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RESEARCH MASTER PLANNING AND SUSTAINABILITY: URBAN AND REGIONAL PLANNING

THE IMPACT OF POLICY MAKING, A CASE STUDY OF BRTS IN A DEVELOPING CONTEXT

PROMOTING SUSTAINABLE TRANSPORTATION THROUGH THE INTEGRATION OF PUBLIC TRANSIT WITH NON MOTORISED TRANSIT

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How can planning policies and tools be adapted and reconciled to most effectively elicit a change in behaviour towards public mass transit and NMTs to achieve sustainable transportation goals in a city?

ABSTRACT

Fast growing economies are paralleled with extensive sprawl and an increasing trend in auto-mobilization. Hence there is a direct effect on the travel demand on transport systems. Cities are confronted by challenges to achieve sustainable alternatives to the benign effects of the private motorcar. The move from an auto-oriented city towards a lesser car reliant city is of dire need. The ways in which people travel have an enormous impact in the urban morphology and also in urban transport systems. Travel patterns are characterized by the trip length, trip time, and trip rate; especially the purpose of travel determines the mode share preferred. Sustainable systems are aimed at reducing over consumption of fossil fuels and land cover therein reducing the emphasis of the private automobile as the primary mode of transport and encouraging shifts towards sustainable modes such as cycling, walking and public transit.

The focus of this paper is on the promotion of sustainable urban transportation through the integration of non-motorized transport systems (cycling, walking) with public transport network systems. A hybrid evolution, an outcome of the synergy between two modes of transport - namely the bicycle and public transport, is an evidence of two complementary transport modes that would cater to diverse individual travel needs in a quick, efficient and sustainable manner.

The current public transport system - the bus rapid transit system of Ahmedabad in the context of a developing country, India is comparatively studied with bus rapid transit system of Curitiba, Brazil. A primary survey is done to analyze the inclination of commuters to shift from their private modes to the BRTS. Existing travel patterns of the city of Ahmedabad are studied to help predict the preferred modal choice and to understand people's behaviour to switch to other modal choices. The pre-conditions and post- conditions are also considered. Some areas of implementation are observed in detail to represent and communicate the issues of its un-sustainable impacts in the urban environment.

The current state of the BRTS of Curitiba is compared to perceive what can be learnt from and what can be implemented in the Indian context, as the BRTS model of Curitiba was one of the earliest implemented BRT system that is functioning very efficiently. When scrutinizing the two scenarios, it shows that executing the BRTS can increase sustainable mobility to a certain extent. In the Indian context, the BRT system can be considered as a step towards implementing sustainable alternatives to the existing deterrent environment. This is done by addressing my hypothesis of how effective planning policies are, in its implementation of the integration of NMT with public transit systems.

KEY WORDS: *Sustainable transportation, mode shift, Bus Rapid Transit System, Non-Motorized modes*

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LIST OF ABBREVIATIONS

AJL	Ahmedabad Janmarg Limited
AMC	Ahmedabad Municipal Corporation
AMTS	Ahmedabad Municipal Transport System
AUDA	Ahmedabad Urban Development Authority
BRT	Bus Rapid Transit
B	Bike (Cycles)
BOT	Build–operate–transfer
R	Ride (Bus in the context of Ahmedabad denotes bus)
PT	Public Transport
FLMP	First and Last Mile Problem
NMT	Non-motorized Transport
CMP	Comprehensive Mobility Plans
CEPT	Center of Environmental Planning and Technology
DPR	Detailed Project Report
GOI	Government of India
GSRTC	Gujarat State Road Transport Corporation
IUTP	Institute of Urban Transport
NMT	Non-motorized transport
NMV	Non-motorized vehicle
NUTP	National Urban Transport Policy
Pphpd	Passengers per hour per direction
ROW	Right of way
SPV	Special purpose vehicle
STA	State Transport Authority
UDFI	Urban Development Formulation and Implementation

CHAPTER 1 |PROBLEM

> INTRODUCTION

According to the World Bank (2005a), the identification of transport initiatives is a consequence of the interactions between the transport and wages, profits, prices and land values as well as gender and race [1].

In the developing world, according to The World Bank Group (2002): “The sacrifice of interests of pedestrians and cyclists to those of motor vehicle users’’ is unacceptable, because it stems from a failure to recognize some of the external effects of motorized transport that distort individual choice against [non-motorized transport], and hence militates particularly against the poor who do not have the means to use even motorized public transport.

Figure 1: SUSTAINABLE TRANSPORTATION, A ROLE REVERSAL

This prioritization of the automobile at the expense of other modes is defined by the World Bank (2002) as a "historic vicious policy circle that has biased urban transport policy unduly in favor of sacrificing the interests of pedestrians and cyclists to those of motor vehicle users” [2].

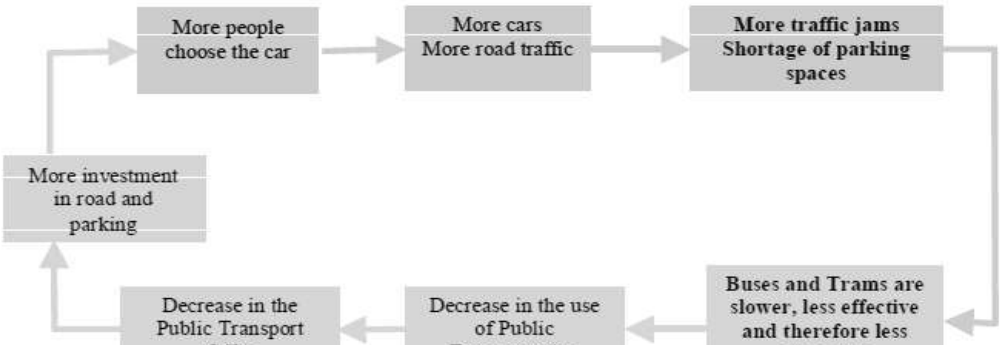


Figure 2: THE VICIOUS CYCLE OF URBAN DECLINE

1.1 HYPOTHESIS

The impact of planning policies and tools to elicit a change in travel behaviour patterns towards public mass transit and NMTs to attain sustainable mobility.

Demand for provision of NMT and Public Transit infrastructure which orients the commuters towards cycling and mass transit.

RESEARCH QUESTIONS:

How can planning policies and tools be adapted and reconciled to most effectively elicit a change in behaviour towards public mass transit and NMTs integration to achieve the sustainable transportation goals in a city?

Non Motorized Transport can be further classified into pedestrian users, cyclists. My sub-question to address the behavioral change is to look at how the provision for NMT and public transit infrastructure would orient the commuter towards the shift to achieving such sustainable alternatives.

This question is addressed in the context of the developing country of India, the city of Ahmadabad in particular. It primarily focuses on the magnitude of urban transport, available modes of transportation, its infrastructure and also its policy point of view.
This is due to the fact that though Indian cities have a lower vehicle ownership rate than its counterparts in developed countries; it suffers the most in terms of environmental problems such as congestion and pollution in the industrialized world. The previous decades' travel trends point to a decline in the use of bicycles and public transport whereas that of the cars and two-wheelers has increased. This has contributed to the rise in vehicular emissions through excessive consumption of the available resources. In accordance with the World Energy Council, 2011, 33% of the oil consumption in India is accounted for the transportation sector for the purpose of intra-urban trips [3].
Re-designing public transport and their feeder networks is crucial. This is because the existing planning policies and proposals are focuses at a city / regional scale rather than focusing on smaller accessibility scale. These are addressed as a whole or a part of CMPs, NMT infrastructure, land-use integration or broad transport management strategies[1]. The notion of introducing feeders is yet to be perceived holistically in the Indian context. Successful developments are being proposed but somehow fail in the implementation process. The proposals are aimed at infrastructure improvement, mobility management and creating more livable cities for providing improved connectivity, accessibility, safety, security, economic possibilities and for its users. However, these plans have failed in promoting "inclusive" land-use planning and transportation integration in the promotion of non-motorized and public modes of transport. It consistently

[1] Institute of Urban Transport, India, 2013

lacks the provision of strategies to enable safe and secure mobility and accessibility for all groups of people. Stringent measures are of dire need to make urban transport truly sustainable and inclusive [4].

The focus of this report in this research is on integrating the modal share of the Bus Rapid Transit System , BRTS, (as Public Transit) with cycling and walking (as NMT) modes.

1.2 THE CASE: CONTEXT OF THE BRTS IN AHMEDABAD

Among the largest cities of the state of Gujarat, the city of Ahmedabad has registered an increase in the growth rate of vehicles of about 9 to 10% per annum [3] due to which the public transportation has deteriorated rapidly resulting in increased congestion and worsened environmental quality. In order to improve the urban transport situation, the State and City governments have instigated several measures. The BRTS is one such strategic intervention initiative, commenced under the guidance of GIDB with AMC and AUDA, whose aim was to improve the public transport image, attract latent transit demand, contribute to improved transit options for people, improve air quality and retain the compact nature of the city [4].

In summary, while the automobile improves mobility, it also contributes to environmental degradation; inequity inherent in a system of mobility, biased towards expensive, private vehicles; and the 'unlivable' urban form resulting from such a bias. The pursuit of sustainable transportation aims to solve the above problems, because it addresses the social, environmental, and economic consequences of transportation behavior. An approach to sustainable transportation would have to be comprehensive, including the promotion of a variety of alternative modes to create a healthier and more livable environment in an economically feasible way. In addition, it should be sustainable for future generations.

The developing context, where motorization rates are often rapidly increasing but have not yet reached the level of developed countries, offers an interesting opportunity to explore the promotion of alternative modes before travel behavior and urban form become more permanently oriented towards motorization. All of this has important implications for urban transport. A large number of people living in large urban agglomerations enable economies of scale in urban transport. At the same time, if urban transport is not managed well it has the potential to choke cities and bring economic activity to a grinding halt. Here lies the promise and peril of urban transport in India.

1.3 OBJECTIVE OF STUDY

The aim of this paper is to introduce viable alternatives through the integration of public transit (viz. the BRTS) with NMTs in the urban areas of Ahmedabad.

The main objective is to assess the effectiveness of a BRT system with NMTs. Specifically the aim of the study is to:

- Determine the impact of the synergy between the two modes on urban travel in Ahmedabad and
- Assess its sustainable benefits

1.4 RESEARCH METHODOLOGY AND FRAMEWORK

My hypothesis is that the current *tools and techniques* employed in the developing city context need to be modified to effectively elicit change in behavior towards public transit and cycling as a mode of sustainable transportation, even in places where there exists no cycling trips. Because of the complexity of achieving behavioral change and sustainable transportation, this modification must take place in an integrative manner needed to more effectively promote such synergies.
To test my hypothesis, I perform a literature review and utilize a case study approach.

My research inspects the effect of various policies on bicycle use and public transit usage, the possibilities to induce behavioral change to support sustainable transportation goals, the role of planning tools in decision making, through studying the application of planning tools to such integration in the context of the city of Curitiba.

I am considering the city of Ahmedabad in India, and comparing it with the city of Curitiba in Brazil. A single case study was analyzed in depth due to a limited time frame. The goal is to identify what can be learnt from Curitiba and what can be implemented in Ahmedabad. The Janmarg BRTS in Ahmedabad is used as a study area, where there exists a proposal to promote NMTs within a larger sustainable transportation plan. A methodology of adapting and integrating planning tools policies and processes to better achieve sustainable transportation goals used are scrutinized. The primary contribution of my thesis is the recommendation of an approach (through urban policy) that can serve as the foundation for discovering the most appropriate steps to promote the integration of public transit with NMT modes in developing cities.

Surveys and interviews were utilized to analyze existing attitudes and perceptions leading to a wide range of policy and infrastructure approaches to promote the collaboration. The existing integration process's vision and goals set by stakeholders are also analyzed to provide a depth of insight. A range of technical tools available is reviewed to deduce their abilities to promote the goal of sustainable integration, resulting in short and long term recommendations with the consideration of available resources. Hence, this research provided me a first step into critical rethinking of the role of planning processes and policies in promoting alternative modes of transportation in a developing city context.

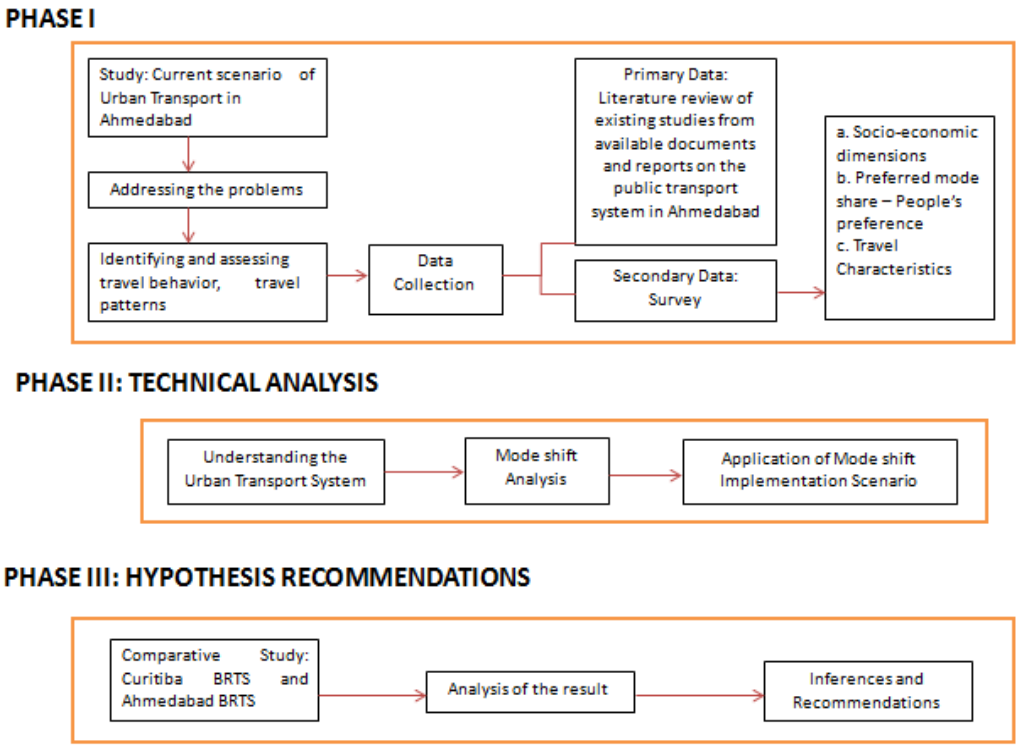


Figure 3: RESEARCH METHODOLOGIES: CONCEPTUAL FRAMEWORK

CHAPTER 2 | EMPIRICAL AND THEORETICAL DISCOURSE

Through literature review the importance of a synergetic integration between public transit and NMT is highlighted.

2.1 INTRODUCTION

In general, in the developing context, the rapid pace of urbanization characterized by motorization, the co-existence of motorized and non-motorized modes, declining environmental quality and deteriorating public transport services and institutions are on the lookout for alternative solutions to their mobility and accessibility issues. A variety of modes such as walking, cycling, two-wheelers, para-transit, public transport, cars, etc. are used to meet the travel needs in Indian cities. The public transit systems are struggling to compete with the private modes. Especially, in India, the shift is noticeable; as the predominant mode share is cars and two-wheelers as the public transport systems are less viable and less-attractive alternatives. In order to compete with the private mode share, the BRTS combined with NMTs is introduced as one of the most effective solutions for the existing mixed traffic circumstances of India [5].

The policy issues necessary for such integration are derived from several stakeholders/decision makers' proposal. **In this paper, the impact of policies on the introduction of such integration is evaluated by studying the similarities and disparities between the cities of Curitiba and Ahmedabad in a developing context.**

2.2 TRANSPORT SCENARIO

Urban transportation plays a key role in urban development. While the automobile improves mobility, it also contributes to environmental degradation; inequity inherent in a system of mobility, biased towards expensive, private vehicles; and the 'unlivable' urban form resulting from such a bias. The pursuit of sustainable transportation aims to solve the above problems, because it addresses the social, environmental, and economic consequences of transportation behavior. An approach to sustainable transportation would have to be comprehensive, including the promotion of a variety of alternative modes to create a healthier and more livable environment in an economically feasible way. In addition, it should be sustainable for future generations. Presently, all cities are on the lookout for sustainable alternatives to meet their accessibility and mobility demands of the transport sector [5] [6]. "Cities are all about people and places. Travel occurs because people want to get to places - places of work, stay, leisure, so on and so forth [7]." The primary determinant of travel demand is the size of population. Other determinants include income levels and travel patterns. This travel demand is characterized by a parallel growth in economy. The burgeoning crisis of urban travel in India has to be met by catering to the travel demand through sustainable and environmental friendly transport modes. People's personal choices and freedom are expressed through increased ownership and usage of private vehicles. This leads to a decrease in the modal share of public transit modes. Significant decrease in public transport and proportional rise in private mode shares results in an unsustainable transport system. Although, both private (cars, two-wheelers, walking, cycling, etc.) and public (bus rapid transits, metro, light rail, monorail, etc.) modes are used to meet travel needs, no individual mode share could meet the demands in a standalone manner [8].

2.3 BRTS APPROACH

Even though several mass transport options are available in the Indian context, the BRT systems are the specific modal shares that deliver public transport services in the city of Ahmedabad. Amongst the domain of high capacity carrying public transportation systems available such as Light Rail Transit Systems or BRTS, the BRTS has been recommended to be financially more viable.

A BRT system can be more effective in improving the service operation of buses rather than implementing more city bus operations. The study presents a proposed BRT system in Ahmedabad; the Janmarg BRTS. According to this system the buses traveling along their respective rights of way (ROW) would be systematic in its contribution towards decongestion [9]. One way to decongest traffic is to also cut through the volume of buses. The transportation impact of the BRT system is evaluated to understand commuter movement and urban travel thereby assessing the sustainable benefits of the proposed BRT system [10] [11].

As the name implies “Bus Rapid Transit Systems”, a high-capacity transport system with its own right-of-way, is regarded as a sustainable, environmental friendly transport mode and is being implemented in many cities of the world [12]. BRTS is a bus-based transit system which allows higher speed, improved capacity, and better bus safety by segregating buses from other roadway traffic into a separated bus way [13]. BRTS is defined as a “flexible, high performance, rapid transit modes that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity” [14] [15]. The BRTS has been recommended considering the above advantages.

The multitude private benefits of the automobile are a primary cause for detrimental consequences in the social and economic profile. The automobile is also very expensive to own and maintain. Large fractions of journeys made by motorized two wheelers and cars for shorter distances, say less than 4 - 6kms, result in higher vehicular emissions because of high fuel consumption. Hence, there is a huge potential for using green modes in place of motorized vehicles.

Walking and cycling are two major modes of the most sustainable form of transportation. BRTS successes across various parts of the world is attributed to the additive components of NMT’s like walking, cycling which resulted in the betterment of the city’s public transport scenario.

There is an inherent need for encouraging green modes like the bicycle and the pedestrian users to overcome the deterrent consequences of the automobile. Though the potential of the green mode is limited for short distances, it provides a significant advantage to the social, economic and health aspect. However, the main disadvantage towards the introduction/efficiency of green modes is the factor of safety and provision of adequate infrastructure facilities. By improving safety, traffic flow can be improved, emissions can be reduced and average speed limits can be set thereby limiting road fatalities. Also, provision of adequate infrastructure discerns the increase in the modal share of bicycles.

Hence, a synergetic integration of both the modes would result in successfully meeting the transportation needs and proposed travel demands. This can be done to improve and overcome

the existing conditions and the inadequacies of the individual mode shares not only through infrastructure development but also through analyzing the impacts of the BRTS and NMTs implementations by including stakeholders, policy makers' proposals [16] [17], thus encouraging local community participation, and considering the standpoints of transportation operators/agencies and transit riders.

2.4 STRENGTHENING URBAN INSTITUTIONS

Lack of appropriate institutional capacities and capitals are the main reasons that adversely affect the transportation problem in Indian cities. Fragmented functional responsibilities among central, state and local governments in the transportation sector due to a lack of coordination amongst themselves are the root cause. The table in **annex 1** denotes the institutional arrangements within the urban transport network in India.

The central government (Ministry of Road Transport and Highways, Govt. of India) is accountable for the operation and management of national highways. State governments are accountable for local land use policies, implications on taxes for motor vehicles and sales tax rates and proposing policies for private sector participation. At the municipal level, the local governments rely on the funds provided by the state. The urban local bodies are responsible for the development of transport, however, lack of resources and adequate political power leads to insufficient and minimalistic operations that affect service delivery. According to the 74th amendment of the constitution, fiscal decentralization at the local level further adds to the lack of infrastructure provisions due to continuous transfer of powers. Hence, there is an innate need to empower the local bodies for independent development projects. They must be further authorized legally for the overall coordination of transport policies and provision of services, only then, can improved services be proposed to contribute to the growth of the Indian economy.

CHAPTER 3 | LITERATURE REVIEW

The intent was to contribute to the practical scenario by studying literature that synthesizes BRT experiences. This is done by extracting lessons for present and future applications in different locations, but similar contexts

3.1 CASE STUDY: CURITIBA, BRAZIL

3.1.1 CONTEXT

Curitiba is the capital city of the state of Parana in Southern Brazil. It is located 250 kms southwest of Sao Paulo near the coastal mountain range. A population of 1.6 million is distributed within the city limits expanding over 430 square kms and a population of 2.2 million over the total metropolitan area [18]. The variations in automobile ownership from 295 per 1000 to 500 per 1000 can be observed between 1997 and 1999 [19] [20] [21].

Figure 4: LOCATION OF CURITIBA

3.1.2 BACKGROUND AND PLANNING IMPLEMENTATION

The decision to rely on buses was perceived as a more flexible and affordable public transport solution than rail transit medium-sized developing city [22].

3.1.2.1 PLANNING PROCESS

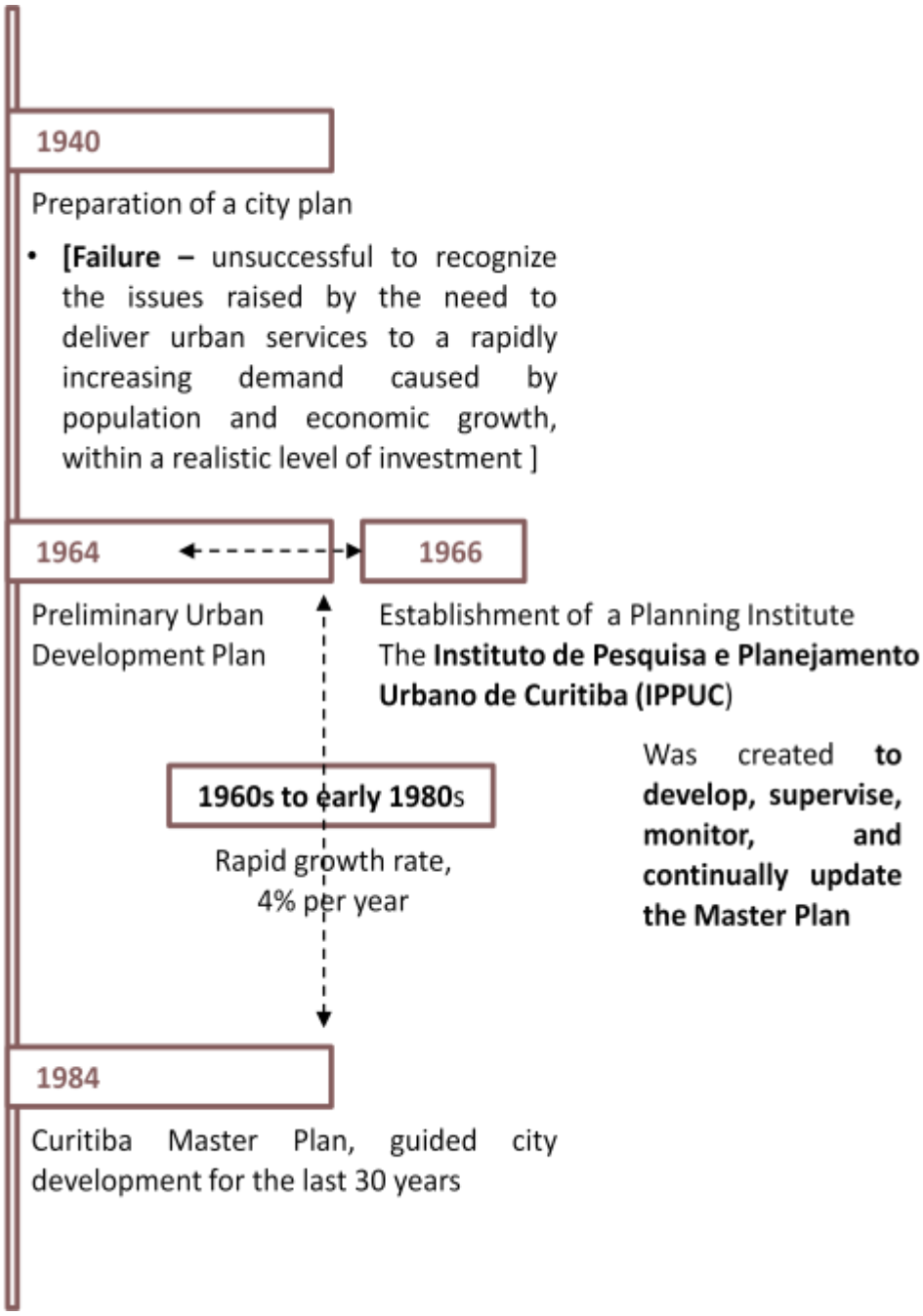
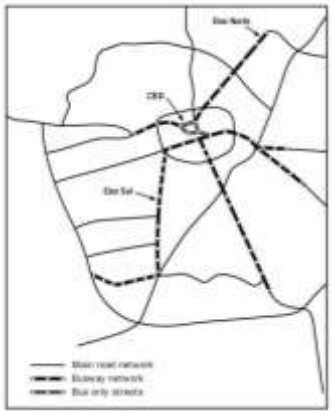


Figure 5: PLANNING PROCESS: TIMELINE

3.1.3 DESCRIPTION

The bus system was designed as a trunk and feeder system. The basic structure of the transport system was founded on an integrated land use and transport policy reflected along the major radial corridors of the city or linear structural axes. Each of these structural axes was developed as a "Trinary system" Refer **annex 2.**



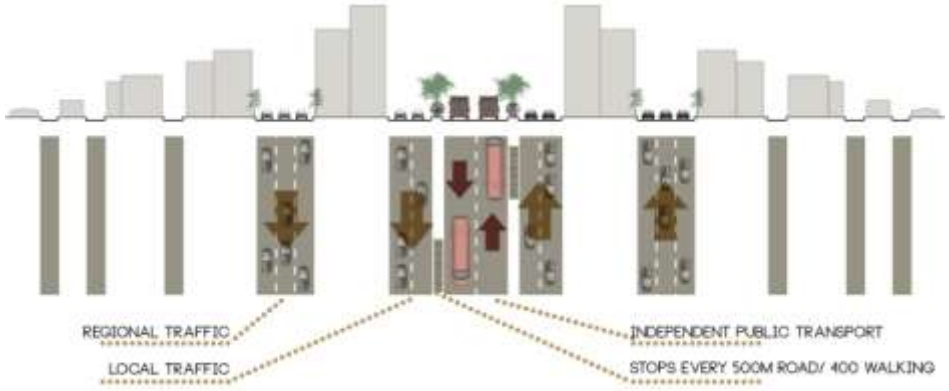


Figure 6: SYSTEM OF BUS SERVICES AND 5 STRUCTURAL AXES

3.1.4 PROPOSAL STAGE

At the proposal stage, the median bus ways occupied the centre of the Trinary road system, comprising of the bus way, local street, and one way arterial in each corridor.

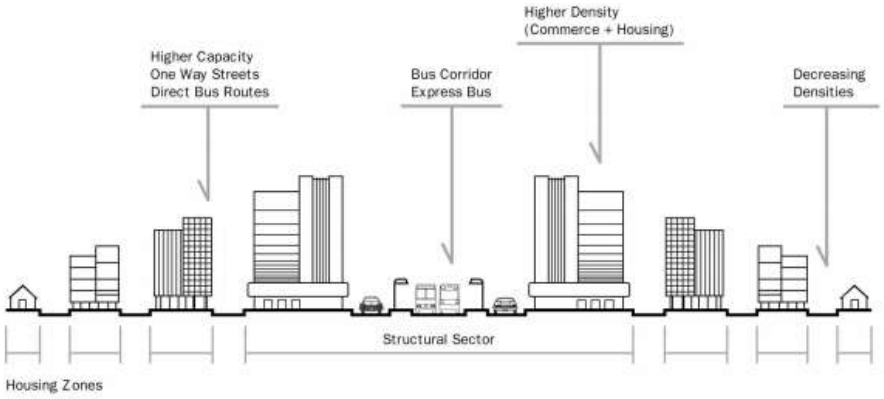


Figure 7: SCHEMATIC REPRESENTATION OF THE TRINARY ROAD SYSTEM [18] [22] [23]

- The central road of the three roads contains a center-of-the-road, two-way bus way that feeds into transfer points called "terminals." It provides a limited number of traffic lanes (one or two in each direction) for non-through movements and for service access to frontage development

- Approximately one block from each side of the central bus way/service road, a one-way traffic road of three or four lanes has been developed for use by private vehicles.
- In the block width between the bus way and the main traffic roads on either side, intensive, high-density land use development has been encouraged/permitted.

Thus the proposal called for creating a dense and compact, narrow corridor accommodating a mixed land use whose needs and demands could be efficiently met by a public BRT network.

Land within two blocks of the bus way has been zoned for mixed commercial-residential uses. The residential densities taper with distances from the bus ways beyond these two blocks as seen **above.**

3.1.5 DEVELOPMENT

Curitiba's bus system was developed as an integral part of an overall master plan whose basic objectives included:

- Radial expansion of the city along five corridors (structural axes),
- Integrating land use and transport, and
- Protecting the traditional city center.

The bus way system along the 5 structural axes is only part of the city wide bus mass transport system of Curitiba. The system, termed (RIT-Rede Integrada de Transporte) Integrated Transport Network provides a **hierarchy of types of bus service citywide.** The buses operating the various RIT services are color-coded by function and include the following [24]:

TYPES OF BUS SEVRICES	COLOR-CODES
TRUNK LINE BUSES OPERATING ON THE AXES/BUS WAYS	RED/ORANGE
EXPRESS	GREY/SILVER
INTER-DISTRICT	GREEN
FEEDERS TO/FROM TERMINALS AND STOPS SERVING TRUNK LINE OR EXPRESS BUSES	ORANGE
OPERATING REGULAR SERVICES ON NORMAL ROADS WHERE OTHER SERVICES ARE NOT JUSTIFIED	YELLOW
SERVING THE CBD	WHITE
SERVING OUT OF CITY DESTINATIONS	BLUE

Table 1: HIERARCHY OF TYPES OF BUSES OPERATING: COLOR-CODED BY FUNCTION

3.1.6 MODE SHARE

70% of Curitiba's commuters use the public transit and non-motorized modes, even though Curitiba's automobile ownership and per capita incomes are significantly higher than the national average for Brazil.

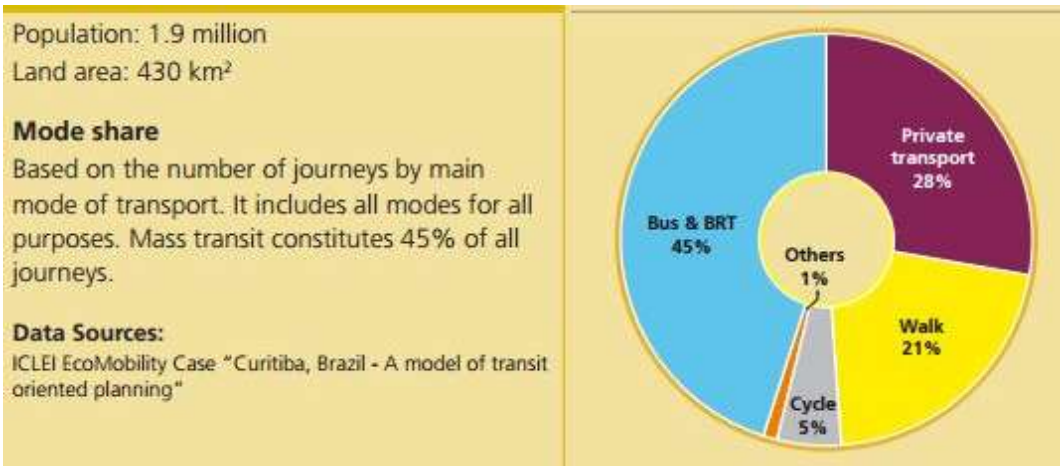


Figure 8: MODE SHARE IN CURITIBA

- VOLUME
-Passenger Capacity Balanced
(Carries Large Volumes)

-INFRASTRUCTURE PROVIDED
-Busway Tracks
-Passenger Facilities
-Tube Stop Platforms

-TERMINALS PROVIDED WITH WEATHER PROTECTION

-DISABLE & WHEELCHAIR ACCESS

-PAID FARE SYSTEM
- Ticket Collector
- Smart Card Technology

-TRAFFIC MANAGEMENT (Of People)

-SYSTEMS AND TRAFFIC CONTROL ELEMENTS include:
Traffic controls and bus way enforcements, Safety and security, and
Fare collection.

3.1.7 INITIATOR

Curitiba was the processing and distribution center for the surrounding agricultural industry. At its peak during the 1960s, the state of Paraná produced 1/3 of the world's coffee [25]. After a series of frosts between 1952 and 1975 sent the industry into a downward spiral, workers began turning to Curitiba in search of employment. During this time Curitiba "was characterized by a shortage of electricity, telephones, and paved streets. Only a third of the families living in Curitiba had access to sewers. And traffic was beginning to become more of a problem in the downtown area." In response to the influx of people, the mayor of Curitiba initiated a Master Plan design competition for the growing capital city. The winning team consisted of young idealistic planners and architects lead by Jaime Lerner [26].

3.1.8 OPERATION

The bus way system is operated largely by a fleet of some 114 bi-articulated vehicles, which are thought to be unique to Curitiba, in provision of day-to-day urban services. The buses are 24.52 meters (80.4 feet) in length, have five passenger doors and a capacity of some 270 passengers. The scale of operation of the city is given as:

- 340 bus lines,
- 1,550–1600 buses,

- 1,100 kms of bus route,
- 60 kms of segregated bus way,
- 26 major and moderate size integration-interchange terminals, and
- Passenger demand of 1.9–2.1 million trips per day [19].

3.1.9 DESIGN

3.1.9.1 SERVICES PROVIDED AND INFRASTRUCTURE PROVIDED

Trunk and feeder bus lines routed through terminals allow convenient fare-free transfer. Bi-articulated five-door buses and tube stations with off-vehicle fare collection and floor-level boarding facilitate passenger access. Finally, a provision of direct express service and tube stations is made along with parallel, one-way arterial streets having an integrated fare structure.

BUSWAY TRACK

The track is used exclusively by trunk line buses which are separated from other service-access traffic by continuous physical islands or by island bus stop platforms. Bus way crossings with other roads are generally at grade and signal controlled. It is located in the center of the bus and service-access road, and thus, the bus way-road, unlike many attempted adaptations of the "Curitiba principle" in other cities, is not a major traffic-carrying route. Passenger access to/from stops does not involve crossing through dense, possibly fast moving traffic. The curb-to-curb envelope contains eight lanes, each 26m wide. Tube stations forestall the parking lanes adjacent to the bus way [24].

PASSENGER FACILITIES

Three types of passenger facilities are provided. They include:

- Tube stops akin conventional stops
- Interchange-integration terminals at the periphery to permit trunk-feeder bus interchange, and
- Mid-route smaller terminals also to permit trunk-feeder bus interchange [24].

TUBE STOPS

They are the trademark of the Curitiba system. They can serve three times as many passengers per hour as a conventional bus and is located at about 500-m [0.3-mile] spacing. Tube stops are equipped with doors for access and egress which are coordinated with the bus doors, for

example, 5 doors on the trunk line bi-articulated buses; 2 on express buses[2]. The tubes include raised platforms (low-floor buses are not in operation) and provide passenger weather protection; the stops are constructed from a Plexiglas-type material with steel ribs, disabled and wheel chair access is provided. The bus-platform positioning is done manually by the driver, hence ensuring safer operation of the system through adequate tolerance.

Also, as stops are located on the central road, the critical nature of accessibility and traffic is reduced when compared to the introduction of a bus way into a previously existing road[3].

SAFETY, SECURITY, AND TRAFFIC CONTROL

Traffic signal actuation exists and that buses are given signal priority where the segregated bus ways cross other roads. Since the intensity of traffic flow on the lateral roads are minimal, the roads are not used by through-traffic. Key streets in the center of the city are pedestrianized and bus-only access [24].

3.1.10 POLICY PROPOSAL | AT SCHEME LEVEL

Follows an integrated approach to development of transport and land use:

- Promotion of a linear urban city growth by integrating public transport, road network development, and land use along key, “structural axes”;
- Decongestion of the city center and preservation of the historic central city core;
- Management and control of land use citywide;
- Provision of economic support incentives to urban development to realize land use aims and to assist employment generation; and
- Improvement of infrastructure.

In addition to the land use-transport sector, Curitiba has also followed enlightened policies on housing, environment, waste recycling, social matters (particularly for the young), and other initiatives [22]. Both city development and the BRTS were the result of policies on land use, parkway, transit management and operations and community participation, established over the last 3 decades.

3.1.11 INTRODUCTION OF NMT MODES AS FEEDERS IN THE TRANSIT SYSTEM

In 2002, the sixth BRT corridor of Curitiba, the **Green Line** (Linha Verde) was conceived as an urban renovation program. This comprised of an initial stretch of 9.4 km having a 20,000 square km linear park along the green line. This included **2600 trees, leisure facilities and a 6km cycle**

[2] Express buses do not use dedicated bus ways but use similar “tube” stops in other locations; in the case of the express buses the doors are on the left of the vehicles to enable easier sharing of a single stop on a median.

[3] A wide range of stop locations and configurations is possible. However, the advantages and disadvantages of the stop type and nature is not studied in detail in this study.

way. When fully implemented, this would have extended to 18kms connecting 23 neighbourhoods catering to 287000 people [29].

This corridor, since its implementation has evolved to display aspects of a fully functioning modern BRTS system. A linear TOD urban renovation program, designed to meet the needs of the pedestrian and cyclist, was an advanced implementation of the synergetic integration of two complementary modes that could cater to the users' demands accommodating lanes for local access, lanes for fast traffic, lanes segregated to buses, also separate spaces allocated to the pedestrian and cyclists [27].

When it commenced the green line carried an average of 18000 people per day. Demand was foreseen to exceed to 32000 people per day. This was further enhanced through a system of efficient infrastructure implementation. For example, concrete was the pavement material, rainwater was used to cool the interiors and the thermal comfort was provided by using special screen films in the covering of the stations. Security was further enhanced by a system of cameras (City of Curitiba, 2010).

With growing demand, the existing corridors were upgraded through capacity expansion facilities. Additional lane provisions were introduced for buses that share the bus way but those that did not have to stop at every station. This further increased the capacity to 20000 people per hour per direction and the average speed to 25kph.

3.1.12 SUMMARY

The table below highlights the evolution of Curitiba's public transport system [22].

Year	Highlights
1974	Implementation of the first two express bus lanes along the northern and southern structural axes.
1978	Three new express busways added along structural axes.
1978	Introduction of a new computerized area traffic control system.
1979	Introduction of the social fare: a standard fare paid by all bus users that benefits those who live on the city periphery (predominantly low-income groups) as shorter journeys subsidize longer ones.
1979	Introduction of interdistrict bus lines to complement the existing public transport system.
1982	Opening of a new connection between the city center and the industrial city and improvement of the interdistrict routes.
1991	Introduction of the Rapid Transit System (Direct Lines) using boarding tubes.
1992	Introduction of bi-articulated buses.

Source: Rabinovitch S., and Leitmann J., "Environmental Innovation and Management in Curitiba, Brazil", Working Paper No. 1 UNDP/UNCHS, (Habitat) World Bank, June 1993.

Figure 9: EVOLUTION OF CURITIBA'S PUBLIC TRANSPORT SYSTEM

It has progressively expanded over the last 30 years. The first 20 kilometers was planned in 1972; built in 1973 and placed in service in 1974. In 2001, there was 40 kilometers of bus ways along the five structural axes. There is 60 kilometers [37 miles] of median bus ways. **It carries** about 2 million **people per day, around** 11,100 passengers one way on the busiest bus ways in the peak direction during the peak hour. **Bus speeds average is** 20 km/hr. [12 mph] along the bus way and about 30 km/hr.[19 mph] on the "direct" express routes. **Development costs** have been estimated at $1.5 million (U.S. dollars) per kilometer [$2.4 million per mile]. All are operated under an integrated tariff system. Bus services are linked through integration terminals and at on-street stops where bus passengers may interchange between bus services without additional payment on the system.

1970s	1980s	1990s	2000s	2010
Bus stop shelters	Tube stations			Real time information
Conventional buses	Articulated buses	Bi-articulated buses	Cleaner buses	B100 articulated buses
Open terminals	Closed terminals (paid area)			
Paper and coin based ticketing (manual)			Electronic ticketing	
Trunk-and-feeder services	+Inter-neighborhood +Direct (Ligerinho)	+Special services		+Overtaking at busway stations
Urban services		Metropolitan services		
	Dispatch at terminals			Real time control

Source: the authors, (URBS, 2010, Ardila, 2004; Rojas Parra, 2006; Levinson et al, 2003)

Table 2: KEY COMPONENTS OF RIT DEVELOPMENT OVERTIME [13] [28] [29] [30]

Articulation of strong, local core values in a city plan. • Creation of an independent municipal authority such as IPPUC to provide continuity and implement plans, as well as to monitor planning and research to improve future efforts. • Integrated planning processes structured to assure that planners in all areas know the strategy and are working with a shared vision and developing their plans together. This way, many problems of unlinked development (e.g., not enough provision for green space) can be avoided. • Establish a close relationship between public transportation and land-use legislation as a guidance and development tool. Cities' environmental quality and economic efficiency are highly dependent on transportation systems that are well-integrated with urban form because this lets them avoid weak transportation systems and unsustainable dependencies on private cars. • Developing new models that provide inexpensive, creative urban solutions and reflect local values are an alternative to standard, often-higher-cost approaches [31]

Thus the study of Curitiba, Brazil presented the positive impacts of the synergies between BRTS and NMT. The BRT produced high level of service along with equity across all income groups and reduction of congestion and reduction in environmental problems. Correspondingly, the promotion of NMTs resulted in cheaper and efficient modes of sustainable transport. Overall, it demonstrated the applicability of an integrated transport guideline for various developing cities [32].

3.2 STUDY AREA DELINEATION: AHMEDABAD

This chapter gives an overview of the city of Ahmedabad located in the developing country of India and enlists its space syntax and its current urban transport scenario, demography and socio-economic characteristics. Salient features of the chosen area of study; the BRTS of Ahmedabad is also discussed.

> **CONTEXT**

3.2.1 CONTEXT OVERVIEW

3.2.1.1 HISTORY

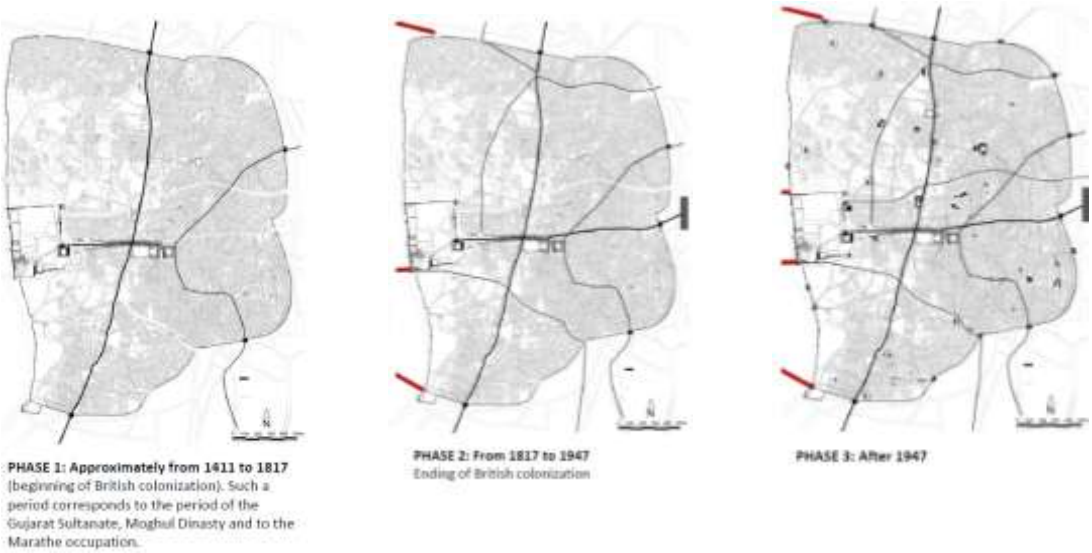


Figure 10: HISTORICAL GROWTH OF AHMEDABAD DISTRICT

The city of Ahmedabad was founded in 1411 AD as a walled city on the eastern bank of the River Sabarmati. It initially developed as a wealthy textile industrial area, attracting migratory population in the 1940s. After the independence of the country, the city witnessed the establishment of strong institutional bodies. Unfortunately, the stagnating economy leads the city towards the tertiary sector around the year 1975. Fast forward 15 years, there was a revival of the economy in the 1990s which lead to the establishment of the financial capital of Gujarat.

Ahmedabad has evolved from a small trade fort on the banks of the river Sabarmati to a metropolis having several layers of historical, political and socio-economic changes. Originally the economy was oriented towards the industrial sector and is increasingly dependent on the tertiary-sector at present. The west is a high income residential and income area and hence it is prosperous and has better infrastructure when compared to its eastern counterparts [33] [34].

3.2.1.2 LOCATION

Figure 11: LOCATION MAP

Ahmedabad lies at 23°02 north and 72°35 east on the banks of the Sabarmati River, 30 km from the state capital Gandhinagar. The land and its surroundings are flat and the region is plain, in a dry and sandy area and the variation in altitude is very marginal, between 46.6m and 50.9m.The past few decades have witnessed a spectacular growth in urban population densities. There is a gradual transformation towards a more urbane society signified by shifts in economy and growth pattern.

Presently the commercial capital of the state of Gujarat, and a major industrial and financial city it contributes to 14 % of the total investments in all stock exchanges in India and 60% of total productivity of the Gujarat. Ahmedabad boasts one of the largest informal sectors in the country and having a strong industrial base it is an attractive investment destination. In 2010, it was ranked third in Forbes's list of fastest growing cities of the decade. Ahmedabad has been chosen as one of the hundred Indian cities to be developed as a smart city under PM Narendra Modi's flagship Smart Cities Mission [35].

3.2.1.3 SPACE SYNTAX

Figure 12: DISTRICT MAP

Apart from its central position in the heart of Gujarat, Ahmedabad enjoys a strategic importance in history – owing to its location on the main highway to the Rajputana and Malwa regions on one hand and to the Saurashtra Peninsula on the other. In the original core or the walled city of Ahmedabad, the industrial area is located on the eastern side of the walled city and the western side comprises of the residential area where the rich and middle class establish housing societies. The south-west and south-east peripheries are made of ghettos whereas the western peripheries are developed into gated communities, scattered with former villages, construction and migrant labour pockets and a few EWS schemes. The eastern periphery has developed into poor to lower middle class residential localities, industrial areas and EWS schemes. “Ahmedabad is a city of many borders.” The city is segmented on the basis of class, caste and religion, also on the quality of housing, its typologies, and levels of services and amenities [33].The city is well connected by an express way, several national and state highways, the broad-gauge and meter gauge railways along with an international airport [36].

3.2.1.4 URBAN TRANSPORT SCENARIO

Ahmedabad is the largest city of the state of Gujarat and is the seventh largest metropolis in India. The municipal area covers about 5.8 million people and being the largest metropolitan region, the urban population agglomerated to 6.3 million as per 2011 which contributes to 25% of the State’s urban population and 20% of the State’s GDP (2001). There is a likely possibility for the area to increase from 464sq kms to 1000 sq. kms by 2035, the sustenance of which would be possible only with an efficient mass transit system.

3.2.2 PLANNING CONTEXT

The Ahmedabad Urban Agglomeration[4] recorded a population of 6.35 million in 2011 [37]. A growth rate of 3.5% per annum, which was higher than Gujarat's and India's urban population growth rates of 3.1% and 2.8% per annum respectively, in the decade 2001-2011 was registered [38]. This growth rate is partly attributed to the increase in the AMC's jurisdiction from 198 to 450 square km in 2006. The planning function was ensured by the AMC while AUDA monitored the peri-urban areas. The current development plan, including both peri-urban and AMC limits, of the city (1996-2011) was prepared by AUDA [34]. The city development plan was prepared in 2005. Ahmedabad has received the second largest per capita grants for JnNURM projects among metropolitan cities [39]. Most of these projects created a pre-conceived image of "a world class city" however, they were not successful enough [38].

The municipal area is under the jurisdiction of the Ahmedabad Municipal Corporation (AMC) constituted under the Bombay Provincial Corporation Act of 1949. It covers an area of 466 sq.km. The AMC is the best administered municipal body; it is to be noted that it is a local body. The AMC is headed by the mayor with the municipal commissioner being the executive authority. The main service provisions are Infrastructure, public transport, sewerage and storm water drainage, water supply, road construction, maintenance, street lighting, etc. The AMC has been taking up development activities to improve traffic conditions, air pollution and the general image and quality of life in the city. The city has numerous innovative development initiatives that have gained international recognition. The planning authority is the Ahmedabad Urban development Authority. This is not an administrative unit.

3.2.2.1 GOVERNANCE STRUCTURE

Ahmedabad is a compact city distinguished by diverse land uses, dense developments and a balanced street network comprising of 5 ring and 17 radial roads of 2400km length. 7 bridges connect the eastern side with the western side; with 16 rail-over/under bridges that enable crossing at appropriate places.

AMTS, one of the oldest urban transport organisations in Ahmedabad is under the supervision and control of the AMC [40]. The status of AMTS declined post 1990s characterised by a decline in the utilization rate. By 2005, AMTS had a drastic decline of 65.33% utilisation rate. The number of passengers also saw a 44% decline [41] [40]. In 2009, the AMTS introduced private CNG buses as a means of public transport. However, the operational routes have declined since 1996. The fiscal estimate between 2010 and 2011 demonstrates the indebted nature of AMTS. It has borrowed loans 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 [42].

The Gujarat State Road Transport Corporation (GSRTC) is responsible for providing inter-city state operations. The Ahmedabad Municipal Transport Service (AMTS) functions under the

[4] Urban agglomeration is a concept which takes into account all the contiguous outgrowths of the main city and hence is more a functional definition than an administrative definition. [44]

Ahmedabad Municipal Corporation. It is responsible for providing public transport services within the city. The AMTS was established under the provision of the Bombay Provisional Municipal Act (1949) which functions as one of the main wings of the AMC. The organization's administrative control lays within a statutory committee viz. the Transport Committee, which comprises of 9 members each from various fields, formed by the general board of AMC who provides financial assistance. AMTS has no capital base. The inability of the AMTS to cater to the increasing demand has resulted in lesser reliance over public transit when compared to that of the car. The city's municipal unit is divided into three areas namely, AMC East, AMC West and the Wall City.

3.2.3.2 ROAD NETWORK

The roads of Ahmedabad are in chaos with no space to walk or cycle. This is because of ever-increasing motorized traffic; road fatalities indicate an estimate of 42% cyclists and 19% pedestrians [43]. This reflects a 61% affected by accidents were NMT mode users. Hence 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 option and an equitable distribution of road space with a proper delineation and demarcation of roads and footpaths with space for bicycle paths and street vendors [44].

Extensive sprawl, heavy congestion due to increase in population with rapid changes in demographic trends generated more demand for transport. The failure to meet these challenges resulted in recent investments being focused on conditions which promised only temporary relief [37] [38]. Hence the government is on the lookout for better solutions.

The culture of organized public transport organizations dates back to pre-independence era. The AMC has been running a well organized public transport system known as the AMTS. However, due to resource crunch and operational inefficiencies in the system, and ever increasing needs of the population drastic losses in the bus patronage levels was observed.

Hence, there was a need for subsidized and efficient sustainable transport system.

3.2.3.3 REASONS FOR BRTS

2005 was declared as the "Year of Urban Development" by the Government of Gujarat in order to resolve urban issues such as management and enhancement of the urban transport sector (Shaheri Vikas Varsh). Further deterioration of the AMTS' situation was an added benefit to the operation of the Janmarg BRTS in 2011. From 2007, Ahmedabad has experienced a great increase in the number of two and four-wheelers; approximately 9 million vehicles which was a rise by 170 times in 40 years [41] [43]. The road transport office (RTO) registered a 32% of four-wheelers and 68% two-wheelers during 2011 [45]. This increase in the number of vehicles with a growing dependence on them has led to a congestion, high carbon emissions and environmental deterioration.

3.2.3.4 DEMOGRAPHICS

3.2.3.4.1 POPULATION

Diverse variations can be noted in the population densities between the west and the east. The east, the old city of Ahmedabad has a gross population density of 560 persons per hectare (ppH.) whereas the west, the new city of Ahmedabad is exposed to rapid globalisation having high-end commercial real estate and residential development. The overall density of the former AMC area is 189 ppH. Hence the total area of the city including the AUDA area is 1330 square kilometres [46].

Travel is contributed by 1/3rd of the people who are working, 1/5th of educationists. According to a survey[5], the total population comprises of 58% working class and 29% of students and 8% of retired and elderly category [47]. The slum population of the city was estimated to be 13.46% of the city's population (Census of India, 2001).

Vehicle ownership and modal choice are dependent on expenditure on transport and income levels on the household. In accordance to the same study, nearly 2/3^{rds} of the population of Ahmedabad falls under the economically weaker section and low income groups because of which they rely on bicycles and walking as the preferred mode choice.

Area	Economically Weaker Sections	%age	Low Income Group	%age	Middle Income Group	%age	High Income Group	%age	total
Walled city	19777	28	32871	47	14960	21	2520	4	70128
AMC west	29438	19	56870	36	47500	30	24993	16	158802
AMC East	170870	35	210974	43	89611	18	20494	4	491948
Rest of the study area	157883	32	200043	40	99176	20	41275	8	498376
Study area average	377967	31	500758	41	251247	21	89282	7	1219254

Source: GIDB IPTS Study (2000) by LBA

Table 3: DISTRIBUTION OF INCOME LEVELS IN AHMEDABAD

Bus also has a significant potential. Similar trends have been observed in the recent survey of GIDB metro study (2003) by DMRC.

[5] GIDB, IPTS study (2000) by LBA [82].

The vehicle ownership percentage of households under different income categories are enumerated in the following table:

Household Income (Rs./month)	Household Vehicle Availability				
	No Vehicle	Bicycle	Motor Scooter+	Car+	Total
EWS <=2500	40%	47%	13%	1%	100%
LIG 2501-5500	19%	38%	41%	2%	100%
MIG 5501-10000	7%	17%	66%	10%	100%
HIG >=10001	2%	3%	66%	29%	100%
Total	21%	34%	39%	5%	100%

Source: GIDB IPTS Study (2000) by LBA

Table 4: HOUSEHOLD VEHICLE AVAILABILITY WITHIN INCOME GROUPS

3.2.3.4.2 LAND USE AND ITS ROLE IN STRATEGIC POLICY MAKING

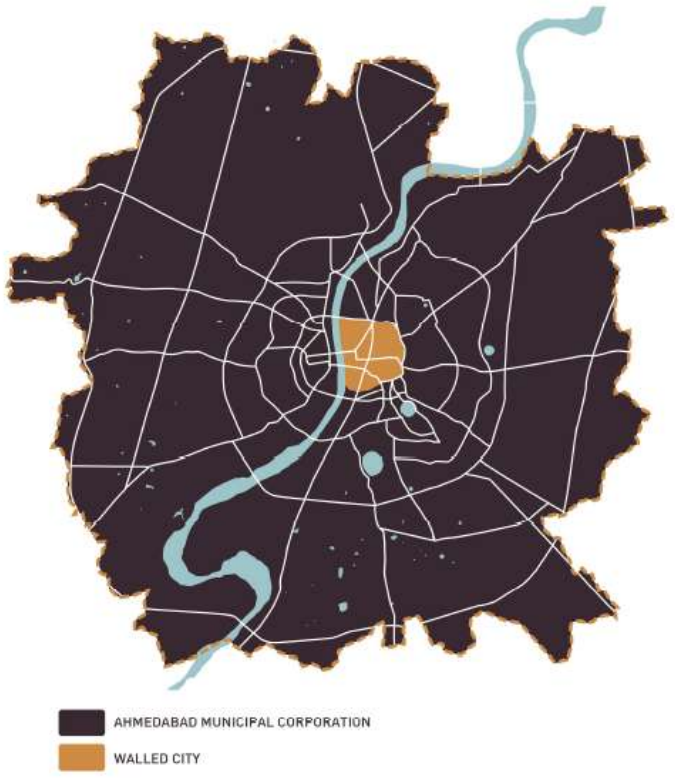


Figure 13: AHMEDABAD CITY [48]

As per the existing land use (1997), more than 1/3rd of the total area is under residential use, followed by 15% under industrial category. Large tracks of land (23.44%) lie vacant in the newly acquired area of AMC. 9.5% of the total area is under the transportation network. Here, roads occupy around 7.5% whereas the recommended National Urban standard for roads is 15-18% [36]. Urban transportation in Ahmedabad is heavily reliant on its roadway systems which are limited in its capacity and experiencing heavy congestion. Rail lines also infiltrate the city but train service is largely dedicated to inter-regional/long distance travelers.

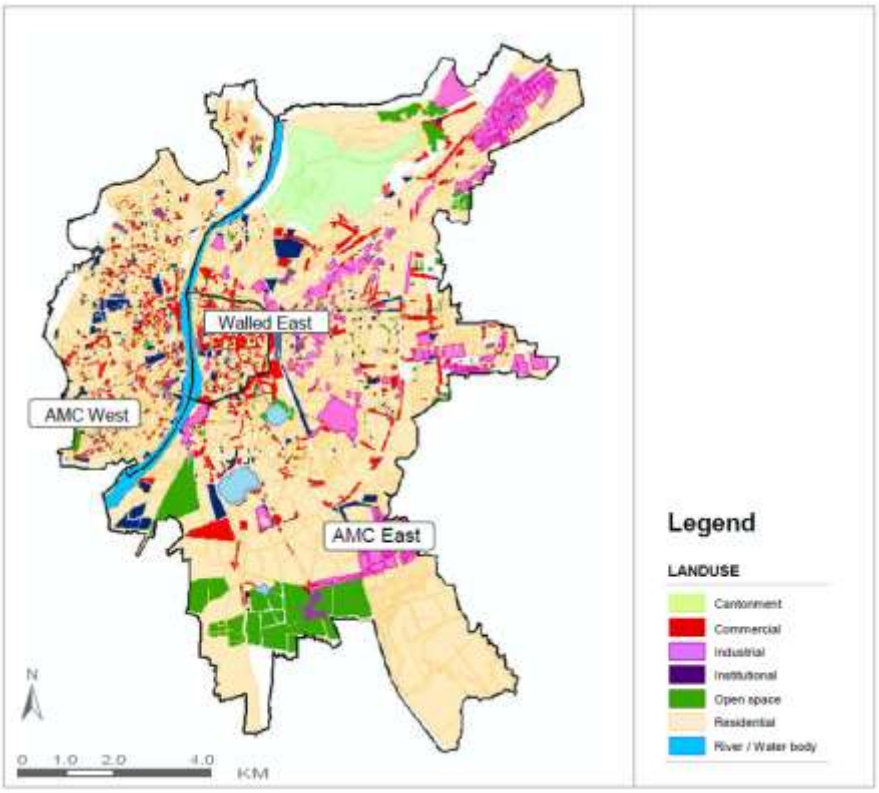


Figure 14: LAND USE WITHIN AMC [48]

Changes in the city's growth and land use planning have not helped the cause of public transport. It has caused significant urban sprawl, the outcome of which is an increase in land values, distances and unaffordable housing within the city. The former land use comprising of commercial and residential uses are converted into purely commercial areas. Such changes in sprawl and land use has not been quantifiable as yet. However, the new urban structure is emerging as a result of change in land use patterns causing greater trip lengths and accessibility crisis [44]. A clear deficit in public transport with a reduction in walking trips and domination of private mode shares over the years is evident.

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)

Table 5: CITY-LEVEL MODAL SPLIT, AHMEDABAD

3.2.3.4.3 TRAVEL/TRANSPORT CHARACTERISTICS

A larger proportion of the city's populace falls under the economically weaker section, lower and middle economy category. They are the captive users of the public transport system and there other preferred modal choices are walking and cycling. Hence there is a need for provision and improvement of the facilities provided by the urban transport sector. The compact land use supported by a diverse densification result in shorter trip lengths. The compactness of the urban structure has to be catered by efficient public transport and NMT systems. However, the increased patronage of motorized vehicles is due to the deterioration and dilapidation of other modal choices. The continuous rise of the number of motorized vehicles would further clog the urban network.

TRIP LENGTH | There is a requirement to consider the travel patterns of the commuters and to study the changes in travel trends to promote a viable integration. The average total trip length inclusive of the access and egress trips was 12.92kms. The average trip length at the city level was 5.4kms and the NMT trip length was 3.5kms. Most of the commuters travel distance less than 10kms. From this it is evident that short trips and less congested streets enhance safety without compromising mobility [41].

TRIP TIME | BRT commuters are mostly long-distance commuters for whom motorized vehicles' usage and affordability is a tedious process. The average trip length increases with income brackets indicating the lower income group traverses shorter distances in general. This is because the lower income and middle income group people commute shorter distances for work than the higher income groups [44].

TRIP PURPOSE | Need of the hour is to change the trip pattern. The purpose is to prioritize seamless integration between the two complementary modes (PT + NMT) against conventional modes of transport. Through empirical studies it is evident that BRT carries the same amount or in fact more people than private vehicles. The amalgamation of these concepts has paved the way for creating infrastructures for walking and cycling in a way that promotes more liveable cities.

3.2.3.4.4 MODE SHARE

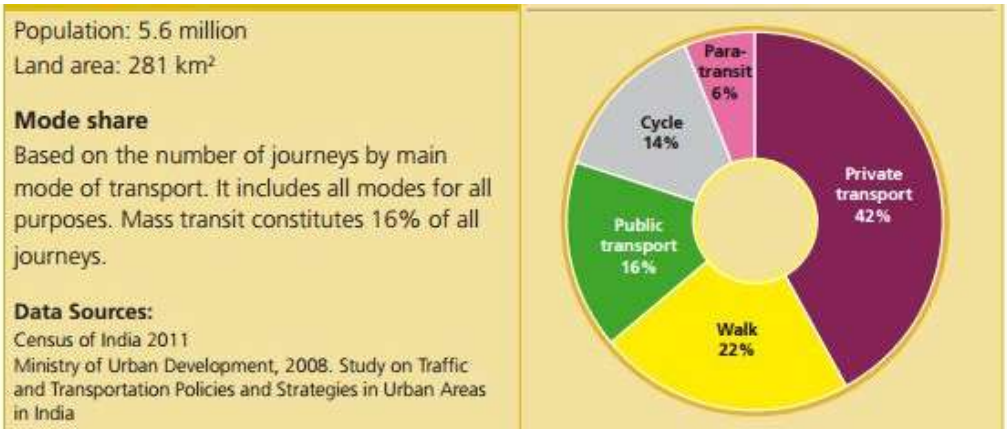
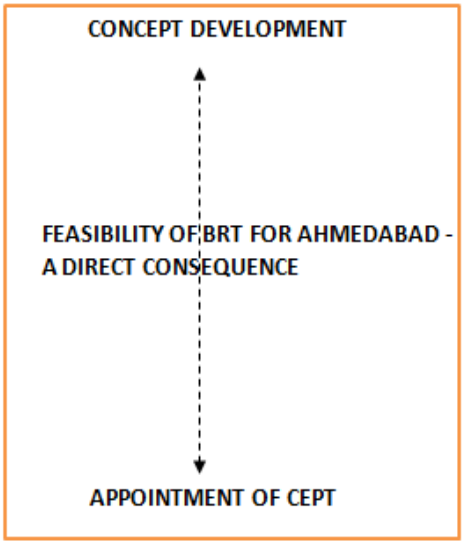


Figure 15: MODE SHARE

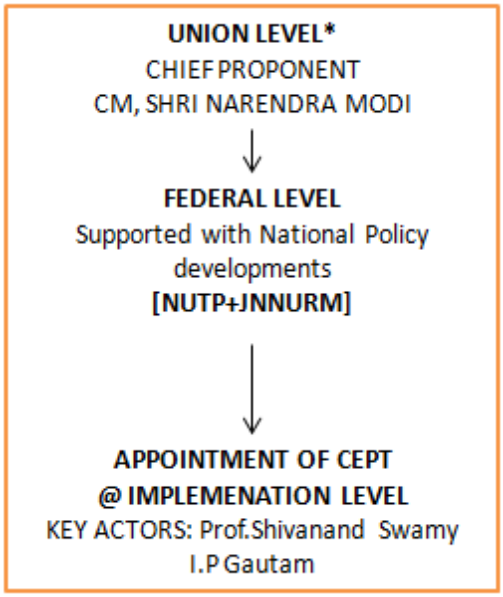
Geographically, the city's ring road structure and relatively short trip length made it particularly suitable to BRT technology. The shortest trip lengths comprise of 5.4 kms. The mode share of NMT modes (walk22%; cycle 14%) is 52% despite the absence of dedicated NMT facilities. The public transit patronage is about 16%. An increase in current rapid motorization trends would crush the existent transportation infrastructure, especially PT and NMT. Hence the need is to arrest the current developments.

3.2.3 PLANNING PROCESS

3.2.3.1 RATIONALE FOR BRT



Given **the complexity of transportation needs** there was a clear recognition that **no single mode could adequately serve the city**. Instead the Gujarat Infrastructure Development Board (GIDB), AMC, and AUDA jointly drafted a **comprehensive mobility plan** for the city that encompassed regional rail, metro, parking policy, existing AMTS service as well as provisions for a new citywide bus-based public transport system with high-end BRT features. This led to the introduction of a proposal for the Bus Rapid Transit System (BRT) project by Gujarat Infrastructure Development Board with support from AUDA and AMC.



CEPT University was assigned the work for the preparation of a DPR. Parallely the announcement of the JnNURM by the Government of India for Urban Development led to receiving proposals for a BRTS project, an implementation of the first of its kind in the country. The approval by the ministry of Urban Development led to a phased implementation of the project.

Thus the Urban mobility plan provides alternatives to the people with respect to each case of mobility demands in terms of different modes (AMTS, BRTS, Sub-urban rail, metro) which are complimentary to one another.

The rationale for BRT adoption in Ahmedabad can be explained by the confluence of numerous factors. This list includes favorable existing travel patterns, a supportive national policy, fortuitous timing and forward planning by key proponents.

3.2.3.2 CONCEPT DEVELOPMENT

The concept development coincided with the Year of Urban Development in Gujarat. A State Urban Development Department initiative to resolve traffic management and also to improve public transport systems keeping in mind the needs of Ahmedabad as a mega city. The vision advocated for measures that reduce the need and length of travel and automobile dependence. The trans-vision captioned, "***Accessible Ahmedabad***" is to redesign the city structure and the transport systems towards greater accessibility, efficient mobility and lower carbon future [49].

The ideology of "***Connecting Busy Places but Avoiding Busy Roads***" played a strong part in the selection of design and implementation of the first corridor. This ideology further facilitated a smooth arrival of the BRTS in Ahmedabad unlike in other cities such as Delhi and Pune where the city had to bear severe criticism from private vehicle users.

"***Designing A Network and Not Corridors***" The Janmarg BRTS aimed at creating a city-wide network rather than delineating it corridor by corridor from the first proposal itself. This helped the realization of the project in the context of a city rather than specific roads. The decision was created on the lines of the Bogota's Transmilenio having median bus ways and NMT facilities along the BRT corridor [44].

"***Equitable Road Space Allocation Amongst Users***" was also another planning philosophy that was adopted.

The focus of the transport strategy was on moving people with efficiency, safety, security, affordability and comfort and not on solely moving vehicles.

Their dependence on multiple alternatives in terms of walking, bicycling, rickshaw, BRT, or any other form of transport on where they are going emphasizes the literal translation of "Janmarg" meaning people's way. The notion is to encourage more people on the public transport system at a particular time when compared to single occupancy vehicles such as cars or two wheelers.

The vision was seen as a tool or an important instrument for defining the future of the city from a planner's perspective.

3.2.3.3 PROJECT DESCRIPTION

The BRTS, a bus-based public transport system in which buses are the most prioritized public transit, is integrated as a holistic system by combining pedestrians and cyclists to meet the goals of equity and sustainability. The long-term perspective includes continuous integration by efficient land use planning and stringent policy-making.

Studies point to BRT systems as important transport options for equitable and sustainable urban growth [53]. Research is available on the status of BRT systems and their characteristics in the Indian context [54]; their technological, institutional, operational and management issues [55]; their financing; and their contribution to improving mobility. Tiwari and Jain [54] have also paid attention to the integration of the BRT with other modes of transport such as walking, intermediate para-transit (IPT), and non-motorized transport (NMT).

The city of Ahmedabad is assessed through in-depth analysis of its BRTS. Sustainable mobility (prioritizing accessibility) describes all forms of transport that minimize fuel consumption and carbon emissions by minimizing the very need to travel [90].

The Ahmedabad BRTS works on a policy-based approach; post formulation of the NUTP in 2006; shifted the focus from congestion relief through road and highway expansion to the promotion of non-motorized transport and improvement of public transport systems [17] [50]. It has received international acclaim and demonstrates a new standard of public transportation for the country that is viable, sustainable and affordable [58].

3.2.3.4 DESIGN IMPLEMENTATION AND CONSULTATION

Implementation of the BRTS was done based on availability of right of way and ridership. The table below denotes the criteria adopted for the BRT corridors election from which a key decision to make it a 'closed system' was taken.

Travel Characteristics	2006	Item	Phase-1	Phase-2
Gross Density (p/Ha.)	106	Number of corridors	5	6
% HHs with personal Vehicles	82	Length approved (Kms)	58	30.5 (4.5 kms elevated)
Avg. Monthly Income (Rs)	8728	Approved Cost (₹ Crores)	493	488
Trip Rate (Tot-> 1 km)	1.14	Cost per km	8.5	15
Avg. Trip Length	5.6	Date of Approval	11-08-2006	19-08-2008
		Exp. Year of Commissioning		
% Bus trips	15	October 24, 2009 – 12.5 kms December 25, 2009 – 05.5 Kms March 25, 2005 -08.0 kms Balance over the next 18 months		
% IPTS Trips	9	Road Width: < 24 m – 5.2 %, 24-30m – 22.4%, 30-45m – 28%, 45-60m – 47% Pavement Type: Bitumen, Mastic at some Bus Stations		
%Bicycle Trips	18			

Source: CEPT University, 2010

Table 6: TRAVEL CHARACTERISTICS AND PROJECT BRIEF

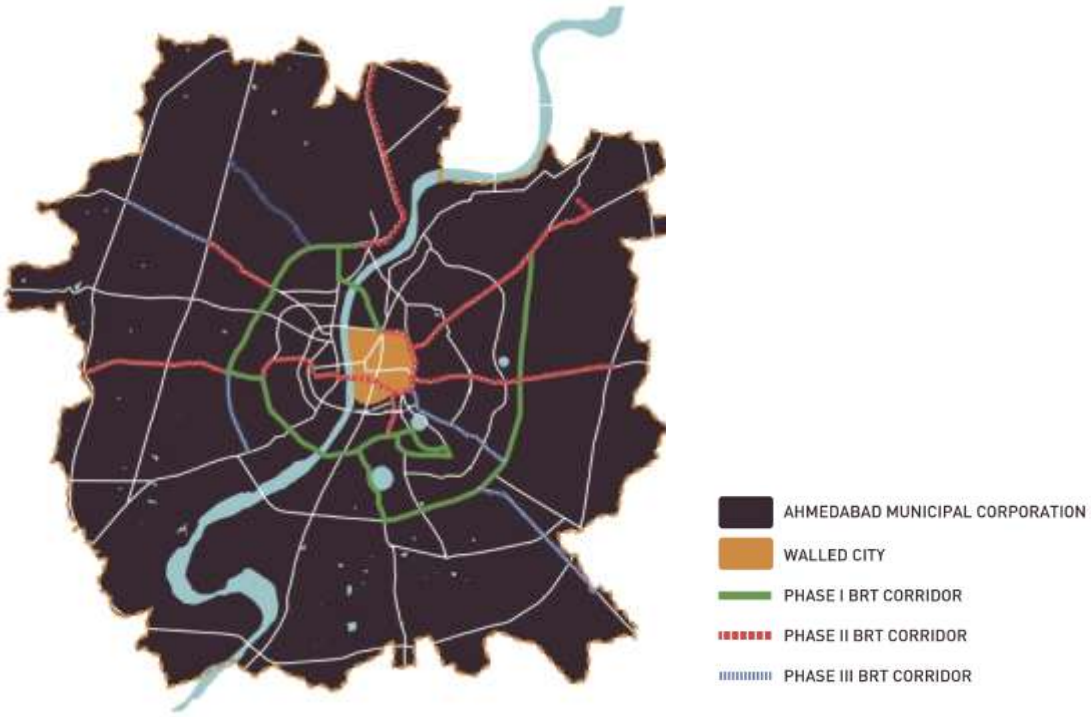


Figure 16: BRT CORRIDOR PROPOSAL

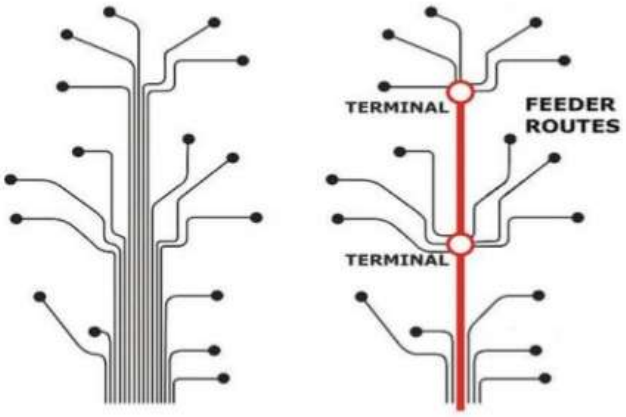


Figure 17: EVOLUTION IN BUS NETWORK

The design process was made very iterative. Reflecting upon experiences from other cities by being aware of the issues faced, the design team had made over a 100 modifications to avoid implementation difficulties. Also changing conditions and experiences led to modifications of the original master plan. Theoretically the system changed from a mixed conventional system to a trunk and feeder system. The project benefited from a collaborative institutional structure with strong leadership. Decisions were led by the municipal authority Ahmedabad Municipal Corporation (AMC) which Included actors from state, city departments and academic institutions; CEPT playing a critical role in mediating and engaging stakeholders. The strategic use of phased construction was instrumental in building support for the system, removing barriers that might otherwise have impeded implementation. CEPT carefully planned an incremental process that engaged the public and maximized ridership.

3.2.3.5 PROJECT STATUS:

The construction of a Bus Rapid Transit System (BRTS) coincided with celebration of the Urban Year (in 2005) in the city. It was a crucial choice, as it amplified expectations of getting properly laid out roads, the conception of proper road space for pedestrians, cyclists and vendors, supervision of on-street parking and mainly the provision of an well-organized and dependable bus system. This concurred 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 improved 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 seize this opportunity and submitted a DPR under the UIG(Urban Infrastructure and Governance) component of the JnNURM. Under the UIG norms,

- 30 % contribution for the project is from the GoI- Government of India,
- 20 % from the state government, (Government of Gujarat – GoG) and
- Another 20 per cent from the city government, the AMC.

3.2.4 THE BRTS PROPOSAL

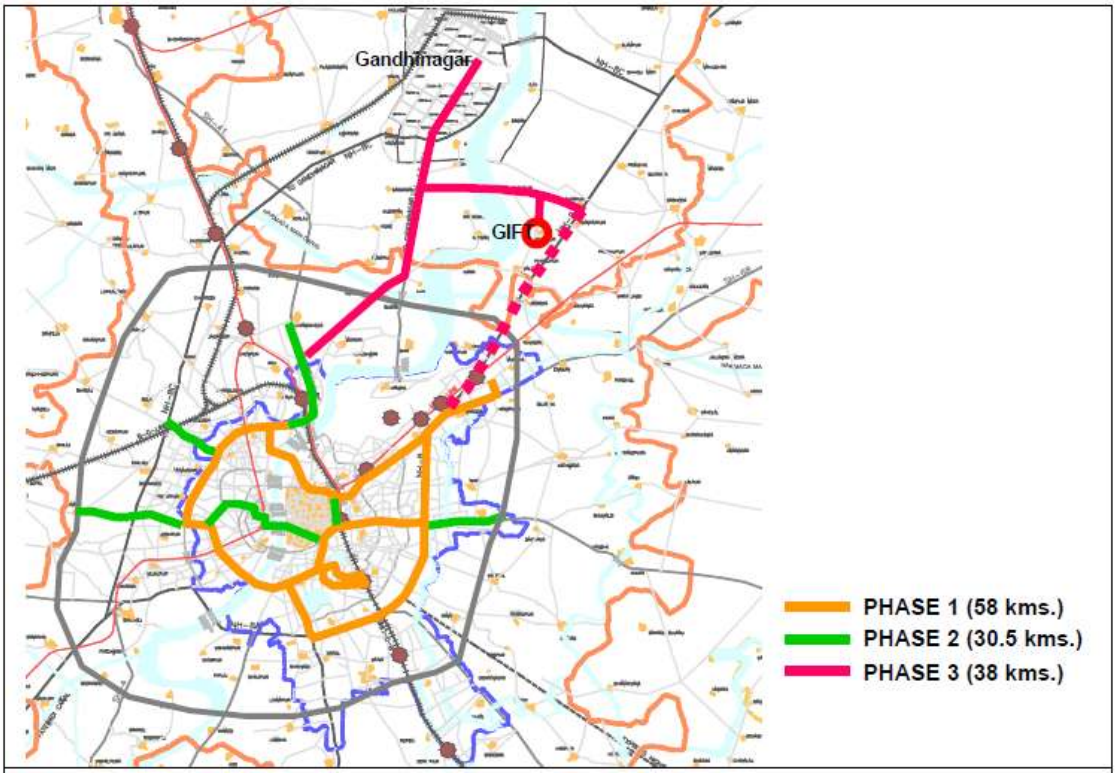


Figure 16: PROPOSED BRTS CORRIDOR

Based on the Integrated Public Transit Plan and BRT plan, phase wide development of BRT system in Ahmedabad was done:

- The first phase, covering an extent of 58.3kms is in its advanced stage of implementation, sanctioned under the JnNURM scheme.
- A second proposal is being considered for the connection of more critical areas – to enable the BRTS to pass through the central areas, connect intermediary city areas, and educational hubs.
- Third phase proposal is aimed at the connections between the state capital and the CBD of Greater Ahmedabad, GIFT.

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.

Phase-II consists of an elevated BRTS corridor, connecting the city's BRTS network to the main railway station. The first corridor, entirely in west Ahmedabad, (of length 12.5 km) was opened to the public in October 2009. 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.

3.2.4.1 DESIGN SELECTION CRITEREA

While existing and potential demand were prime factors that determined the BRT corridor selection, the availability of infrastructure was also considered a critical part of the selection. The corridors provided connectivity to both low income and high income groups of society. Thus this system was designed for the poor as much as it was for the rich and the elite. Often, the availability of the right of way and ease of implementation took precedence over demand because of the implementation of the concept for the first time.

3.2.4.1.1 PHASE I AND PHASE II: ROAD CLASSIFICATION

RIGHT OF WAY | Different right of ways available were 60m, 45m, 40m, 36m, 30m, 24m and 18m on the BRTS corridors. Slight differences observed in the road sections' **distribution of ROWs** between phase I and phase II is summarized in tables below.

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

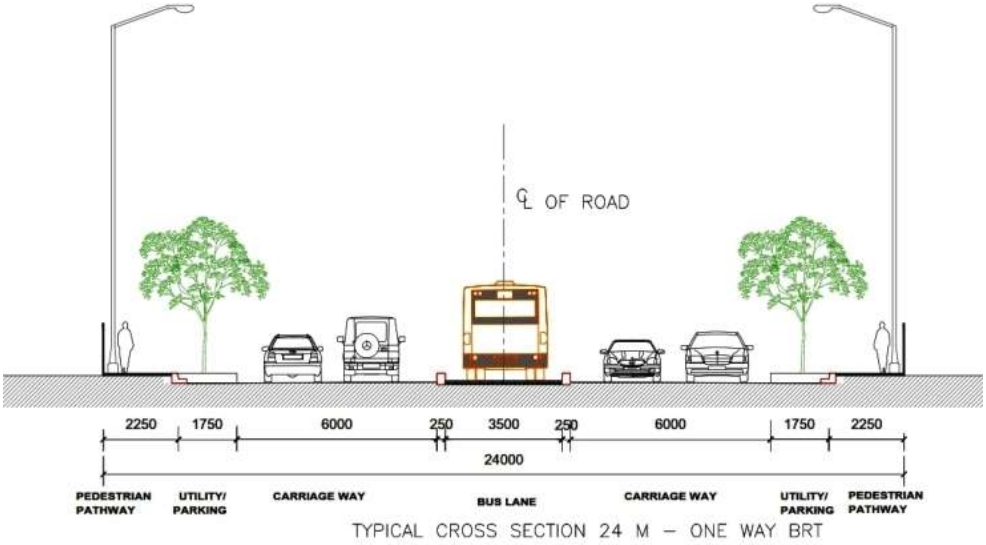
Figure 18: DISTRIBUTION OF ROAD SECTION AT DIFFERENT ROW'S IN BRT PHASE I

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

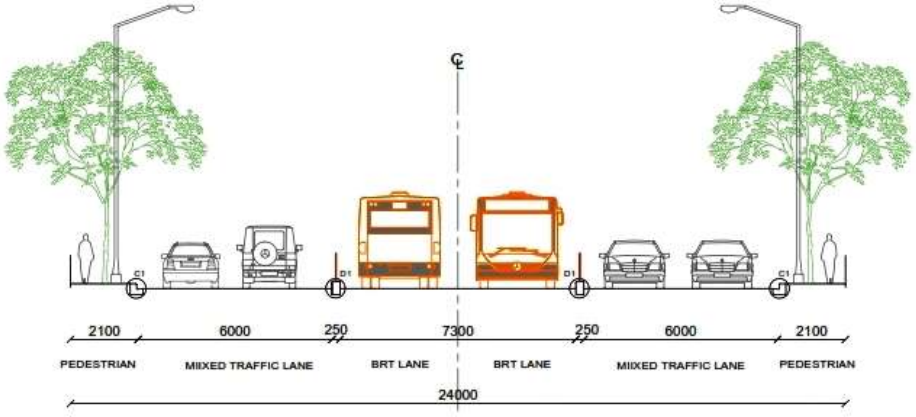
Figure 19: DISTRIBUTION OF ROAD SECTION AT DIFFERENT ROW'S IN BRT PHASE II

- The proposed cross sections as per the available ROW are presented below.
- In all the cross-sections, due importance has been given to pedestrians and cyclists with wide footpaths and segregated bike tracks wherever possible.
- Drainage is a critical issue and has been included as part of the project design and costing. Similarly other relevant utilities and amenities have been integrated.

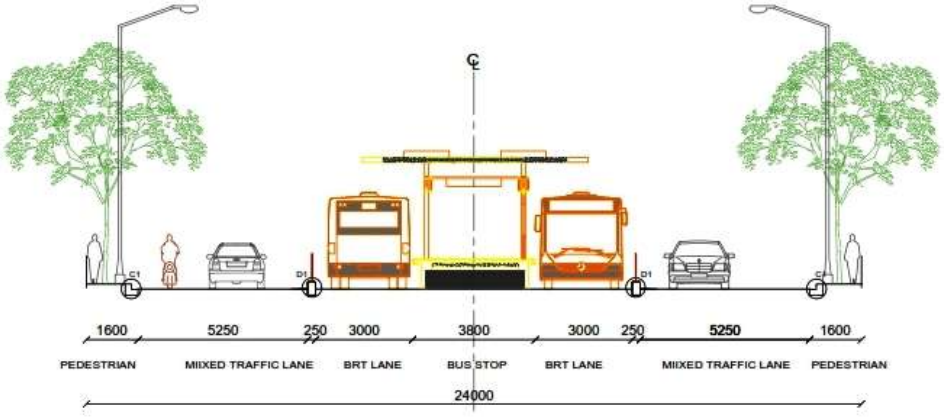
>>24m WIDE



TYPICAL CROSS SECTION 24 M – ONE WAY BRT

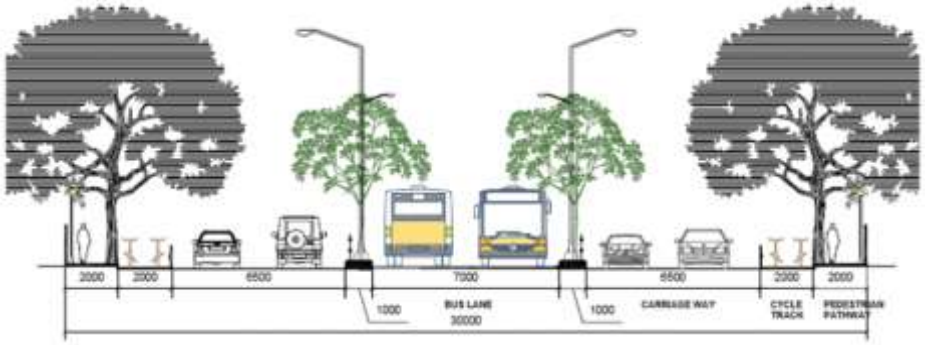


Typical Cross Section for 24m RoW Two Way Phase 2

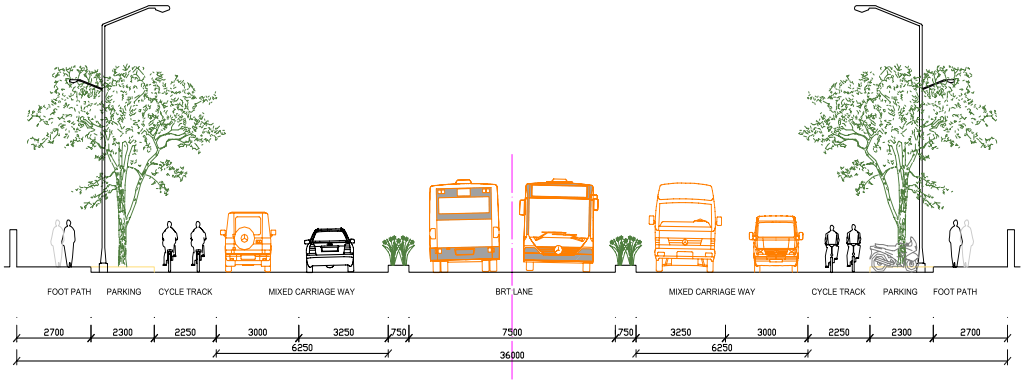


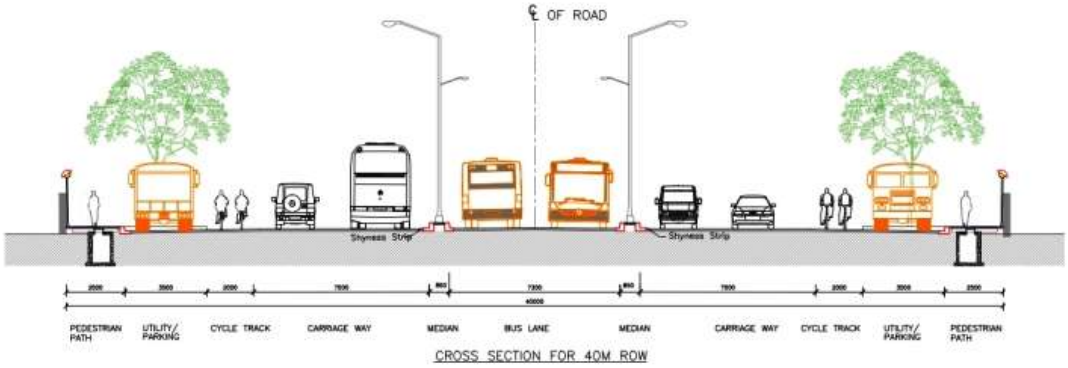
Typical Cross Section for 24m RoW Two Way Phase 2

30m RoW [43]



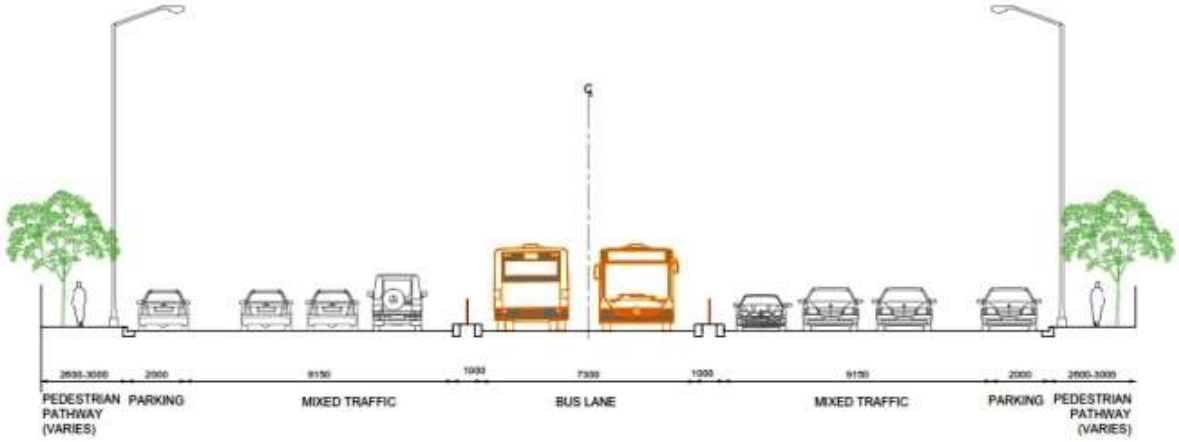
36 m RoW





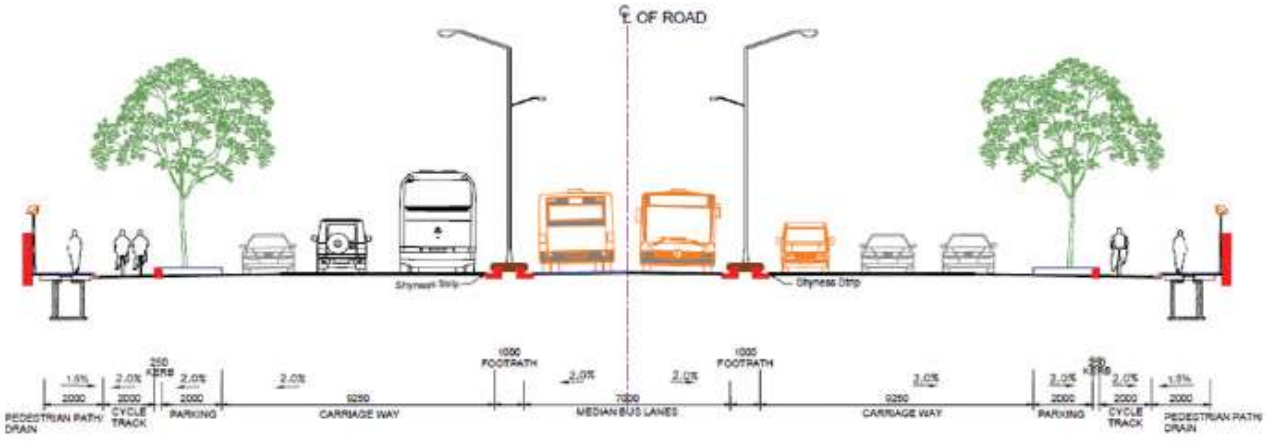
CROSS SECTION FOR 40M ROW

40m ROW



TYPICAL CROSS SECTION AT MID BLOCK LOCATION 40M ROW

TYPICAL CROSS SECTION AT BUS STOP LOCATION 40M ROW



60m ROW

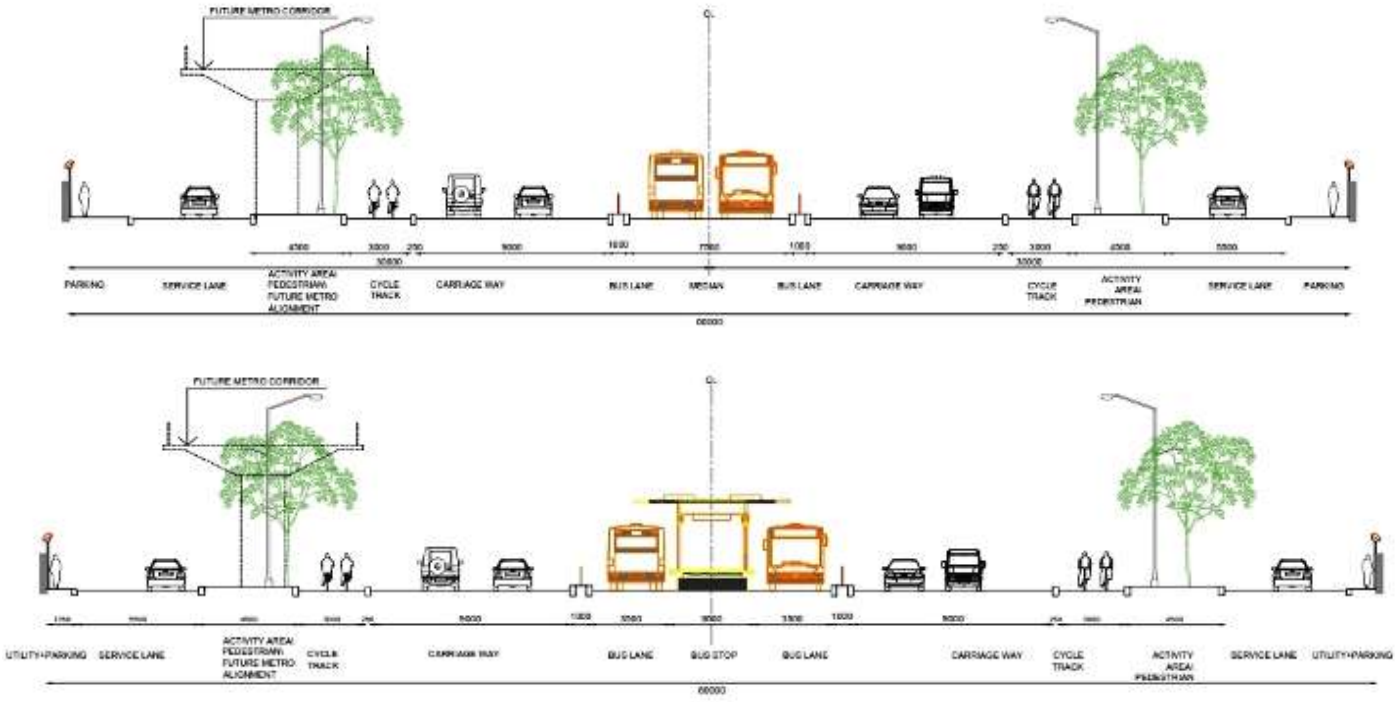


Figure 20: TYPICAL CROSS-SECTION OF RIGHT OF WAY [41] [51]

ELEVATED BUSWAY | The roads accessing the main railway station (in Kalupur) do not have a wide RoW. The RoW (from Dariapur to Kalupur and onwards to Sarangpur) varies from 24m to 36m. This road is the primary access to the railway station and also has wholesale fruit and vegetable markets. The inner city is also accessed through this road. Thus, this road sees very high traffic and tends to get congested throughout the day.

Introduction of an additional facility demanding dedicated road space (of whatever measure) instantly exposes the inherent inadequacies of the existing road network.

An elevated corridor functions naturally as an access controlled corridor and is thus, highly suitable for any facility requiring dedicated carriageway. In the present instance an elevated corridor for the BRT is a necessity as that would best take care of the established travel desire lines without significantly cutting down on capacity of the existing road network.

An elevated corridor of 4.5 km is planned to enable connection to the railway station. Bus stops will be on the elevated corridor and will be connected directly to the railway pedestrian bridges. This will ensure that passengers connecting directly to Indian Railways do not have to climb down from the elevated structure. An elevator/ escalator will be provided for passengers who wish to access the areas at road level. Along with the elevated corridor, at grade improvements in the form of pedestrian paths, designated parking areas for auto rickshaws and buses, space for informal sector and redesigned junctions will be done. With the elevated corridor and 8 bus bays

with overtaking lanes provided, headway of less than one minute between buses can be easily achieved.

Figure 21: VIEW OF PROPOSED ELEVATED CORRIDOR (AT KALUPUR)

There are 75 bus stations planned in phase 2. This is in addition to the 98 bus station planned in phase 1. The stations are located on the median. Stations will have provision for ticketing, display, audio systems and other support infrastructure. Off-board ticketing systems are proposed at all the stations on the corridor. Use of smart card is expected to be extensive.

3.2.4.1.2 PEDESTRIAN AND NMV FACILITIES

NMTs are the best modes for short trips with almost no carbon emissions. In spite of this, the basic infrastructure for comfortable accessibility and usage of NMTs are in a state of decrepit. The space provided for NMTs is unsafe, discontinuous, narrow or encroached further reducing the capacity of NMT usage and exposing the user to susceptible conditions. The fabric of the city is thus made unsuitable to cater to the needs of the NMT user. Cyclists share the road space with motorized vehicles. The congestion factor of the motor vehicle is further enhanced by unregulated networks of NMT. Although cycle tracks were built along the BRT corridors, supply did not meet the demands posed as a consequence of poor implementation and maintenance. There is an inherent need to identify NMT as a low-carbon mode share and implement it at the national and city levels through stringent policy-making. There is an urgent need to stress on the provision of better NMT facilities.

Providing walkable streets and bicycle facilities is a priority action on the agenda of AMC.

- Integration of BRT and other major roads:
    - Pedestrian facilities on all the BRT corridors and other major roads (88 kms).
    - On all roads with width over 36 m, a separate bicycle lane has been proposed.
    - Bicycle parking has been integrated with BRT plan. A comprehensive bike plan is underway.
    - Designation of Inner city and Kankaria Area as vehicle free zones as they attract a large volume of traffic.

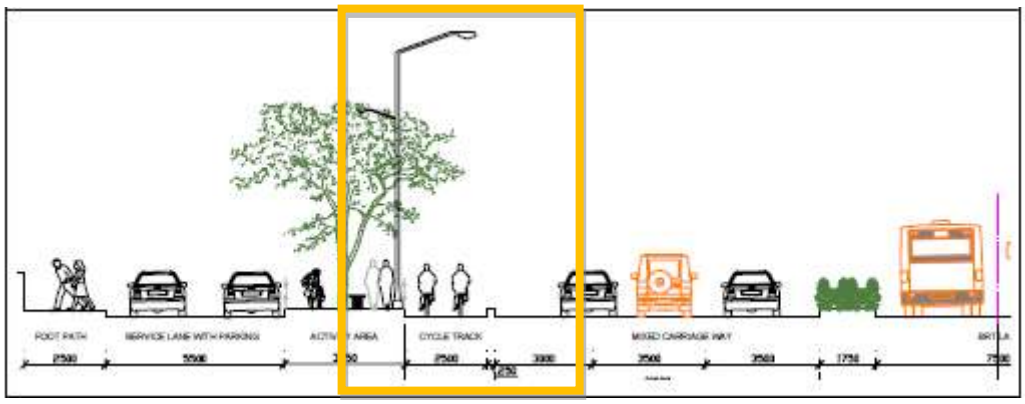


Figure 22: PROPOSED PEDESTRIAN PATHWAYS AND CYCLE TRACKS - SECTION ACROSS ALL BRTS CORRIDORS

3.2.4.2 IMPLEMENTATIONS AND OUTCOMES

The BRT system, (little more than a year into its operation, the service comprises an impressive network of) currently with a network length of 59 kms attracts 1.17 lakh passengers daily. There are 9 operational routes and the peak headways are around 2.5 minutes. Due to the dedicated corridors and priority given at major intersections, the peak hour speeds of BRT buses are 25 kmph and comparable to mixed traffic speeds.

Bus operations and efficiency benchmarks for the Janmarg BRT are favourable relative to other systems in India. Janmarg BRT boasts the highest peak average speed (24-25 km/hr) of all 9 existing BRT systems in India with a 2.5 minute frequency, supplying 30 buses per hour per direction across the network [54]. Customers express high levels of satisfaction with the system. The BRT is a popular way to commute for work, education and leisure and attracts both male and female passengers. Consumer satisfaction surveys suggest that passengers find the BRT service reliable, comfortable and affordable (Swami, 2010). The network connects central city with traffic generators such as transit terminals, markets, industries and institutions designed to serve the people of Ahmedabad.

3.2.4.3 SUMMARY OF THIS CHAPTER

The first few sections throw light upon the existing transport infrastructure and the network characteristics of the city of Ahmedabad. Ahmedabad, a compact city with mixed land use patterns is constantly growing. Urban transportation relies on the road infrastructure, which includes 5 ring roads, and the 17 well-developed radials. As it can be seen from all referred literature and reports, Ahmedabad is sprawling city with dire need of upgradations in transport infrastructure to cater to the enormous number of vehicles in the city.

The sustenance of economic growth occurring at a rapid pace is possible only through development of efficient mass rapid transit system. Hence an integrated approach in the transportation sector is a high prerequisite. Public transport plays a vital role not only in

mitigation of social and environmental impacts, but in offering affordable integrated solutions to the commuters. The existing public transit services are of poor quality and cater to an overwhelming demand; insufficient supply to meet exceeding demands. All of this is a result of fragmented governance systems, lacking in coordination between services, operators and governing agencies. Dissatisfaction in existing conditions has shifted the commuters towards reliance on private vehicles, which has led to increasing traffic congestions, pollution and dangerous road condition. The Government of India addressed the woes mentioned above through the promotion of sustainable urban transport development alternatives. In a developing country context the application of the BRT system is a recent initiative. The Ahmedabad BRTS along with Delhi Metro were some such projects centrally financed and funded under the seven year JnNURM scheme (2005-2011) in compliance with the NUTP guidelines [60]

Therefore the most promising solution to current scenario is the BRTS Corridor proposal in the city of Ahmedabad. This concept of the BRT system is an inferred implementation from studying different approaches of BRT systems in different countries especially Transmilenio Bogotá BRTS and also Curitiba, Brazil. Amongst the first cities in the country to adopt BRT technology ,launched in 2009, with an operational experience of 7 years, the Janmarg BRTS: successful in overcoming initial hiccups, lauded as a success story benefited from careful design, clearly assigned responsibilities, a strong political will and artful planning processes. Initially the system was well-received by residents.

The development of the Janmarg BRTS offers some insights into the potentials of sustainable alternatives' implications in a developing country context. The initial master plan proposal consisted 88km of closed BRT system corridor identified based on the socio economic needs, rights-of-way, mobility and traffic demand, existing routes, land use and future development plans. The aim was to create a multi-modal system that served both dense and dispersed areas and catered especially to the bicyclists and pedestrian users [52].

The BRTS, a bus-based public transport system in which buses are the most prioritized public transit, is integrated as a holistic system by combining pedestrians and cyclists to meet the goals of equity and sustainability. The long-term perspective includes continuous integration by efficient land use planning and stringent policy-making.

At the city level, there were expectations that roads would be well-laid, road space would be created for pedestrians, bicyclists, and vendors, on-street parking would be managed, and an efficient and reliable bus system would be provided as promised in the detailed project reports in 2006 and 2008. AMC Ahmedabad Municipal Corporation manages the city, responsible for the provision of multifarious urban services. The greater urban agglomeration is managed by AUDA.

The "Ahmedabad Municipal Transport System" is plagued with persistent problems of financial viability, lack of organizational autonomy and basic infrastructure constraints. In the present situation, Ahmedabad experiences an increased traffic flow. Without further actions to improve the flow, the transport network of Ahmedabad may experience an unbearable imbalance of situation. Based on statistical data available, it can be seen that the increase in population coincides with the increase in automobile usage and mass transit usage. Hence, a shift to a more efficient transport system is desirable.

It is argued that in traditional urban transport planning, the growth of mobility and travel time saving by increasing speed creates more socio-economic, environmental and transport problems [53]. Urban mobility is indicative of specific socio-economic situations; hence the transport systems should be inclusive and equitable. This resulted in creating a situation in which the dependence on automobile, infrastructure and urban forms complicated the operation of sustainable modes within cities. Complimentary modes of transport induce lesser emissions per commuter from the environmental perspective. Equitable appropriation of space and accessibility is very important to sustainable transport. Massive investments have been made in developing the urban infrastructure in developing cities. Policy formulation considers whether these investments are used for the betterment of all in the society. The idea of equity is a paradigmatic approach to policy making where everyone's share in the system is recognized and provided for.

CHAPTER 4: RESEARCH FINDINGS AND DEMONSTRATIONS

4.1 POLICY AND PLANNING

How it can be used to strategize 'better' planning processes - One that gives the planner greater control over the project and yields stronger outcomes. I conclude by highlighting the implications of these findings for both theory and practice.

> CONFORMITY, CONTRADICTIONS

Comparing and contrasting the experiences of the BRT planning processes in Curitiba and Ahmedabad to develop an understanding of the distinctly different situations and decisions made in the two cities and how this is translated to different outcomes, both real and perceived. This chapter concludes with the summary of the proposed policies and its impact on planning.

4.1.1 COMPARISONS AND CONTRASTS IN THE IMPACT OF POLICIES

4.1.1.1 POLICIES: PROPOSITIONS, IMPLICATIONS AND ASSESSMENTS | CURITBA

> POLICIES: PROPOSITIONS, IMPLICATIONS & ASSESSMENTS

PROPOSITION	IMPLICATIONS AND ASSESSMENTS
LAND USE POLICIES	
Land use and transport are integrated; the structural access concept of high- intensity development has resulted in corridors which meet the travel demand posed by transit network **[24] [54] [55] [18].**	*Land use zoning that has been prescribed in the proposal has been realized by a combination of incentives and control measures. The bus way system has been instrumental in driving land use development and has been used to stimulate development along the structural axes.*
PARKING POLICIES	
It is paradoxical that the highest parking provision is, by virtue of the highest density of development, along the structural axes. However, two points are significant: The design of the transit way eliminates any access or interference from parked private vehicles, and The limited parking provision in the central area has assisted in maintaining a high mode share to transit (about 70%–75% of journey to work) despite the	*Travel demand is shaped by parking policies. The parking supply has not matched the demand arising from the growth in vehicle ownership and is limited in location and duration. Interference from private parked vehicles is eliminated. Also, limited parking provisions have assisted in maintaining a high mode share to transit despite the relatively high automobile ownership.*

relatively high automobile ownership.

In addition, the city's central area is partially closed to vehicular traffic.

Bus/pedestrian streets further reinforce transit use **[24].**

GOVERNANCE, MANAGEMENT AND OPERATIONS

IPPUC, a largely independent institute, monitors, implements and updates the plan**. [19]**.

The IPPUC is less liable to the political pressures and changes than a municipality-based department of division.

Operation of bus services is controlled by URBS, a municipal company which defines routes, capacity and schedules, regulates and controls the bus system and collects all the fares.

The levels of payment depend on a formula involving kilometers operated and the type of service and bus provided.

Operations are contracted to private sector operators. The efficiency is maintained by close control of service provision by the URBS through comparison between different companies **[56] [57]**.

From the URBS's payment, operators pay their full operating costs and capital replacement costs, depending on the age and type of bus operated.

Fare revenues are pooled and paid to the contracted operators on the basis of the service provided.

COMMUNITY PARTICIPATION

A municipal company, URBS (Urbanizacao de Curitiba SA) which controls the operation of bus services, responds to public concerns over the transit system.

Public participation is a prerequisite for innovative advancements. This is evident in the BRT network of Curitiba as it follows an open approach to information thereby providing data accessibility across every plot of land in a city to the citizens.

Public consultation has taken place to promote the central area pedestrian usage schemes, and low-income riders are encouraged to collect waste from more inaccessible areas in exchange for bus travel tokens (leading to a cleaner environment and promotion of public transport) **[24]**

ADVERTISING AND PROMOTION

A world-class model, with a well-defined identity is further enhanced by color-coded bus services. The philosophy of the BRT network is focused on creating an efficient and affordable system that allows the provision of a 'state-of-the-art-image'.

*Making **the citizens aware** and proud of the fact that their bus system is **a world model**. This has been achieved by ensuring that the **bus services supplied are of high quality** and that the mass media are aware of the views and reports from*

	abroad.
FISCAL NATURE	
A comparison of the costs incurred is difficult to obtain due to early infrastructure constructions followed by continual modifications and upgradations over the last few decades. Also, the integration of the busways into the Trinary system makes the monetary assessment impossible in an isolated manner. The series of financial inflation and deflation events in Brazil further add to this obscurity.	*The complete RIT system, with its range of buses and integrated flat passenger fare, is reported to operate without subsidy.* *The remuneration to bus operators is adequate to cover vehicle replacement costs and to allow operators to make a profit; and* *The "tube" stops and integration terminals are planned to avoid all fare collection on buses.*
Periodical revision of fares is done by URBS. Equitable solutions are provided for all members of the society **[56] [20]**.	*This has labor cost implications, and* *Smart card fare payment systems are scheduled for imminent introduction.* *No data are available on fare avoidance, but the "tube" entry system and the integration terminals (which are manned by inspectors at the bus entry to prevent passengers attempting to enter without payment) appear to be secure systems.*
SAFETY AND SECURITY	
Traffic signal actuation exists and buses are given signal priority where the segregated busways cross other roads. In Curitiba, pedestrian access is safeguarded by signals at the junctions also the traffic flow is less intense on the lateral roads as these roads are not used by through traffic **[24]**.	*No report of safety issues*

ASSESSMENT OF THE CURITIBA BRTS

A pioneer in the BRT system, cited as the model for BRT development in other cities. It is effectively coordinated with land development, it is heavily patronized, and it operates quickly and reliably. The result of this land use form is that it created concentrated high demand for transport services along a narrow corridor which had to be met by a track-based public transport service i.e. the bus system, in an efficient manner [24]. Express and feeder services are effectively integrated with free transfers between them. Bi-articulated, multi-door buses with level boarding coupled with off-vehicle fare collection significantly reduce passenger service times. Colored

buses and transparent tube stations provide a clear distinct image. The vehicles, routes, terminals, and surrounding land uses are key elements of an integrated transport system. The bus way system which was developed at a cost of about $1.5 million per km have costs which are much lesser than any street-based LRT, and the bus way system does not require any subsidy as it is financed from the fare box revenues.

Curitiba has been triumphant in integrating land use and transport to ensure an efficient and self-sustaining transport system. Its mixture of incentives and controls applied to land use planning are precisely what transport planners worldwide have sought to achieve - but often with less success. Collectively, Curitiba has achieved a transit-oriented land use pattern and continued ridership growth. Curitiba's bus way system was a key tool in directing the growth of the city; this contrasts with experiences in other cities where busways were a response to immediate problems of traffic congestion.

SUMMARY

This chapter is a case study of the successful integration of public transit with non-motorized transit systems in the city of Curitiba, Brazil. A model BRTS recognized widely for its innovative features through the integration of land use and transport was a result of incremental decisions aimed at providing affordable, efficient and pragmatic services. A system of median bus ways along 5 structural axes, complimented by direct express service on parallel arterial roads is supported by an extensive bus feeder network. Each of the structural axes was developed as a Trinary system. Successful implementation of BRTS and integration of mixed land use along with introduction of feeders demonstrate Curitiba's evolution towards a better city. The launch of the 6th corridor indicates the advantage of the transport system towards cleaner modes satisfying increased demands. The success is a derivative of innovative policy measures, stringent land use implementation, political acceptability favored by the pragmatic public. Curitiba faced periods of turmoil as a developing city but succeeded with solid support through efficient planning of traffic and mobility management. Through this it is evident, that once established as a solution for integrated urban mobility (BRTS), it further developed its potential by setting new standards (introduction of feeders- cycle lanes) for higher performances of the transit system. Curitiba has directed its growth by integrating urban transportation, land use development and environmental preservation. Constant innovations have been achieved through performance and capacity building.

4.1.1.2 POLICIES: PROPOSITIONS, IMPLICATIONS AND ASSESSMENTS | AHMEDABAD

PROPOSITIONS	IMPLICATIONS AND ASSESSMENTS
LAND USE POLICIES	
The implementation of the Janmarg BRTS led to significant increase in land prices along the corridors. Prior implementation, post proposal, the land use catered to mixed densities. However, since the commencement of the operation, the economic growth rate further increased changing land use patterns.	*Land use diversities and the impact of sprawl have not been quantifiable. The new urban structure is emerging as an area faced with mobility and accessibility crisis* [44].
PARKING POLICIES	
The government of Gujarat has prepared a draft parking policy which is still under consideration of the state government.	*The proposals under implementations/consideration are:* *- Developing multi-storied parking complexes on a BOT (Build-Operate-Transfer) basis.* *Five locations with heavy parking demand have been recognized on priority for development.* *- As part of the 58 km long first phase BRT roads, utility areas on either side have been developed and parking will be integrated along with BRT operations.* *- Detailed assessment of parking demand and supply is underway*
GOVERNANCE, MANAGEMENT AND OPERATIONS	
Fragmented political hierarchies in the urban set up and lack of strong political enforcements combined with corruption in a developing context demonstrates the governance structure.	*Strong political leadership is the major criteria necessary for a successful system* [61].
>>LAW ENFORCEMENTS	
A heavy mix of motorized travel modes with an especially high share of motorcycles and scooters a variety of NMT modes, including bicycles, tricycle wheel chairs, vendor carts and push carts; heavy pedestrian volumes; dominate the roads of Indian cities **[58]**.	*Crumbling road infrastructure, inadequate accommodations for both motorized and non-motorized modes, rising fatality rates; due to lack of adherence to road routes with a lack of law enforcement; inappropriate development densities; abundance of road obstructions and*

	encroachments on roads are the resulting environment. The main cause is the fight for space between different mode shares [62] [63].
>>OPERATIONS	
The deplorable conditions of the transportation network are not only seen as a threat to the economy but also to the safety and community welfare. This is attributed to a technocratic, top-down planning process.	*However, Indian officials have begun to adopt more viable strategic alternatives to address the underserved transportation needs.*
COMMUNITY PARTICIPATION	
The successful functionality of the BRT with NMT Is dependent on public acceptance of the user. Responses to unified public interests lead to the planners' doubt of difference and heterogeneity. This was because of diverse and conflicting interests among various users **[59]**.	*The limitations in defining public interests are critical for communicative planning for reaching consensus-based outcomes. The conceptualization of public interest from its origin in political theory to its modern day critiques among the planning theorists is persistent* [64].
ADVERTISING AND PROMOTION	
Glamorous branding of the Ahmedabad BRTS has been encouraged. This has been one of the most highly advertised government projects in Ahmedabad **[44]**.	*However bus systems are always associated with inadequacies and poor services. Awareness of the BRTS and NMT integration has to be increased in a strategic manner.*
SAFETY AND SECURITY	
Inadequate license procedures, disregard for road rules, lack of personnel for surveillance and enforcement and corruption **[60]**.	*The safety of all road users especially pedestrians, cyclists and those on non motorized two wheelers is always compromised. This has to be counteracted to implement successful BRT and NMT integration thereby fostering safer travel corridors in the Indian context* [60].

SUMMARY

Transport decisions impact not only individual transport users but also transport operators, local residents and businesses, land and property owners, local and national tax payers. Each of these stakeholders will seek to review the impact of the proposed project from their standpoint.

The various interactions should be comparable on the basis of some criteria to make a choice between different alternatives. Projects proposed under the transport sector are valued in terms of their net worth, in terms of monetary units. When the economic status is assessed, the economic appraisal lies at the interface between political decision-making and technical work (planning, engineering and economics) for civic projects. This is a pivotal position as it not only requires a technically sound evaluation, but must also be capable of effective communication to the decision-makers [65].

Most literature addressing India's state of transportation refers to it, in one way or another, as a crisis [17] [66]. Inadequate infrastructure, rising motorization, unsafe travel behavior, and lack of law enforcement are a threat to not only public health [17], but also to the national economy and the social welfare of residents [67]. Along with the aforementioned qualities, several studies point to the potential benefits that BRT implementation offers to pedestrians, cyclists, and other NMT users in the form of auxiliary, corridor-wide improvements [68] [69] [50]. Being that the installation of BRT facilities often requires substantial road construction, it allows for the opportunity to improve or install walking/cycling facilities where they may not have existed before.

The assessment of the Ahmedabad BRTS will be explained in detail in the subsequent sections through demonstrations of the research findings.

4.1.2 STRATEGIC APPROACH TO URBAN PLANNING

4.1.2.1 CURITIBA'S STRATEGIC APPROACH TO URBAN PLANNING

In 1943, Alfred Agache, a French planner, was the first to develop a plan to direct the urban growth. However, the implementation of the plan was unsuccessful. The main notion was to introduce the concept of urban planning to its citizens and the government of Curitiba. This notion approached implementation when the city commissioned a preliminary urban plan. An influx of ideas was encouraged through competitions held among local and national professionals, as a basis of which the Curitiba Master plan was founded. Parallely, the Curitiba Research and Urban Planning Institute was developed to monitor, supervise and continually update the planning process.

The adaptive nature of the political system was an important factor in instigating the two-dimensional planning concepts towards a three dimensional reality. The outcome, a pragmatic and repetitive planning process, was a result of the interaction between concept and reality.

At present, the planning process of Curitiba is well established. This is affirmed as the conceptual ideas are first tested and then further applied through implementation. The feedback generated through these tests lead to additive improvements. Solutions are created after assessing the materialization of the ongoing planning processes. Rather than being stymied by feedback growth is re-directed towards a progressive path. Hence, the Urban Planning Institute is well established as the local incubator for urban planning which emphasizes the interplay between participatory planning, analyses, decision-making, and implementation [70].

4.1.2.2 AHMEDABAD'S APPROACH TO URBAN PLANNING

A BRT WITHOUT NMT FACILITY | Walking and cycling are two major low-carbon modes of transport. The DPR for phase-I realized that the pedestrians and cyclists were the most accident prone, comprising 61% of the total accidents when their modal share comprised of 55.21% of the total trips in the city [41].

4.1.3 SUMMARY

Innovative policy inventions have been made to establish the full priority of public transit - either functioning as independent networks or as feeders to a network. The key objective was to understand how implementation can be achieved through particular policy-making processes or how sufficient policy proposals can be made. The case study denotes how the decision-makers position influences efficient modes of transport and also deals with issues faced through institutional fragmentation. The most important need is to cater to the demand posed by the public. Hence there is a necessity to exercise comprehensive planning through effective proposals from different stakeholders. The hypothesis can also be justified by saying that policy-making processes can be expanded to the field of implementation through concentration of political acceptability by increasing public support. This would lead to more focus on various stakeholders' management strategies.

4.2 PROCESS DOES MATTER

4.2.1 OVERVIEW

An overview of the proposed BRTS is presented below. This chart represents the plan that was to be implemented at the proposal stage in the year 2010.Though construction began in 2007; the operation began only in the year 2009. This reflects the delay in implementing a proposal. Also the proposal suggested for very sound design aspects; however on implementation most of it was either discarded or not implemented.

CITY PROFILE	Population in lakhs (2001)	45.25
	Existing modal share of Public Transport	8%
	Weighted Average Trip Length	5.3 km
	Per Capita trip rate	1.14
BRTS DETAILS		
Responsible Authorities	Executing authority	Municipal Corporation
	Funding agency	JNNURM
Cost	Total approved cost	Rs. 984.15 crores
	Unit Total Cost	Rs 11.08 crores per km
Time line	Construction started	2007
	Operation started	July 09
Bus corridor design details	Type of BRT system	Closed
	Total planned	88.8 km
	Total length executed or under construction	25km operating
	Width of bus lanes	3.5 m
	Tools to separate bus lane from mix traffic	Railings
	Total no. of routes in existing bus system (open)	150
Fleet usage	Existing fleet used or not	No
	Passenger capacity in bus	60-70
Bus stops	Distance between bus stops (meters)	Average 800 m
	Bus stop location wrt junction/intersection	Far-side of junction
	Type of bus stop: staggered/island platform	Island platform
Bus operations	Frequency planned	2 min in peak hour and 4 min in off-peak hour
	Frequency achieved	2.5 min in peak hour
	Average speed on corridor (kmph) (planned)	30
	Average speed on corridor (kmph) (achieved)	24-26 (peak hour)
	Planned ridership	15,000 – 20,000 pphpd
	Achieved ridership	2350 - 2600 pphpd
Fare collection	Type of fare: fix/progressive	Progressive
	On-board/off-board ticketing	Off-board
	Fare amount in INR (with slabs for progressive fare)	Maximum fare Rs15 for existing route
Other services & operational details	Space availability for vendors along corridor	Yes
	Passenger information: dynamic/static	Dynamic
	Any other service for public convenience	Public toilets, dustbins
Integration with other modes	Walk	Non-continuous 2m wide footpaths, signalized level crossing and sub-ways at mid-block
	Cycle and cycle rickshaws	2 m wide cycle track with signalized crossing, parking at specific locations
	IPT and Motorized vehicles	On street 3m wide parking lane, 50m away from junction, free parking for 679 autos in front of mid-block bus stops and 3624 for 2-wheelers & 425 for 4-wheelers paid parking

Source: (Ahmedabad Municipal Corporation, 2010; CEPT University, 2005; CEPT University, 2008; Janmarg, 2010)

Table 7: OVERVIEW OF AHMEDABAD BRTS

4.2.2 METHODOLOGY

Documentary analysis was done through interviews with multiple stakeholders. The primary elements considered were users' needs, feedbacks and perceptions. A systematic performance survey was done to find out bus frequency; the conditions of boarding or alighting; further a survey of the frequency of time intervals and the number of commuters was done. Several research papers were also studied to further analyze the road conditions to determine the speeds on the road. The availability of NMT facilities was assessed to understand or identify the infrastructure available or the existent inadequacy in the infrastructure.

4.2.3 POLICY FRAMEWORKS AND FLOW OF FUNDS

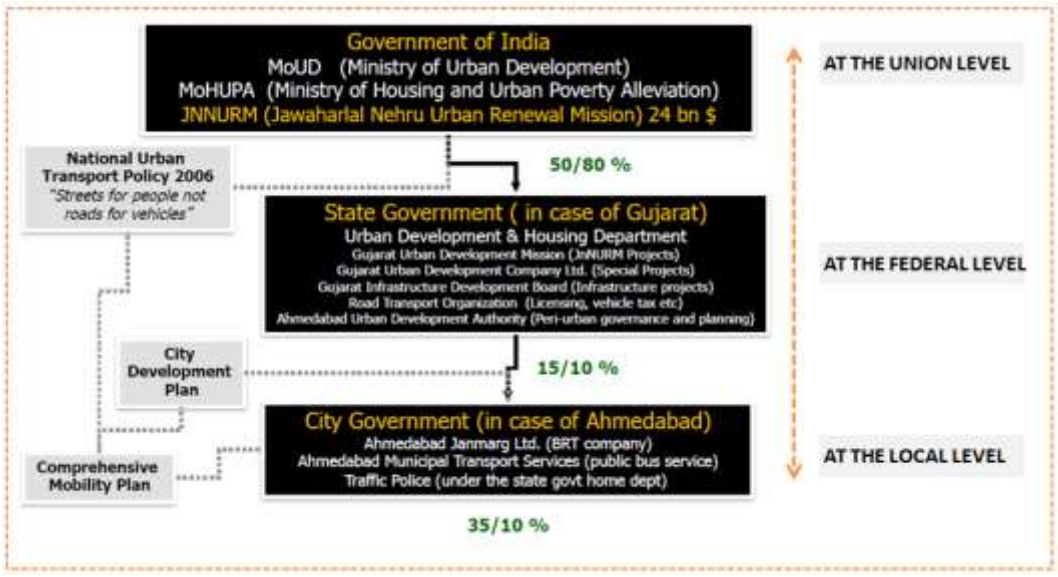


Figure 23: POLICY FRAMEWORKS AND FLOW OF FUNDS

The flowchart above depicts the classification within the urban governance hierarchy. The distribution of political powers across several authorities maybe one of the causes for the failure in effective implementation of policies proposed. Also the fragmented system further supported by corruption in a developing context may lead to a disconnect between reality and idealist planning. *This issue addresses my hypothesis of policy makers and their impacts in the urban environment.*

4.2.3.1 TRANSPORT PROJECT APPRAISAL

A smart consumer investigates all costs and benefits of each option prior to making a major purchase decision. Before buying a car, one wants accurate information on its fuel, insurance, maintenance and repair costs. Similarly, one also wants information on the reliability, comfort and safety of each option [2]. Just as consumers need precise and all-inclusive information when making personal travel decisions, government and other funding agencies expect accurate and comprehensive information on the full economic, social and environmental impacts associated with each option when making transport policy and planning decisions [16].

Availability of personal transport is a function of income [2]. In the absence of access to personal mode, people resort to a variety of forms of public transport. According to [17] as cited in [18], owing to the scarcity of public finances for transport policy options, there is little point of developing options which are unaffordable either to the society or individual users. The distribution of benefits from a transport project such as the BRTS might have policy implications. Scrutiny of land use in and around the proposed BRTS corridor in addition is essential to alleviate the lower sections of the society. Hence, this difference in land-use classification and income levels along with consideration of the nature and intensity of inequity among the different societal groups could give an informed input for formulating area-based policies based on intra-city and inter-zonal comparisons of the deprived and the benefited [19]. These area-based policies or remedial policies to ensure equitable redistribution of benefits shall lead to a sustainable society.

Economic, social and environmental changes are inherent to development. While development aims to bring about positive changes, sustainability in the society is aimed at ensuring long-term benefits and minimizing the adverse impacts. There are often conflicts between transport objectives. For example, congestion reduction strategies degrade walking conditions or increase pollution emissions. Conversely, some emission reduction strategies increase consumer costs or traffic congestions. Such tradeoffs must be considered in transport planning and policy making. Any development project should aim at increased well-being and greater equity in serving the basic needs for the present and future generations [20].

4.2.3.2 STATISTICAL MEASURE: COST ESTIMATION OF THE PROJECT

Economic evaluation is a comparative tool [21]. Distribution amongst population sub-groups, the spatial syntax, the economics of development projects are indispensable in analyzing the existing demographic framework and identifying the current active institutional members that serve as indicators which emphasize the outcome of policy planning.

The decision makers understanding of the actual project is aided by land use planning, cost estimation and zoning across different areas with varying nature and intensity. This is expected to have a complementary input role to the current transport evaluation role [2].

Developments in the transport sector are a means to improve the economic opportunities, quality of life and ultimately, income of people in a particular area (Weisbrod and Weisbrod,

1997). Apart from the well-being objective of any transport development project, a review of the investments is an important issue in transport planning and policy (Nijkamp et al, 2003). The initial and the final costs are compared with the projected flow of the proceedings to reflect upon the impacts of the monetary requisites.

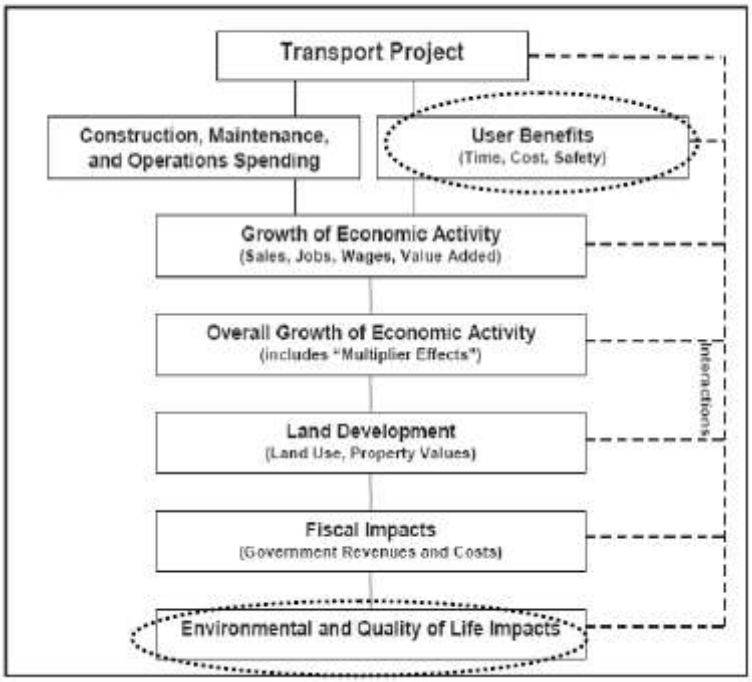


Figure 24: ELEMENTS OF IMPACT OF A TRANSPORT PROJECT (Weisbrod and Weisbrod, 1997)

None of the impacts resulting from a transport development are mutually exclusive. Interactions between economic, environmental, social and monetary impacts are always interrelated. These are visible across the entire range of stakeholders like the government, users, and operators besides the groups and organizations who are a part of the vicious circle owing to the multiple interactive effects (Gannon and Liu, 1997)

4.2.3.3 COST IMPLICATIONS AND SUSTAINABILITY

Economic evaluation of the project involves the assessment of the net value of the projects and its policies. The key consequence of the proposed project is identified and its quantitative information is considered as a major scope of evaluating the project [22].

Project Phase	Date Of Sanction	Cost In ₹ Lakhs
Phase-1		
Stretch1 of First Phase Construction of 12 Km. long stretch	11th Aug '06	8,760
Stretch2 of First Phase Construction of 46 Km. long network	6th Oct '06	40,572
BRTS Phase II	19th Aug '08	48,813
Construction of 30 Km. long network	19th Aug '08	48,813
Total	₹ 98,145 lakh	

Source: CEPT University, 2010

Table 8: PROJECT COST (PHASE I)

The funds are sanctioned under the JnNURM scheme in phases:

- 35% from the Central Government;
- 15% from the State Government; and
- 50% by the local body [49].

But the perspective of transport evaluation needs to be a social one, that is, one which takes account of significant impacts of the project or policy whoever is affected. There is a dire need to study the various interactions in a conjunctive manner. However, as they are hardly studied in that manner, one group tends to be more benefitted than the others. Hence there is a necessity to study the impacts through a holistic manner. Through this the demographic study is justifiable. (Grigalunas et al., 2005)

An important aspect of the economic evaluation of the transport project is its reflection on the human behaviour and it must be evidence-based in a reasonable manner [21]. So, knowledge of the factors which influence behaviour, and the way in which transport improvements are likely to impact is important. Thereby, economic evaluation needs to be holistic in nature. That is to say, it needs to cover economic, social and environmental impacts of the project and its policies in a coherent and consistent manner [2].

SUMMARY

- Bus Rapid Transit Plan for Ahmedabad is a multifaceted project which integrates land use and transport, various forms of public transport services as well as other motorized and non-motorized modes. Therefore, due to multi-dimensional nature of the BRTS, the economic evaluation and expected incomes and profitability of the system is of paramount importance.
- Both the Phases combined of the Janmarg Proposal run in a nearby circular fashion around the city coming up to a total stretch of 89 kms with base cost as high as 984 crores.
- A total of Rs. 493 crore has been sanctioned for Ahmedabad BRT phase 1 for a total of 58.3 km. As part of phase-1, all 58.3 km have been tendered out and work on 53 km is underway. The detailed financing scheme for Phase-I of the BRTS Proposal is given in Table 20.
- As part of phase-2, 30 km have been identified. The base cost of phase-II is another 490 crores. The detailed breakup of the costs of the BRTs corridor is given in table 19.

- The Economic Internal Rate of Return of the project is expected to be around 45.3 percent.
- The day-to-day operation of the BRT system is based on the profitability of the scheme. The bus cost was assumed to be 40 lakh. The revenue earned per bus depends on various factors such as fare prices, the capacity of the buses, the vehicle utilization per day as well as the average occupancy of the bus during the day.

4.2.4 STAKEHOLDERS

A special purpose vehicle (SPV), Ahmedabad Janmarg Limited (AJL) is responsible for planning of services, selection of operators, monitoring service quality, periodical revision of fares and coordinating various stakeholders.

4.2.5 POLICIES THAT ARE BEING INITIATED

- Consultative planning processes has been adopted as an integral part of transit oriented development (TOD)
- Urban mass transit authority is being considered.
- Parking policy is in place thereby putting in place pay and park spaces along the BRTS corridor.
- Dedicated Urban transport fund has been set up.
- A fund is proposed to be created as Urban Transport Fund mainly to sustain transit operations and for development of transit infrastructure. The sources of fund include:

  - Net revenues from Pay and Park Facilities
  - Advertisement Charges along the BRT roadway
  - Advertisement charges on the buses and bus related facilities
  - Charges on outsourced activities such as Ticketing System, Seasonal Ticket Issue
  - Land Value Capture
  - Grants, if any.
  - Other sources in terms of cess/charge as a travel demand management measure are under consideration.

- Advertisement policies are also under preparation.

4.2.5.1 MANAGEMENT

The Janmarg BRTS' responsibilities are demarcated under three sectors namely, operations, maintenance and finance/administration.

4.2.5.1.1 OPERATIONS DIVISION

The day to day operations is managed by this department, the largest in terms of manpower, manages the control centre, performs quality control checks and oversees the system functioning by communicating directly with the operators fare collection agencies, infrastructure maintenance agencies and other stakeholders involved with the operations. The main function is

to provide delivery of on-time, dependable transportation services to the community. Hence it is responsible for the overall BRTS operation.

4.2.5.1.2 MAINTENANCE DIVISION

The maintenance division will work closely with the operation division in oversight, enforcement and management of system operator contact related to the maintenance of the vehicles.

4.2.5.1.3 ADMIN AND FINANCE DIVISION

This division is responsible for revenue and general accounting, fare collection, budget organization and financial grant reports. This division is equally responsible for internal administration as all payments are made on the basis of information received from the operation management sector.

4.2.6 SUCCESS FACTORS

The sustainability of the BRT system depends on the core objectives of a good institutional structure which should maximize the quality of service and benefits from the public sector to the end user and enhance its sustenance over a longer duration. The institutional structure should promote availability of quality services.

Multiple operators should be chosen in a competitive manner to encourage low cost of operations and cost sharing should be done using a PPP (Public-Private-Partnership) model [49].

Component	Solution/Design	Construction / Supply	Operations	Management	Maintenance
Bus Stations/ Corridor/ Flyovers	AJL/CEPT	Fixed Time / Fixed Rate Contractor	-	-	Presently under Defect Liability Period
Buses	AJL / CEPT	Buses hired for 7 years from Operator	Bus Operator	Janmarg / Operator	Bus Operator
Ticketing, CRM, IT Systems	AJL/CEPT	Service Provider	Service Provider through annuity	Service Provider through annuity	Service Provider through annuity
Sky Walks	Conceptual Design: CEPT / Detailed Design by Concessionaire	Concessionaire	Concessionaire	Concessionaire	Concessionaire
Component	Solution Design	Construction / Supply	Operations	Management	Maintenance
Parking	AJL / CEPT	Parking constructed as part of corridor	Pay and Park Operator	Operator overseen by Janmarg	Pay and Park Operator
Hardware elements: Sliding doors / turnstiles	AJL / CEPT	Supplier	Janmarg / Service Provider	Janmarg / Service Provider	Supplier through AMC
Advertisement Rights	AJL / CEPT	Licensee	Licensee	Janmarg	Licensee
House Keeping	AJL / CEPT		-	Janmarg	Service Provider
Landscaping	AJL / CEPT	Licensee	-	Janmarg	Licensee

Source: AMC, 2010

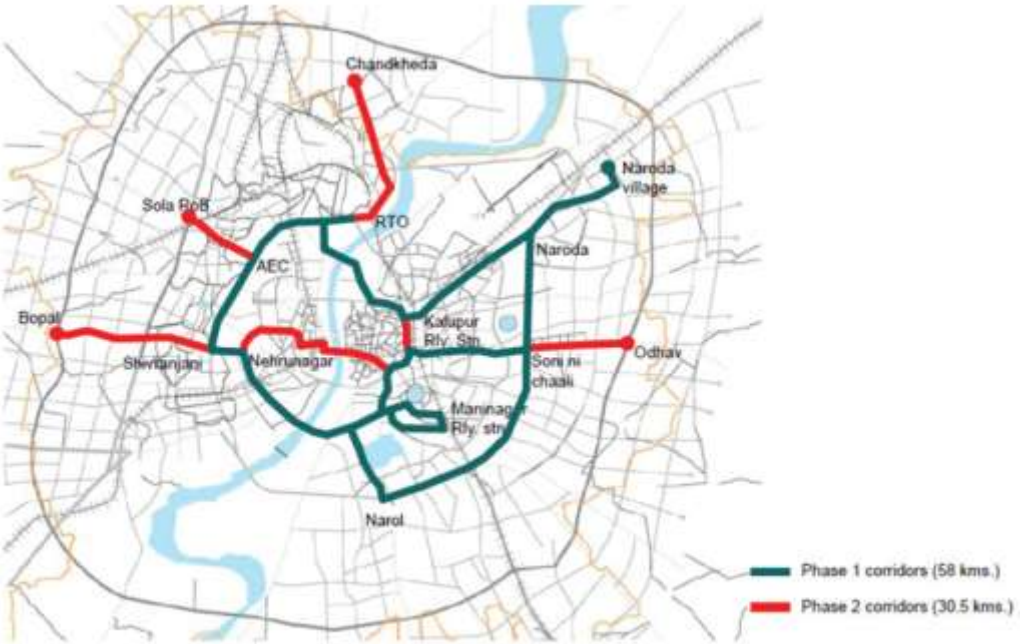
Table 9: PPP RESPONSIBILITY MATRIX

4.3 PROCESS INFLUENCES OUTCOMES

4.3.1 OPERATIONAL AND UNDER CONSTRUCTION JANMARG ROUTES

"Janmarg", literally translating to "People's Way" was proposed as an integrated public transit plan at the state government and municipal levels. In traditional urban transport planning, it is argued that the growth of mobility and travel time savings by increasing speed creates more socio-economic, environmental and transport problems [53]. As urban mobility is indicative of specific socio-economic situations; the transport systems should be designed in an inclusive and equitable manner. The automobile dependence should be reduced in order to simplify the operation of sustainable modes within the cities.

The map below depicts the flow of the proposed transport system integration in the city of Ahmedabad.



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

Figure 25: MAP OF PROPOSED JANMARG PHASE I AND PHASE II ROUTE MAP **(88.5kms Operational)**

4.3.2 ANALYSIS: TRANSITIONS AND PROJECTIONS

A short stretch of the proposed BRTS implemented is analyzed in detail.

>The line in black represents the proposed BRTS

Figure 26: BRTS ROUTE NETWORK

4.3.2.1 PRIMARY SURVEY OBSERVATIONS:

The primary observations revolve around the frequency of bus availability and the time frame between one bus and the other. *For example, at one of the stops: Akbar Junction: the observed frequency of the bus at peak hours was about every 3-4 minutes on the RTO-Maninagar route and 7-8 Minutes on RTO-Naroda Route. The distance covered was 22.5 kms, and the total duration was 40-48minutes along the Maninagar route. The average speed of the bus was estimated to be 20-35 km/hr. Also the time taken to reach Naroda was 60-69 Minutes covering a distance of 33 kms. The average speed of the bus was noted to be a constant of 25-30 km/hr. This was due to law enforcements with relation to speed limits. At the stops, 18-25 seconds was the timeframe for boarding and de-boarding a bus.*

4.3.2.2 ADDRESSING THE BRTS ROAD NETWORK

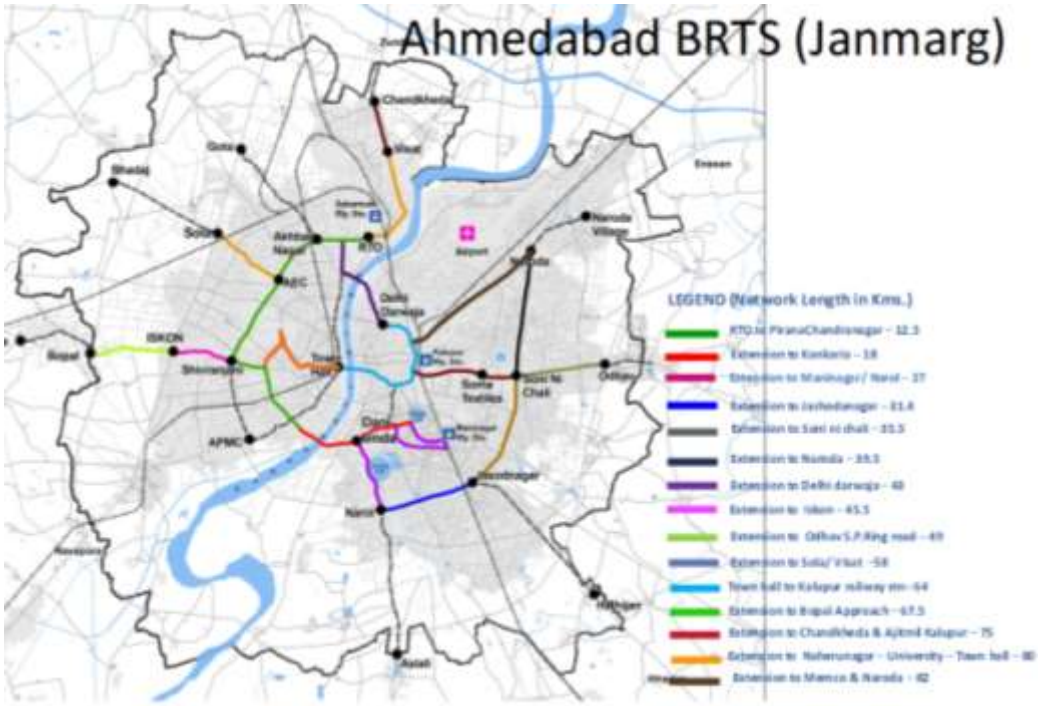


Figure 27: THE BRTS ROAD NETWORK

The BRTS network gives the impression of a well connected and well integrated route that links various parts of the city appearing to be continual across the fragmented parts of the city. However, the surveyed stretches indicate a lesser percentage of provisions made. Roads were not obstruction free; footpaths and dedicated spaces were not allocated. Inadequate provisions of the proposed facilities rendered the network unusable.

4.3.2.2.1 ADDRESSING NMT FACILITIES | FOOTPATH AVAILABILITY

Figure 28: PEDESTRIAN ROUTE | PROPOSAL

Figure 29: PEDESTRIAN ROUTE | IMPLEMENTATION

The maps above describe the exact availability of the footpaths and its nature of usage.

The image on the left indicates a well connected network in accordance with the proposed route map. **The image on the right** indicates a short shrift in NMT infrastructure implementation. A poor design translation of the BRTS plan proposed could be observed. By observing the usage pattern of the NMT facilities, the question of their nature of adequacy and discouraged usage can be understood.

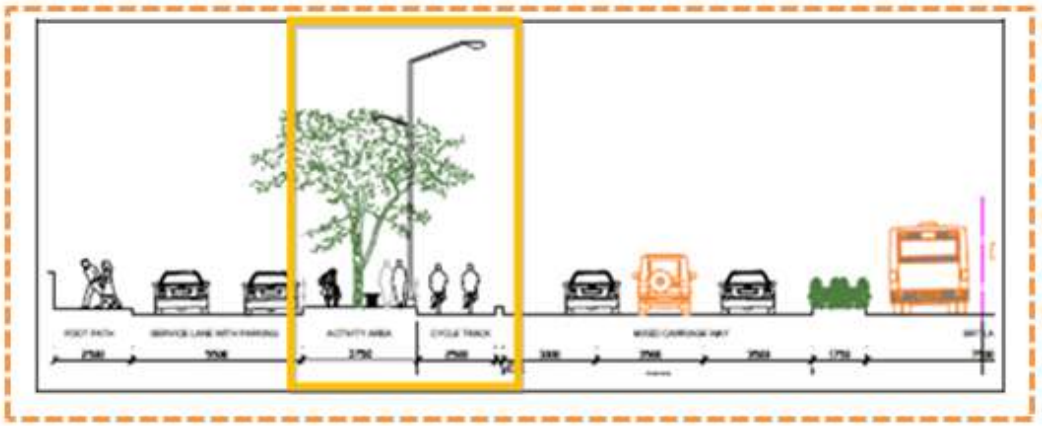


Figure 30: DESIGN PROPOSED

Figure 31: DESIGN IMPLEMENTED

A detailed analysis depicts the broken pedestrian facilities. It also denotes that poor maintenance and inadequate provisions might be a cause factor of not preferring walking over the automobile. Footpaths are very poorly planned and fail in the implementation phase. Hence the integration of pedestrian streets as NMT modes may be lacking in the design and integration phase.

4.3.2.2.2 ADDRESSING NMT FACILITIES | CYCLING TRACK AVAILABILITY

Figure 32: CYCLE TRACK| PROPOSAL

Figure 33: CYCLE TRACK| IMPLEMENTATION

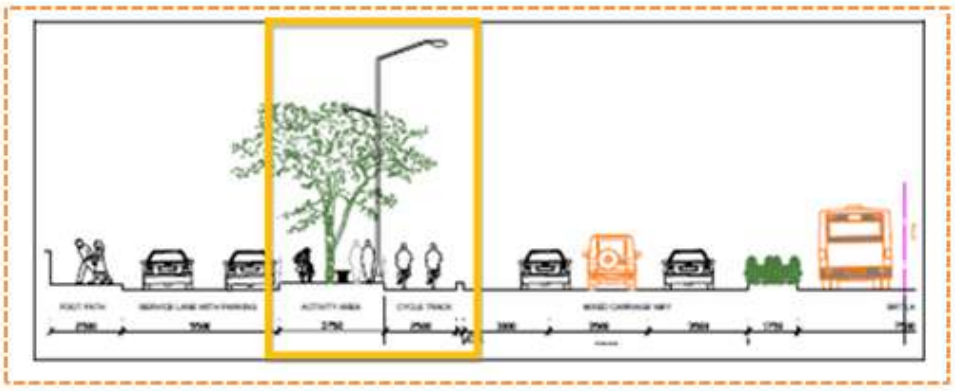


Figure 34: DESIGN PROPOSED

Figure 35: DESIGN IMPLEMENTED

From the above two figures, it can be noted that further analysis emphasizes the existing disconnect between stops and access routes. Components that obstruct the paths include: electric poles, manholes, parked vehicles, vendors, etc. (Refer annex).These may be the components that deter the mode choice of people thereby prohibiting them from shifting to other modal choices. For a maximum population that supposedly uses the bicycle, there is very less amount of space allocated for the cycle tracks. This leads to the share of road space between fast and slow moving vehicles. This is further the cause for serious road fatalities and severe injuries. This may also be the reason for people to not use the sustainable alternatives and maybe the reason why people prefer exceeding fuel prices over healthy mode choices. ***Detailed maps have been added in the annex 4.***

4.3.3. HOW "INCLUSIVE" IS BEING "EXCLUSIVE?"

ENCROACHMENTS

Deteriorating conditions, decaying urban environments, inadequacies in existing infrastructure facilities may all be reasons for the failure of implementation of the proposed policies to improve the existing conditions. Hence there might not be a possibility to upgrade to sustainable alternatives for the commuters. This may also be a reason for them to prefer the comfort of their private vehicles over the comfort of the public transit systems.

PARKING ISSUES

BRT is not integrated at all with the existing municipal bus services, in terms of route structuring and operational planning; access and egress; ticketing and fare collection; institutional limits. No other buses are allowed in the BRT corridor - not even ambulance services.

LACK OF INFRASTRUCTURE

Also the existing roads are in a state of dilapidation. From the figures below it is evident that:

a. The roads are encroached by street vendors.

b. No separate lanes are provided as proposed in the plans prepared.

c. In some conditions the road condition itself has to be improved.

d. In cases where there are roads of appropriate standards there has been no infrastructure facilities provided.

DISCOMFORT

4.3.4 RECOMMENDATIONS

Several concerns have been addressed while implementing the BRTS and NMT integration. From the above analyses, we may conclude that the street design has not been sensitive to the street activities which characterize the street nature of the roads of Ahmedabad as informal street activities are an important facet of urban life. Also, the location of the corridors in close proximity to the EWS and LIG sectors should have resulted in better facilities for the weaker sectors of the economy. However, it has only resulted in eviction and displacement further aiding to encroachment. At present the design of NMT facilities along the newly planned stretches of the Janmarg BRTS is being discarded as it is masked by notions of "lack of space" and "security concerns" (Times of India, 2011). From this it is evident, that the Ahmedabad BRTS has failed to achieve its goal of sustainable and inclusive transport system.

4.3.5 ASSESSMENT OF THE AHMEDABAD BRTS

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 the NUTP. The justification of every BRT system started with the encouragement of NMT modes and public transport allowing universal accessibility and providing mobility for all. The Janmarg BRTS was partly funded by the Central Government under conditions of implementing the National Urban Transport Policy (NUTP). Analysis of the fiscal nature of the BRTS proposal under the JnNURM scheme (in accordance to the NUTP) asked for all cities that were funded by this scheme for mandatorily building NMT facilities alongside the BRT system implementation. The Janmarg BRTS has managed to attract worldwide attention as it has received numerous laurels and awards[6] stating it to be a leader in the Sustainable Transport sector in India. However, this justification can be proved to be a theoretical one. This is because of the fact that there are many components that have been found to be missing or lost in the design aspect thereby, leading to repression of the inclusive nature of the design. However, the Janmarg BRT system which received awards on the basis of reducing carbon emissions and dramatically improving commuters' accessibility failed due to poor incorporation of the proposed high-quality pedestrian and bicycle lane facilities along the BRT corridors. In the case of Ahmedabad, the claims made by the planners in their DPRs (Detailed Project Reports) were not met.

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[6] Janmarg received a sustainable transport award for the year 2010. The citation of the award mentions, ""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**." [79]

CHAPTER 5: IMPORTANT LESSONS RELEVANT TO CONDITIONS OF AHMEDABAD

> **LESSON DRAWINGS: INFERENCES**

Mass transit has become more than just a transportation system; it is an instrument to control and guide city growth. Despite the differences in city structure, economic prosperity and income levels, automobile ownership, public perspective and image of public transport, and other factors make it essential that local conditions be evaluated. Indeed, one of the great merits of bus way transit is that it can be planned, designed, and operated in a flexible manner and thus can be geared to local conditions. Hence, there are some policies and principles that may be applicable.

Prerequisites of any system that is to be well used and financially viable should include protection of the transit right-of-way from traffic congestion, good and preferential access to areas of high demand, and planning around land use that provides a potentially high passenger demand. The characteristics of the Curitiba bus way system are precisely those necessary for any fully successful transit scheme.

>> **TRANSIT FIRST POLICY** | The need to give public transport priority in large cities and to integrate public transport with community development wherever possible are the most important lessons.

>> **BUSWAYS AS A MASS TRANSIT SYSTEM** | The Curitiba experience shows that with good planning and organization busways can carry high volumes of passengers at reasonable commercial speeds - equivalent to those of LRT or tram technology under the same operating environment.

>> **BUSWAY PASSENGER HANDLING** | The operational success of the Curitiba bus ways depends on the ability of the system to handle passenger boarding and alighting efficiently, with little delay as efficient passenger handling maximizes the use of buses and reduces operating costs [24]. Curitiba shows that with good organization and appropriate design, passenger handling delays can be minimized and can assist in achieving a very high level of operational performance; efficient passenger handling and fare payment systems are also possible with busways/buses and are a vital part of a modern system.

>> **BUSWAY DESIGN** | Many busways in Brazil are located in the center of the road with the great advantage that they are freed from the effects of - frontage property servicing/loading and, by virtue of the central location, are less liable to violation by other traffic.

The Curitiba center-of-the-road bus way design (as part of the “Trinary” system) is unlikely to be exactly replicable except in transit corridors that are either new or subject to massive redevelopment. However, alternative design actions exist to overcome center-of-the-road issues. The main constraint is finding roadways that are wide enough and also suitably located. Curitiba’s 85-foot wide rights-of-way are not common in Indian cities.

>> **BUS OPERATIONS** | The bus system in Curitiba, with its functional mix of buses and bus services, interchange integration terminals, and integrated fares is unsurpassed worldwide [24]. At the core of the bus way system is the trunk-and-feeder principle. Curitiba uses the trunk-and-feeder system to overcome mainly the capacity issue, and, by the use of very large buses on the

trunk lines, is able to use buses efficiently and maintain bus flows at a level that optimizes the bus way operation. Key to the success of the trunk-and-feeder system, however, is good integration both in terms of service and fares between the trunk-and-feeder lines, and Curitiba has achieved this integration. However, there can be a problem if demand is very high, and there is a danger that busways may be over-loaded. There can also be a problem if bus volumes are high, but vehicles are not fully occupied. Such uneconomical use of vehicles requires that other bus routing arrangements be made. In such cases, trunk-and-feeder services with good passenger interchange are essential.

While the Curitiba trunk-and-feeder system is not a prerequisite for successful busway operation, the system can offer potential in the corridors of developed cities where demand is high.

>> LAND USE AND TRANSPORT COORDINATION | Curitiba is one of the few cities worldwide that has successfully implemented a policy of integrated land use and transportation supply [71]. It has been stated that Curitiba chose to integrate land use and transportation at a very opportune time in its development, just prior to a very significant population surge. It is difficult that U.S. cities can expect such significant growth also because they are at a mature point in development, and significant redevelopment is unlikely.

Although this is clearly the case, Curitiba has been able to sustain land use development by a mixture of controls and incentives and has used the transport system both to sustain and to encourage development (e.g., around terminals) [24].

Integrated land use and transport is the aim of any well-managed city, but in well developed cities, that linkage is difficult to achieve. However, a long-term view must be taken. Transport supportive activities should be encouraged in busway transit corridors, and, where new development is scheduled, integrated development of busway transit and land use can bring great benefits [72].

>> SUPPLY OF BUS SERVICES | In the developing world, it is a commonly held view that public sector bus services are inefficient, unresponsive to public demands, subject to political interference over fares, unable to generate adequate revenues for investment-replacement of buses, and require heavy subsidy [24]. To seek to overcome these issues in developing cities, there has been a trend towards privatization of bus services.

However, Curitiba has demonstrated that a well-run, regulated system is possible. Although the Curitiba system is operated by private sector bus companies, the system is highly regulated (in all respects including fares, service levels, quality of service, profits etc.), and service levels delivered to users are high. Bus mode share has been maintained despite increasing automobile ownership. Although the organization of bus services in a city depends on specific circumstances, the Curitiba system has shown that a combination of public-private initiatives can deliver a high-quality and efficient bus service and demonstrates the case for a regulated service to any city.

>> ORGANIZATION | A citywide busway-based mass transit system; in which the deficiencies of busway transit is that it has no unified promoter, and responsibilities are fragmented. LRT is usually developed by a single agency and sometimes supplied as a “package” by a single supplier (or some form of supply-operator consortium under a single contract). In the case of busway transit, numerous agencies are likely to be involved, including the transport

planning agency, the traffic management agency, the highway agency, bus vehicle suppliers, bus operating companies, traffic police and so on. There is no unified structure for the delivery of busway transit.

Planning, design, procurement, and operation of busway transit should be treated in an integrated manner similar to an LRT system; the IPPUC/URBS arrangement in Curitiba is one example of how this may be achieved and possibly replicated.

Curitiba has combined the functions necessary for the successful planning and delivery of the busway system under two agencies – IPPUC for planning and URBS for delivery. Not only are the two agencies professionally at a high level, but their semi-independent status from the city administrative structure appears to have ensured policy continuity.

>> **IMAGE** | Many decision makers, politicians, and the general public do not view busway transit as a "state-of-the-art" mode. Arguments such as cost-effectiveness, potential for citywide route coverage at a fraction of the cost of LRT, and potential for incremental implementation, and so on, do not counteract the "image" deficiency of buses. The Curitiba system has a good image within the city and is much admired worldwide.

With additional resources, the quality of systems in Indian cities could be increased through such measures as the following:

- Clean fuel buses;
- Low-floor, quiet buses;
- Real-time passenger information at stops and terminals;
- Smart card fare systems;
- Security and safety;
- Improved amenities at stations; and
- Urban design and marketing enhancements

Many features of the Curitiba system have applicability in Indian cities. These include: the segregated median busways, multi-door buses, fare prepayment at major boarding points, distinctive vehicles, and attractive passenger interchange facilities. Several features, however, are not directly transferable [71].

SUMMARY

A simple but detailed analysis of a short stretch reflects the choices made of the BRTS in Ahmedabad to demonstrate how planning policies, processes and tools influenced implementation outcomes. Through this, the aim is to simply demonstrate the role played by policies in dictating outcomes through the process to maximize the projects' effectiveness.

- Complimentary modes of transport induce lesser emissions per commuter from the environmental perspective.
- Equitable appropriation of space and accessibility is very important to sustainable transport. Massive investments have been made in developing the urban infrastructure in developing cities.

Policy formulation considers whether these investments are used for the betterment of all in the society. The idea of equity is a paradigmatic approach to policy making where everyone's share in the system is recognized and provided for.

The combined reflection of the analyses stated above lead us towards the inference of the poor state of affairs in the urban spatial context in the system of Ahmedabad.

For a city with numerous laurels on promoting the BRTS network, there exists a poor state of reality that has to be taken into serious consideration.

Also the growth of the city towards sustainable alternatives has to evolve from the paper level of planning to the implementation in a reality based context. Recent proposals are focused on doing away with the NMT facilities on being introduced.

Through the findings one can interpret that the conflicting interpretations of multiple stakeholders and the user was the root cause of poor policy implementation. Also, supporting representations from the media and the organizations involved, portray the imbalance of attitudes from the political figures, decision-makers and the users - the citizens. The repercussions of the above research findings will further be concluded by making proposals through a framework for the planner.

CHAPTER 6: CONCLUSIONS

The developing context, where motorization rates are often rapidly increasing but have not yet reached the level of developed countries, offers an interesting opportunity to explore the promotion of alternative modes before travel behavior and urban form become more permanently oriented towards motorization.

A large number of people living in large urban agglomerations enable economies of great scale in the urban transport sector. At the same time, if urban transport is not managed well it has the potential to choke cities and bring economic activity to a grinding halt. Here lies the promise and peril of urban transport in India.

As stated in the beginning, in accordance to the World Bank review of urban transport it is found that BRT had great potential as an instrument to achieve "modal split, environmental and poverty related objectives"

BRT technology is a particularly appealing option for developing countries – can be adopted as a planner or policy maker's flexible alternative to a city's urgent urban problem. The BRTS has a relatively short planning and implementation timeline that conforms well to short political cycles. The BRTS can also extend further into neighbourhoods making it more accessible to feeder modes such as cycle rickshaw, bicycles and pedestrians.

Some advantages include its ability to be implemented rapidly and quickly, its adaptability to various urban and suburban environments, its service quality and capacity, its suitability as a feeder service for rail and its ability to be integrated into urban development and pedestrian friendly environments.

Also serves as an important consideration in financially constrained economies

For all of the reasons outlined above, BRT is a particularly attractive mass transportation option for India where public transport is in crisis.

- Ahmedabad benefitted from strong leadership and political commitment. Design problems arose in the course of implementation, but committed leadership combined with aligned, well-coordinated institutions were able to overcome a few missteps and contribute to successful outcomes.

-Despite significant initial political support and thoughtful and inclusive design as well as clearly assigned project responsibilities, the Ahmedabad BRTS has faced many operational challenges.

-It continues to face public relations obstacles.

-Future of the integration with NMT feeders with the Ahmedabad BRTS is precarious, as discussions concerning its fate are entering current political discourse.

The impact of planning processes' combined with the integration of NMT on BRT outcomes is an on-going debate. Institutions in developing cities tend to be 'young' relative to their developed city counterparts.

The larger success of the planning process is relative to the right institutional set-up, political will and provision of appropriate design standards. These are variables that are contextual and that keeps changing and influencing the prime process.

Drawing on the comparisons and contrasts, the direct and indirect role of planning process in influencing the outcomes is demonstrated.

Through my research, I argue that the policy makers' decision which proceeds as a one-dimensional sequence has to be revamped to a multi-dimensional approach that provides a comprehensive framework. This broader approach can be used to achieve better design, institutions and leadership qualities.

Surveys conducted were limited to people belonging to diverse categories. The classification of grouping of the results obtained was varied and could not be considered as the only data for implementing the requisite facilities. However, it served as a sample quantity to measure that enabled me to relate to what was existent before and after the implementation of the proposal. A well-designed policy may have the potential to overcome the political, institutional and design weaknesses thereby building support leading to more viable and sustainable systems.

For practitioners, an improved understanding of the nature and influence of the planning process can lead to better decisions and actions, leading to more successful projects.

For theorists, a more nuanced and practical understanding of the role and nature of the planning process can lead to improvements in the quality and applicability of models, reducing the normative gap between theory and practice.

For all planners, renewed attention on the role and importance of the planning process is empowering, and offers the profession a new and compelling way to influence outcomes

REFLECTION | The process was complex, locally specific and involved many actors, actions and influences. The usual suspects were too deterministic as they did not give adequate consideration to the powerful role of policies and planning tools which could have had an influencing role in the project outcome. Thus the case of Ahmedabad was an opportunity to not only capture lessons on the integration practice in India but also to re-examine the theoretical framework and understanding the planning tools and its implications.

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APPENDICES

PERCEPTIONS

> PERSPECTIVES

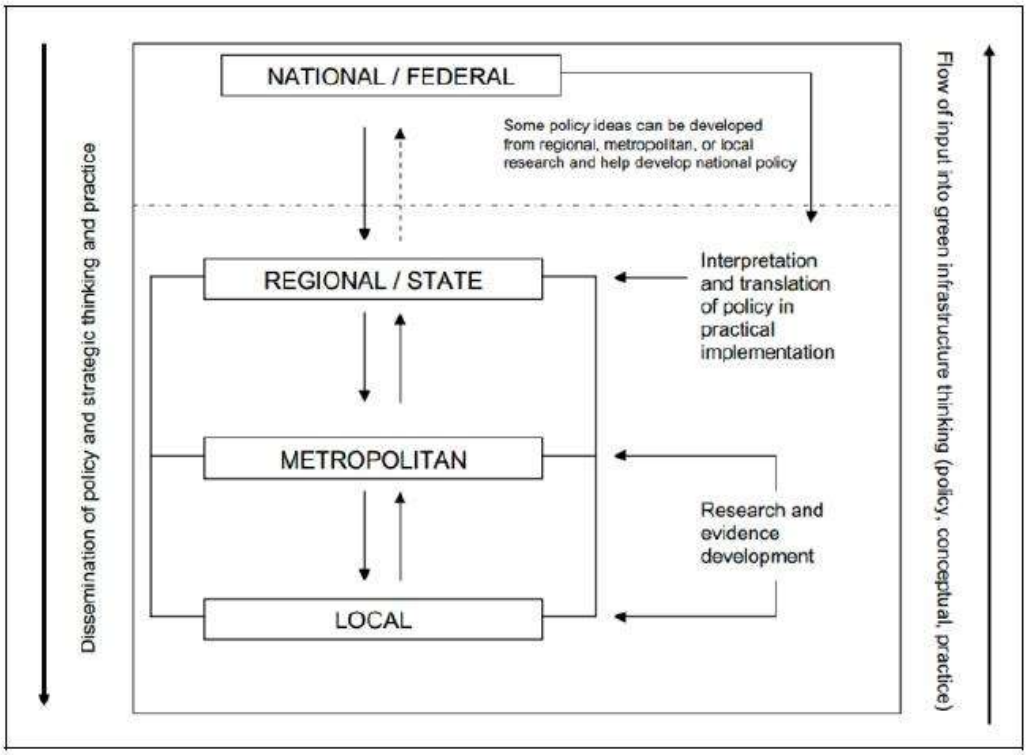
"A comprehensive bus system - which would help remove thousands of cars from the streets - can be set up for the same cost as constructing a flyover, which often only serves to shift a traffic jam from one point to another… It is crucial to give due consideration to the magnitude of a project in order to avoid the risk of presenting 'show-case' solutions which are conceived for the media and only benefit a minority of the inhabitants".

-Jaime Lerner, Former Mayor of Curitiba, Brazil.

"A sustainable city is one that wastes the least and conserves the maximum. Most importantly, it means making the existing system of people and resources work better--rather than throwing it away and trying to replace it with a single, capital-intensive project such as a subway or a rail-based system. Curitiba began with buses because it had buses; it did not have a subway" (The "Surface Metro", 1995).

-Jonas Rabinovitch, UNDP

ANNEX 1



ANNEX 2: TRINARY ROAD CONCEPT

1. CITY: Curitiba
Country: Brazil

Population: 2.7 million

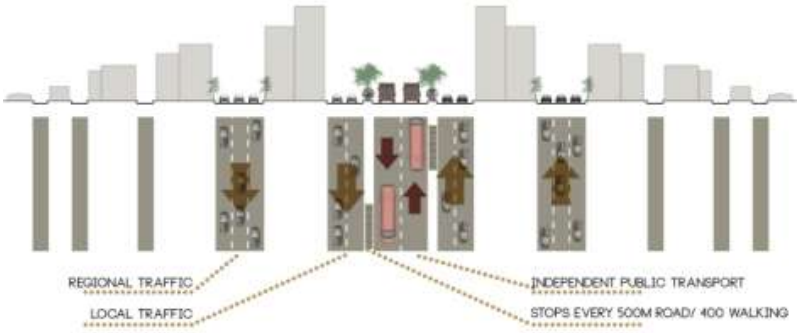


Figure 36: trinary road concept

An overhead perspective of this Trinary road concept: The central road of the three roads contains a center of-the-road, two-way busway that feeds into transfer points called “terminals,” and also provides a limited number of traffic lanes (one or two in each direction) for non through movements and for service access to frontage development. Approximately one block from each side of the central busway/service road, a one-way traffic road of three or four lanes has been developed for use by private vehicles. In the block width between the busway and the main traffic roads on either side, intensive, high-density land use development has been encouraged / permitted **(TCRP REPORT: BRT CASE STUDIES)**.

ANNEX 3

Brazil

BRT Feature	Curitiba
Year system commenced	1972
Number of existing trunk corridors	6
Total length of existing trunk corridors (km)	64.6 km
Number of trunk routes	12
Location of busway lanes	Curbside & centre
Location of doorways	Curbside (right)
Type of surface material on runways	Asphalt
Type of surface material on runways at stations	Concrete
Total length of existing feeder routes (km)	Not available
Projected length of total future trunk corridors (km)	Not available
Number of stations	123
Average distance between stations (m)	540 m
Number of stations with passing lanes	0
Number of terminals	16
Number of depots	12
Number of total system passenger-trips per day	562,000
Actual peak ridership (passengers per hour per direction)	20,000
Actual non-peak ridership (passengers per hour per direction)	Not available
Average commercial speed (km/h)	19 km/h
Average peak headway (seconds or minutes)	2 minutes
Average non-peak headway (seconds or minutes)	6 minutes
Average dwell time at stations (seconds)	22 seconds
Number of trunk vehicles	232
Trunk vehicle type	Bi-articulated
Fuel type used in trunk vehicles	Euro III Diesel
Trunk vehicle capacity	270
Trunk vehicle length (m)	24 m
Number of feeder vehicles	Not available
Type of guidance system, if applicable	None
Type of fare collection / verification technology	Smart card
Number of intersections with priority signal control	0
Number of grade-separated intersections	0
Fare (US$)	US$0.74
Total planning costs (US$)	US$380,000
Average trunk vehicle costs (US$)	US$395,000
Total infrastructure costs (US$per km)	US$1.1 – US$6 mill/km

1. Curitiba data courtesy of URBS

Table 10: QUANTITATIVE COMPARISON

BRT Feature	Curitiba (Rede Integrada)
Segregated busways or bus-only roadways	✓
Existence of an integrated "network" of routes and corridors	✓
Enhanced station environment (*i.e.*, not just a bus shelter)	✓
Special stations and terminals to facilitate transfers	✓
Overtaking lanes at stations / Provision of express services	x
Improvements to nearby public space	P
High average commercial speeds (> 20 km/h)	✓
Actual peak ridership over 8,000 passengers per hour per direction	✓
Pre-board fare collection and fare verification	✓
At-level boarding and alighting	✓
Fare- and physical-integration between routes and feeder services	✓
Entry to system restricted to prescribed operators under a reformed business and administrative structure (closed system)	✓
Competitively-bid and transparent contracts and concessions	x
No need for operational subsidies	✓
Independently operated and managed fare collection system	✓
Quality control oversight from an independent entity / agency	✓
Low-emission vehicle technology (Euro III or higher)	x
Automated fare collection and fare verification system	P
System management through centralised control centre, utilising automatic vehicle location system	x
Signal priority or grade separation at intersections	x
Distinctive marketing identity for system	✓
High-quality customer information (*e.g.*, clear maps, signage, real-time information displays)	✓
Modal integration at stations (*e.g.*, bicycle parking, taxi stations, easy transfers between public transport systems)	P
Supporting car-restriction measures (*e.g.*, road pricing)	x

1. Brazil data courtesy of Eric Ferreira (ITDP) and Wagner Colombini (Logit)

✓ – Yes x – No P – Partial I – Insufficient network to make a conclusion NA – Not applicable

Table 11: QUALITATIVE COMPARISON

ANNEX 4

Figure 37: (LEFT) ELECTRIC POLE OBSTRUCTION; (RIGHT) MANHOLE OPENED

Figure 38: (LEFT) INAPPROPRIATE VEHICLE PARKING; (RIGHT) SIGNBOARD OBSTRUCTION

Figure 39: (LEFT) UNUSABLE FOOTPATH AND BICYCLE TRACK - INSUFFICIENT WIDTH ALLOCATION; (RIGHT) UNAVAILABILITY OF SIDEWALKS OR CYCLE TRACKS

Survey Questionnaire:

1. Where are you coming from?
    a. Home
    b. School/College
    c. Place of Work
    d. Market
    e. Relatives
    f. Hospital
    g. Recreation, Space like Park, Theatre, Restaurant, etc
    h. Others (Please Specify)
2. How did you reach the BRT Station from the above mentioned place?
    a. Walking
    b. Cycling
    c. AMTS
    d. Auto-rickshaw
    e. Motor Cycle/Scooter
3. Journey from _____ Station to _____ Station
4. Fare Paid for the BRTS Trip Rs. _____
5. Where will you go from the destination BRTS Station?
    a. Home
    b. School/College
    c. Place of Work
    d. Market
    e. Relatives
    f. Hospital
    g. Recreation, Space like Park, Theatre, Restaurant, etc
    h. Others (Please Specify)
6. How will you go to your destination from BRT Station
    a. Walking
    b. Cycling
    c. AMTS
    d. Auto-rickshaw
    e. Motor Cycle/Scooter
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
    b. Cycling
    c. AMTS
    d. Auto-rickshaw
    e. Motor Cycle/Scooter
    f. Motorized 4 wheeler
    g. Trip was not undertaken
9. Which vehicle(s) your household owns out of the list?
    a. Bicycle
    b. Motorcycle/Scooter

c. Car
d. Others
e. None

10. What is your monthly household income?
    a. Below Rs. 2500
    b. Rs. 2500 - 5000
    c. Rs. 5000 - 7500
    d. Rs. 7500 - 10,000
    e. Rs. 10,000 - 20,000
    f. Rs. 20,000 - 30,000
    g. Rs. 30,000 - 40,000
    h. Above Rs. 40,000
11. Whether you could have undertaken this trip if BRTS was not available?
    a. Yes
    b. No
12. Suggestions/Comments for improving the BRTS Project?

    _____
    _____
    _____
13. Respondent Age _____
14. Sex of the Respondent (M/F) _____
15. Occupation _____

PROMOTING SUSTAINABLE TRANSPORTATION THROUGH THE INTEGRATION OF PUBLIC TRANSIT WITH NON MOTORISED TRANSIT

THE IMPACT OF POLICY MAKING, A CASE STUDY OF BRTS IN A DEVELOPING CONTEXT

How can planning policies and tools be adapted and reconciled to most effectively elicit a change in behaviour towards public mass transit and NMTs to achieve sustainable transportation goals in a city?

ABSTRACT

Fast growing economies are paralleled with extensive sprawl and an increasing trend in auto-mobilization. Hence there is a direct effect on the travel demand on transport systems. Cities are confronted by challenges to achieve sustainable alternatives to the benign effects of the private motorcar. The move from an auto-oriented city towards a lesser car reliant city is of dire need.

The ways in which people travel have an enormous impact in the urban morphology and also in urban transport systems. Travel patterns are characterized by the trip length, trip time, and trip rate; especially the purpose of travel determines the mode share preferred. Sustainable systems are aimed at reducing over consumption of fossil fuels and land cover therein reducing the emphasis of the private automobile as the primary mode of transport and encouraging shifts towards sustainable modes such as cycling, walking and public transit.

The focus of this paper is on the promotion of sustainable urban transportation through the integration of non-motorized transport systems (cycling, walking) with public transport network systems. A hybrid evolution, an outcome of the synergy between two modes of transport - namely the bicycle and public transport, is an evidence of two complementary transport modes that would cater to diverse individual travel needs in a quick, efficient and sustainable manner.

The current public transport system - the bus rapid transit system of Ahmedabad in the context of a developing country, India is comparatively studied with bus rapid transit system of Curitiba, Brazil. A primary survey is done to analyze the inclination of commuters to shift from their private modes to the BRTS. Existing travel patterns of the city of Ahmedabad are studied to help predict the preferred modal choice and to understand people's behaviour to switch to other modal choices. The pre-conditions and post- conditions are also considered. Some areas of implementation are observed in detail to represent and communicate the issues of its un-sustainable impacts in the urban environment.

The current state of the BRTS of Curitiba is compared to perceive what can be learnt from and what can be implemented in the Indian context, as the BRTS model of Curitiba was one of the earliest implemented BRT system that is functioning very efficiently. When scrutinizing the two scenarios, it shows that executing the BRTS can increase sustainable mobility to a certain extent.

In the Indian context, the BRT system can be considered as a step towards implementing sustainable alternatives to the existing deterrent environment.

This is done by addressing my hypothesis of how effective planning policies are, in its implementation of the integration of NMT with public transit systems.

KEY WORDS: *Sustainable transportation, mode shift, Bus Rapid Transit System, Non-Motorized modes*

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