people die each year because of air pollution; this figure represents about 5% of the total 55 million deaths that occur annually in the world. Vehicles are major sources of urban air pollution and greenhouse gas emissions. There are economic consequences as well. As per a recent study of the World Bank[1], the costs to society due to air pollution in large cities of India, a part of which is direct productivity loss, was found to be nearly as high as one-tenth of the income generated in these cities from all economic activities.

The trends appear similar in most third world cities. The city of Ahmedabad, largest among all cities of Gujarat state, accommodating about 5 million people, has a registered vehicular strength of 1.4 Million. The rate of growth of vehicles has been about 9 to 10% per annum. Public transport situation has deteriorated rapidly over the past decade. The end result is visible in terms of increasing congestion on the city streets and the worsening of air quality.

Recognizing these problems areas, the State and the City governments have initiated a series of measures to improve urban transport situation in Ahmedabad. The significant efforts of the recent past are:

1. Integrated Public Transit System project by GIDB (1998-2002),
2. Sub-urban Rail System by AUDA & GIDB (2004),
3. Metro Rail Transit System by GIDB (2004),
4. Introduction of CNG buses by AMC (2005), and
5. Comprehensive Road Improvement Plans by AMC and AUDA (2004-5).
6. Bus Rapid Transit System (BRTS) initiated by GIDB with AMC and AUDA. (2005).

The present initiative to develop BRTS is in recognition of the fact that no single mode will completely serve the mobility needs of the city, and the bus system, both in its basic form and rapid transit form, makes it a critical and major component in an integrated transit system of any mega city.

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[1] *Kseniya Lvovsky, World Bank, Economic Costs of Air Pollution with special reference to India, World Bank*

These efforts receive further fillip due to the fact that the state government has declared year 2005 as an Urban Development Year and concerted efforts are being made to improve the condition of urban areas.

1.1 The City

The city of Ahmedabad was founded in 1411 AD as a walled city on the eastern bank of the river Sabarmati, now the seventh largest metropolis in India and the largest in the state. The urban agglomeration (UA) population has increased from 3.31 Million in 1991 to 4.5 Million in 2001. Ahmedabad is the commercial capital of the state.

1.2 Location

Ahmedabad City lies between 22^{o} 55' and 23^{o} 08' North Latitude and 72^{o}30' and 72^{o} 42' East Longitude. The city is devoid of any major physical features except for the river Sabarmati, which is a perennial river cutting the city into two parts: eastern walled city and western Ahmedabad on either side of its banks.

1.3 Land Use

Spatial arrangements of activities determine the travel pattern in the city. This section briefly describes the land use pattern of the city.

The Ahmedabad Urban Development Authority is responsible for land use planning within its jurisdictional limits. As stated above, the area under AUDA may be seen as various subunits depending on the administrative jurisdictional limits and extent of development. Of this area delineated as Ahmedabad Urban Complex consisting of AMC, outgrowth adjoining AMC and area likely to develop in the ten years has been designated as Ahmedabad Urban Complex. It is this area, which is the focus in this study.

1.4 Traffic Generating Activities

The nature and location of economic activities in relation to houses determine the travel demand in a city. Nature and location of these within AMC have been presented below.

The city of Ahmedabad has had great importance in the economy of Gujarat owing to the large concentration of economic activities and their high growth rates and productivity. Ahmedabad accounts for 7% of the state's total population and around 20% of its urban population. In 1995, with 7 percent of the total population, Ahmedabad contributed to 17 percent of the state income *(4)*.

Ahmedabad has a strong industrial base of traditional manufacturing, especially textiles, plastics, machinery and basic metals and alloys. Ahmedabad city accounts for 21.5% of factories in the state employing 18% of workers (2000). In 1981, before the textile crisis, Ahmedabad city used to account for 19.3% of factories and 27.7% of workers in the state. During the 18th and early 19th centuries, Ahmedabad was one of the most important centers of trade and commerce in western India. The economy of Ahmedabad has passed through various phases of transformation over the years. A gradual shift has been noticed from manufacturing oriented industries to services oriented economic scenario. The tertiary sector is gaining, in terms of share which includes business and commerce, transportation and communication, and other services.

1.5 Employment Distribution

The major employment zones in the study area are primarily located in the industrial belts of Naroda, Odhav and Vatva. Old city continues to be a major trading area. C.G. road and Ashram road have emerged as important commercial hubs in the city. Now SG highway and 132ft ring road have started showing similar development trends.

1.6 Vehicles

At the time of formation of the state of Gujarat, in 1961, there were only 43000 vehicles registered. This figure has risen to over 70 Lakh vehicles by the year 2004, recording a rise by 160 folds in four decades. In the recent past, annual additions have been high and increasing. During the years 2001 to 2002, the increase in the number of vehicles registered was 4.3 lakh. This has risen to 5.1 and 5.7 during 2002 to 03, and 2003 to 04 respectively.

Ahmedabad district has a total number of 14.9 Lakh motor vehicles registered in the year 2004. Of this 73% were two wheelers. The district, which accommodates 11% of the state population accounts for about 21% of the vehicles registered in the State[2]. This high density and rapid growth of vehicles have worsened the transport situation to a significant extent.

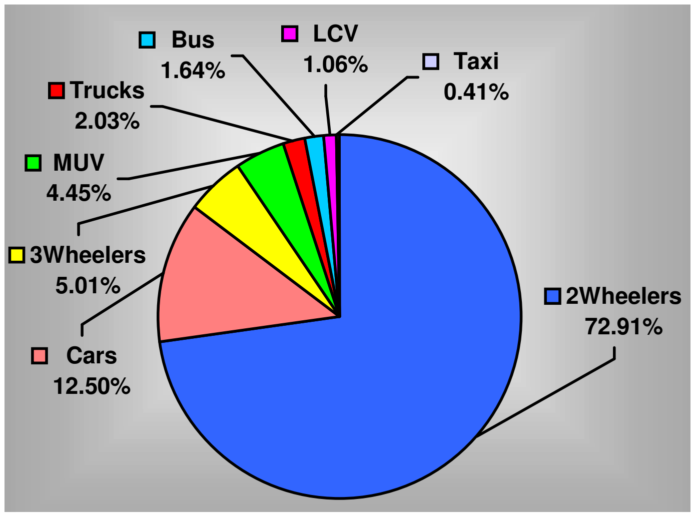


Fig 1-1: Figure showing the composition of vehicles in Ahmedabad

The graph shows the composition of vehicles in Ahmedabad. Currently vehicles are growing at the annual rate of 13%, which is quite high and indicates towards a greater vehicular population in the future.

[2] *Ahmedabad Agglomeration accounts for78% of the total district population*

Table 1-1: Total motor vehicle growth and growth of two/three wheelers and AMTS buses in Ahmedabad (1961-2001)

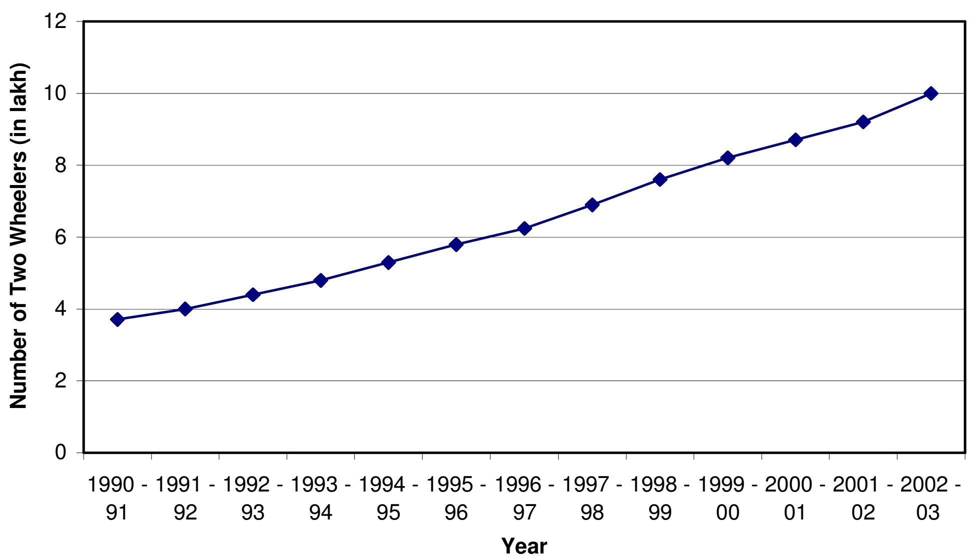
Year	All Vehicles		Two Wheelers		Three Wheelers		AMTS Buses	
	Total	Growth	Total	Growth	Total	Growth	Total	Growth
1971	62922	-	21702	-	4865	-	525	-
1981	165620	163%	86550	299%	16741	244%	610	16%
1991	538182	225%	361372	318%	38359	249%	756	24%
2001	1210278	125%	863003	139%	65868	72%*	886	17%
Total Growth (71-2001) 1823%			3877%		1253%		69%	

Source: Transport Department, Gujarat, Ahmedabad, 2004

Note: Sudden reduction in growth rate is due to the restriction levied by the transport department

Fig 3.2 presents the graph of two wheelers' growth in Ahmedabad. Ahmedabad experienced 18 times growth of vehicular population in last four decades (1971-2001) with almost 39 times of growth in two wheelers population.

Fig 1-2: Growth of Two Wheelers in Ahmedabad 1990- 2003

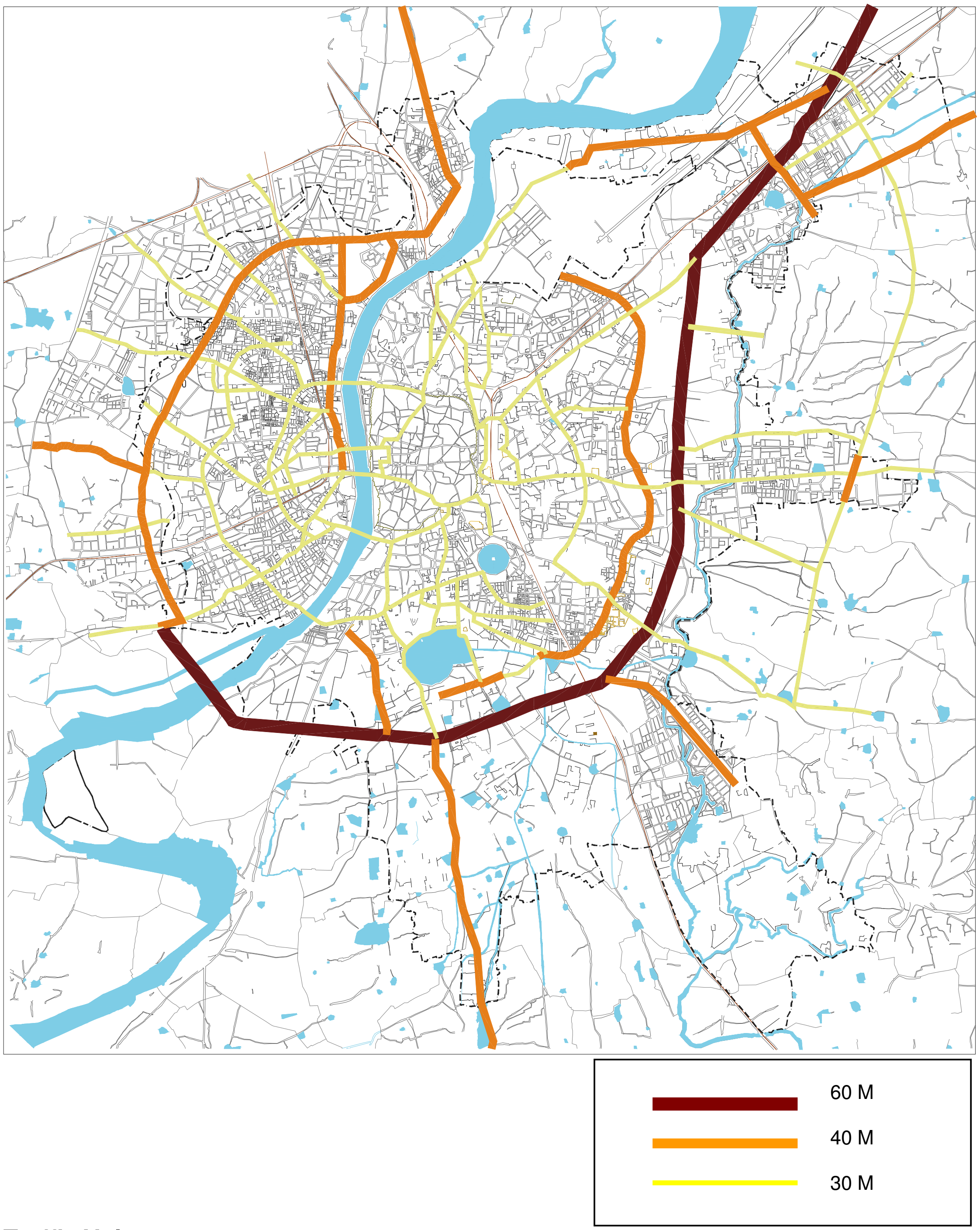


Source: Transport Department of Gujarat, Ahmedabad, 2004

1.7 Road Network

The study area roadway system is approximately 3478 Kms. Other than the National Highway Authority, which maintains National Highways and the State Roads and Buildings Department, the two urban local bodies; AMC and AUDA, are responsible for developing, operating and maintaining road infrastructure.

Map 1-1 : Showing Roads Widths



1.8 Traffic Volume

The Western part of the city has developed as a mainly residential area and the eastern part has the industrial estates. Because of this, the traffic flow is very heavy from west to east in the mornings and vice-versa in the evening, which causes serious traffic congestion and frequent traffic jams on the city roads during morning and evening peak periods. Lately, road widening of the major radial roads has been undertaken which has helped ease the traffic flow to some extent. Traffic volumes on major roads has been presented in the map below. As may be observed, volumes far exceed capacities at many places.

1.9 Public Transportation System in the city

The Ahmedabad Municipal Transport Service (AMTS) functioning under the Ahmedabad Municipal Corporation (AMC), is responsible for providing the public transportation system in the city. The responsibility of providing inter-city state operations lies with Gujarat State Road Transport Corporation (GSRTC). Over the years, the AMTS has seen a rapid decline in its ridership levels, on account of stiff competition from rising two-wheeler ownership levels, lack of route rationalization and inability to upgrade its infrastructure to cater to the existing public transport demand in the city. The inability of AMTS to cater to the city's demand has resulted in people shifting to auto-rickshaw, the shared auto-rickshaw *(chakdas) and two wheelers*.

1.10 Level of Operations and Coverage

AMTS caters to 2.5 lakh trips every day. About 150 routes are in operation with a fleet size of 540 buses. Fleet utilization has been consistently low. The average load factor has decreased and the number of cancelled service kms has increased.

AMTS bus route lengths average about 17 kms and range from about a minimum to 5km to a maximum of 57 kms. About 55 percent of buses operate on routes with lengths of 10 to 20 kms, with a running time of 30 to 90 minutes. The AMTS average bus stop spacing is 410 meters which is convenient for passengers, but results in longer travel time and delays. In the absence of faster bus services, average operating speed of AMTS is between 15-20 kmph.

Though the primary duty of AMTS was to provide bus-services only within the municipal area, the AMTS gradually expanded its services to the areas on the outer periphery of municipal limits with the increased dependency of the city and peripheral areas with each other. As a result the operational area of AMTS grew to as high as 375 sq. kms. compared to the earlier 198 sq. kms. area of the city.

Table 1-2: Level of Operations of AMTS (1948-2005)

Year-ending 31st March	Fleet-size (Buses)	No. of Routes	Service kms per day	Buses per lakh of population	No. of passengers per day
1948	205	38	15000	26	109024
1951	188	57	19755	21	153004
1961	337	100	44038	27	333865
1971	525	164	75757	33	541096
1981	610	205	96685	30	786301
1991	756	248	111452	24	619726
1995	705	180	115123	19	625479
1996	724	170	119563	19	683607
1997	820	164	134192	21	800822
1998	882	166	141726	22	791370
1999	882	132	150134	22	799321
2000	942	144	155675	22	757852
2001	886	140	151245	21	678861
2002	801	136	124375	18	574257
2003	687	115	81802	15	385682

2004	601	110	76028	13	325378
2005	540	117	77411	11	349653

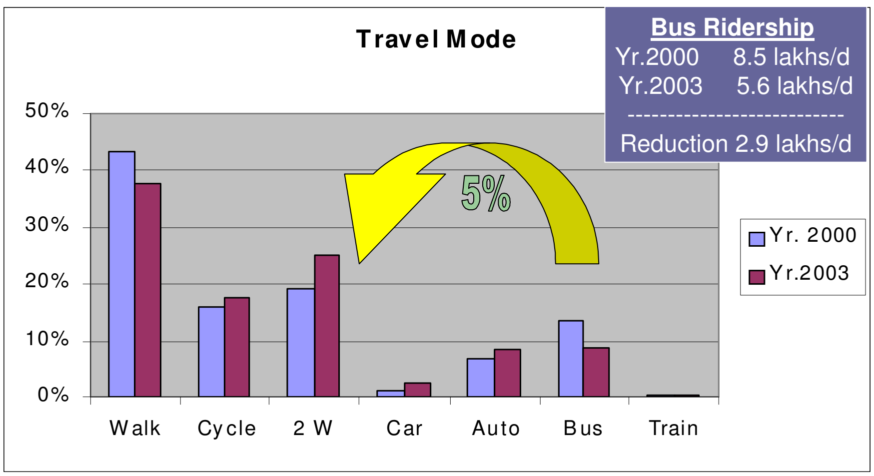
Source: AMTS

A foremost reason for the decline in number of passengers is the decline in number of short-distance passengers due to the rise in fares and decline in the service. A significant decline in the AMTS fleet and services coupled with a significant growth in IPT modes like Auto-Rickshaw or Chhakda has been the main reasons for the decline in the market-share of AMTS.

1.11 Decline in Patronage:

It was after the year 2000, that the bus patronage levels in AMTS started to decline drastically, due to insufficient bus fleet to cater to the ever-increasing needs of the population in the city, and stiff competition from intermediate modes of transport such as shared auto-rickshaws plying on the same routes as the buses. The fleet size of AMTS has come down from 886 buses in 2001 to 540 in 2005.

Fig 1-3: Decline in Bus Patronage Levels



Derived From: AMTS, IPTS Study by Louis Berger, 2000

The bus patronage declined very sharply from 2001 to 2003 by almost 5% with a comparable increase in the two-wheeler ownership.

1.12 Spatial Pattern of Passenger Movement

The outcome of interaction between socio-economic characteristics, land use and transport system results in a movement pattern. The movement patterns generated, based on origin-destination table for the years 2000 and 2003, have been depicted in the form of desire-lines.

From the maps below it is evident that still the movements across the river are very large. As expected, the walled city (Kalupur, Gita Mandir), Naroda, Odhav, Vatva industrial estates, Ashram Road, CG Road, 132 feet ring road and Highway are major trip attraction places. More detailed description is provided in subsequent chapter.

Fig 1-4: Desire line Diagram - 2000 (Total Zone-Zone Movement in excess of 300 Trips)

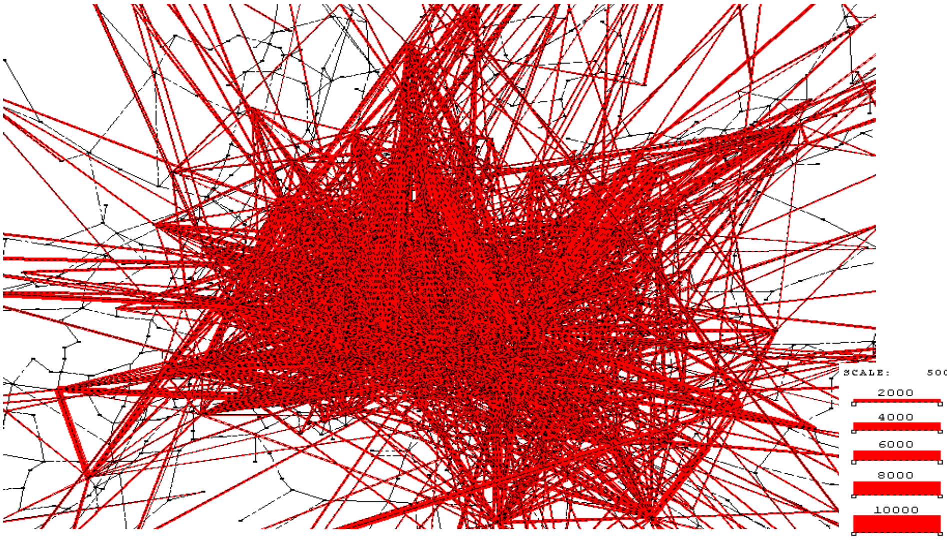
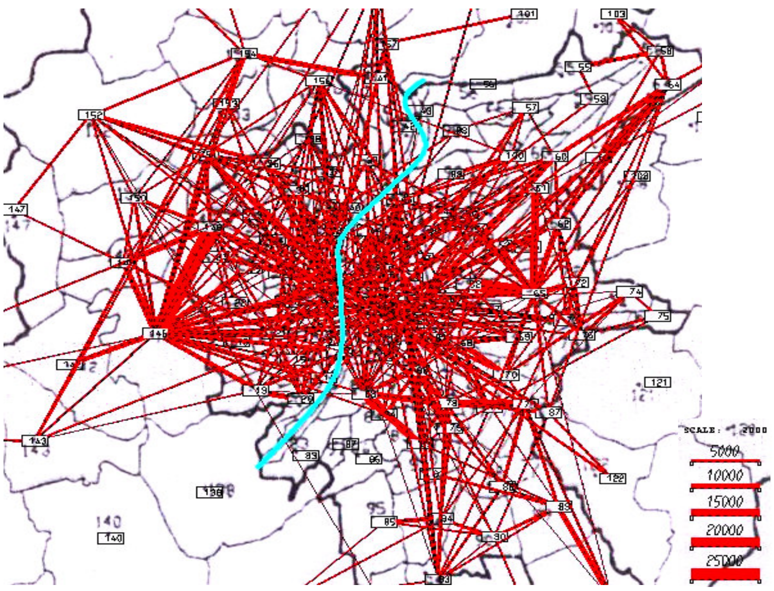


Fig 1-5: Desire line Diagram - 2003



1.13 Corridor Assessment and Identification

The purpose of the chapter is to identify the corridors on which opportunities for developing BRTS exist and prioritize for implementation. As discussed earlier the public transport system supply situation is very poor both in quality and quantity terms. At present there is no single corridor in Ahmedabad on which high frequency public transport services are offered and supply is constrained due to congestion. In the light of this the objective of this effort would then be to develop BRTS as a **strategic intervention**, which would improve public transport image, attract latent transit demand, contribute to improved transit option for people, improve air quality and help city remain a compact city.

1.13.1 Identification of Potential BRTS Corridors

To identify the potential corridors, road network was screened with regard to three criteria.

Table 1-3: List of Potential Corridors

Corridor No	Name of Corridor	Length of Corridor (kms)
1	VASNA-SABARMATI – NARODA-NAROL	47.5
2	VASNA-SABARMATI	15
3	NARODA-NAROL	18
4A	THALTHEJ TO KALUPUR	9.1
4B	SATTADHAR TO KALUPUR	9.55
5	GHATLODIA TO VADAJ	4.92
6	SABARMATI TO SARKHEJ VIA ASHRAM RD	17.63
7	ISKCON TO KALUPUR	11.09
8	ST TO NAROL TO LAMBHA	8.44
9	ST TO JASODANAGAR CROSSROAD TO HATHIJAN	12.81
10	KALUPUR TO ODHAV	9.49
11	KALUPUR TO NARODA	10.29
12	THALTHEJ TO NAROL TO LAMBHA (UNIV ROAD)	17.15
13	SARKHEJ TO GOTA	12.45
14	PALDI TO ST VIA JAMALPUR (OPTIONAL CONNECTION)	3.25
15	ISKCON TO VASNA VIA. NEHRU NAGAR CIRCLE	6.35
16	SABARMATI – KALUPUR	8.98
17	VADAJ-GOTA	5.75
18	SHIVRANJANI-KALUPUR VIA SHREYAS, NEW BRIDGE, ST	11.57

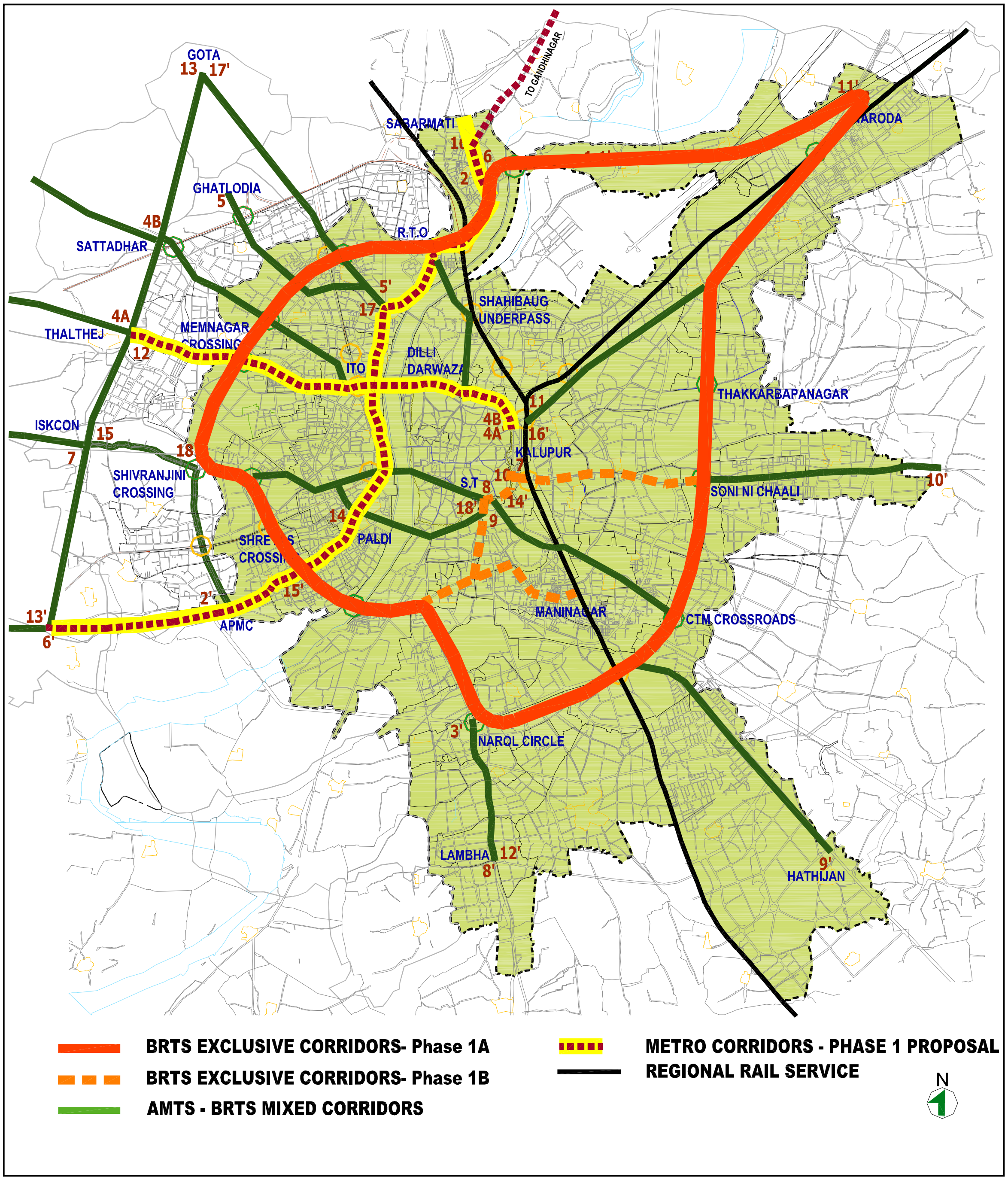
1.13.2 Corridor Assessment

The assessment process is carried out in three parts:

1. Travel Demand Assessment
2. Technical Feasibility
3. System-wide Impact

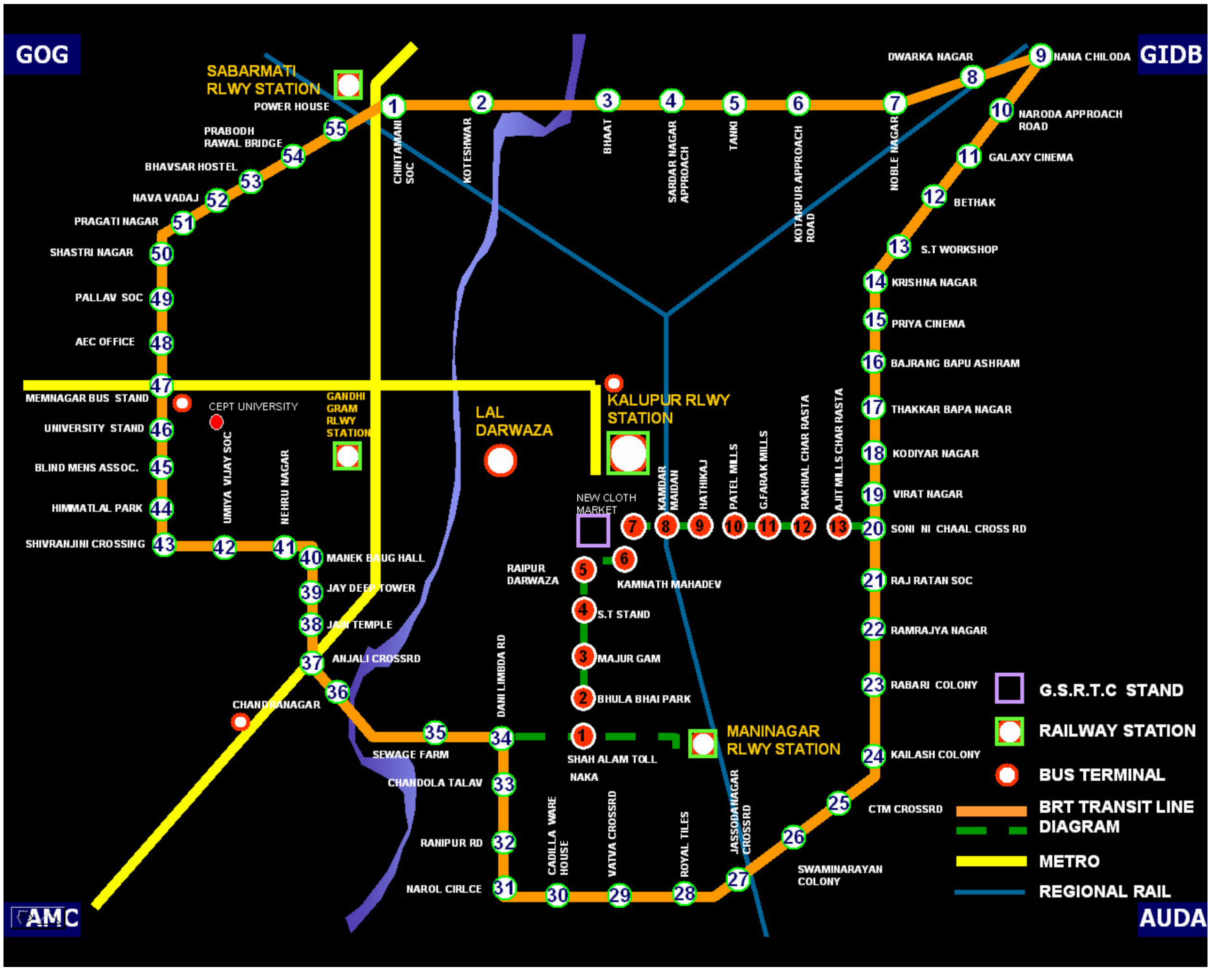
Table 1-4: Final Ranking of Corridors and Recommendations

Corridor No.	Name of Corridor	Rank as per respective considerations			Cumulative Rank (equal weight)	Final Rank	Recommendations
		Transit Demand	Technical Feasibility	System Impact			
1	VASNA-SABARMATI – NARODA-NAROL	7	1	1	9	1	Exclusive BRTS Corridor and Closed System Operation
2	VASNA-SABARMATI	1	3	9	13	4	Part of C- 1
3	NARODA-NAROL	6	1	2	9	1	Part of C-1
4A	THALTHEJ TO KALUPUR	2	5	6	13	4	METRO Proposed – 1st Phase. AMTS-BRTS Mixed Service
4B	SATTADHAR TO KALUPUR	2	5	5	12	3	Parallel to Metro Line ***AMTS-BRTS Mixed Service***
5	GHATLODIA TO VADAJ	6	2	12	20	8	No BRTS
6	SABARMATI TO SARKHEJ VIA ASHRAM RD	5	3	3	11	2	METRO Proposed – 1st Phase. AMTS-BRTS Mixed Service
7	ISKCON TO KALUPUR	2	5	4	11	2	***Partly included in C-1*** Phase-2 ***AMTS-BRTS Mixed Service***
8	ST TO NAROL TO LAMBHA	7	2	7	16	6	Part of several corridors- no specific suggestion.
9	ST TO JASODANAGAR CROSSROAD TO HATHIJAN	8	2	8	18	7	Parallel to Regional Rail Line AMTS-BRTS Mixed Service
10	KALUPUR TO ODHAV	7	2	5	14	5	Exclusive Bus Lane Phase-1.b AMTS-BRTS Mixed Service
11	KALUPUR TO NARODA	4	1	7	12	3	Parallel to Regional Rail Line AMTS-BRTS Mixed Service
12	THALTHEJ TO NAROL TO LAMBHA (UNIV ROAD)	6	2	8	16	6	Part of other corridors
13	SARKHEJ TO GOTA	9	1	11	21	9	Phase-3
14	PALDI TO ST VIA JAMALPUR (OPTIONAL CONNECTION)	6	5	9	20	8	Part of C1 AMTS-BRTS Mixed Service
15	ISKCON TO VASNA VIA. NEHRU NAGAR CIRCLE	6	3	13	22	10	Part of C1 AMTS-BRTS Mixed Service
16	SABARMATI – KALUPUR	3	2	6	11	4	AMTS-BRTS Mixed Service
17	VADAJ-GOTA	5	1	10	16	8	Phase-2
18	SHIVRANJANI-KALUPUR VIA SHREYAS, NEW BRIDGE, ST	4	3	5	12	4	Exclusive Bus lane (part C1) & part phase-1 b



Map 1.2 BRTS Network

Map1. 3 BRTS Transit Line Diagram



1.14 Bus Rapid Transit System Design

The proposed Bus Rapid Transit System will be a high quality, ultra-modern and passenger oriented rapid transit system to deliver fast, comfortable, economical and eco-friendly mobility to urban dwellers. By introducing the BRT system, the overall traffic flow will improve as significant shift from privatized modes towards BRT system is expected. Having identified BRT system corridors, this chapter discusses the policy and planning issues related with the development of BRT system as a whole.

1.14.1 Median versus Side Lanes

Exclusive bus lanes are proposed to be mostly at grade, segregated from the existing volume of traffic by means of a physical separation. These exclusive bus lanes could be strategically placed either at the centre of the road (Median Bus lanes) or at the side (Side Bus lanes). Experiences worldwide suggest having BRT system in the central verge (median lane) of the roadway is better option than curb lanes. For the city of Ahmedabad, given the constraints of road widths, encroachments, cattle menace and traffic disorder the median lane option for BRT is recommended.

1.14.2 Open versus Closed System

Open System: BRT system lane is kept open for all existing bus operators. The benefit of dedicated infrastructure is distributed to all operators.

Closed System: BRT system lane is restricted only for BRT buses. BRT operators remain the only beneficiaries and hence responsible for efficiency and maintenance.

It is recommended to have a “Closed System” on the corridors where exclusive BRT system lane is proposed to be developed. The exclusive BRT lanes must be physically separated from the rest of the traffic by a physical barrier. ***However, considering the criticality of services, it is recommended that Fire Brigade and Ambulances will be allowed on the BRTS Lane.***

1.14.3 Exclusive/Dedicated versus Mixed Corridor

The presence of other bus service such as AMTS in the mixed traffic lanes would not only undermine the rider ship and hence profitability of the new system (BRT) under consideration; it will also congest the already reduced lanes for other traffic. Therefore it is recommended that the BRT corridors having dedicated BRT system lanes shall have only BRT system bus service running. No other service shall be allowed to compete with BRT system. However, BRTS buses will share other feeder routes with AMTS where there is no provision of dedicated bus lanes. Such a facility is referred as mixed corridor. BRT system buses, other buses and other traffic will share the available right of way.

1.14.4 Land Ownership of the corridor

One of the corridors under consideration for BRT system is part of National Highway 8 currently under the ownership of the National Highway Authority of India (NHAI). This highway may be handed over to Ahmedabad Municipal Corporation (AMC) once bypass to this is open to the traffic. Effort to develop BRT system on this corridor therefore should be coordinated with NHAI.

1.14.5 Bus Technology/Size Issue

To start with, we recommend using Standard buses having capacity between 60 and 70 passengers at a time.

The buses operating in the BRT system could be Indian buses, manufactured in India and eventually assembled in Ahmedabad. Clean bus technology to reduce emissions is essential. In this regard, we recommend exploring possibilities of having standard buses with required modification in floor height, seating arrangements etc. running on Compressed Natural Gas (CNG).

1.14.5 Advance Technology

The use of advanced technologies (or Intelligent Transportation Systems) to improve customer convenience, speed, reliability, and safety will be explored. Examples include systems that provide traffic signal preference for buses at intersections and cross streets, as well as Global Positioning Systems (GPS) to provide passenger information including real-time bus arrival information.

1.14.6 Fare Policy

Fare structure for the BRT system will be as competitive as possible.

1.14.7 Pavement Design & Drainage Arrangement

The BRT corridors are recommended to be developed for the running of standard buses customized to suit specific requirements along with high capacity urban buses. The pavement design requirement therefore would not be different from existing practices in a mixed traffic condition. There will be three types of pavement design requirements for developing BRT corridors.

1) Bus Lane

- The existing median portion will be dismantled and all the kerbs etc. will be removed. Excavation will be done up to the required depth and length. Over this cut surface, Wet Mix Macadam (WMM) of 30 cm thickness (in two layers 15 cm each) will be placed over a layer of Granular Sub Base (GSB) of 42 cm thickness (GSB in two layers, 20 cm and 22 cm thick respectively). Then 16 cm of Dense Bituminous Macadam (DBM) will be placed in two layers (8 cm each) on the top of WMM. Prime and Tack coats will be provided over existing road surface and finished DBM.
- The total width of the BRT lane (7.0 m) including the old median portion will be provided with 40 mm thick Ashphalt Concrete (AC) as a top layer for strengthening and providing proper camber, slope correction over the existing road surface.
- Implementing alternate pavement color through colored asphalt or concrete can reinforce the notion that a particular lane is reserved for BRT use, thereby improving aesthetics.

2) Mixed Lane (existing bituminous carriageway)

- It is proposed to have two lanes (7.0 m) on each side for the mixed traffic. If the existing carriageway width is not sufficient to accommodate, widening has to be done in the same line of existing median portion. Prime and Tack coats will be provided over existing road surface and finished DBM. Thereafter, a common Ashphalt Concrete (AC) layer of 40 mm thick will be put for the entire width (Mixed Lane) for strengthening and providing proper camber slope correction over the existing road surface.

3) Service Lane

- Baring few sections, service lanes are not very well defined along the proposed BRT corridor. It is proposed to construct a fresh pavement comprising 40 cm thick GSB (in two layers, 20 cm each), 20 cm thick WMM and then 60 mm thick DBM over the finished WMM surface. Prime and Tack coats will be provided over finished DBM. Over this a layer of 40 mm thick Ashphalt Concrete (AC) will be placed.

1.14.8 Drainage Arrangement

The existing storm water drains will be dismantled if not at the outer side of the roadway width. The storm water drain is proposed to be underneath the proposed footpath adjacent to the service lanes. It will be a box type concrete drain with manholes at regular interval. The manholes shall be covered with airtight inspection covers. There will be a provision of duct to accommodate other utility lines within the same. There would also be a provision for drain inlets at appropriate spacing. Physical separators between BRT lane/Mixed lane and Mixed Lane/service lane will also have provision for surface water to flow towards main storm drain running parallel to the corridor.

1.14.9 Location of Bus Stop/Bus shelter

Bus stops to be generally provided before intersections in the direction of travel to utilize the stoppage time wherever practicable/possible. Average spacing between two bus stops should be 800 m. Bus stations can have more than one loading platform depending upon the demand at given locations. 55 bus stop locations have been identified along phase 1 BRTS network (circular one). Bus stops will be on the left side (in the direction of travel). Hence, the doors of the buses will also be on left side (standard practice in India). However, there should always be a provision for two boarding/alighting platforms per stop on each side.

At mid-block, bus shelter should be staggered by at least 50 m (c/c) to facilitate overtaking of the buses and pedestrian flow.

Other design details of a bus stop/shelter are as follows:

- To achieve a safe, easy, and efficient means of passenger boarding and alighting, platforms level with BRT vehicle floors (approximately 35 cm above the pavement for low floor vehicles) are the preferred station platform treatment. The level station boarding and alighting platforms will create a seamless transition between the station and the vehicle.

- Raised verges between BRT lane and mixed lane will be made friendly to the physically challenged persons near bus stops and intersections by providing a gentle slope with different surface treatment.
- 3 m wide and 12 m long bus box (marking), two on each side.
- Extended shelter to accommodate more waiting passenger and at least two platforms.

1.14.10 Access to Bus Stop

Adequate provision in design should be made to ensure safe and convenient movements of passengers to/from BRT bus stops. At mid-block bus stops, a pedestrian phase signal to be provided to enable safe crossing of the urban dwellers guided through zebra crossings. The maximum number of mixed traffic lanes the pedestrians would need to cross is only two at a time, which can generally be negotiated safely.

At high-volume bus stops, a pedestrian subway will be provided to facilitate unrestricted crossing of BRT system users and other urban dwellers.

The bus stop near intersections shall be accessed using zebra crossings provided at intersection and then 2.0 m footpath between BRT lane and mixed traffic lane.

1.14.11 Treatment of Intersections

We recommend a grade-separated facility along the BRT system corridor at major intersections. Grade-separators should have six lanes. Two at the middle should be dedicated for BRT service and two lanes on each side for mixed traffic other than BRT buses. However, on flyover section, the physical separator between BRT lane and Mixed traffic lane can be reduced to 0.5 m width gradually before take off point of the flyover. By doing this we will be able to have extra width/lane near intersections underneath the flyover. This shall partly be utilized in accommodating counter fort wall for the flyovers.

The junctions recommended to have flyover/ROB by AMC/AUDA are:

1. Naroda Railway Crossing (ROB: Old NH8 and Ahmedabad - Himmat Nagar BG)
2. Thakkarbapa Nagar Intersection (Old NH8 and Nikol Road)
3. Soni Ni Chal Intersection (Old NH 8 and Odhav Road)
4. CTM Cross Road Junction (on Old NH 8)
5. Memnagar Bus Depot Intersection (Drive in Road and 132’ Ring Road)
6. Shivranjani Crossroads (Satellite Road and 132’ Ring Road)
7. AEC Cross Road Intersection (132’ Ring Road and Sattadhar Road)
8. Shreyas Crossing (ROB: Old NH8 and Ahmedabad - Rajkot BG)

In view of the proposed BRT corridor, all these proposed flyovers/ROB should be a six-lane facility. In addition, following are the locations where we recommend having grade-separated flyovers.

9. Akbar Nagar Circle
10. Nehru Nagar Circle

11. Narol Circle

All remaining intersections along BRT system corridor will be signalized at grade. The design should be done with a view to minimize conflicts and improving traffic flow with preference to BRT buses. All movements at the intersections should be controlled through signalized phasing. The present free left turning movements too would be regulated through traffic signals to provide safe pedestrian crossing. Since traffic is segregated into BRT bus lane, mixed lane, service lane (on few corridors), cycle tracks (on some corridors), each of these lanes will have their unique signal posts which may have overlapping or staggered phases for different lane movements from the same arm. Wherever sufficient Right of-Way is available, an additional storage lane should be provided.

1.14.12 Parking Provision

The corridors having Right-of-Way equal to or more than 40 m should be provided with a parking lane (3 m) on both sides to accommodate existing parking demand. Parking lane should be integrated with proposed service lanes and physically separated from mixed traffic lanes. However, parking will not be allowed on parking lanes, 50 m before and after any intersections. Instead, these lanes will be utilized for providing additional storage lanes at intersections. So will be the case in front of mid-block bus stops, 100 m of this parking lane should be designated only for auto/taxi parking. Also, off-street parking will be provided underneath the flyover wherever recommended.

1.14.13 Bicycle Tracks

Looking at the existing share of bicycle traffic volume on the corridors under consideration for BRT system, we recommend having cycle tracks with a minimum width of 2.0 m on both sides of the road adjacent to the footpath. Generally, cycle tracks are separated by physical barrier (verge or berm) from the main carriageway, but we recommend here to separate cycle track by level difference (20 cm) with a mild slope (1:1). By doing this, we will be able to save approximately 0.5 m on both sides.

1.14.14 Pedestrian Facilities

A footpath with a minimum width of 2.0 m should be provided for each side along the BRT system corridor. This would facilitate longitudinal movement of urban dwellers. The level of footpath shall be higher by 20 cm than cycle track with a mild slope (1:1). The pedestrians other than BRT system users will also use the subways provided at selected mid-block bus stops for crossing the entire roadway. For pedestrian crossings, a 3-5 m wide zebra crossing is recommended across all arms at intersections.

1.14.15 Street Lighting

Street lighting design of the proposed BRT corridor assumes special significance as it has to cater to various lighting requirement such as BRT buses plying on BRT lane, other motorized traffic on mixed lane, slow moving and motorized traffic on service lanes and pedestrian on footpath. The lighting design therefore should cater to all these users simultaneously taking care of the basic design parameters of luminous intensity, the contrast, glare, light uniformity over the pavements and aesthetic. Various alternatives could be explored in detail design stage.

1.14.16 Street Furniture

Adequate attention will be paid towards development of the corridor as a model road corridor, which not only satisfies the requirement of moving traffic in BRT system but also addresses the needs of all users of the urban road. In this regard, adequate attention to be paid towards providing adequate furniture along the road such as: Traffic signs, Road markings, Traffic signals, Railings/guard rails, Channelisers, Planters, Tree guards, Landscaping of untreated areas, Roadside toilets, Auto/taxi stand and Garbage dumps

1.14.17 Relocation of Existing Services/Utilities

The existing overhead and underground utilities such as telephone poles, electric poles, transformers, underground cables, water drains, sewage pipelines etc. will be shifted appropriately and efficiently at proposed locations.

1.15 Operational Issues

1.15.1 System Capacity: is a function of the capacity of the vehicle, the load factor, the frequency of the vehicles and average speed of the vehicle. Based on our rider-ship estimate, we have fixed the following parameters which in turn effect the operational requirement in terms of number of depots, terminals, and fueling stations etc.

- Capacity of the bus: 60-70
- Load Factor: 0.6
- Frequency Peak: 2 minute
- Frequency Off-Peak: 4 minute
- Dwell Time: 20-40 sec.
- Average Journey Speed: 30 kmph

It is recommended to have 50 buses to start with plying on one circular corridor covering around 50 km of length in a closed system. Another 100 buses will run on 5-6 radial corridors identified as feeder in a “mixed system”. The total fleet size can be gradually increased to 1,000 in next ten years with increase in demand.

The first phase would be to build as “closed system” on one circular corridors. In addition, there would be feeder corridors on which BRT buses would be plying in a mixed system with other service such as AMTS. In subsequent phases some of these corridors could be converted into BRT exclusive “closed system” corridor. In all phases for better integration, there would be “transfer stations” that would allow free transfer for passenger using BRT buses in mixed/open situation probably on radial roads.

1.15.2 System Operation: In the first phase, to start with, there would be only ‘local service’ which stops at all bus stops. Subsequently ‘express service’ would be introduced which will not stop at all bus stops. Based on the performance of the system and specific demand, other services like ‘Ladies only’, and ‘AC service’ could also be considered in future.

1.15.3 Fare Collection System: A BRT system design should consider fare collection policy in terms of its impact on both bus dwell time and passenger convenience. From the point of view of the speed and capacity of the BRT system alone, the current manual collection method with an independent collector inside the bus could be very efficient. Passengers board fast from all doors without the restrictions of turnstiles. However, there are always some merits in collecting fare outside the bus at bus stops too. Hence, in case of BRT system Ahmedabd we recommend having hybrid system. At high-volume stops where many passengers board at the same time, the external collection system should be placed. The use of prepaid tickets, tokens, passes, or smart card can be encouraged by fare policy or developing an enclosed monitored paid-fare area. External fare collection system also allows boarding passenger demand to be more evenly distributed between doors, rather than being concentrated at the front door.

The cash fare can be higher with discounts offered for purchasing multi-trip tickets or cards. This policy has the potential to reduce dwell time. In addition, it is a form of price differentiation, which has been successfully used in other countries to increase both revenue and ridership.

The BRT operator should consider various alternatives and select an appropriate system only after the basic design of the system and institutional arrangement is clearly established.

1.15.4 Basic Infrastructure: the basic infrastructure of a BRT system such as number and location of bus depots, bus terminals and fuel station etc. will be created suitably.

1.15.5 Integration: Four types of the system could run on various corridors in the city of Ahmedabad. These could be:

- Only BRT buses: closed system
- Mixed BRTS System/ AMTS: open system
- AMTS: open system
- Rail based system (in future)

In the larger interest of public transport users, an integrated policy should be devised to provide efficient transfer between different systems on different corridors including creating physical infrastructure for transfer.

1.16 Block Cost Estimates

The cost estimate for the BRT corridor phase-I (Circular: Shivranjani – Sabrmati – Narol - Shivranjani) has been prepared, covering Dismantling, road work, paving and concrete, road marking/traffic signs, street furniture, landscaping, electrification, traffic signals etc. and miscellaneous items. Estimate of the quantity related to civil work is primarily based on the typical pavement design explained in earlier section. As regards other items such as bus shelters, subway, flyovers buses, depots, terminals etc. lumpsum provision have been made.

The table below shows the item wise capital cost for the corridor development.

Table 1.5: Cost Estimate

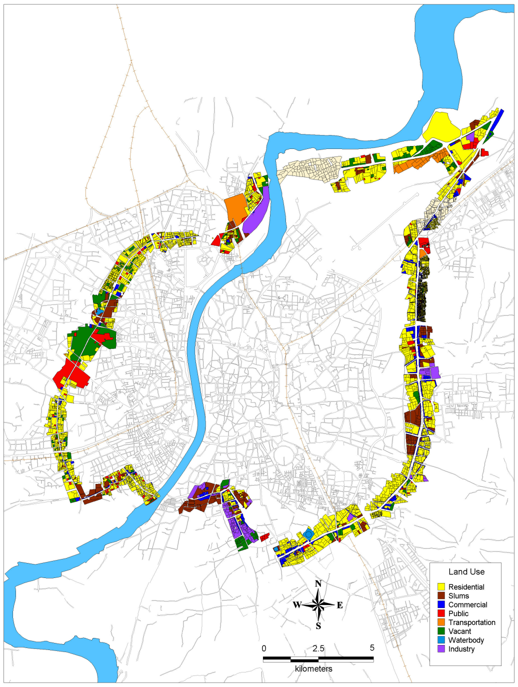
Road Section	Length (km)/No.	ROW (m)	Unit Rate (Rs.)	Total Cost (Rs. in lakh)
Shivranjani Cross Road – RTO	8	40	58,813,689	4,705
RTO - Sabarmati	2.7	60	79,968,779	2,159
Sabarmati – Sardar Nagar	3.3	24	40,881,863	1,349
Sardar Nagar – Narol Circle	24	60	79,968,779	19,193
Narol Circle – Chandola Lake	2	30	40,881,863	818
Chandola Lake – Shivranjani Cross Road	7.5	35	47,050,952	3,529
Bus Stop	(2X55)	n/a	300,000	330
Road Improvement Cost				***32,083***
Bus	100	n/a	3,000,000	3,000
External Ticketing System	Lump sum	n/a	10,000,000	100
Information System at Bus Stops	Lump sum	n/a	10,000,000	100
Depot-cum-Terminal	2	n/a	20,000,000	400
Terminal	2	n/a	5,000,000	100
System Operation Cost				***3,700***
Flyovers	11	n/a	200,000,000	22,000
Subways	5	Varying	20,000,000	1,000
				23,000
GRAND TOTAL (Rs. in lakh)				**58,782**

The cost of minor improvement/maintenance of the corridors proposed for BRT buses to run in open system is not considered.

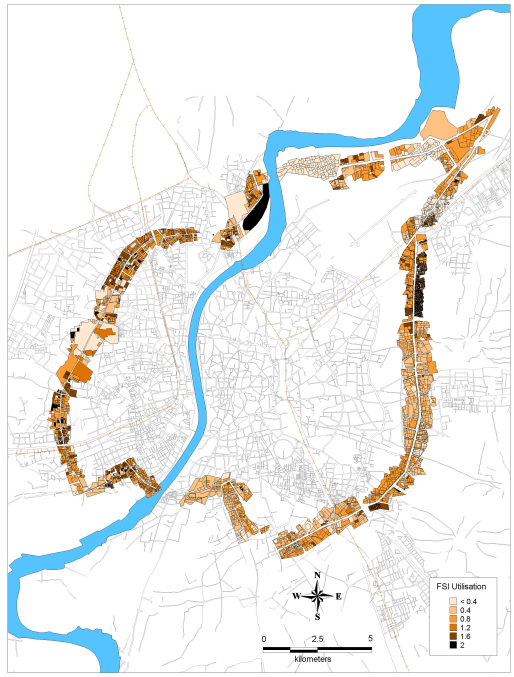
1.17 Support Mechanism

Transport projects are known to yield wide-ranging benefits to the individuals and also induce land-use changes resulting in increased land value. On the other side land-use changes help transit system to attract more Rider ship. Hence, the need is for land-use-transport integration. This chapter briefly dwells upon the support measures required to make transit oriented development and also explores possibilities of cost recovery.

A land use survey of the entire corridor stretch covering 250 meters or upto the immediate parallel road was undertaken to establish the land use potentials. The land-use along the corridor is presented below. (Table 9.1 &. Map 9.2)



Map 1-4: Land Use along the Corridor



Map 1-5 : FSI Utilisation along the Corridor

The total area is about 31 sq. kms. While the permissible FSI is 1.8, present utilization rate is only 0.68 which is quite low (Map 9.3). However, it is to be noted that much of the road was developed very recently. Hence full potential of development is yet to be exploited. The identified corridor for BRT system is very much in the developing part of the city. Ahmedabad having the culture of liner shopping and mixed-use development, the corridor has the potential to become a major commercial street. Mixed land use and linear shopping character appears help keep trip rates and length lower and hence to be encouraged. Legislative measures to utilize the full land use potential of the road are to be designed.

In addition, addressing other integration issue is also important. A comprehensive AMTS and BRTS integration plan, BRTS project implementation, developing a clear-cut parking policy are some of the issues to be tackled.

1.17.1 Resource Generation

Of the estimated cost of INR 588 Crores about Rs. 321 Crores is for basic infrastructure development. In addition on optional elements (Fly over, subways) another 230 Crores would be spent. Buses and depot/terminals would cost about 37 Crores.

It is expected that buses and bus operation related expenses would be borne by the private operators without any support from Government. Infrastructure development costs would have to be recovered through direct/indirect mechanisms.

In this regards, various options have been examined at a preliminary level. The likely yield and feasibility are summarized below.

1.17.2 Land Development

Land Development Option and Assumptions:

1. Total area likely to develop : 21 Sq. Km
2. 50% of Residential /commercial and vacant land will available for development.
3. The development will be staggered beyond 20 year time period and by 20th year 50% plot owners will use additional FSI
4. F.S.I to be provided: 3.5 on either side of the road for 250 meters and 500 mts along intersecting road
5. For the rate chargeable for additional F.S.I three scenarios have been developed
    a. Rs. 500
    b. Rs. 750
    c. Rs. 1000.

Table 1-6: Revenue Yield from sale of FSI

Year	End of 3rd Year	End of 5th Year	End of 10th Year	End of 15th Year	End of 20th Year	Total
Pace of restructuring (%)	5	15	25	30	50	
Land Developed	0.65	1.297184	1.2972	0.64859	1.2972	5.19
Amount Rs. Lakh @.500/ Sq. Mt	3242.96	6485.92	6485.92	3242.96	6485.92	25943.68
Amount Rs. Lakh @ Rs. 750 Sq. Mt	4864.44	9728.88	9728.88	4864.44	9728.88	38915.53
Amount Rs. Lakh @ Rs. 1000 Sq. Mt	6485.92	12971.84	12971.84	6485.92	12971.84	51887.37

However, direct cost recovery is generally not feasible in such cases. Recovery of costs through indirect methods needs examination.

1.17.3 Other Options

Of the other options pay and park facility and advertisement revenue are two important sources likely to yield revenue on regular basis. Their significance will grow with the development of area.

Other sources include adopting Benefit Cess model (Mumbai model), Parking Charge (Delhi model) Toll (Mumbai model) are examples tried out. However these have not been proved as sustainable sources. Initial estimates from these have been presented below.

Table 1-7: Revenue Options and Realization Potential: Preliminary Estimates

Sl. No	Description of Potential Revenue Generation Mechanism	Revenue Potential (Rs. Crores) Quick Estimate
1	Conventional Sources - Pay and Park Facility and Advertisement Revenue	15 / Year
2	Land Development / FSI With 150 Mts. either side along 132' ring road and Naroda Narol Highway over a total length of 30 kms. With an increase in FSI by **1** at Rate**:** a. Rs. 500 sq. Mt b. Rs. 1000 Sq. Mts	 259 518
3	Road Improvement Benefit Cess (On the lines of Mumbai,s Sewerage Benefit Cess) on Property (Along with Property Tax) Rate of Cess on Property Tax - at 5% - AMC Area - at 5% - AUDA to charge similar to sewerage charge TOTAL - at 10% AMC Area - at 10% AUDA to charge similar to sewerage charge TOTAL Average amount per property at 5% Rs. 95/Year at10% Rs. 190/Year	 7.53 1.88 **9.41 / Year** 15.05 03.76 **18.82 /Year**
4	Transport Improvement Cess (On the lines of earlier Mumbai's Cess on Fuel) @50 Ps per Litre sold	15.0 / Year
5	Addl Charge (Parking Charge as in Delhi) on New Vehicles one time on new vehicles @ Rs. 5000 for Cars & Trucks @ Rs. 1000 for 2 wheelers	20.0 / Year
6	Addl. Cess on Octroi at 5%	17.5 / Year

1.18 End Note

It is important to note here that the entire cost required to develop such BRT system is not only for BRT system as such but also to enhance overall mobility on the corridor. The support measures and mechanism discussed so far is primarily an initial thought. A detailed financial viability of the project based on the capital cost, operation & maintenance cost and revenue through fare box and other means needs to be done in the next step.

Building on the design concepts presented in this report towards finality, more robust travel demand data and system operations design are the next important steps. Working out institutional framework is a critical task.