1 INTRODUCTION

1.1 General Introduction

In India, the urban population has increased substantially from 62 million in 1951 to 285 million in 2001 and is estimated to grow to around 540 million by 2021. In terms of the percentage of the total population, the urban population has risen from 17% in 1951 to 29% in 2001 and is expected to rise by 2021 to around 37%. Consequently, the number and size of towns has also increased significantly. Although circumstances vary considerably across India's cities, some basic trends that determine transportation demand (such as substantial urban population increase, household income, and industrial and commercial activity) are the same. These changes placed heavy demands on urban transportation systems, a demand that many Indian cities were unable to satisfy.

Transfers in urban transport generally occur because the transportation system is unable to meet the needs of all origins and destinations, so there may be transfers to change the route for a commuter to reach its destination. In general, commuters prefer direct services rather than opting for a transfer involving time factor and inconvenience. Factors such as design, convenience of interchange provided by the authorities are critical for efficient transfer. If Interchanges are planned considering the above factors, the time minimizes and may reduce waiting time and comfort factor may increase for the commuters. Hence achieving integration in urban transport is necessary to make transfers easy and can attract ridership in public transport.

1.1.1 Urban transport responsibilities

Urban transport responsibilities are all those functions relating to the planning and management of the circulation of vehicles, passengers and pedestrians on the road system, and where relevant. They generally include:

- Planning and development of transport infrastructure (road and rail networks);
- Management of roads and road use, including licensing of vehicles and drivers;
- Public transport organization, development and regulation;
- Financing and investment;

» An interface with land use and urban planning.

Earlier public transport was designed to meet the mobility needs, but now the current situation requires not only mobility but also good connectivity and convenience for two or more modes of transferring. Many cities have come up with a proposal for transit systems such as BRT, MRT to meet transportation needs as no single mode can fully meet urban area needs. Multiple modes and possible integration need to be established between them, so that the traveler has less inconvenience to reach his destination.

1.2 The Meaning of Integration

Integration is defined as "the organizational process through which elements of the passenger transport system (network and infrastructure, tariffs and ticketing, information and marketing etc.) are, across modes and operators, brought into closer and more efficient interaction, resulting in an overall positive enhancement to the overall state and quality of the services linked to the individual travel components.

Integration refers to the strategic integration of various policy instruments in order to achieve better transportation performance. It may involve combining various measures within the 'tools' dimension, including infrastructure, management, regulation, and pricing. It can also involve the integration of transport policies and land use policies.

1.3 Need for the Study

The city of Ahmedabad is experiencing rapid growth and transportation issues have assumed critical importance. The city's transportation requirement is largely met by the following modes of transport.

» Bus transport as the major public transport with modal share of 42 %.

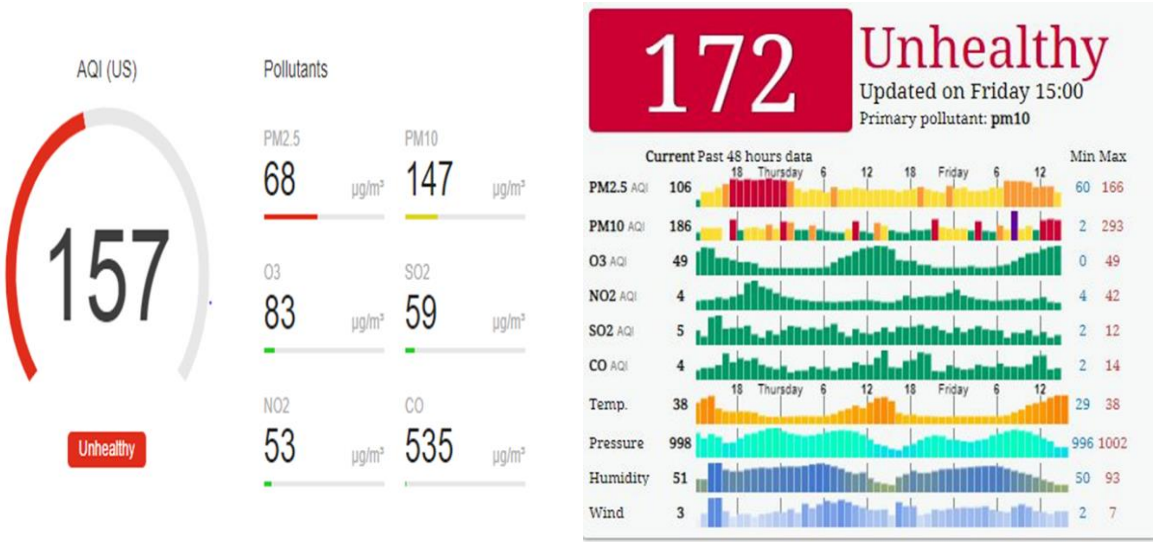
» Three and seven seated autos acting as the Para Transit contributing to nearly 6 % of the travel demand.

» Private vehicles (two and four wheelers) mode share is about 50 % of the total vehicular traffic.

» On average, 4-5 fatal accidents involving BRT buses are reported every year.(https://timesofindia.indiatimes.com/)

» More waiting time at interchanges and poor transfers increasing travel time (between two buses modes).

» Ahmedabad Air Quality Index (AQI) and PM2.5 air pollution is 157µg/m³.(https://aqicn.org/city/ahmedabad/)



Date: 25/11/2019 Date: 26/06/2020

Figure 1.1Ahmedabad Air Quality Index (AQI)

(Source: www.airvisual.com)

1.4 Aim, Objective and Scope

Aim: To identify the issues of the existing nodes and design or proposed interchange centres which can increase commuter's convenience at transfer stations.

Objectives: The following research objectives have been dealt with:

» To identify different levels of transfers possible and analyzing best practices for each transfer;

» To identify locations for designing transfers stations.

» To suggest parameter for achieving efficient transfers.

Scope: The main focus is on exchange transfers. Work emphasizes how to achieve physical integration by helping interchange commuters.

1.5Methodology

The in table 1.1 shows the research methodology, which indicates the data required, research question and the method of interpretation order to achieve main objective of the research.

Table 1.1Research methodology

Sr.no	Objective	Data collection	Interpretation / Method
1	To identify different levels of transfers possible and analysing best practices for each transfer.	Collection of case studies, analysing their different types of transfers.	Secondary data, physical interaction analysis
2	To assess type of transfers in Ahmedabad through analysing interchanges.	Questionnaire survey at interchanges for assessment of facilities and existing arrangements for transfers. Secondary data regarding commuters and transit systems (frequency, demand, no. of commuters)	Primary survey at interchanges, Management issues at the transfers
3	To identify gaps and barriers in achieving efficient transfers.	Identifying physical barriers and management issues	Interventions from case studies

Data Collection includes:

Primary Data - Field surveys at the transfers and analysing the commuter movements and routes; assessing the facilities at inter modal canters (paid area, unpaid area, shelters etc.)

Secondary Data– Planning Authorities, Bus operators, and previous (studies) project reports

Details of secondary data:

- Avg. Passenger/day (BRTS)
- Avg. km of Passenger travel
- Route Information (2 wheeler, 4wheeler, Para transit /Taxietc.)

2 LITERATURE REVIEW

2.1 Concept

The urban transport system have an enormous impact on the way people travel. However, increased urbanization population growth, urban expansion, dispersal of amenities and activities have increased the demand and dependence on motorized transportation. Consequently, urban transportation problem like congestion, accidents, environment degradation and urban sprawl have increased. Sustainable transportation development plans are thus replacing the conventional approach of building more road to alleviate congestion along with and integrated-mass-transport system, which is affordable, space and resource efficient, and minimizes environmental impacts and transport nuisance. As a consequence, encouraging and improving public transport system in developing countries like India has got wider attention and has become an important strategy for sustainable transportation development. Prior to sustainable planning, a detailed evaluation of the public transportation system with the help and performance indicators & evaluation is to be developed.

2.2 Definition

2.2.1 Urbanization

In simple word “urbanization is shifting of population from rural area to urban area” as a result of which there is gradual increase of population in urban area with vertical and horizontal physical growth. As per prediction of UN 60% people will live in urban area by 2030.

Cause of urbanization:

- People move from rural urban area due to lack of resources available in rural area.
- People living in rural area believes that standard of living in high in urban area compared to rural area, this is reason behind their migration. More job opportunity is also one of the major reason behind migration.
- Decrease in death rate and increase in birth rate is natural reason behind urbanization.

As per census 2001, there were two type of town identified by India.

a. Statutor Towns: All the place having municipality, corporation, cantonment board or notifies town area committee is declared as statutor town.
b. Census Town: All the place which satisfy following criteria is known as census town.
    - ✓ Minimum population 5000.
    - ✓ Minimum 75% of male population should be engaged in non-agriculture activities.

2.2.2 Urban Transport

The defining of urban transportation is the ability to cope with this density while moving people and goods. These characteristics mean that two of the most important phenomena in urban transportation are traffic congestion and mass transit.

2.2.3 Sustainable Development

Sustainable development is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural system to provide the natural resource and ecosystem service upon which the economy and society depends.

2.2.4 BRTS

Bus Rapid Transit (BRT) is a high-quality bus based transit system that delivers fast, comfortable, and cost-effective service at metro-level capacities. With the right features, BRT is able to avoid the cause of delay that typically slow regular bus services, like being stuck in traffic and queuing to pay on board.

2.3 Literature Review

Table 2.1 shows list of research papers which are reviewed for deriving objectives and find solution.

Table 2.1 Summary of Literature Review

SR. NO.	TOPIC NAME	AUTHOR NAME	JOURNAL (PUBLICATION)	YEAR
1	A New Vision for the Design Process of Sustainable Urban Transportation	Tarek Mahmoud Yousry Hassan, Wahab Mohammed	The Academic Research Community Publication	2019
2	Urban Data Integration Using Proximity Relationship Learning for Design, Management, and Operations of Sustainable Urban Systems	Karan Gupta, Zheng Yang, Rishee K. Jain	American Society Of Civil Engineers (ASCE)	2019
3	Efficient, effective and sustainable transport systems	Transperu	The Deutsche Gesellschaft für Internationale Zusammenarbeit (**GIZ**)	2018
4	Integration of a Multilevel Transport System Model into Sustainable Urban Mobility Planning	RomanikaOkraszewska , Aleksandra Romanowska , MarcinWołek , Krystian Birr	Multidisciplinary digital publishing institute (MDPI)	2018
5	Urban Transportation Information Platform for Next-generation Transportation	Akio Kani, Kojin Yano, HisanoriTeshima	Mobility Services for Better Urban Travel Experiences	2018
6	A Study of Sustainable Transportation System in Ahmedabad and Delhi	Pankaj Sharma	International journal of advance research, ideas and innovations in technology	2017
7	Evolution in land use and transportation research	Dea van Lierop, Genevieve Boisjoly, Emily Grise	Journal of Transport and Land Use (JTLU)	2017

8	Integrated and sustainable service level benchmarking of urban bus system	Pradeep chaitanyajasti , Prof. v.vinayaka ram	Transportation Research Procedia	2016
9	Public transport accessibility levels for ahmedabad, india	Jay shah, Bhargavadhvaryu	CEPT University	2016
10	GIS Integrated Urban Transportation Planning	Khajafariduddin, Dr. M Anjireddy	Indian journal of applied research	2015
11	Sustainable urban transport in the developing world: beyond megacities	Dorinapojani , Dominic stead	Multidisciplinary digital publishing institute (MDPI)	2015
12	Sustainable urban mobility: challenges, planning and initiatives in Jalandhar	Sahil, sahildugg,Manpreetsinghsaini	International Journal onEmerging Technologies	2015
13	Cetool to identify the Transit Demand at Public Transit Stops; A Case of Ahmedabad City, India ntrality Measures’	AmilaJayasinghe, TalatMunshi	International Journal of Advanced Research	2014
14	Integrated Mobility: A Research in Progress	Gianmario Motta, Antonella Ferrara, Daniele Sacco, Linlin You	Journal of Software Engineering and Applications	2013
15	Linking urban transport and land use in developing countries	Robert Cervero	The journal of transportation and land use (JTLU)	2013

16	Urban transport systems and congestion : A case study of indian cities	Absaralam, Faisal ahmed	Transport and Communications Bulletin for Asia and the Pacific	2013
17	Optimization of public transport demand: A case study of bhopal	Aranujjaiswal, dr. Ashutoshsharma	International Journal of Scientific and Research Publications	2012
18	An optimization procedure to design a Minibus feeder service: an application to the Sintra rail line	Luis M. Martinez, Tomas Eiro	Transportation Research Procedia	2012
19	Planning of an integrated urban transportation system based on Macro – simulation and MCDM/A methods	Szymonfierek, jacekzak	Procedia - Social and Behavioral Sciences	2012
20	Travel behaviour studies facilitate integration of land use and transport planning	K. Puntambekar	WIT Transactions on The Built Environment	2011
21	Integrating the Urban Poor in Planning and Governance Systems, India	DarshiniMahadevia, Rutul Joshi, Rutool Sharma	CEPT University	2009
22	Impacts of bus rapid transits lance on traffic and computer mobility	Vishali M.Patankar1, Rakesh Kumar, and Geetam Tiwari	Journal of urban planning and development	2007
23	Developing Integrated Schedules for Urban Rail and Feeder Bus Operation	Ashish varma, S.L.Dhingra	Journal of urban planning and development	2006

24	Review of urban transportation in India	Sanjay K. Singh	Journal of Public Transportation	2005

2.4 Critical Literature Review

Transperu (2018) Driving is becoming increasingly popular in Lima and Callao because of the poorly organised public transport system. These two factors are leading to more cars on the roads, longer traffic jams and a high level of pollution.

Pioneering structural changes contribute towards sustainable, efficient and low-emission urban transport in Lima and Callao.

1. Non-motorised transport
2. Fleet modernisation
3. Improving air quality and emission monitoring (MRV)
4. Implementing a national scheme to help local governments promote sustainable transport

Romanika Okraszewska, Aleksandra Romanowska,MarcinWołek, JacekOskarbski (2018) It is estimated that by 2050 cities will have attracted 70% of global population causing a threefold increase in urban trips identified the main challenges of growing urban transport. They are to:

1. Improve urban traffic flows by optimising the use of the private car, promoting active mobility (walking, cycling), sustainable freight transport
2. Increase the use of intelligent transport systems (ITS) within urban transport
3. Improve the safety and reliability of urban transport
4. Change transport behaviour and how urban communities perceive transport.

Pankaj Sharma (2017) The various modes of urban transportation – BRTS, metro, bicycle-sharing, usage of CNG fuels – currently available in the city of Ahmedabad and Delhi are discussed in the paper in the context of urban transport characteristics, public transport, and non-motorized transport. A multi-modal and integrated transit systems comprising of pedestrians, bicycles, buses, metro, and rail is to be created to monitor the

sustainable development of the city, use of an integrated mass-transportation system as a planning mechanism.

Pradeep chaitanyajasti, Prof. v. vinayaka ram (2016) Deteriorating quality of public transport has forced many commuters to shift from public transport to personal modes. This shift has translated into ever increasing traffic congestion, air and noise pollution, Green House Gas(GHC) emissions, reduction and deterioration of public space and urban from, social exclusion and many other negative externalities.In a system as complex as urban bus transport, one cold probably devise hundreds of measure to assess performance. The existing methods and techniques adopted globally to evaluate the public transportation system and integrated it with sustainability aspect. Sustainability is not just environment or social.

Dorina Pojani, Dominic Stead (2015)sustainable urban development, as cities across the world strive to meet urban sustainability standards by improving public transport, encouraging non-motorized modes, creating pedestrian zones, limiting the use of private cars, and otherwise trying to undo the transformation of cities caused by automobile dominance.

Some of the key strategies to be considered in these developing cities include:

1. street conditions conducive to green modes via low-cost interventions such as sidewalk maintenance and speed restraint
2. pedestrian-only zones in areas with heavy pedestrian traffic
3. exclusive lanes for busses and bicycles, which are adequately protected from car traffic

Amila Jayasinghe, TalatMunshi (2014) To measure transit demand of public transit stops based on network centrality parameters and how transit demand of PT stop are vary with network centrality, Ahmedabad city, India.

- This study concluded that centrality measures are useful to measure transit demand of transit stops of Ahmedabad city with referring to both AMTS and BRTS.
- Accordingly, following centrality parameters were selected.
    - To captures the level of accessibility (based on physical distance) of a stop from neighbourhood nodes.
    - To captures the level of legibility of a stop from neighbourhood nodes.
    - To captures the level of image ability of a stop at the city scale.

3 INTEGRATION IN URBAN TRANSPORT

3.1 Types of Services in Urban Transport

In general there are three options in terms of the overall service structure:

1. Trunk-feeder services;
2. Trunk-trunk service;
3. Direct services;
4. Mix of trunk-feeder services and direct services (hybrid services).

Trunk service: Service that generally has bus or rail lanes and connects major activity centers in the city referred to as trunk services (usually a trunk service may simply be the transit system running on the main corridor of public transport)

Feeder service: A transit service that picks up and delivers passengers to a trunk transit station generally referred to as a feeder service (mainly feeds residential areas, inner areas of a city).

Direct service: Service which offers trips to all major destinations and origins. Ideally this can not be done to provide direct services to the whole city. Most urban areas have a mixture of trunk feeder and direct services to meet their people's needs.

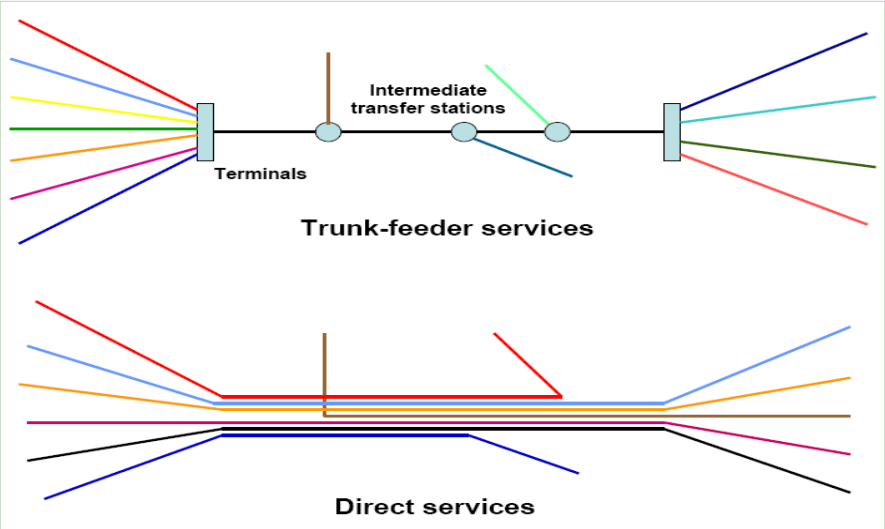


Figure 3.1 Representation of Trunk -feeder and direct services

Source: BRT Planning guide, 3rd edition March 2006

The following table explains the characteristics of trunk and feeder services.

Table 3.1Charteristics of Trunk and Feeder Services

Characteristics	Trunk	Feeder
General	Service that provides direct links between major centers of activity and suburban neighbourhoods at times. These are generally long distances and can often run through the city or along the main roads	Service providing suburban neighbourhoods not served directly by trunk routes and providing access to the transit station. In general these are short distance services
Exclusiveness	Trunk services may run on exclusively used ways (bus ways or tracks)	Mostly feeder services run on normal streets providing connections between the communities and the stations in the trunks. There are many cases where even feeder will have exclusivity
Vehicles	Trunk services will use high-capacity vehicles	Feeder services will use small capacity vehicles

Trunk – feeder services

These use smaller vehicles from residential areas to give access to terminals or transfer stations, where customers transfer to large trunk vehicles. Feeder services may operate on mixed lanes while trunk vehicles operate on exclusive tracks or bus or main hub for public transport. The concept of trunk-feeder services is similar in many respects to the practice of hub-and-spoke operations as used in the airline industry.

The following table 3.2 represents the advantages and disadvantages of Trunk feeder and direct services.

Table 3.2Advantages and Disadvantages of Direct Services and Trunk Services

Advantages	Trunk-feeder services	Direct services
	Operational efficiency: Ability to closely match demand and supply	**Time savings:** Only fewer passengers require transfers between routes. It can save travel time in two ways: 1. Reduction in waiting times at transfer stations 2. Potentially more direct routing to a destination.
	Transfers occurs causing cost and convenience to the traveller	No transfers occurs

	Service quality: These are coupled with closed system business structures.	
Disadvantages:		
	Time loss due to transfers: It takes time and causes passengers discomfort. When the convenience is too cumbersome, passengers may switch to different mode.	**Operational efficiency:** Passenger demand along a single route can vary widely. As a result, a large number of smaller vehicles are likely to operate at a lower capacity than would be optimal on the trunk roads.
	Distance travelled: The detour factor affects customer travel time from a residential area to transit station.	**Average speed and total travel time:** The slower operating speeds, due to congestion, can more than offset the customer's time advantage from avoiding a transfer.
	Infrastructure costs: Multiple platforms and pedestrian infrastructure facilities and O&M costs and construction costs. The economic costs associated with a trunk feeder service will be the amount of travel time delay due to transfers.	**Impact on mixed traffic congestion:** If direct services require more buses on congested trunk corridors to accommodate the same passengers, then the impact on the corridors will be great.

Source: BRT Planning Guide, June 2007 (ITDP)

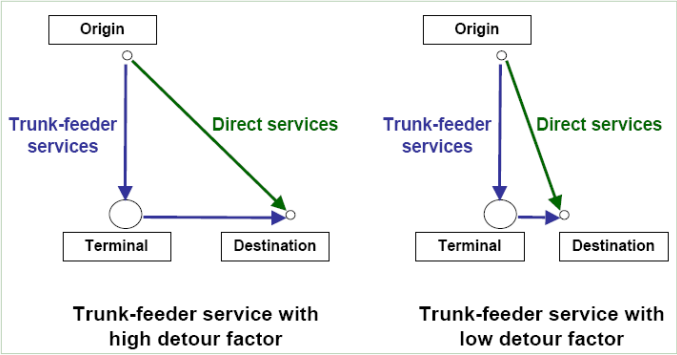


Figure 3.2 Detour factor of trunk feeder services

Source: BRT Planning guide, 3rd edition March 2006 (ITDP)

3.1.1 Decision Framework for Optimum Choice

Inherently, neither trunk-feeder services nor direct services are a right or wrong design option. In the right circumstances, either of these options can become effective. The factors that can help determine the optimum choice are below. The ideal solution should match the local distribution of the origins and distributions, as well as local demographics.

Importance of transfers:

Transfers can't underestimate the impact on ridership. Transfers are often one of the principal reasons why discretionary rides choose not to use a system. Furthermore, if the transfers involve any form of physical hardship, such as stairs, tunnels, or rain, cold, or heat exposure, then the acceptability of the systems becomes even more compromised.

In transport field, the terms trunk and feeder services / routes are associated which determine the major mode of transport or the transport network over which routes are designed.

Infrastructure of any transit system contains not only road work / rail work but also range of other components which includes

- Bus / Rail Infrastructure
- Feeder infrastructure
- Stations
- Intermediate transfer stations
- Terminals
- Depots
- Integration infrastructure
- Public utilities and Landscape

The physical design and engineering of the system follows directly from the features of operation and customer service. The expected capacities and service options selected by the corridor all influence physical design. The operational characteristics may also be influenced by even the physical design.

Landscaping

The transit stations should add aesthetic quality to the public space of a city, rather than diminish it. We should make every effort to retain existing green spaces. Pedestrians and bicycles can also get climate protection from trees and plants.

Transit stations

"All architecture is shelter, all great architecture is space design that contains cuddles, exalts, or stimulates the person in that space." – Architect Philip Johnson, 1906-2005.

Transit stations consist of three principle elements:

1. Platforms
2. Transition areas
3. Integration infrastructure

Most sizing aspects of the stations and sub-stop design are determined by the operational design.

Intermediate transfer stations*:* Facility that permits transfers between feeder services and trunk-line services.

Interchange stations*:* Facility that permits transfers between different trunk line routes.

Terminals*:* Large facility typically located at the end of a trunk line corridor that allows transfers between multiple feeder services.

The number and type of transfer facilities will depend in large measure on the transit system's operational plan. Several key factors will have been determined by the operational plan, including the number of BRT / MRT vehicles, the number of corridors and the number of trunk and feeder converging to a site. Likewise the location of transfer facilities will be determined in part by local physical factors such as the right of way available.

Intermediate transfer stations*:* Feeder connections to the trunk lines do not necessarily occur only at major terminal facilities. Feeders can also intersect the trunk corridors at what are known as intermediate transfer stations. These stations are somewhere in between ordinary local stations and terminal facilities.

Unlike terminal sites, intermediate transfer stations may not have the luxury of space to easily accommodate the platforms of both feeder and trunk-line. So designing and controlling the transfer process requires a bit of creativity.

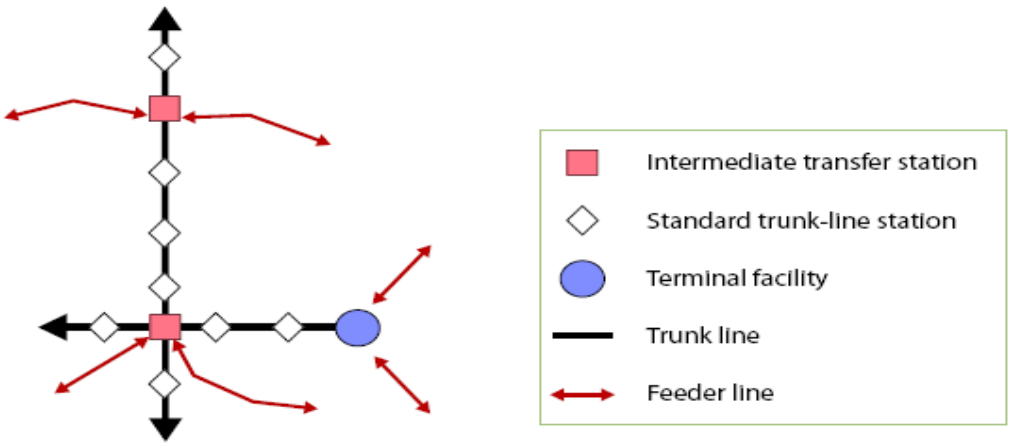


Figure 3.3 Open transfer and closed transfers

Source: BRT Planning Guide, June 2007

3.1.2 Corridor Integration

Before an integration with other modes of transport can be considered by a public transport system, a basic first step is to ensure the system is integrated with itself. This type of system integration refers to ensuring there is physical and fare integration between the various corridors, routes and feeder services. Unfortunately, this simple integration step fails with many bus way systems. Systems that operate as individual corridors forget the many synergies arising from the formation of a fully integrated network. As customer mobility needs are likely to include destinations on multiple corridors, a portion of its potential customer base is scarified in the system. Instead of enduring several different transfers each involving an additional payment, customers are likely to look for alternative means of transportation. Integration starts with a focus on internal routes and corridors for the systems. An internally integrated system can then considerably expand its base by allowing other modes to form a seamless interconnection within the main transit system.

3.1.3 Planning for Pedestrians

Pedestrian ways are the key components of the planning of ant transit stations. If it is not done then the system may distract customers. An evaluation framework was devised to assess the quality of pedestrian access to public transport. In particular, efficient public transport access is achieved with affordable, attractive, comfortable, direct, legible, safe and secure infrastructure.

Table 3.3 Parameters for Planning for Pedestrians

Category	Description
Affordability	The cost of providing access to transit is greatly impacted by the need for pedestrian bridges, underpasses and other important infrastructure.
Aesthetics	The pedestrian access area's aesthetics include the attractiveness of the walkway, the street furniture and the congruence between street design and local architecture.
Directness and connectivity	Directness involves a pedestrian path that minimizes the travelled distance to reach the transit station. Connectivity refers to pedestrians being able to easily access a wider network of destinations.
Legibility	Area readability refers to the ease of understanding the street environment. Maps and signage availability can help to make it legible.
Safety	A safe pedestrian pathway implies that pedestrians are well protected from road hazards such as vehicles.
Security	Security refers to providing an environment where pedestrians are not susceptible to robberies and other crimes.

Source: BRT Planning Handbook, ITDP, June 2007

Pedestrian access to public transport stations involves considering ease of movement at three critical points;

1. From the neighbourhood area to the corridor
2. Crossing the corridor to access the station
3. Movement within the station area

Ignoring just one of these pedestrian trip components can mean that the system is effectively non-accessible for a percentage of customer base.

3.2 Transfers between Trunk and Feeder Services

Transfers between the Trunk Service and the Feeder Service determine the efficiency of intermodal public transport, efficient integration between them ensures short-term journey, minimizes transfers, and ensures the commuter in a single public transport system.

The various levels of transfer that can happen between the trunk and feeder services are given below.

Table 3.4Levels of Transfer

Level	Name	Type of service	Case study
1	Good Route design	No Transfer necessary	Ideal case (No case study)
2	Platform Transfers	High customer convenience	Bogota
3	Grade separated in closed environment / fare integrated	Less convenience	Hong Kong
4	Grade separated in open environment / fare integrated	Less convenience	Seoul
5	Grade separated in open environment / fare compatible	Inconvenient	Singapore
6	Grade separated and Fare separated	Inconvenient	Kuala Lumpur
7	Physical barriers to transfer and fare separated	Poor customer services	

Source: Perception of the author

The above mentioned various transfer levels are explained in detail in Chapter Three with their respective case studies. There is no need to have the same level of transfers throughout the mentioned city. There may be more than one transfer level in one city but the different concepts and issues for each transfer level are examined in this research and the institutional and management aspects have been noticed for the effective functioning of that respective transfer. For the interchanges all aspects of success will be considered and analyzed for Ahmedabad.

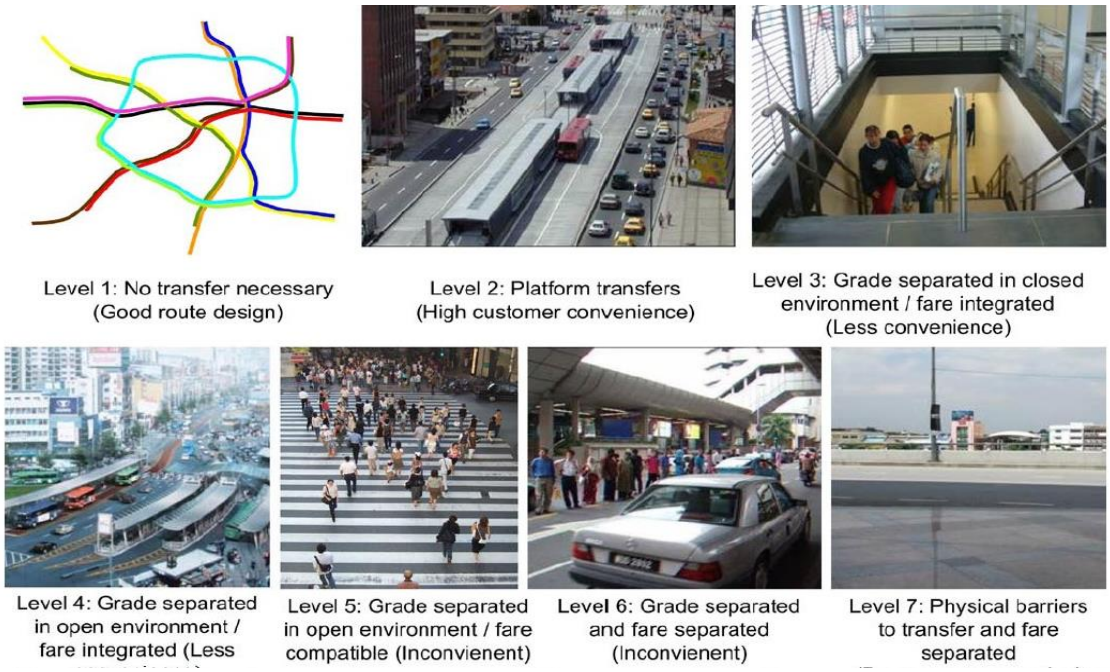


Figure3.4 Various Levels of Transfer

Source: BRT planning guide, 3rd edition March 2006 (ITDP)

The following are the description of each of the levels of transfer:

» Level 1 underscores the importance of having good system and route design to eliminate the need for transfers.

» Level 2 is the recognition that some transfers may be necessary but the use of multiple stops at stations can permit customer friendly platform transfers.

» The example for level 4 transfer is Seoul integrated transit system. Customers that enter a bus must use an onboard card reader to swipe their smart card. When existing, the same customers must remember to swipe their cards over again. Then if a person wishes to continue a journey using the metro system of the city, the card will be swiped when the metro system enters and exits. The Seoul system, however, is fully "integrated tariff" The total fare charged to the customer is based on the total distance traveled with a fare-integrated system. In Seoul, the smart card technology allows to deduct a quantity primarily from distance. However the distance covered is charged at a higher rate when using the metro rail system than when using the BRT system.

» The difference between a type 4 and type 5 is the difference between "fare integration" and "fare compatibility". Whereas fare integration allows a customer to avoid paying an additional entry fee into the second system, fare.

» Compatibility does not. With fare compatibility, a customer can use the same fare medium, such as the smart card, but must essentially, pay for an entirely new fare when entering the second system. Fare compatibility does not imply that there is any distance based consideration in determining the fare for a journey that encompasses two different systems. For example in Tokyo, there are two different metro rail systems; 1) Tokyo Metro and 2) Toei Metro. It is possible to purchase a smart card that can be utilized on both systems. However, while transferring from one system to another; a customer must effectively pay two separate fares. Thus, fare compatibility allows some convenience in terms of using a single convenience in terms of using a single fare payment method, but the fares, are not fully integrated and this lack of integration means that customers will likely pay more.

» By the time that one reaches transfer levels 6 and 7, optional customers will generally opt not to utilize the public transport system. At levels 6 and 7, there is neither physical nor tariff integration between different systems. Customers must not only pay twice but also must endure a difficult physical environment to walk from one system to another. Level 7 is the most difficult with actual physical barriers making transfers at the same station area almost impossible. For example in Kuala Lumpur the KL Sentral station hosts both PUTRA LRT operations and the KL Monorail operations. Likewise, changing from an intersecting PUTRA LRT line and a START LRT line in Kuala Lumpur is also a challenging experience.

3.3 Types of Integration in Urban Transport

Mainly the cities consider the function of urban travel as movement of passengers from one direction to other direction but they won't consider the traveller perceptions like convenience change of mode.

Theme of Integration: Integration refers to the strategic integration of different policy instruments to achieve improved performance of the transport system and other forms of integration are described below:

Table 3.5 Types of Integration in Urban Transport

Type of Integration	Main Objective	Ways to achieve
Physical Integration	Close proximity and ease of access at mode interchanges	Walkways and surroundings should be carefully designed for passengers to change mode so that minimum distance is required to change mode
Network Integration	Maximum coverage of routes and each mode should complement each other	Feeder services using buses, Trams/Light rail or Metro as Trunk service. It is closely integrated to physical integration
Fare Integration	Common fare for multiple modes	Common card or ticket can be issued for the passengers. This involves coordination from agencies of both modes
Information Integration	Comprehensive and easy travel convenience	Provide effective and accurate information to passengers in both modes. ITS will play important role.
Institutional Integration	A single Organization can easily handle and undertake decisions	Provide common framework, coordination amongst govt. agencies

Source: Compiled from various sources

3.4 Possible Integration Principles

There are certain defined principles that are pre-requisite for any city to achieve the highest possible level of integration. We can assess the level of integration in any urban area by basing the following principles.

The essential principles of integrated transport are:

The system must have effective public transport at its heart with:

- Ready access for all the population
- High frequency service

- Connections that are well-signposted, quick and easy
- Single tickets for multi stage, multimode journeys (e.g. Train, bus)
- Real time information as the journey progresses
- Integrated information for all transport modes within the city and with external connections (including the integration of all route and timetable information from all bus & tram operators)

It must be recognized that the process of transport integration is long term, that public support for it is vital given its cost and the disruption it will cause, and that this depends on success of all its phases.

Westerman (1998) proposed a new Integrated Transport Planning Directive. He argued that the planning process is of critical importance given the complex factors involved in integrated transport and land use planning, and the trade-offs involved. He also mentioned that stakeholder participation is important in the process, and the process applies to all planning levels, and guidelines are developed to ensure good practice.

He also proposes that better integration is achieved between the various modes is by first sharing the right and accurate information to passengers and then followed by common ticketing and suggests that ITS (Intelligent Transport system) can be triggered for achieving Integration.

According to English Tourism Council Study (ETB, 1999; ETC, 2001; Cole, 2001) the concept of 4 I's is very much essential for a system to achieve Integration. They identified the Integration equation as:

Information + Interchange + Investment = Integration

The absence of any of these elements will hinder or even prevent the development of an integrated passenger transport system. The details of each of the component are explained below.

Information

Visitors, especially those from other cities, need to know more than just how to embark on the first stage of their travel. They must know how to travel beyond any given intermediate transfer point and on the destination they choose. Each mode of transportation can provide

information about its services and route schedulers. The ultimate goal should be route planner plus information system, which shall contain the following:

- Accurate bus information available
- Information such as important telephone numbers for bus and rail services and online mapping should be provided for all routes in the city
- Timetables are difficult to read and often not lit, at bus stops and railways/bus stations.
- Signage outside bus/rail stations is generally poor and at best average. Railway station on platform information on buses, taxis, routes to telephone and village/town Centre requires improvement.
- Connecting services bus/rail is often uncoordinated.
- There is a need for travelers to have their own pre information on locations. More training in route geography for call Centre staff was identified.
- Printed versions of through travel information would be welcomed by travelers.

Interchanges

High quality seamless interchange facilities are an essential requirement to suit private vehicle convenience. Particular attention should be paid to the ease of ticketing arrangements, e.g. tickets allowing to travel on different types of transport, and the physical environment of interchanges;

Studies into traveller needs (DCMS, 1999; ETC, 2001; INIT, 2003) have suggested the following criteria for seamless interchanges;

- Clear, comprehensive information on the interchange characteristics;
- Ease of movement (particularly for those with heavy luggage or young children);
- Secure parking for cycles, cars and motorcycles;
- Clear directional signs, between modes and to local destinations (eg. town Centre, hotels);
- Short walking distances;

- Good timetable displays;
- Well maintained infrastructure, clean toilets, etc.;
- Left luggage facilities;
- Car hire provision.

Action has to be taken to implement these policies, so providing seamless interchange between train, bus, bus and taxi. As with many policies, their success lies in the positive impact on traveller convenience.

Investment

On the strategic level, the achievement of traveller requirements – the prerequisite to inducing modal change – is through funding and organization of change.

This requires investment to make the train or bus more attractive. Sometimes it needs to smart the image and the quality of the service. Often a more radical and expensive expenditure program is needed because of underinvestment in the long term. Large-scale public funding should be the answer for enhancing quality and reliability.

3.5 Advantages of Integration in Urban Transport

Urban transport if integrated has many advantages for both the users and the operators as most of the services are shared by many operators. The following are the advantages if the public transport is integrated:

- Accurate information available to travelers
- Through ticketing
- Lead to some improvements to buses and bus journeys
- Increases reliability of public transport system

The following are the specific advantages for the customers due to Integrated Transport

- Free choice of transportation system (e.g. Bus, rail etc.)
- Comprehensive strategy one tariff – one ticket
- Coordinated timetables (best connections)
- Improvement of quality

The following are the advantages for the service providers due to Integrated Transport

- Synergy effects for marketing, customer information etc.
- Unification of distribution (ticketing)
- Simple tariff system for all public transport systems
- Consistent market presence
- Higher demand on public transport

3.6 Concept of Synergy and Removal of Barriers in Integration

Most approaches to strategic integration focus on one of two types of principle: the pursuit of synergy and the removal of barriers.

The pursuit of synergy involves finding pairs or groups of policy instruments that reinforce one another in bringing about changes in the transport system, such as modal shares, or improvement against goals of strategy such as efficiency or environmental protection. Removing barriers implies identifying factors that hinder the implementation of a policy instrument otherwise desirable, and using a second tool to overcome it. Parking fees, an increase in fares or revenue from road pricing can all be seen as ways to provide financing for new infrastructure.

3.7 Role of Coordination for Integration Process

Coordination plays a key role in integration to achieve common objectives. It should be attained at both the strategic, implementation, and operational levels. The top-down approach is considered better for quick integration outcomes. The table below explains the stage of the planning process and the level of coordination required at each level.

Table 3.6 Role of coordination for Integration process

Stage of the planning process	Potential role of the coordination
Strategic planning	Consultation between planning and operating agencies in the definition of problems, problems and needs and in the development of possible solutions
Implementation planning	Development of both qualitative and quantitative approach to project identification and development with coordination among agencies and government at different geographical levels
Operational planning	Service coordination and synchronization of schedules

	among the different transport providers

3.8 Intermodal Transport Planning Principles

There are certain principles which are considered necessary for successful intermodal system.

1. Connection

All modes should be well connected with one another to accomplish the convenient and efficient movement of commodities and people. Connecting points should be conveniently located and connections timed to facilitate movements from one mode to another.

2. Choices

The intermodal network should offer choices, allowing its users to select the mode that can most efficiently satisfy their transportation needs.

3. Coordination

The transportation infrastructure should be planned, designed and built in such a way as to bring the modal networks closer together enough to make connections relatively effortless. In addition, transportation providers must coordinate their schedules to reduce dwell time between intermodal movements.

4. Cooperation

There should be cooperation and collaboration among transportation providers and governmental agencies at the federal, state, and local levels to ensure that the needs of the users for seamless service are realized.

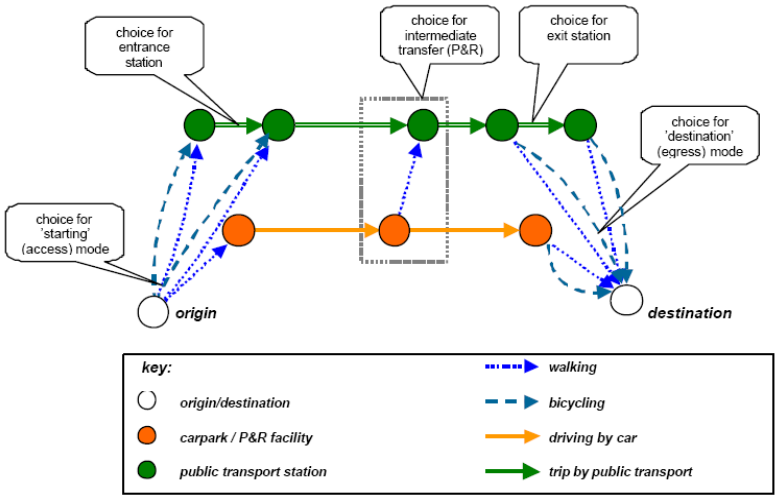


Figure 3.5Importance of Physical Integration

Source: EMTA - European Metropolitan Transport Authorities Presentation (www.emta.com)

Overall it is concluded that, with regard to inter urban transport, spatial structures and transport network structures are robust over time. Multimodal transport will not affect, and still govern, the mechanisms that have resulted in, these structures. Then, the main design problem for multimodal interurban networks is reduced to allocating transfer nodes only.

3.8.1 Multimodal Transport Systems

Usually, travellers may choose between different modes for a specific trip, for instance, either private car or public transport. However, travellers can also choose a combination of travel modes in a multimodal transport system. That concept isn't as new as one might think. All public transport journeys can theoretically be defined as multimodal trips. This is particularly true for train journeys. Various modes can make the trip to and from the railway station, such as bicycle, private car, taxi, and bus. Bicycle parking lots, park and ride facilities are examples of such services.

The transport network description includes aspects such as:

» Space accessibility: where can a user enter and leave the transport service;

» Time accessibility: when can a user actually use the transport service;

» Travel speed or travel time: how long does it take to travel from an entry point to an exit point.

3.9 Learning

From the major literature learning, the first output to achieving good physical integration includes a series of identification of pedestrian movements and guidelines that can help planners, designers and managers to systematically analyse interchanges, taking into account the different types of barriers to passenger use. The tools will have their main application in the design stage of interchanges. They include guidance on what user prefers and on involving users and non-users in the process of planning new or improved facilities.

Key factors influencing the effectiveness of interchanges have been identified as:

» Two effective running transit systems having demand for each of the system

» Logistical and operational factors, such as the failure to synchronize services between different modes;

- Psychological factors, notably the fear of crime in the area around the interchange;
- Institutional and organizational factors, particularly due to poor co-ordination between the many stakeholders;
- The functional quality of the physical design and layout;
- The ease of access to the interchange and the availability of parking;
- Economic and social factors, such as cost of travel and the development of commercial services at the interchange;
- The availability of pre-trip and real-time information.

The various aspects and features of an interchange analysis showed general agreement about the high importance of safety/security, information and car parking. However, experts in infrastructure design emphasized the aspects of layout, location and quality of connections, while users had more uniform concerns across all interchange characteristics, with preference for comfort and security issues. Certain features – surveillance, toilets, traffic and travel information, cleanliness and security against theft and vandalism – have been perceived to be poorly performed at a number of locations.

It was concluded that improving interchanges at a network-wide level requires:

- A definition of the strategic public transport network, which identifies the demand for interchanges;
- An overall information strategy for the network, covering pre-trip and real-time information;
- A system of quality standards to monitor the performance of interchanges;
- Fare and ticketing policies that minimize the barriers to interchange between services;
- Organization and management structures that can take an integrated view of the interchange within the network as a whole;
- The promotion of co-ordination arrangements at the location-specific level.

4 CASE STUDY

4.1 Case of Bogota

Bogota the capital city of Columbia and the most populous city in the country with a population of 67,76,009 and an area of 1587 sq.kms. Bogota has a very good BRT system , known as Transmilenio, which acts as a city service provider for both the trunk and feeder services. It has 470 articulated buses running at a capacity of 160 passengers per bus. It has 300 standard feeder services, with a capacity of 90 passengers. It has very good, closed terminals so transfers can easily take place. To transfer from main to feeder, it has a single ticketing facility and vice versa. Bogotá's average travel length of 16 km and typical destinations occurs on specific corridors and these corridors have excellent BRTS connectivity through both the trunk and feeder services.

Bogota mainly runs four types of public transport systems namely: Traditional bus service, Spun off services, Informal or Illegal often known as Pirate services and the BRT system Transmilenio. The traditional bus service which is operated and maintained by private operators competes with the Transmilenio by fare.

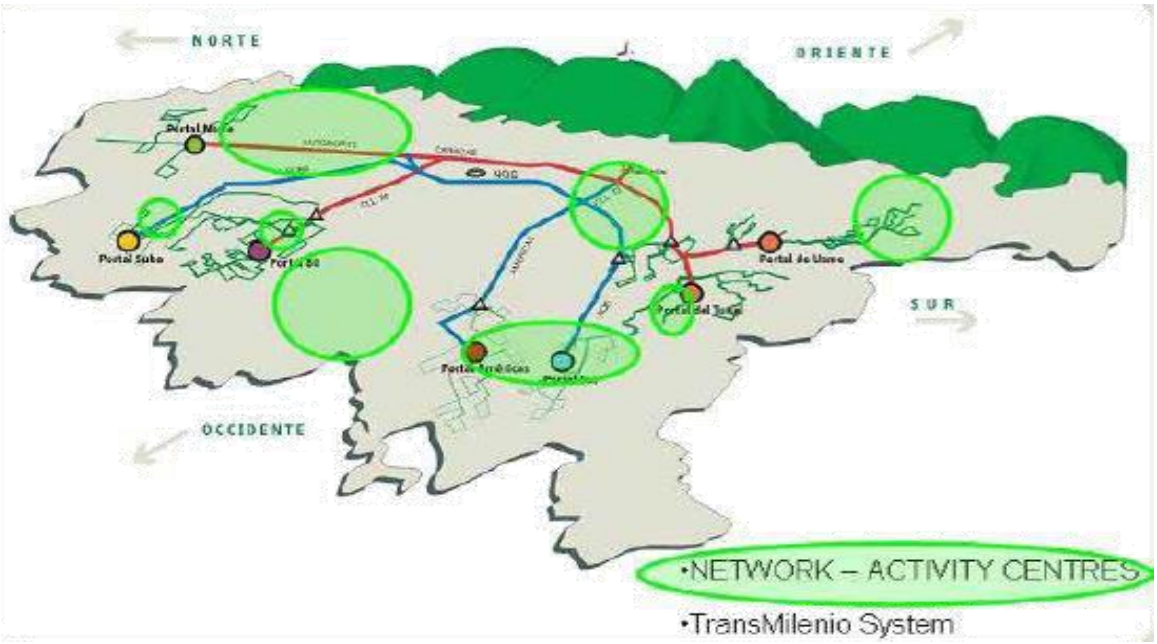


Figure4.1 Network Activity centers

Source: Study of urban public transport conditions in Bogota

In Bogota, the route of trunk and feeder services is planned in such a way that major centers of activity are covered and based on the identification of demand areas where

formal feeder routes are required. Transfers between Transmilenio's Trunk and Feeder services occur in a closed system that provides the passengers with high convenience. But there are no convenient transfers between Transmilenio Trunk and Informal feeder service due to different fare structures and institutional problems. Bogota has excellent bicycle – bus integration.

Type of transfers in Bogota

In Bogota transfers are discussed in two ways, one in the mid-way of the lane and other at the terminal point. The following diagram represents the two types of transfer.

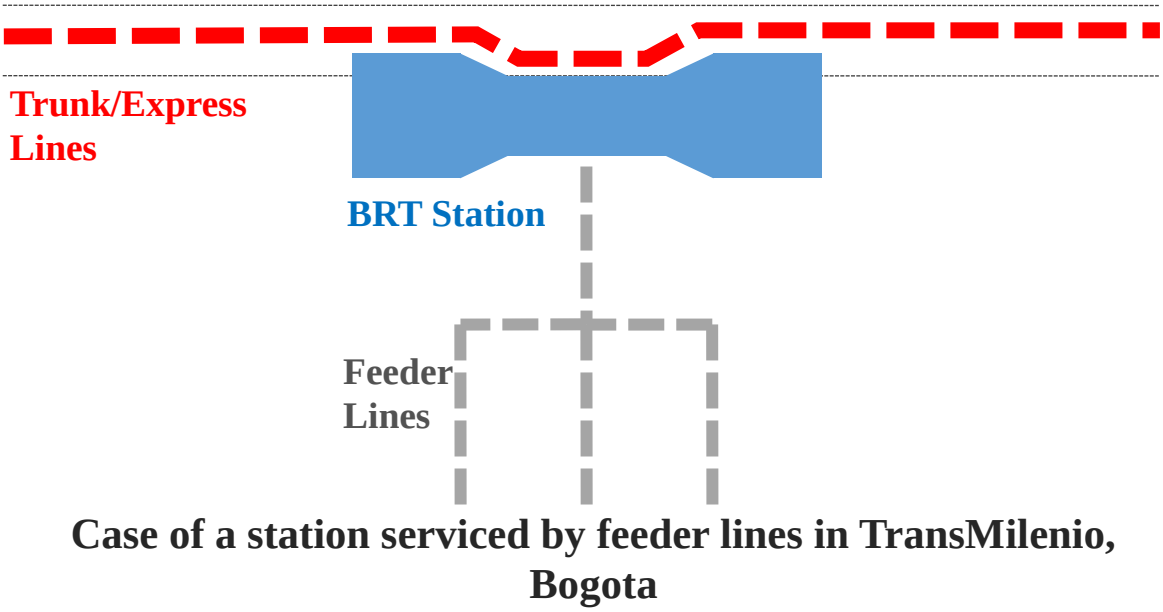
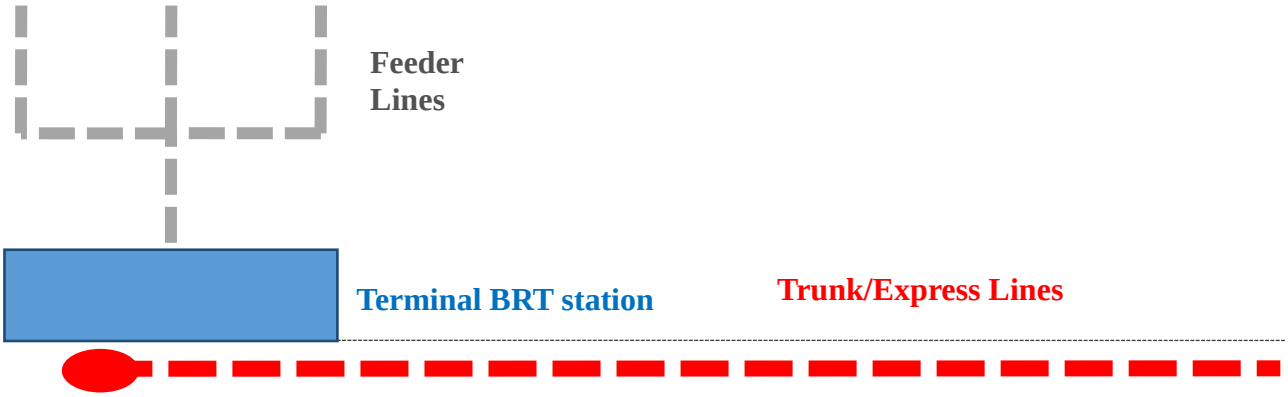


Figure 4.2Type of Transfer in Bogota

Figure 4.3Transfers at Terminal point of BRT Station

Source: BRT Planning guide, June 2007 (ITDP)

The type of transfer at terminal point is represented in line diagram as follows:



Case of a Terminal station in TransMilenio System, Bogota

Figure 4.4Transfers at Terminal point of BRTS

Both type of transfers happens at same platforms providing greater convenience to the commuters, which is supported by fare integration of Transmilenio at both trunk and feeder services.

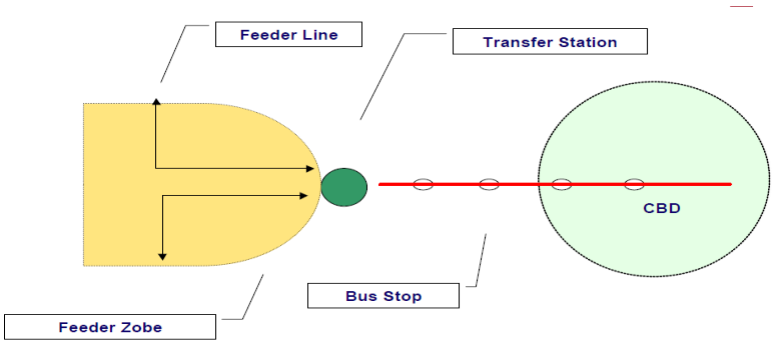
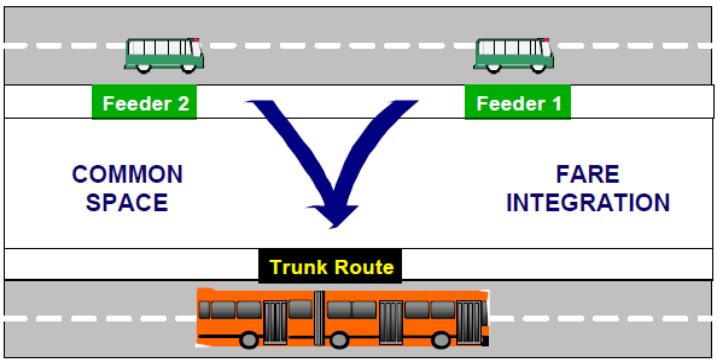


Figure 4.5 Physical connection of feeder and mains

Source: Public transport in Bogota, Arthur Cadilla (2011)



`Figure 4.6 Integration of feeder and trunk services

Figure 4.7 Integration of cycle with bus services

Figure 4.8Grade separate crossings in Bogota

Source: BRT Planning guide, June 2011(ITDP)

Bogotá's ramped pedestrian bridges work quite well with virtually no non-compliance. Key features include: 2.5 meters wide, aesthetically attractive, clean and well maintained facilities.

Table 4.1 Urban Trannsport in Bogota

		Transmilenio		Standard Bus	Spun off Traditional Bus	Small Vehicles
	Usage type	Trunk service	Feeder Service	Feeder Service	Feeder Service	Para Transit-suburbs
Who operates?	Planning	Gov. authority	Gov. Authority	Take permission from government	Take permission from government	Informal Private
	Operator	Private	Private	Informal Private	Informal Private	Informal Private
Mode	Route length (km)	38	107	NA	NA	NA

Choice	Mode selected	Articulated bus	Standard bus	NA	NA	NA
	Characteristics	On grade-dedicated bus lanes	On grade-mix traffic system	NA	NA	NA
	Capacity	160	90	35 – 40	35 – 40	8 - 10
	No. of stations	62	51 routes	NA	NA	NA
	Distance between stations	500 m			NA	NA
Level of service	Average speed	32	20	NA	NA	NA
	Headway	2 min	3 min	Unorganized	Unorganized	
Fare Integration	Fare system	Flat fare				
	Fare cost ($)	0.79		0.46	0.46	Informal
	Fare where	Off board		On board	On board	On board
	Fare technology	Contactless smartcard				
Usage	Daily ridership	519676	499297	NA	NA	NA
	PPHPD	42000	NA	NA	NA	NA

Sources: Compiled from various sources

4.1.1 Lessons from Bogota

- Horizontal integrated services are provided within the system of Transmilenio at both midways and terminal points. BRTS even has excellent integration with cycles.
- Design issues are considered at the transfer points catering the needs of both trunk and feeder passengers.
- Integrated ticketing facilities ensured passengers the convenience, savings in time and machinery. Feeder services attract zero fare.
- The terminal points and mid way transfers are designed by considering the efficient demand for the transport at that point.

4.2 Case of Singapore

» Singapore an island city state with an population of 48, 394, 00 (2016) and an area of 710.2 sq.kms. The first strategy implemented in the town is to give high priority to city wide planning (Wang and Yeh, 1993). The transit system (electric rail) is fixed, fast and comfortable, and is also flexible and local (standard and mini buses). In Singapore, the buses and railways are well integrated. The success of the model in Singapore goes to the high-density urban development closely integrated around the transit station. Singapore 's basic urban structure plan shows a series of radial and circumferential mass transit and light rail lines with major and minor sub-center nodes that develop around the intersection of all these lines at high densities.

» The success of Singapore in integrated development around their respective stations goes to high percentage of city's activities concentrated within walking distance of stations and the ease with which stations are reached either on foot or by transit.

Table 4.2 Statistics of Singapore (2016)

Sr.no	Descriptor	Percentage of population / Passengers
1	Percentage of Singapore population living within walking distance of MRT station	30 %
2	Percentage of Singapore population living within 1 km of the line	50 %
3	Percentage of all businesses and industrial areas located near stations	40%
4	Percentage of passengers who walk to and from MRT stations	65%
5	Percentage of passengers who transfer to or from buses at MRT stations	35%

Source: Introduction to "The MRT story", MRT Corporation, Singapore

» According to the report of LTA, the story of Singapore's successful transit system is not without its battles, nor is it without the support of other highly successful policies aimed at restraining car use. The advice from the World Bank and some American consultants in the 1970s was that it would be wrong to invest in an expensive, high profile, fixed rail facility; according to the World Bank all that was needed was to upgrade their buses. However, Singapore chose to go ahead with their rail system as they realized that buses alone do not offer a

competitive service to the car and they would not be able to implement their transit-oriented city plan without a high capacity rail service linking their sub-centers both to the city center and across the city in a series of circumferential rings. Buses, it was realized, would not have the capacity to serve such dense activity concentrations without severe congestion problems and their stop environments would necessarily be much larger, dirtier and noisier places than electric train stations. Such environments would be unattractive places for the density of the planned development and the resulting intense pedestrian flows, and physically more difficult to integrate than an underground or elevated railway station. Since its opening in 1987, Singapore's MRT service and integrated bus system has been extremely successful in both economic and environmental terms. In 1990 the overall transit system in Singapore achieved a 15% operating profit.

» Some of the groundwork for transit's success, as well as its ongoing achievements in Singapore, are due to Singapore's famous Area Licensing Scheme (ALS) introduced in 1975 to reduce morning peak commuting into the CBD, and its long history of steep vehicle taxes, including the more recent Certificate of Entitlement (COE) system which requires would-be car owners to bid for the right to buy a vehicle. The price of a COE varies continuously, but in early 1994 it was as high as $S63,000 on top of the car purchase price (The Straits Times, December 17, 1993).

» Separate bikeways, for example, are part of New Towns' planning to facilitate access within the cities to MRT stations and commercial areas. Bikeways are planned for many routes as well. In the central area there are pedestrian precincts, transit malls, malls, walks and galleries consisting of covered streets with lots of shops, restaurants and cafes. Extensive greening of the town to moderate the harsh climate is an important part of the pedestrian and bike plans. (Urban Redevelopment Authority, 1991: p.39)

» The harmonious policy-making for coordinating complicated problems in Singapore is handled easily by efficient coordination between the agencies as shown in the figure below.

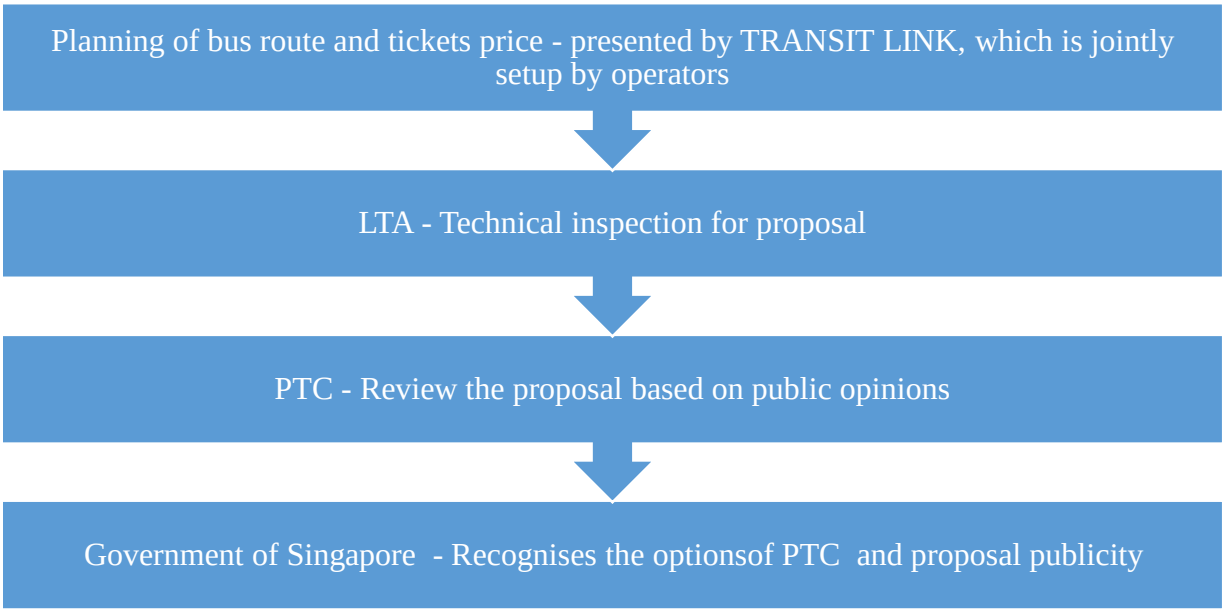


Figure 4.9 Plan flowing process in Singapore

Source: Compiled by the Author

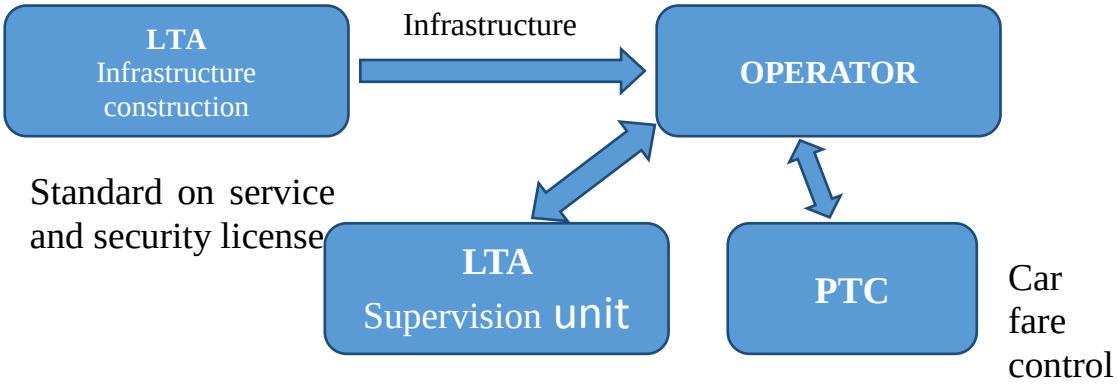


Figure 4.10 Duty division of Rail transportation

Source: Compilation of Author

Singapore has effective pricing program to manage traffic congestion. It is the first city in the world to introduce the Area licensing scheme and Electronic road pricing to implement congestion charging for traffic management. The car costs are kept high through vehicle quota system and other ownership fees.

Singapore has many modes of transport catering the needs to its citizens. The average trip length is 8.6 Kms. It has Rail, LRT, traditional bus services and Taxi services. The rationale for providing LRT services is to act as feeders to main MRT line from high density housing estates. It provides a good linkage for short distance trips between two or more high activity centres. It also provides long distance links and direct inter-town transit

between new towns. Even the LRT stations are located on the arterial roads and integrated within feeder bus routes for easy access. The stations are within the 400 m walking distance.

4.2.1 Physical Integration in Singapore

New transit stations are designed to integrate with commercial development and at least one other transport mode (Tong 2002). The North East line, which opened in June 2003, has well integrated all of its stations with the adjacent activity centres. This policy is a departure from earlier MRT station design – often separated on average by a 10 minute walk from the nearby neighborhood and shopping area. The architectural design is given more attention from both an aesthetic and an accessibility point of view. Secure and easy walking trails and elevators are now available for all users, especially for the ageing population.

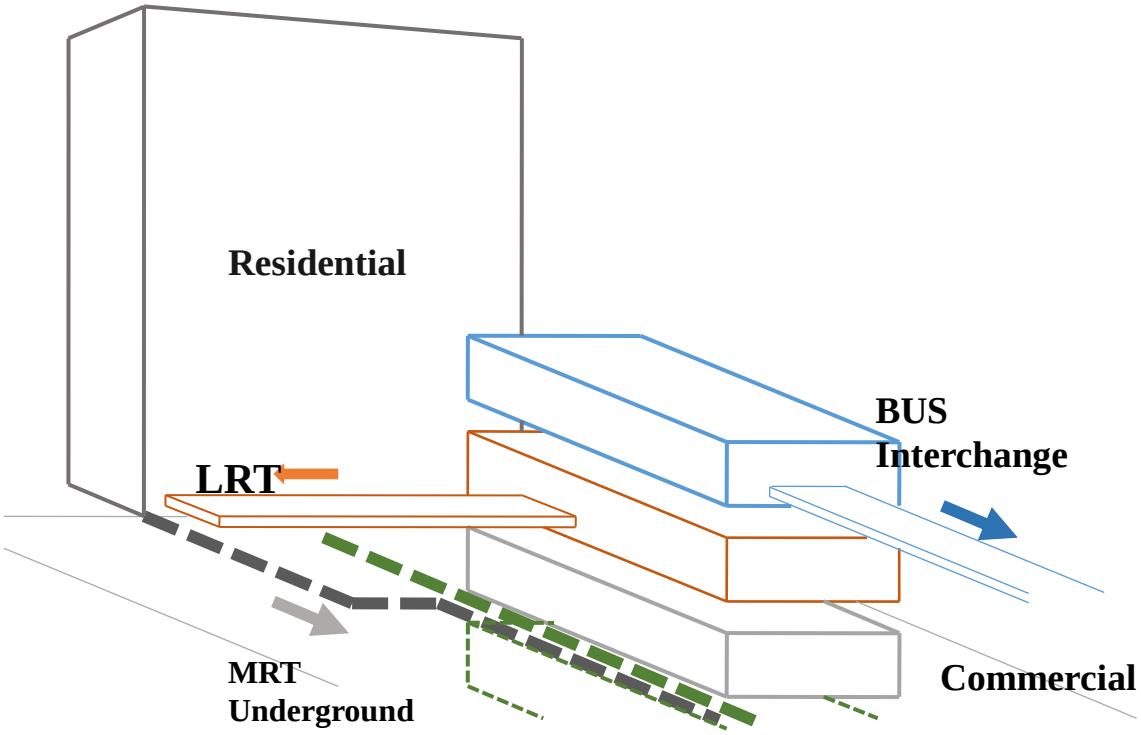


Figure 4.11Integration at various level of space

Source: Drawn by the author

Figure 4.12 Physical Integration in Singapore

Source: BRT Planning Guide, June 2009 (ITDP)

» To allow seamless travel experience bus shelters are refurbished, better taxi stands are provided, ne link ways from station entrances to bus shelters, interchanges and adjacent buildings upgrading and improvements to overhead bridges.

» In the above figure with in the MRT station on the first basement level and the LRT station on the elevated platform level, the two stations are vertically integrated. At ground level the LRT station is linked to Sengkang bus interchange and surrounding buildings via bridges or covered link ways. Within the station, vertical transportation between the LRT/MRT platforms is through the escalators and lifts without having to exit the paid area of the station area of the station, using the same fare card.

» The annual Transit Link guide gives commuters integrated information on all aspects of travelling on both the buses and the MRT. Comprehensive information panels are also put up at all MRT stations and major bus stops, particularly for the ease of commuters making transfers.

Table 4.3Urban transport scenario in Singapore city

		MRT	LRT	BUS	TAXI
	Usage type	Trunk services	Feeder service	Wide Range	Para Transit-Parallel system

Who Operates?	Planning	Government authority			Controlled by Govt authority
	Operator	Private consortium			Private company
Mode Choice	Route length (km)	109	29	260 routes	
	Mode selected				
	Characteristics	At all three grades			
	Capacity	610	105		
	No. of stations	66	43	4375	174 stands
	Distance btw stations		400 m	400m	
Level of service	Average speed (km/hr)	45	32.5		
	Headway (min)	2	3	5	Upto 10 min
Fare Integration	Fare system	Progressive fare			Metered
	Fare cost ($)	0.47 - 2.6	0.4 - 0.84	0.6	
	Fare where	Off board			On- board
	Fare technology	Contactless Smartcard			
Usage	Daily ridership	1564000	81000	2969000	927000

Source: Compiled from various sources

Lessons from Singapore

The solutions are on their Singapore Government door step and involve a three-pronged attack along the lines of Singapore:

- Commitment to building up quality transit, preferably rail;
- Efficient land use and transport integration at the city planning level ensured that transfers work efficiently and sufficient demand is created
- Some preparedness to introduce parallel physical and economic restraints on private transportation which support the investment in transit preferably before the decision to build transit and;

- To invest in relatively inexpensive improvements in the environment of pedestrians and cyclists
- Vertical integration is possible by encouraging the concept of ToD which enables public transport ridership and also efficient transfers.
- Institutional integration with all operators (LTA as the Regulator) has ensured the design aspects of the transfer stations.

4.3 Case of Seoul

Seoul is the capital city of South Korea with a population of ten million with an area of 605 sq.kms.

Transportation in Metropolitan Seoul

The urban transport system in Seoul has changed continuously as the economies grow and demand for transport increased. Until 1945, surface trams were the most popular mode and were used by more than half of the Seoul population. Public buses became the major mode when trams were abolished in 1968.

The economic development and urbanization are pulling more people in to Seoul, causing rapid growth in transport demand in urban areas. However since 1992, the population of the core city itself has decreased steadily. In contrast, metropolitan Seoul has increased continuously due to sub urbanization.

With an aim to achieve a transit system which is both faster and convenient, in July 2004, Seoul opened a new chapter in public transportation by introducing bus transit system. Each bus in the municipal transit system now employs one of four colours; blue, green, red or yellow depending on its function. Passengers can easily identify the starting point and the destination of the bus at a single glance. The entire area of Seoul is divided into eight zones, which are clearly indicated in the numerical designation of the bus.

Blue buses (Main line): These serve as the major trunk roads between down town Seoul and satellite cities of Seoul. These buses have the letter “B” on them representing blue buses. Bus numbers has 3 digits (Example 141)

Green buses (Branch line or Feeder Services): These buses serve the routes subway stations and nearby residential areas/ main bus lines. (These routes are often covered by village buses). The buses have the letter “G” on them, representing green buses. Bus numbers have 4 digits.

Red buses (Wide area lane): These serve routes between major areas (downtown, Gagman, Uijeongbu, etc). The buses have the letter "R" on them, representing red buses.

Yellow buses (Circular lane): These serve circular belt roads in the downtown and major metropolitan area. The buses have the letter "Y" on them, representing yellow buses. Bus numbers have 2 digits (Example: 41)

Bus numbering system

In Seoul the numbers and colours differentiate the bus types as mentioned above (Blue – Main line, Green- Branch line, Red- Wide area lane, Yellow- Circular line)

The most important feature Seoul ensured for Integration of public transport is integrated fare system designed to reduce financial burdens when switching between forms of mass transportation. Passengers get free transfers or discount benefits only when using a transportation card. No discounts are available when using cash or single tickets. From 2005, no more cash is accepted in buses.

Table 4.4 Urban Transport in Seoul

Sr. no.	Parameters	Seoul Metropolitan Subway corporation	Seoul Metropolitan Rapid Transit Corp.	Incheon Rapid Transit corp.	Korean Railroad corp.
1	No. of lines	4	4	1	4
2	Type of body	Public corp. under control of Seoul metropolitan Gov.	Public corp. under control of Seoul metropolitan Gov.	Public corp. under control of city of Incheon	NA
3	Operation	Operates metro lines 1,2,3,4	Operates metro lines 5,6,7,8	Runs one metro line	Functions like a metro in the city, suburban rail in other portions
4	No. of km	135 km of metro routes	152 km of routes	22 km of routes	178 km system (57 km in Seoul city boundary)
5	No. of stations	115	148	22	104
6	No. of trains	199	201	25	150
7	Intervals peak	2.5 - 3 mins	2.5 - 6 mins	4 - 6mins	1.7 - 8 mins

8	Intervals off-peak	4 - 6 mins	5 - 6 mins	7.5 mins	3.6 - 12 mins
9	Average daily ridership	Avg. ridership lines 1,2,3,4 - 4.2 million passengers	Avg. ridership lines 5,6,7,8 - 2 million passengers	3,25,000	2.2 million passengers

Source: Compiled from various sources

Transportation card in Seoul

Transportation card in Seoul is called T – Money stands for "top, touch, total, travel, technology", making it much more than just transportation card. The fare discounts can be obtained when changing mass transportation means to reach a destination. Passengers should have their T – Money or existing transportation card read by a machine.

Integration in public transport and coordination of public transport is done by easing transfer between transport modes, linking urban rail and express way networks for regional travel demand.

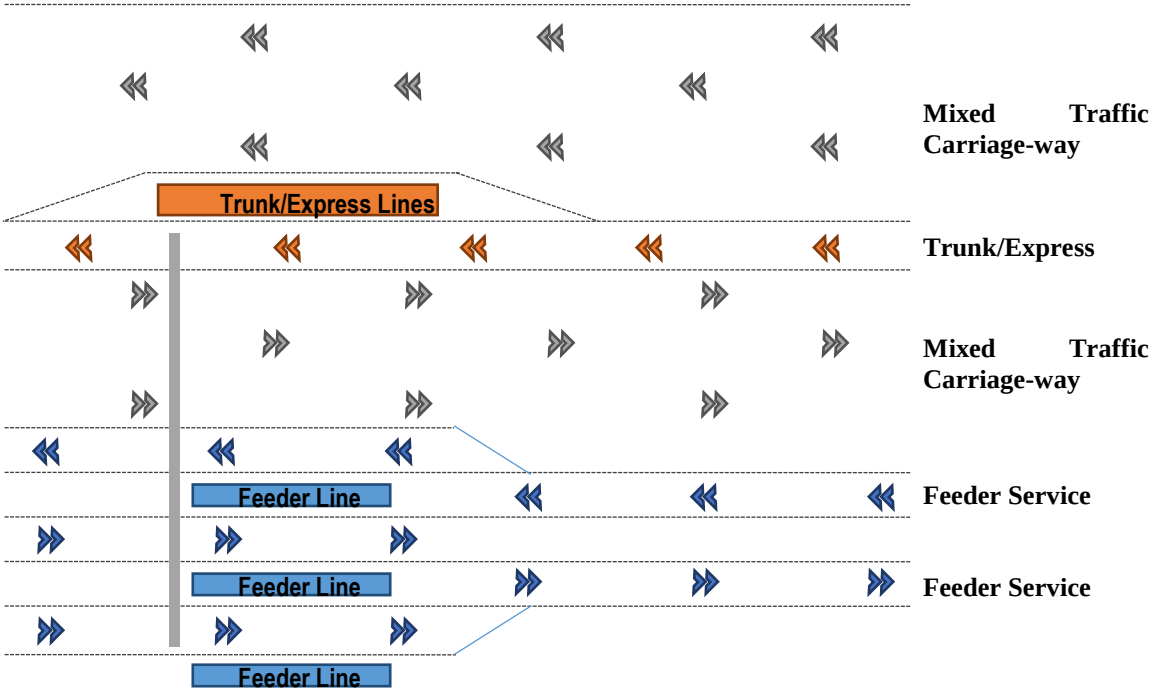
The SMG (Seoul Metropolitan Government) regulates the bus companies as a public utility to ensure realizable services. It ensures route monopoly by regulating route changes, fare levels, vehicle numbers and service frequency. These severe restrictions on bus operators make it hard for the companies make it hard for the companies to optimize service levels and respond to market changes; also they can cause an unbalanced distribution of transport modes, increasing private vehicle use in particular.

Rail Transit System

Unlike the public bus service, Seoul's railway system is constructed and operated by the government. It forms a reliable and comfortable mass transit system within Seoul's traffic policy. Although Seoul's urban railways have only a short history dating from 1974, they are a key transport mode and occupied 35 percent of passenger trips in 1996. When phase II of the urban rail network, the total network became 278 Kms and about 42 percent of all passenger trips will be by rail. The Rail system consists of Seoul Subway and Metro Rail, operated by two public corporations. Seoul Metropolitan Subway Corporation (SMSC) operates lines 1 to 4 of the Seoul subway, and the Seoul Metropolitan Rapid Transit Corporation (SMRTC) operates lines 5 to 8 of Metro rail. To improve intermodal transfer and environment friendliness, 24 parking lots have been built at 22 stations, along with bicycle racks at 47 stations.

Transfers at Seoul

The following represents the transfers between different bus services (trunk and feeder services) which involves at grade transfer with zebra crossings. Transfers in Seoul generally happen at At-grade level which involves crossing the lane, or using foot over bridges. People find it very convenient and people do transfers easily with minimum time required without any obstacles.



Case of grade separated Interchange in Open environment, Seoul

Figure 4.13Transfers between different bus lines (Red and Green; Trunk and Feeder)

Source: Drawn by Author

4.3.1 Learning's from Seoul

» Even though the fare is integrated between bus services the seven bus interchanges are not physically integrated and others need at grade transfers which causes less convenience for the commuters.

» The organizations SMG and SMRTC are in the regulatory control of SMG (Seoul Metropolitan Government) so that stations are designed at a least possible distance and provision of least convenience is made for transfers.

4.4 Case of Kuala Lumpur

It is the largest and the capital city of Malaysia. The city has an area 244 sq.km has an estimated population of 1.6 million in 2006. Greater Kuala Lumpur also known as Klang valley is an urban agglomeration. The city covers a variety of transport modes such as bus, rail and taxi.

Bus System

RapidKL bus is the largest bus operator in the Klang Valley Malaysia, statistics of 2008 reveal that it operates 167 routes with 650 buses covering 980 residential areas with a ridership of about 4, 00,000 per day. The other operators in Kuala Lumpur and Klang valley are Metro bus; Len Seng Omnibus Co. Ltd and Selangor Omnibus Co. Ltd also serve the Klang Valley. Rapid KL operates three types of bus services: City Shuttles, Trunk Buses and Local Shuttles. There are also point to point Express buses.

RapidKL's new bus system expects users to hop on more than one bus to complete journey. This is unlike the previous RapidKL bus system and that still in use by other bus operators in the Klang valley, where most buses begin in suburbs, follow a trunk route to the city, then perform a sweep in the city centre before terminating.

The fare system consists of no single or return tickets are issued (with an exception of express bus). Tickets issued on board buses are daily passes that allow passengers unlimited travel on buses, although there are restrictions as to which buses may be boarded depending on the type of pass purchased. There are several major bus stops in Kuala Lumpur. Many local bus routes, especially those operated by private operators, terminate and begin at the old quarter of Kuala Lumpur, typically along Jalan Cheng Lock.

Regulation of Public Transport

Regulation of public transport is regulated by various authorities including the Commercial Vehicle Licensing Board (CVLB) of the Ministry of Entrepreneur and Co-operative development, the Ministry of Transport and local governments and municipal councils. There is no body that regulates the whole sector. Furthermore the fare structures vary different from various operators.

4.5 Case of Hong Kong

Hong Kong with a population of over 7 million is one of the densest places in the world. Hong Kong too has an effective transit stations, well integrated land use and transport

system and restrictions on the automobile. Due to topographical constraints, the intense pressure on available land in Hong Kong and the potential for overwhelming congestion if the private car was to be unleashed, the physical planning principles of Hong Kong have always been strongly based on the need to create super-compact nodes of strongly mixed development in which people can access most local needs within a short walk. Now these nodes are mostly connected by the MTR system, so that longer trips do not require a car or a bus trip that has been congested.

Coupled with effective land use-transit integration, Hong Kong's traffic management is directed not at facilitating car use by creating quantum leaps in road capacity, but at optimizing the existing road system. The success so far is evidenced in the fact that average traffic speed rose from 20 km/h in 1979 to 24 km/h in 1988 and again to 26 km/h in 1991 (Kam, 1993). Hong Kong has achieved such results through the following:

- Computerized Area traffic control
- Transit priority measures – bus only lanes, bus-only streets, bus only turns etc
- Developers are not required to provide parking in the core urban area according to the size of buildings, in recognition of good accessibility by transit or by foot.

Transport services in Hong Kong are provided by the railway corporations and private sector, and they operate profitably. Government is responsible for the co-ordination of the various modes, and has been successful in regulating the system.

The public transport services dominate the transport scene in Hong Kong and account for around 90 percent of all passenger trips. The main provider of the trunk route is a heavy metro system with a large number of passengers at low marginal cost and low adverse environmental effect. Next are the buses, and LRT as the other major trunk service providers.

Hong Kong’s high density provides easy physical integration and most of the Mass Transit Railway (MTR) stations are well-integrated with activity centres and local neighborhoods. The city has integrated fare system since1997. The investments are in more and better modal interchanges in heavy and light rail routes.

Coordination of Different Transport Modes

One of the principles of governments transport policy is "expanding and improving public transport", and given the variety of modes, some degree of coordination by government is necessary. The government's intermodal co-ordination policy, as stated in the 1900 white paper on transport policy, is intended to:

*"*Give priority to off-street modes and economic road users, and to minimize wasteful competition*."*

It should be noted that the objective is not to eliminate all competition, but to strike balance between effective use of public transport facilities and the freedom of choice for the public. Such a policy also provides positive environmental benefits.

The principal components of co-ordinated public transport system are suited public transport interchanges, an information system, so that passengers can effectively choose their routes and a common payment system.

Public transport interchanges should be convenient, comfortable and easy in use, in order to attract the maximum number of passengers. There are already several interchanges in Hong Kong, including MTR stations in the Central / Hong Kong, Admiralty Station, Sha Tin Station, Tung Chung Station and several others. Each of these interchanges has a set of feeder services that connect to a wide variety of local destinations, using appropriate capacity modes of transport. Future interchange locations could include West Rail stations, such as Kam Tin, and new Central and Wan Chai Reclamation rail stations. It is not essential for all connections to be by rail and for some, trunk bus systems would definitely be needed. Bus interchange schemes at Shing Mun and Tai Lam Tunnels were introduced.

Cycling in Hong Kong plays a minor role for topographical reasons, though major efforts are being made to increase through cycling facilities such as bicycle parking areas at rapid transit stations and the development of shaded cycle ways.

Table 4.5 Statistics of Hong Kong related to Urban Transport

Sr.no	Descriptor	Percentage of population / Passengers
1	Percentage of Hong Kong population living within an MTR catchment area - a walking distance of 500 m from any MTR station.	50 %
2	Percentage of passengers who walk to and from MTR stations.	69.4 %

3	Percentage of passengers who walk either to or from an MTR station, requiring feeder service at only one end.	28.3%
4	Percentage of passengers who require a feeder service at both ends of an MTR journey	2.3%

Source: Mott Mac Donald, Hong Kong (2001)

Hong Kong has both Metro and Light rail as their main modes of transport which are operated by MTR. Hong Kong physical integration is a type of cross junction. The figure below shows the combined use of two cross platform interchange stations at stations in Mong Kok and Prince Edward for transfers in different directions in Hong Kong. They are stations adjacent, and combined together. There is a single platform between the two travel directions or two side platforms between the tracks connected by level corridors in this type of transfer. Passengers do not need to transfer to another level of the platform, thus increasing commuting efficiency. Building a cross-platform interchange can be expensive because of the complexity of alignment of rail tracks.

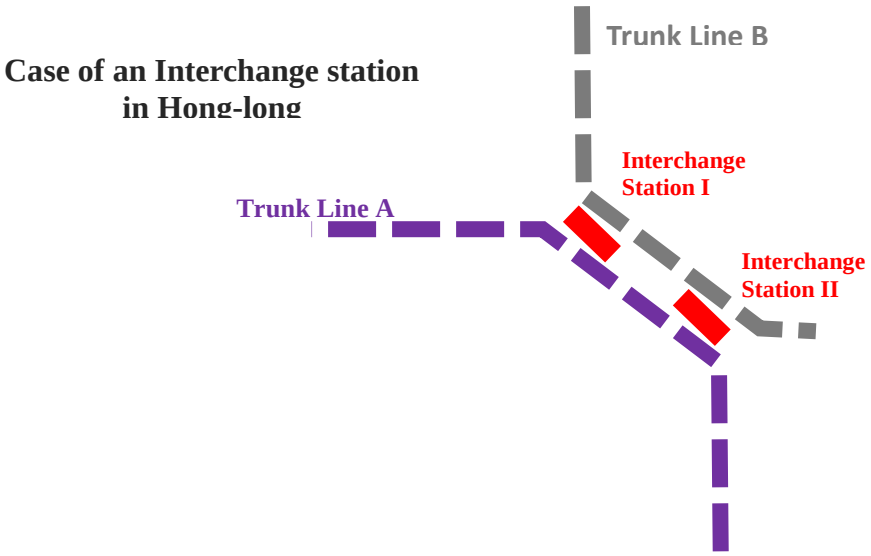


Figure 4.14 Cross junction type of integration in Hong Kong

Source: Drawn by Author

The details of the various modes and their operation is given in the below table

Table4.6 various modes and their operation in Hong Kong

		HONG KONG							
		MTR	LRT	BUS	Kowloon bus	Ferry	Minibus	Tram	Taxi
	Usage type	Trunk service	Trunk + Feeder	MTR feeder service	Trunk + Feeder	Short trip	Feed heavy rail, light rail and ferry	Short trip service	Para Transit
Who operates?	Planning						Informal		
	Operator	MTR corporation limited			Private Comp Ltd		Informal	Hong Kong Tramways Limited	
Mode Choice	route length (km)	175	36.2	20 routes	420 routes		352 routes		
	Mode selected								
	Characteristics						Informal	30	
	Capacity	2500	238				16	123	
	No. of stations	82	68				no fix routes	250	
	distance btw stations								
Level of service	Average speed (km/hr)	max 80 km/h							
	Headway (min)	2 to 3						1.5	
Fare Integration	Fare system	Progressive					Informal	Flat fare	Progressive
	Fare cost ($)							0.25	
	Fare where	Off board					on board	Off-Board	On board
	Fare technology	Octopus card		Free with card					
Usage	daily ridership	3400000	370000		2700000	62300	1798500	240000	1100000
	PPHPD	80000	20000						

Sources: Compiled from various sources

4.6 Learning's from the best Practices

There are various steps involved for planning of feeder services to the trunk and physical integration between them. It involves identifying areas most likely to be using the transit and identifying routes for them.

Feeder service is planned for the second grade routes where the demand or ridership expected is comparatively low than served by main trunk service and still requires having comparatively high frequency and formal scheduled service. These routes should either serve the suburbs or the inner routes of commercial centres, etc. where there are many branches to be served by mass transit system.

Feeder routes should be planned to take passengers from the terminals of truck service to branches. These routes should be appropriate from the start or end of the trips within 500 metres. The routes may be in loop as in the case of Singapore if the length of the route is not too long or open ends as in the case of Bogota.

In the cities Singapore and Hong Kong, the development of integrated transport has not developed from a common platform. Only with real, strategic effect and a high level of cooperation between transport agencies and operators could the integration of such services happen. Singapore demonstrated a systematic approach to implementing multimodal travel measures package and benefited from a relatively new public transport infrastructure (MRT and LRT) and government funding. Hong Kong, on the other hand, benefits from its high density and the people's close proximity to the many available public transport systems. Its transport infrastructure is already well integrated with the development of land use but will continue to benefit from better designed interchanges.

Table 4.7 Factors of Integartion in case study cities

Factors for Integration	Where it is done	How it is done
Institutional Structuring	Bogota and Singapore	In Bogota Transmilenio operates as both trunk and feeder services and free transfers happen between them. In Singapore LTA is responsible for entire regulation of transport systems and hence transfers are planned in efficient manner so that less inconvenience is caused to the commuter
Interchange Design	Singapore	Transfers are done in closed environment, High percentage of activities concentrated within walking distance of stations and the ease with which stations are reached either by foot or by transit. 65 percent of Singapore passengers walk to and from to transit stations. Safe and easy walk ways are always cleanly maintained
Fare Structuring	Seoul	Transportation cad in Seoul called T –

		Money. The fare discounts can be obtained when changing mass transportation means to reach destination.
Land use - transport Integration	Hong Kong	Hong Kong supplied high-density areas along the transit station, creating sufficient demand for transit systems. A mix of land use can be found at every station which provides the commuters with all kinds of facilities. The vertical level of integration occurs at the retail level and businesses raise funds for the transit company
Network Design	Singapore	Heavy rails are planned for the high density corridors and LRTs are planned for Residential developments. The bus services will act as feeder routes to complement those services
Bicycle – bus integration	Bogota	Bogotá's ramped pedestrian bridges work quite well with virtually no non-compliance. Key features include: 2.5 meters wide, aesthetically attractive, clean and well maintained facilities.

Source: Compiled from various sources

Lessons from other Principles of Integration

» There are many advantages for travellers to use a common ticket system for all, or most of the public transport modes. It reduces transfer time required from one mode to another.

» Real time information about the transport system at both on and off board adds to comfort level and easiness of the passengers.

» Barrier free design of stations increases accessibility for even the physically disabled people.

» Locations of stations of multi transport systems plays crucial role towards the efforts made by passengers in doing transfer. The transfers may be:

- Between on-grade modes (using interchange cross platforms may be useful)
- Between different modes

» Passenger should be avoided to counter the regular road traffic while transfer is required.

4.7 Comparison of Cities for various parameters

The following table represents the comparison of various cities based on various parameters of physical integration.

Table 4.8 Comaprision of various indicators for case study cities

S.no	Parameters	Cities			
		Bogota	Singapore	Hong Kong	Ahmedabad
1	Existing Modes of Transport	Traditional Bus service, Transmilenio	Rail, LRT, Bus and Taxi	MTR, LRT,MTR CL buses	AMTS, BRTS Buses
2	Average time taken from feeder services to trunk services	5 mins	5 mints	5 - 10 mints	Varies from 5 - 20 mints
3	Frequency of the Trunk services	2 mints	2 mints	3 mints	20 mints in peak and 40 mints in off peak
4	Frequency of the feeder services	3 mints	5 mints	10 mints	Average 3 mints in peak and 15 mints in off peak
5	Average distance for availability of feeder services from Residential areas	700 meters	200 - 300 meters	300-600 meters	500 meters to 800 m
6	Facility of common ticketing	Yes, Smart card facility	Progressive fare	Progressive fare	Yes (Common monthly pass is Issued)
7	Extensive Information on routes and stations	Provided	Provided	Provided	No
8	No of stations in Trunk service	62	66	NA	26
9	No of routes for feeder service	51	43	NA	NA
10	Distance between Trunk stations	500 metres	400 metres	NA	Average 1.2 Kms
11	Average speed of the feeder service	20 Kms	33 Kms	30 Kms	25 Kms
12	Provision of Taxi stands	Provided	Provided	NA	Provided
13	Approach roads and linking of buses	Good condition, No major issues	Routes from all corners	Good condition	Moderate, new roads are being added
14	Average distance for availability of feeder services from Residential areas	700 meters	200 - 300 meters	300-600 meters	500 meters to 900 m

Source: Compiled from various source

The previous table brings out the issues related to the transfer time, provision of feeder services to residential areas etc. These factors are analysed for the study area of Hyderabad. The table4.8 brings the comparison of case study cities with their transport characteristics and level of integration existing in city.

5 STUDY AREA PROFILE

Metropolitan city Ahmedabad is located in western India, Which is know as ‘Amdavad’. It is located on the bank of the river Sabarmati, It is Gujarat’s formal capital. Ahmedabad having a latitude of 23,0225 degrees N 72,574 degrees E longitude. Ahmedabad is Gujarat 's largest city with a population of 5577940 (as of 2011 census data) which is India's fifth most populous city with an area of 464 square kilometres under Ahmedabad Municipal Corporation (AMC) while Ahmedabad is larger with an area of 1866 square kilometres and 72 lakh population under Ahmedabad Urban Development Authority (AUDA). According to Forbes Magazine, after two Chinese cities in 2007, Ahmedabad is the fastest growing city in India and the 3rd fastest in the world. Ahmedabad is popular for production of cotton, it is second largest producer of cotton in India, as well as having good economic and industrial hub in India. Cricket is popular sport in Ahmedabad, city having stadium “Sardar Patel Stadium” with 54000 seats. The motera stadium (Ahmedabad) known as the motera stadium is being rebuilt with 110,000 seats, making it the largest cricket stadium in the world. Developing waterfront in Ahmedabad along the bank of the Sabarmati River which is known as the Sabarmati Riverfront. Ahmedabad is selected in 2015 alongside India's first 20 smart cities and scored 66.81 per cent for the smart city plan. In 2010 Ahmedabad was ranked third in Forbes ' list of the decades' fastest growing cities. Ahmedabad was also selected in 2012 by Time of India as the best city in India to live in. In 2014 Ahmedabad's Gross Domestic Product stood at $64 billion. Old Ahmedabad was declared first UNESCO World Heritage City by India in 2017.

Governing Authorities

Ahmedabad Urban Development Authority (AUDA)

State Government of Gujarat established AUDA in 1978 with prime objective to carry out the sustainable planned development of the area falling outside of the periphery of Ahmedabad Municipal Corporation (AMC). AUDA's expansion comes from 1866 square kilometer Area, in which, in addition to AMC limits, it also includes 5 growth centers and 169 district village Ahmedabad(In 2018). AUDA's core functions are to prepare physical plan , implement the planning proposal, regulate development as per infrastructure and social facilities planning, planning and implementation.

Ahmedabad Municipal Corporation (AMC)

In 1950 is established under the Bombay Provincial act, 1949. AMC is responsible for the Ahmedabad town's civil infrastructure and administration. Area under AMC is located on the bank of the river Sabarmati.19 other municipalities are included within the jurisdiction of AMC. AMC is divided into a total of 6 different zones with North Zone, South Zone, East Zone, Central Zone, West Zone and New West Zone names. Between 2003 and 2011 AMC is awarded a total of 20 times for various practices and works of excellence. Area below AMC is located on Sabarmati River bank.

Demographic Characteristics

As per census 2011 data, Ahmedabad is 5th most populated city in India and is on 7th for most populated city of India encompassing urban agglomeration. Population density of Ahmedabad city was 1200/km2 in 2011. Literally rate of the city was 89.62% in 2011 in which 93.93% male and 84.81% female population were literate, while sex ratio of Ahmedabad city was 1.11.(Source: AMC website)

Trends of Population Growth

Ahmedabad is largest city in the state of Gujarat having population of 5577940 (As per 2011 census data) which is 5th most populous city of India having area of 464km2 under AMC with population density of 120pph, while grater Ahmedabad having area of 1866km2 and 172 lakh population and percentage increase or decrease year wise as per census report.

Table 5.1 Population Growth of Ahmedabad under AMC

Census	Population	%Increase/Decrease
1951	7,88,300	32.4
1961	11,49,300	45.9
1971	19,50,000	69.6
1981	25,15,200	29.0
1991	33,12,200	31.7
2001	45,25,013	36.6
2011	55,70,585	23.12

Source: Census Data Report 2011

5.1 Economic Profile

Ahmedabad is an industrial base for sectors like chemicals, textiles, drugs and pharmaceuticals, as well as food processing. Since 1980 textile and chemicals have been the district’s main investment and employment sectors. The district of Ahmedabad accounts for 21.5 percent of factories, and employs 18 percent of state workers. The

district contributes more than 14 percent of total investment in all stock exchanges in India, and 60 percent of total industrial productivity.Several business conglomerates such as Adani Group, Reliance Industries, Nirma Group and Industries, Arvind mills, Claris Life Sciences,Cadilla Pharmaceuticals, Shell, Vadilal Industrial Ltd., Rasna, BoshRexroth (Germany), Stock and Rollepaal are present in the district. Presence of Ahmedabad Textile Industry's Resarch Association (ATIRA), the largest association for textile research and allied industries in India, has helped the district in becoming a thriving textile centre. Most of the medium and large scale industries are concentrated in talukas such as Ahmedabad city, Sanand, Viramgam, Daskoi and Dholka. There are around 422 medium and large scale industries based in Ahmedabad district with total investment of INR 5,45,988crode (US $1,33,167 million) providing employment around 79,904 people. The district has over 23,734 small scale industries generating over 95,591 jobs with total investment of INR 89,356.5 lakhs (US$ 21,794 million). Engineering, textile, chemical, and paper products are the major small scale industry sectors present in the district, withaninvestment to tune of INR 68,22lakh (US$6,639 million).

Ahmedabad is a key center of growth and development for the entire region and also for the state. Ahmedabad contributed to 17 per cent of state income in 1995, with 7 per cent of the total population. Ahmedabad city accounts for 21.5 per cent of the state's factories employing 18 per cent (2000) of workers. As history goes, for its large base of textile mills & related industries, Ahmedabad was once known as the "Manchestra of the East." The city currently serves as the corporate headquarters for many large and small business houses like Arvind, Adani, Nirma, Torrent, ZydusCadila etc. The Adani Group is a leading multinational trading and development company with infrastructure.Two of the biggest pharmaceutical companies of India namely, ZydusCadila and Torrent Pharmaceuticals, are also based in Ahmedabad. Ahmedabad is also an educational hub having leading institutions like Indian Institute of Management (IIMA), Nirma Educational and Research Foundation (NERF), National Institute of Design (NID), Indian Institute of Packaging, Mudra Institute of Communications, Ahmedabad (MICA), Centre for Environmental Planning and Technology (CEPT), Applications Centre of Indian Space Research Organisation (ISRO), Central Institute of Plastic Engineering Technology (CIPET), Ahmedabad Management Association.In recent years significant growth in automobile manufacturing has been concentrated around Ahmedabad. Ford, Hero Honda and Peugot production units are also being set up in Ahmedabad, and in the near future around 35 ancillary industries will likely follow. Various efforts have been made to promote the

tourism industry in Ahmedabad such as the development of hotel industry and the introduction of medical tourism.

Economic Drivers

An increase in the investments in sectors such as textiles, chemicals and agro processing over the last 20 years has made Ahmedabad has emerged as a thriving industrial center in the state. By leveraging the existing textile, chemical and pharmaceutical base, Ahmedabad is attracting several large multinational giants. Due to various prominent educational institutes such as Indian Institute of Management (IIM), Center for Environmental Planning and Technology (CEPT) and Mudra Institute of communication, Ahmedabad (MICA), there is a presence of a large qualified pool and manpower for various industries. The purposed Delhi Mumbai Industrial Corridor (DMIC), Dholera (Special Investment Region) and Gujarat International Finance Tech-City (GIFT) are expected to fuel the industrial growth of Ahmedabad. A newly emerged corridor between Ahmedabad and Pune which connects the district to other metropolitan cities including Vadodara, Surat and Mumbai has led to the axial growth of the region.

5.2 Demographic Profile

Ahmedabad being the commercial capital, the general safety environment and Gujarat's entrepreneurial people contribute to the attractiveness of the city. It has a strong industrial base of traditional manufacturing, in particular textiles, chemicals, plastics, machinery, and alloys and basic metals. The cities located on the proposed industrial corridor Delhi-Mumbai, therefore the city region remains an attractive investment destination. Several SIR's and SEZ's are being proposed for the region. Because of these trends the city will experience rapid population growth and demand for travel. The regional city of Ahmedabad accounts for:

• 25% of the States 'urban population

• 20% of the State's GDP

• 14% of the total investments in all stock exchanges in India

• 60% of the total productivity of the state and

• 22 % of factories in the state employing 18% of workers

Ahmadabad Urban Development Authority (AUDA) is lead organization for planning and regulating development in and around Ahmadabad. It has an area of total area of 1866 sq km (includes new AMC area of 466 sq km) under its jurisdiction. .Ahmedabad also has The first full BRTS of India.

The population in the AMC limits increased from 4.5 million in 2001 (AMC, 2012) to 5.56 million in 2011, with a population density of 118 persons per hectare. Spatial distribution of this population in the city over the decades shows that up until 1981, the majority of the new population added to the city was concentrated within the limits of the old AMC itself, particularly in the eastern part. In the 1980s, expansion of the peripheral areas, especially on the west, began and has continued to date. While the western area accommodates high-income residences, the south-west and north-west part of the institutional low-income areas.

Table 5.2 Ahmedabad area and population

Area and Population Details	2015	2012
AMC Area	466 km2	466 km2
Population (AMC)	61,93,040	55,70,585
Population Density (AMC)	133 pph	120 pph

Source:Provisional Census, 2011,CEPT Estimations, 2015

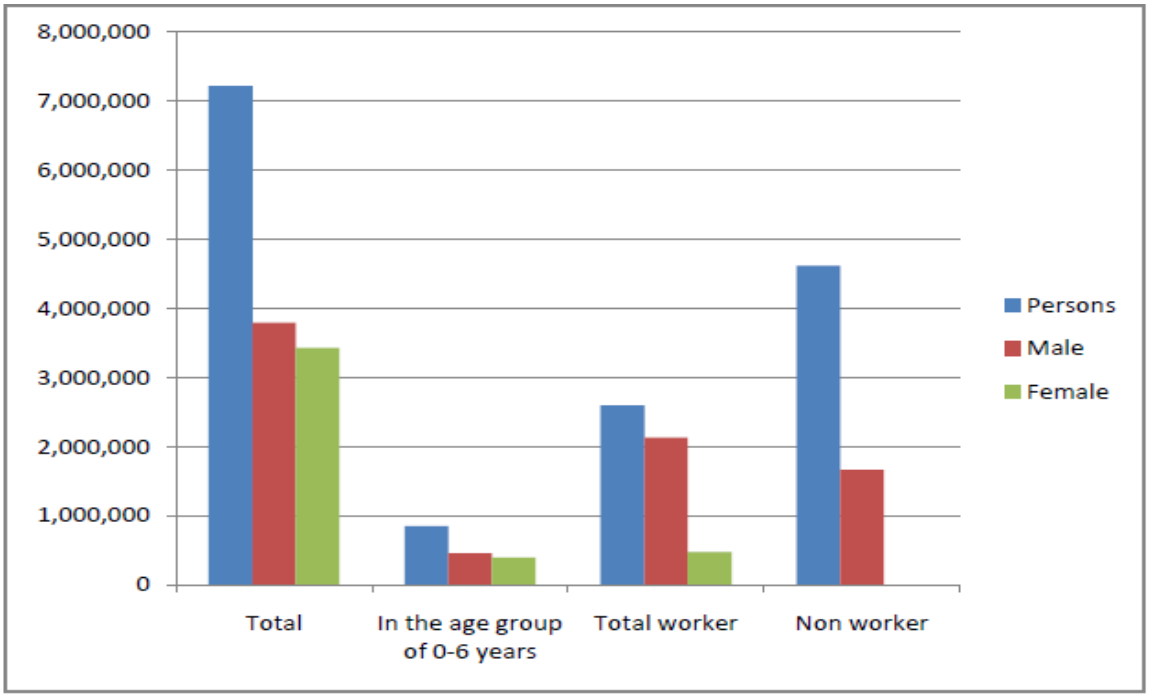


Figure 5.1 Population of Ahmedabad

Source: Provisional Census, 2011

5.2 Land Use

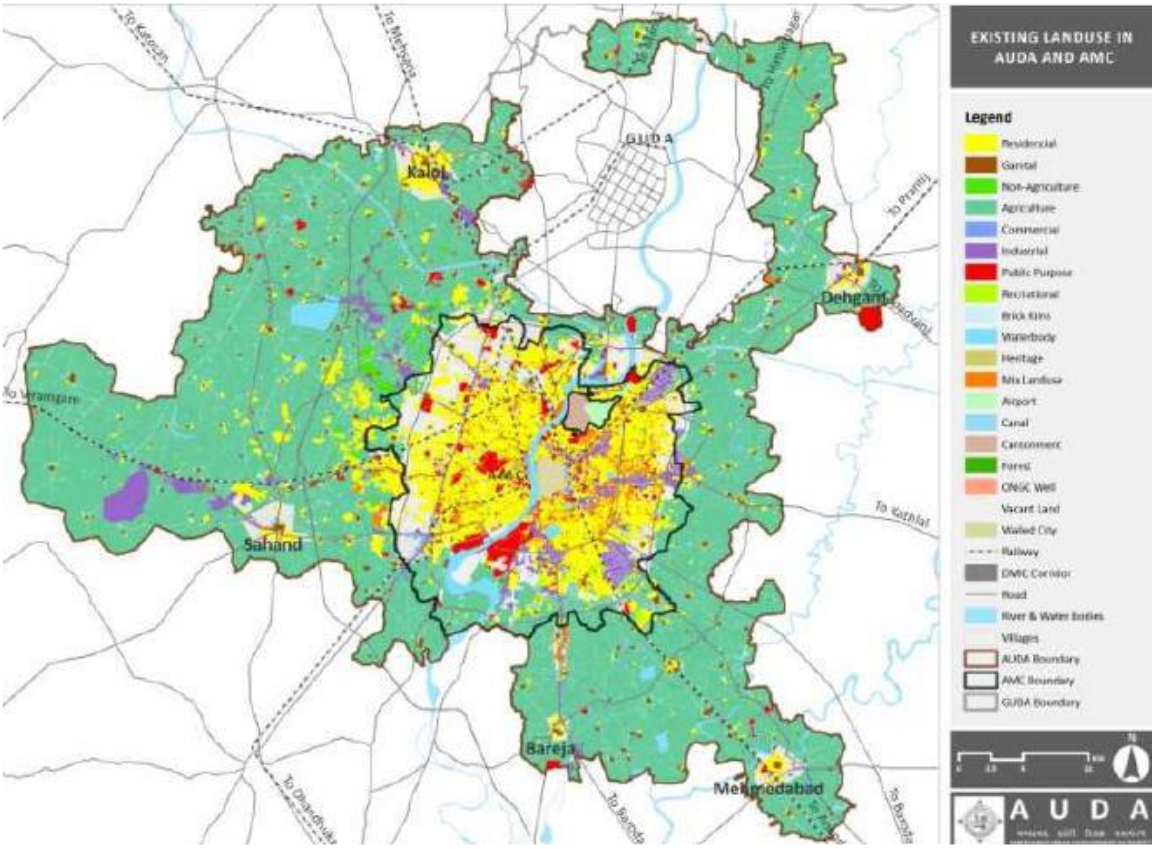


Figure 5.2 Land use of AUDA

Source: CoE in Urban Transport, CEPT University, Ahmedabad

Table 5.3 Land use of AUDA

NO	Land Use	Area (Ha)	%Share
1	Residential	175.33	9.39
2	commercial	12.66	0.68
3	Industrial	57.48	3.08
4	Institutional	48.28	2.59
5	Agriculture	1167.25	62.52
6	Mixed Use	42.14	2.26
7	Open Space	5.08	0.27
8	Heritage	0.27	0.01
9	Transportation	95.85	5.13
10	Vacant land	28.76	1.54
11	Walled city	4.46	0.24
12	Water bodies	88.29	4.73
13	Other users	141.06	7.56
	Total	1866.90	100

Source: CoE in Urban Transport, CEPT University, Ahmedabad

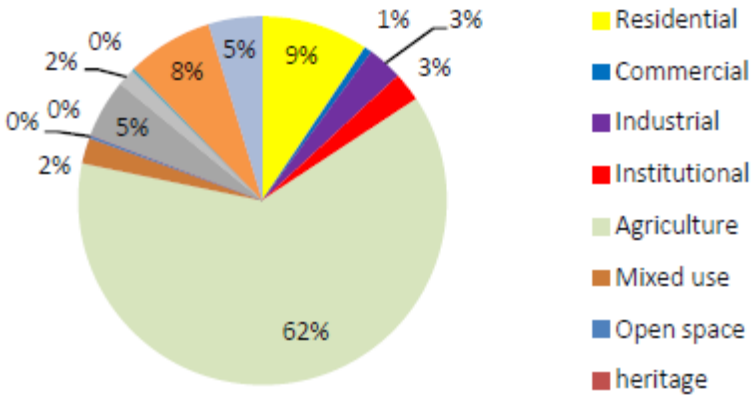


Figure 5.3 Pie chart of land use of AUDA

AUDA land use classification system categorizes almost 1866 sq km of land area into more than ten types of land use. Nearly 84 per cent of the land is undeveloped (i.e. In agriculture or acanthropy). Water bodies, rivers and lakes make up about 2 per cent of the area. More than 50% of the developed land is under residential use, nearly 16% under industrial use, 13% under institutional use and about 4% under commercial use.

5.3 Infrastructure Provision

5.3.1 Ahmedabad Transport System

Ahmedabad is well connected to rest of the country by Road, Rail and Air Transport. The transportation system of the city is mainly dependent on roadway system. The vehicular growth has been increasing day by day and there is a strong need to control the increasing traffic congestion and reduce the accident rates.

5.3.1.1 Road Network

In Ahmedabad the road network has a ring-radial pattern like in fig. There are twenty well defined radials; twelve in the West and eight in the East. There are ring roads connecting these roads and making mobility across easy. Inside AUDA region there are 5 complete rings. The town's 2 main ring roads are SP ring road and 132-foot ring road. Apart from these C.G. The road on the west side and the walled city on the east side together form a ring road as a pattern and the 120-foot road also forms a similar pattern in the city. All roads which provide efficient links between the city centre and the periphery of the city can be called radial roads.Some major ones are Rakhial road, Narol-Naroda road on east

side of the city and Drive-in road, Vastrapur Road, Prahlad Nagar road, Ranna Park, Satellite road, ManavMandir road on west side of the city.

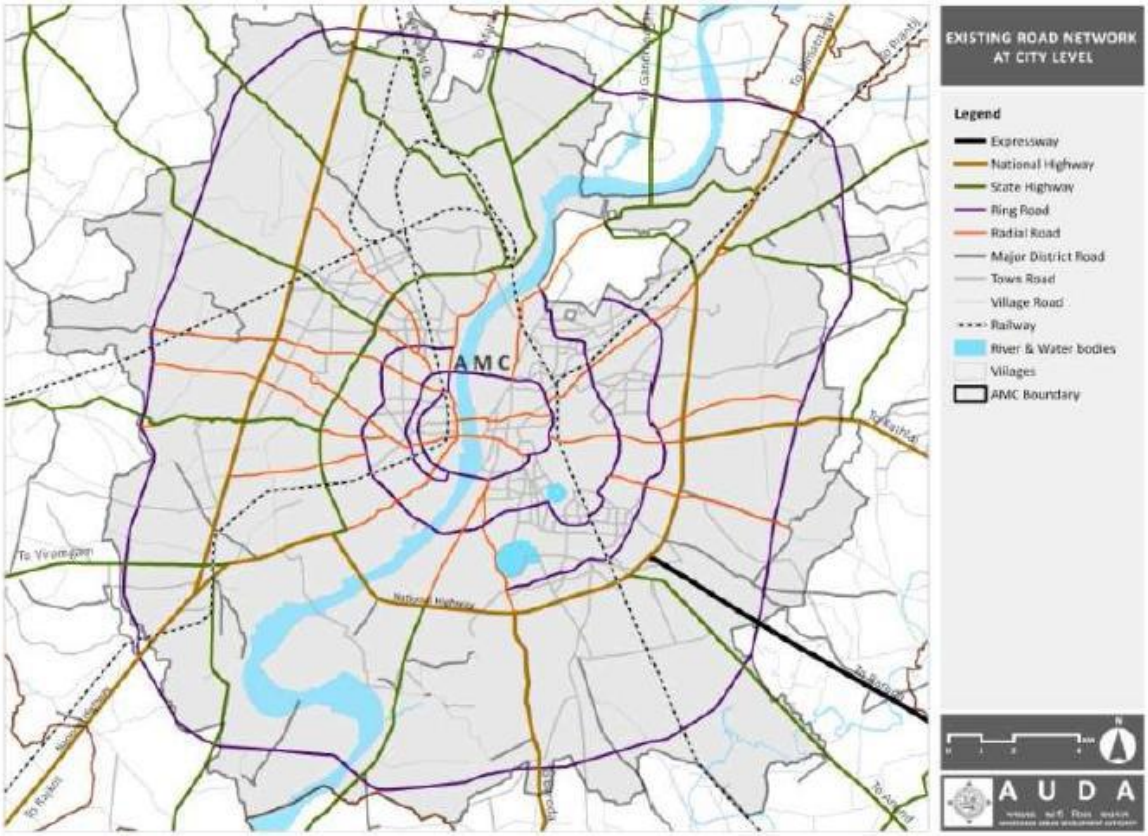


Figure 5.4 Exixting road network Ahmedabad

Source: CoE in Urban Transport, CEPT University, Ahmedabad

5.3.2 Intra City Transportation Facilies

5.3.2.1 AMTS Bus Transit

The Ahmedabad Municipal Transport Service provided by the Ahmedabad Municipal Corporation connects all areas within the town as well as the peripheral villages as in fig. Since 1947 it provides public transportation facilities. AMC invited private operators to participate in the provision of public transport on a gross contract model (kilometre scheme), in order to improve the transit service. Since AMTS was unable to meet the fleet's growing demand as well as the increasing deficit, in 2005 the private operators were asked to run the buses. Daily passengers (daily boarding) reached 9.36lakh.This number clearly indicates the latent demand waiting to be serviced. AMTS is currently running its services on 194 routes. AMTS has introduced 38 new routes and total average vehicles on the road have increased from 371 in 2004-05 to about 751 in 2009-10. Apart from this the daily average number of passengers carried has also gone up from 3.5 to 8.2lakh.

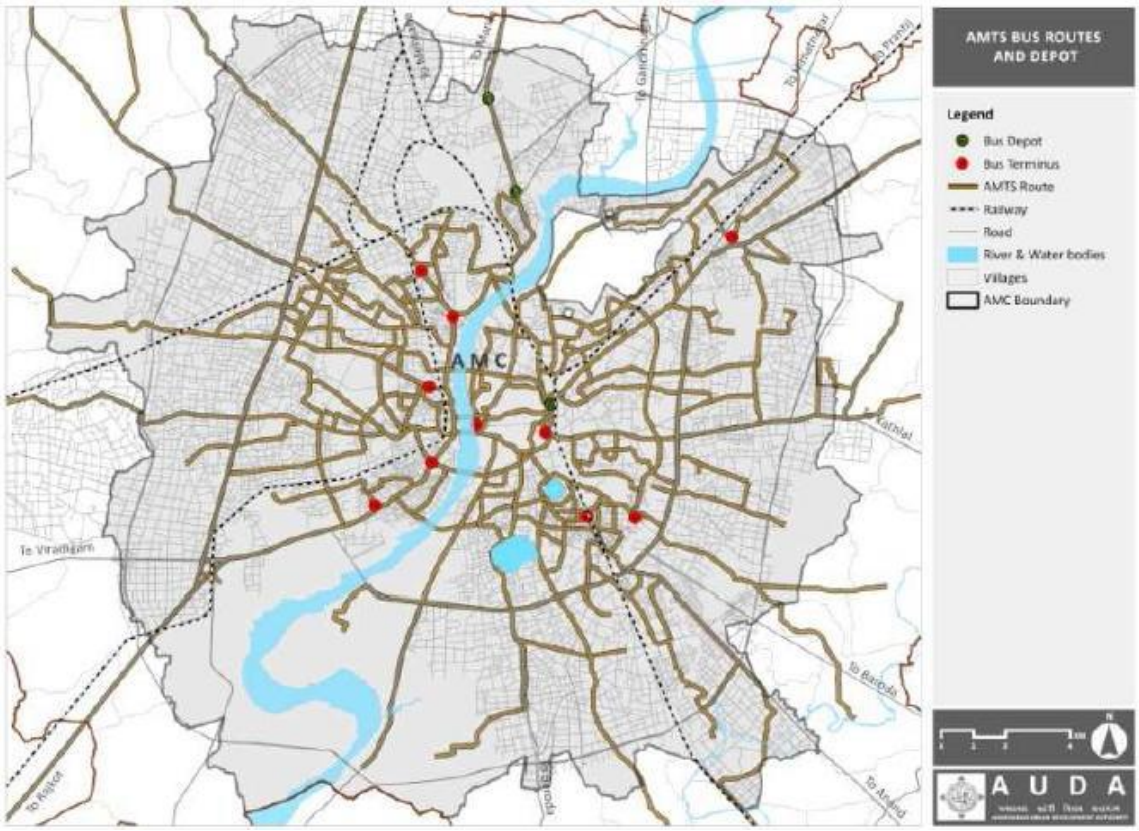


Figure 5.5 AMTS Bus routes

5.3.2.2 Janmarg Bus Rapid Transit System(BRTS)

BRTS development in Ahmedabad town is one of the most comprehensive public transport initiatives. AMC partnered with CEPT University to implement a BRTS system that includes not only a dedicated bus rapid system but also an improved AMTS feeder system and the provision of non-motorized transport catering to 15 to 20 percent of the population that either walked or used a bicycle. BRT is a core part of the integrated transport programme, developing an 89 km long network. Ahmedabad transport strategy, consistent with the NUTP and JnNURM, is focused on moving people and not vehicles.The plan is based on the premise that all people should be able to move around in Ahmedabad with comfort and efficiency and mobility. Currently 39 kms route from R.T.O - Maninagar – Naroda is in operation with 61 bus stations. Four routes are in operation for this corridor. The daily ridership of all BRT stations is 1,32,000 passengers per day. Off board ticketing and intelligent traffic management system makes buses and passenger traffic movement quicker. System operators are also given incentives for safe driving.

5.3.2.3 IPT-Auto Rickshaw

Only 51,876 auto rickshaws were registered at Ahmedabad RTO in 2001. By 2009 this figure had risen to 1,17,838 in Ahmedabad. Of the total number of registered auto

rickshaws in Gujarat, Ahmedabad registers 30.6 percent. The routes are generally decided by the passenger in Auto rickshaw but at the same time sharing based Auto rickshaw drivers only operate on popular routes where demand is high. Lal Darwaja, Iskon Mandir, S.T. are the major points of origin of shared rickshaws. Kalupur stand, and major centers of activity where demand is high. The auto rickshaws are used primarily as AMTS and BRTS feeder service.

5.3.2.4 Growth of Vehicle

The total vehicles registered in the area of Ahmedabad (RTO) rose from 28,67 lakhs in 2016 to 37,04 lakhs in 2019 at an annual compound rate of 8.92 percent, of which 80 percent are presumed to be in the city of Ahmedabad as in table 5. If we see the personal vehicle per 1000 inhabitants, it is obvious that 2 wheelers are 307 high, while cars are still below 100. It is also observed that roughly 612 vehicles are currently registered daily at the RTO (419 two wheelers, 142 cars, 19 cars, 20 goods vehicles and 2 buses).

Table 5.4 Growth of vehicles in Ahmedabad

Vehicle Category	No. of Vehicle		%Share	
	2019	2016	2019	2016
2-Wheeler	19,46,346	16,17,939	71.1%	71.6%
4-Wheelers	4,52,128	3,46,032	16.5%	15.3%
3-Wheelers	1,28,313	1,11,670	4.7%	4.9%
Goods Vehicle	1,23,531	1,05,642	4.5%	4.7%
Buses	21,336	20,208	0.8%	0.9%
Others	65,388	57,427	2.4%	2.5%
Overall	27,38,654	22,60,027	-	-

Sources: RTO (2016, 2019)

5.3.2.5 Traffic Volume

Traffic congestion on Ahmedabad's city roads is still very high when compared to many similar-sized cities. However, the congestion levels are beginning to show up on certain stretches with the rapid rate of motorization. The western part of the city has developed as a predominantly residential area, with the industrial estates in the eastern part. Because of this, the traffic flow is heavy in the mornings from west to east and vice versa in the evening, causing traffic congestion and frequent traffic jams on the city roads during peak morning and evening periods. Volumes of traffic on major roads are shown in the map below.

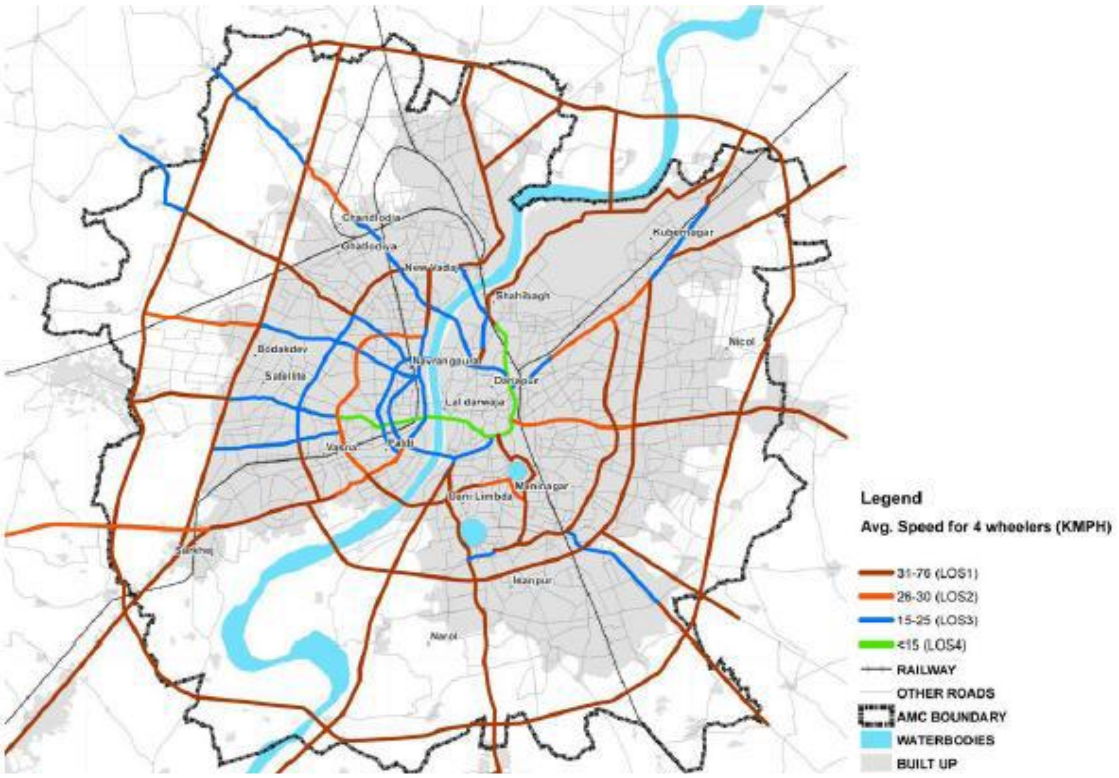


Figure 5.6 Traffic volume of Ahmedabad

Source: CoE in Urban Transport, CEPT University, Ahmedabad

5.3.2.6 Accidents

The city's road fatalities are low at 227 deaths per annum. The main concern, however, is that 8% of road deaths involve cyclists, 30% of two-wheelers, and 49% of pedestrians. Thus, the non-motorized travel is attributed to approximately 57 per cent of deaths. Approximately as in 2011, 27% of total serious accidents are caused by two wheelers, 19% by three wheelers, 33% by four wheelers, AMTS 5% and BRTS 1% of total accidents. Freight vehicles are responsible for nearly 4 per cent of total accidents. It should be noted that there was a decrease in total number of accidents.They descended from 2931 in 1991 respectively, to 2718 in 2001 and 2020 in 2011. In the road accidents last year 227 people were killed. The Naroda Narol-Aslali stretch accounted for nearly 50 per cent of the total fatal road accidents in Ahmedabad. An analysis of causes of fatal accidents shows that trucks accounted for about 23 per cent of the city's total fatal deaths. Pedestrian traffic accounts for roughly 49 per cent of the city's total deaths. More than 8 per cent of deaths on bicycles belong to those. The following table shows road safety indicators performance at Ahmedabad.

Table 5.5Fatality rate of Ahmedabad

Sr.no.	Road Safety	Ahmedabad Indicator Value Road Safety	
		2015	2012
1.	Facilities per lack Population	5	4
2.	Facility Rate for Pedestration & NMT(%)	52%	56%
3.	Serious Injurious Per lack Population0	6	6

Legend-Change Colour Code	
	No Change
	Positive Change
	Negative Change

Source: CoE in Urban Transport, CEPT University, Ahmedabad

5.3.3 Travel Characteristics

For all trips, the per capita trip rate including a walk is about 1.44, excluding all walk trips below or equal to 500 metres, the AMC trip rate is about 1.39. Approximately 70% of walking trips were less than a distance of 0.5 km. Work trips from 47% of total trips followed by educational trips at 32% in AMC.

5.3.3.1 Trip Rate

Table 5.6 Trip rate of Ahmedabad

% Trips by Mode	
Walk	37.23%
Bicycle	9.00%
2 Wheeler	25.95%
Car	3.94%
Auto Rickshaw	6.11%
Bus	10.29%
BRTS	1.14%

Others(School bus,Staff bus,ST bus,Rail)	6..34%
Total	100%
%Trips by purpose	
Work	47.16%
Education	32.82%
Shopping/Social/Recreational	6.68%
Other	13.34%
Total	100%

Source: Ahmedabad Household Data (CEPT, 2012)

5.3.3.2 Travel Pattern

Ahmedabad traffic is concentrated in the walled town, the eastern part of town and across the bridges of the river. The movement of bicycles is shorter and largely concentrated in and around Ahmedabad's North , East and Central zones. Auto trips are largely dispersed over the AMC region with shorter journey lengths in which long distances are largely dispersed as car trips. Trips with 4-wheeler use are comparatively very low, as the map shows sparse red lines. The share of two wheel trips is considerably high compared to other modes with shorter distances, resulting in more compact travel over the AMCP-proposed corridor

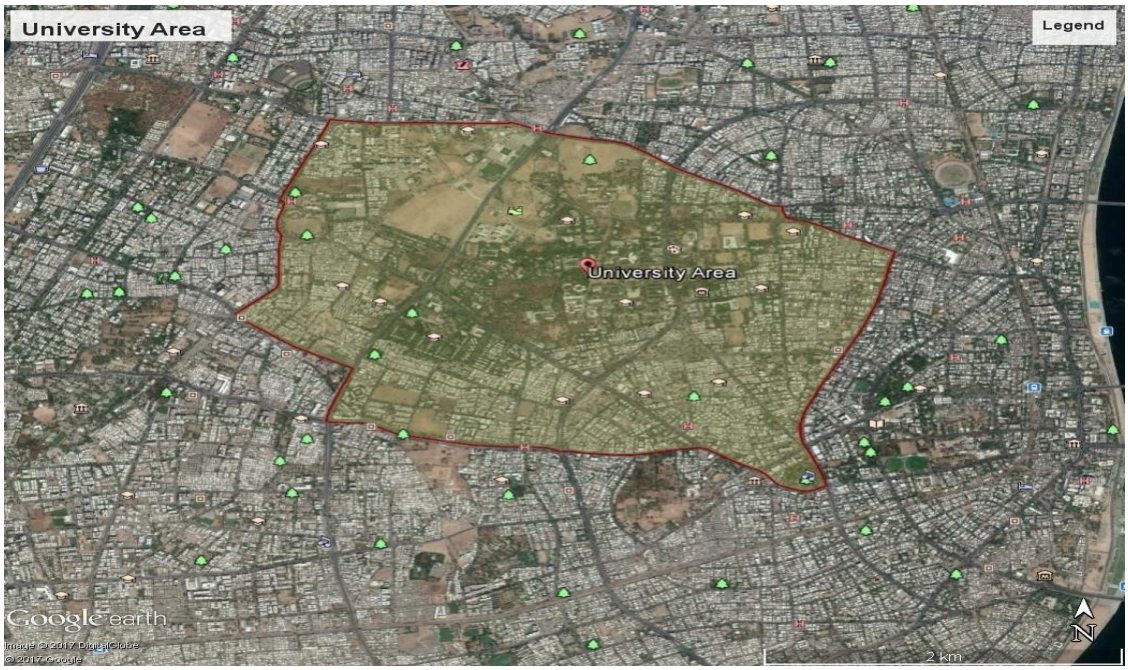


Figure 5.7 Proposed corridor

There are two large universities in this area such as GUJARAT University and CEPT University, and there are many other educational institutions. Due to the absence of systematic parking and traffic sense, the reality is taken away by chaotic parking and selling activity that leads to traffic congestion during peak hours and leaves insignificant space for pedestrians and cyclists to thrash out their way safely. The main significance of this study is to depict and describe a secure, coherent, easy to use and high-quality network.

5.3.4 Land Use

Land use indicates that most of the land is occupied by the residents there. The formal land use in the locality shows that a wide range of institutions are present in the immediate vicinity of the area, such as CEPT University Campus, Gujarat University Campus and many more educational establishments. The University Area contains no industrial areas.

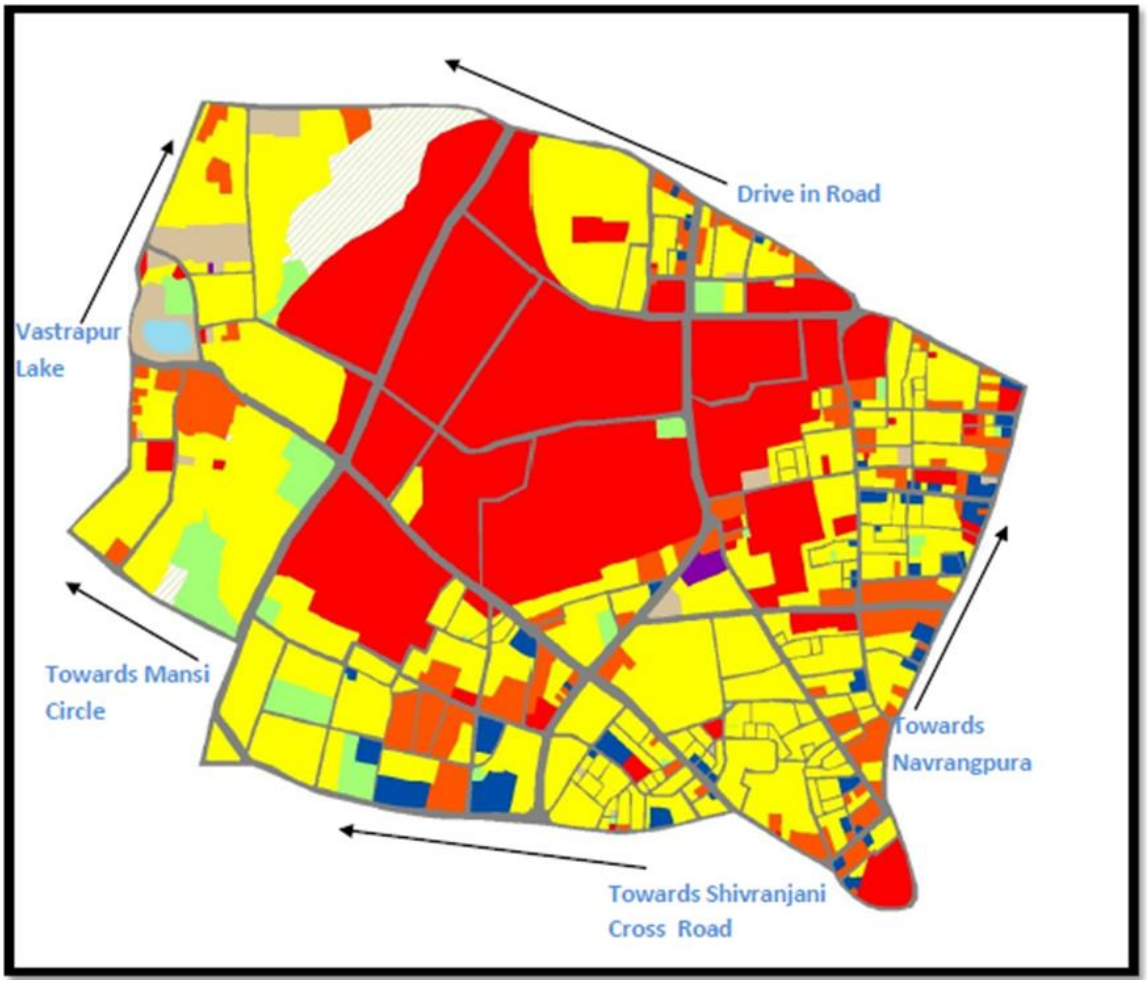


Figure5.8Situational analysis of proposed corridor

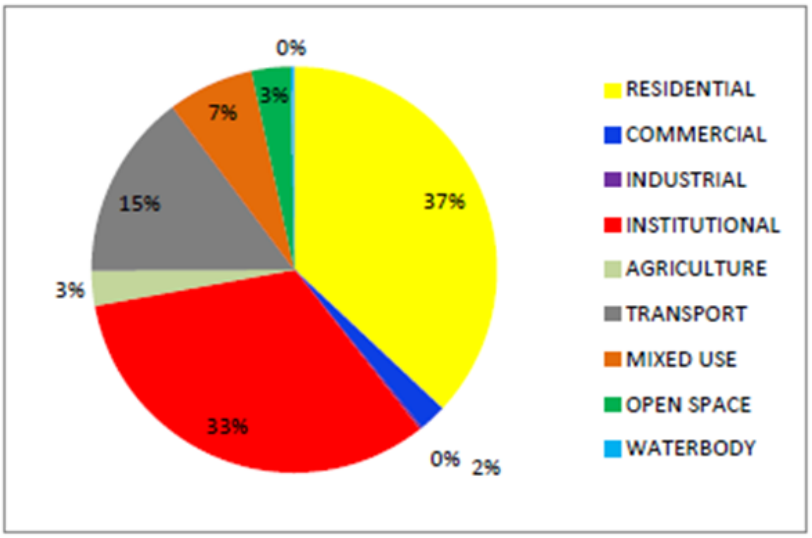


Figure5.9 Land use of proposed area

Figure 5.10Sitephotographs

A detailed study of the land use area shows that there are a wide range of institutions present in the area such as CEPT University, University of Gujarat and also hostels for the university students. There may be no two-wheelers or any motorized transportation facility for many students. Thus, they need last-mile connectivity from any public transport station

to their institution. And this is what the study is focusing specifically on which last-mile connectivity for users of public transport. The 37 percent residential land use companies and 33 percent institutional companies.

5.3.5 Road Hierarchy

Road Hierarchy includes various types of roads like arterial, sub-arterial roads, collector roads and local roads which are shown in fig. The total network of major road (arterial and sub-arterial) is 115.57km.

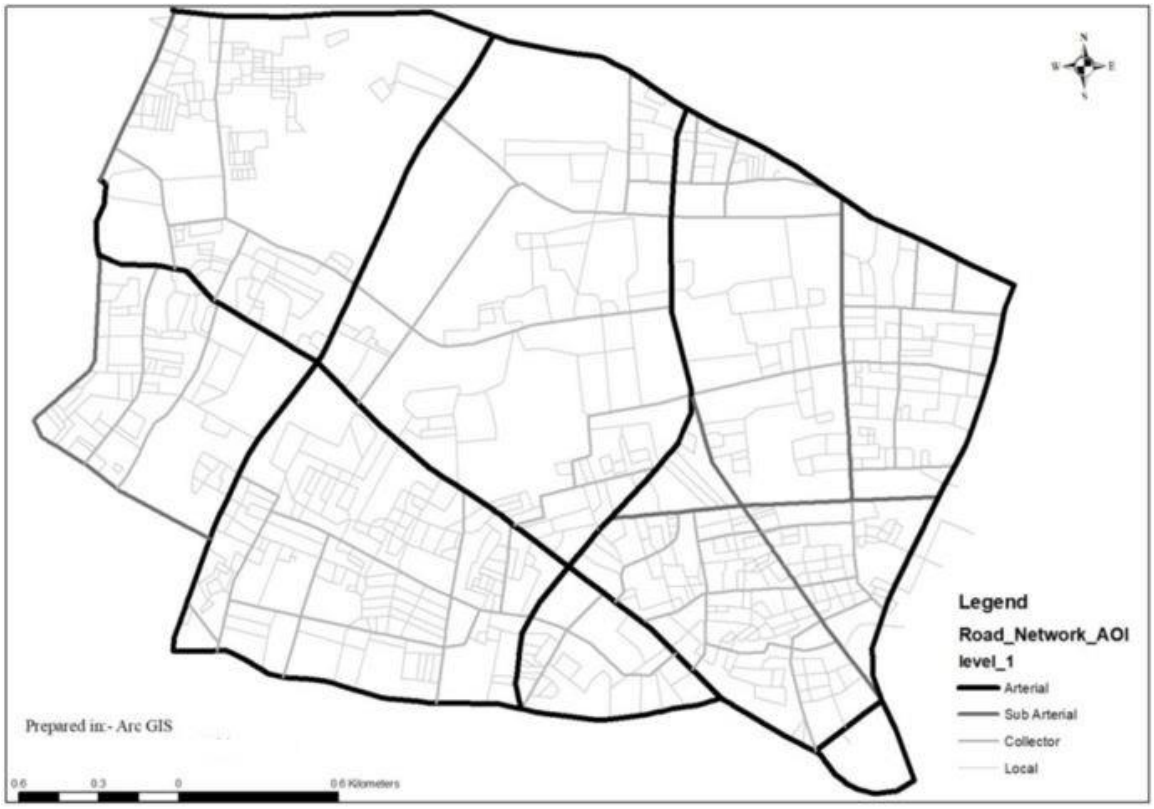


Figure5.11 Available road network

5.3.6 Nodes of BRT under proposed corridor

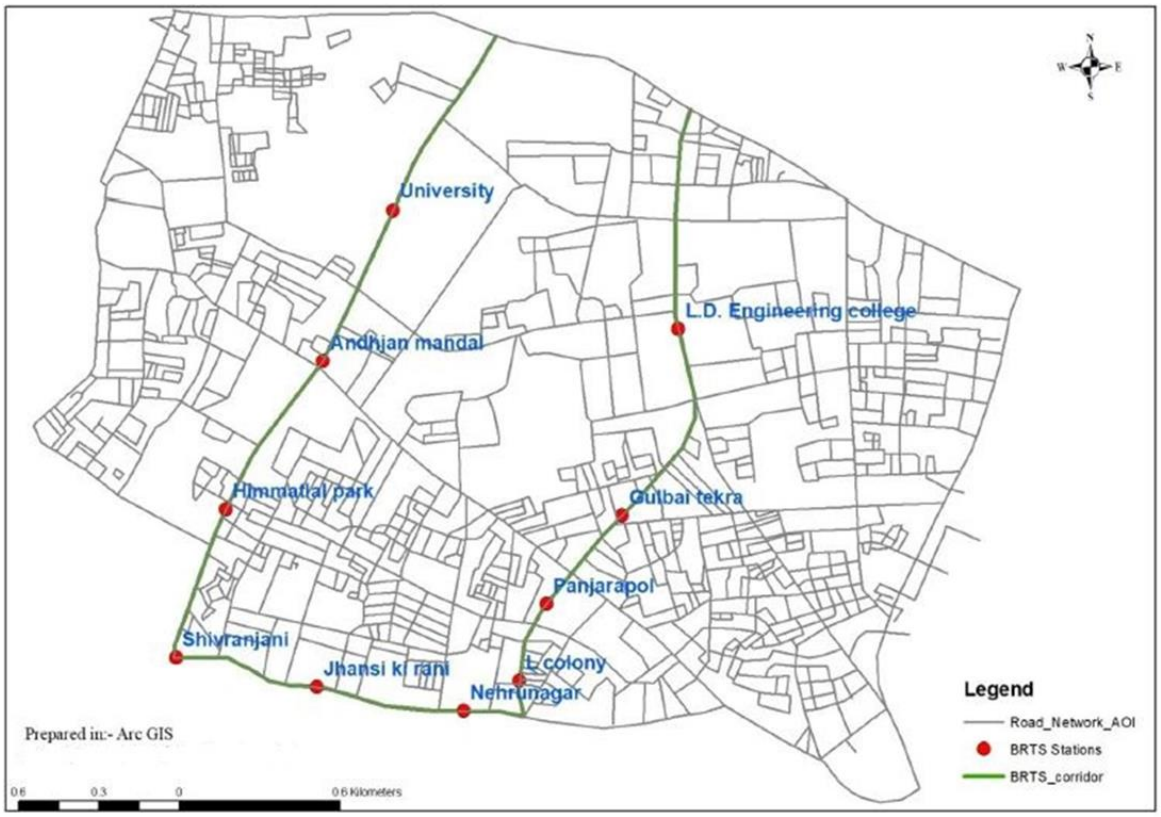


Figure 5.12BRTS Station and corridor

Total 10 BRT stations comes under the selected corridor. The main objective is to provide last mile connectivity for the BRTS corridor of the selected zone.

6 DATA COLLECTION AND ANALYSIS

6.1 Data Collection

Primary survey is conducted by various stakeholders, who travel frequently or daily through the node, as well as by students from various institutions covered under the study area. The method adopted for survey is survey questionnaires. The questionnaire includes parameters such as age, gender, household size, household income, information about the trip and their willingness to move from motorized to non-motorized.

In secondary survey, data is gathered from various transport agencies such as the Center of Excellence in Urban Transport and Ahmedabad Janmarg Limited.

6.2 Data Analysis

6.2.1 Mode of Transport

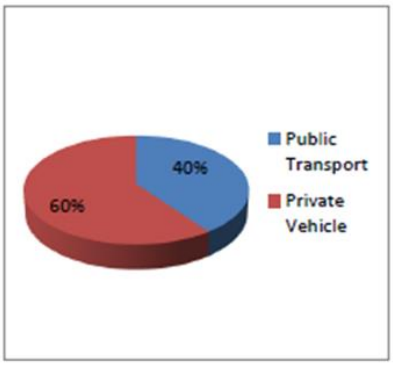


Figure 6.1 Mode of transport

From the data collected at different locations, 40% people using public transport and 60% using their private mode of transport.as shown in fig.

It means that more people using their private mode of transport because of some inconvenience of public transport and last mile connectivity of public transport.

6.2.2 Private Vehicle Users

6.2.2.1 Male-Female Ratio

From the survey the male female ratio of using private vehicle is 44% male and 56% female as shown in fig

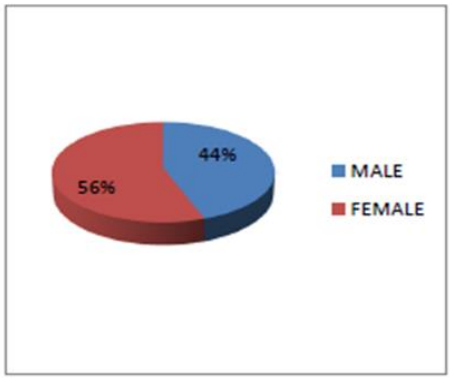


Figure 6.2 Male female ratio

6.2.2.2 Household Income

The commuters' household income is shown in fig. The survey is conducted mostly from a group of students, so from the fig. We can see that nobody belongs to the income group of under 5000.

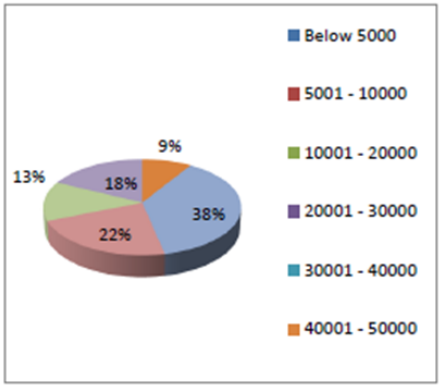


Figure 6.3 Household income

6.3 Identification of Interchanges

BRTS stations are used to identify intermodal centres. This route features 11 interchanges in the city. These are the stations which most passengers are trying to switch from one mode to another. Intermodal center selection is done in a way that covers all major points in the city and has the potential to attract most passengers.

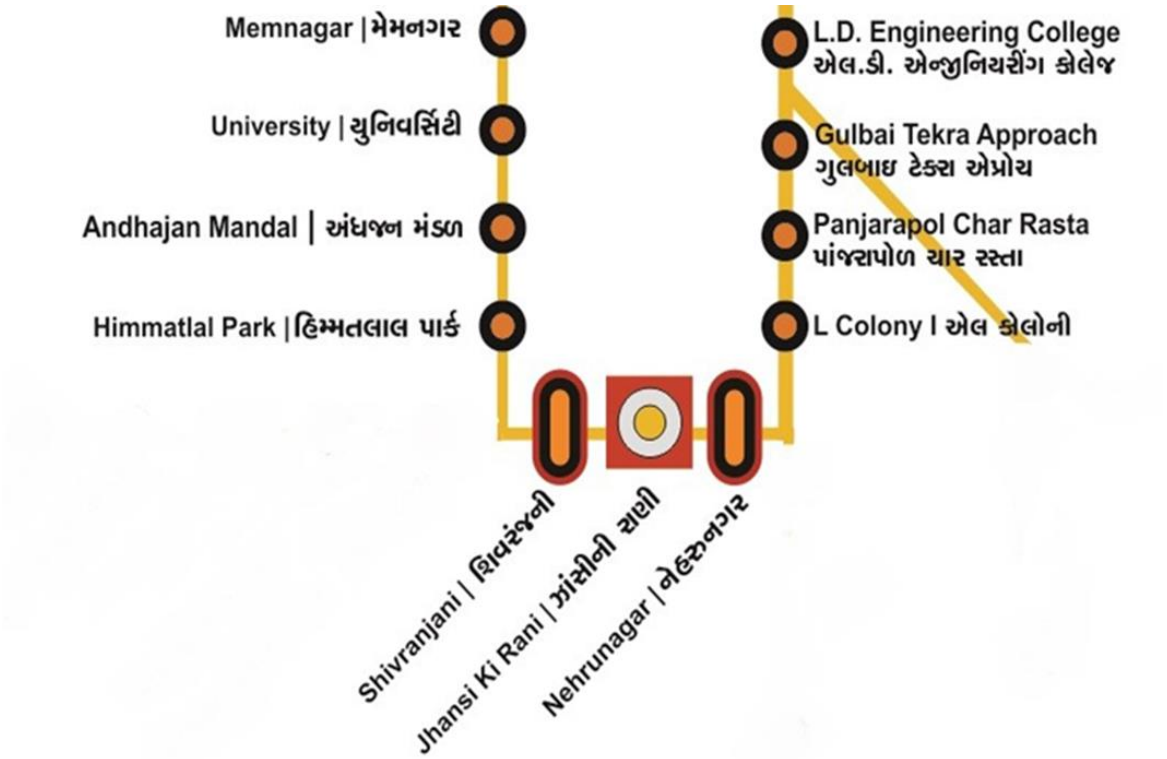


Figure 6.4 Location of transit stations BRTS

Source: Compiled by the author

Table 6.1 List of Stations, Ahmedabad

List of Stations			
1. Memnagar	2. University	3. Andhajan Mandal	4. Himmatlal Park
5. Shivranjani	6. Janshi Ki Rani	7. Nehrunagar	8. L-Colony
9. Panjarapol Cross Road	10. Gulbai Tekra Approach	11. L.D. Eng. College	

Limitations of field data collection method

- The scope of the project will be limited to the latest data available and sources available from different Government departments.
- Scope of the project does not include the technical details of the system.
- Primarily, the study will be carried out based on the primary data (visual and Questionnaire) obtained.

6.4 Interchange Survey

Survey purpose: To assess the quality of the current interchange arrangements and to identify ways to ensure multi-modal interchanges of good quality, especially those where quality falls short of the guidelines.

Possible Survey outcomes:

The outcomes are not intended to provide detailed guidance on interchange construction standards; rather, they focus on planning and designing the various elements that can make an effective interchange of transport that is useful for less seam transfer for travelers.

The following criteria are used to determine in which category the individual interchanges fit best, noting some variation / flexibility between categories.

- Adjacent activity, town centre or commercial activities and planned future land use;
- Degree of transport service activity by modes;
- Frequency of major services;
- Number of bus services and bus stands provided;
- Level of multi modal transfer and
- Passenger movements

Planning for Effective Interchange facilities

The primary services an interchange provides include:

- Passenger access to the public transport network and inter modal transfers;
- Access point or gateway to the town centre and community
- Sheltered public waiting areas
- Passenger information to assist travel decision making and;
- A focus on activity and catalyst for increased economic development in the area

6.5 Finding and Analysis

This section deals with the findings from the observatory and questionnaire surveys and views of the various stakeholders and travellers about the transport system and its integration.

6.5.1 Primary Survey Finding

The survey provides the information about the provision of services and the gaps in its provision at interchanges. The interchanges are classified on various parameters like availability of feeder services, major land use around etc, as shown in the table below.

Table 6.2Primary survey findings at transit stations

Sr. no	Name of the Interchange	Major Land use around station	Provision of feeder bus services	Interchange with proposed BRTS	Avg. time for Interchange* (In min)	Approach roads and linking of bus
1	Memnagar	Commercial	Yes	No	00-5.0	Far to bus stop
2	University	Institutional	No	No	10.0-15.0	Pedestrian crossing
3	Andhajan Mandal	Institutional	Yes	No	5.0-10.0	Far to bus stop
4	Himmatlal Park	Commercial	No	No	10.0-15.0	Far to bus stop
5	Shivranjani	Commercial	Yes	No	00-5.0	Bus link
6	Janshi Ki Rani	Residential	No	No	10.0-15.0	Access to station
7	Nehrunagar	Commercial	Yes	No	5.0-10.0	Bus link
8	L-Colony	Residential	No	Yes	5.0-10.0	Access to station
9	Panjarapol Cross Road	Commercial	Yes	No	00-5.0	Many issues
10	Gulbai Tekra Approach	Commercial	Yes	No	00-5.0	Bus stop
11	L.D. Eng. College	Institutional	Yes	Yes	10.0-15.0	Far to bus stop

6.5.2 Secondary Survey Finding

Table 6.3 Secondary data (20 Jan 2020, Monday)

Sr. no	Station name	Avg. Passenger /day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	3427	6.22	1836	811	430	350
2	University	203	3.83	96	12	39	56
3	Andhajan Mandal	1838	15.60	675	164	467	532
4	Himmatlal Park	1153	8.93	376	245	148	384

5	Shivranjani	3983	12.27	2230	783	469	501
6	Janshi Ki Rani	768	5.18	265	136	162	205
7	Nehrunagar	2046	13.62	978	261	389	418
8	L-Colony	315	8.19	112	28	95	80
9	Panjarapol Cross Road	923	7.03	460	116	234	113
10	Gulbai Tekra Approach	740	5.92	376	149	76	139
11	L.D. Eng. College	1535	10.35	728	256	255	296

Table6.4 Secondary data(21 Jan 2020, Tuesday)

Sr. no	Station name	Avg. Passenger/ day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	3036	8.65	1756	348	423	509
2	University	256	4.96	125	30	47	54
3	Andhajan Mandal	2048	17.40	978	243	435	392
4	Himmatlal Park	1053	10.36	346	213	279	215
5	Shivranjani	3565	13.51	1946	686	356	577
6	Janshi Ki Rani	644	6.12	247	156	93	148
7	Nehrunagar	2238	12.79	1148	236	151	467
8	L-Colony	370	7.93	115	56	46	153
9	Panjarapol Cross Road	876	6.32	461	186	124	105
10	Gulbai Tekra Approach	965	5.53	349	237	182	197
11	L.D. Eng. College	1745	13.63	842	326	210	367

Table 6.5 Secondary data(22 Jan 2020, Wednesday)

Sr. no	Station name	Avg. Passenger/ day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	2838	5.63	1256	471	467	644
2	University	316	3.72	114	36	78	88

3	Andhajan Mandal	1745	12.67	946	231	265	303
4	Himmatlal Park	1197	7.53	464	178	276	279
5	Shivranjani	3354	11.47	1545	746	447	616
6	Janshi Ki Rani	542	6.18	234	70	99	139
7	Nehrunagar	1817	11.60	976	261	226	354
8	L-Colony	412	7.36	173	54	82	103
9	Panjarapol Cross Road	881	6.94	389	116	162	214
10	Gulbai Tekra Approach	1056	4.48	478	154	218	206
11	L.D. Eng. College	2036	11.37	945	211	356	524

Table 6.6 Secondary data (23 Jan 2020, Thursday)

Sr. no	Station name	Avg. Passenger/ day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	2865	7.56	1356	443	465	601
2	University	247	4.35	114	28	40	65
3	Andhajan Mandal	1875	14.61	943	216	348	368
4	Himmatlal Park	918	7.43	457	118	127	216
5	Shivranjani	3128	11.20	1648	438	389	653
6	Janshi Ki Rani	516	4.67	211	64	117	124
7	Nehrunagar	2410	12.37	1142	347	426	495
8	L-Colony	343	7.15	109	68	71	95
9	Panjarapol Cross Road	782	6.48	316	116	144	206
10	Gulbai Tekra Approach	870	4.34	348	167	137	218
11	L.D. Eng. College	1964	12.61	976	248	318	422

Table 6.7 Secondary data(24 Jan 2020, Friday)

Sr. no	Station name	Avg. Passenger/ day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	2563	6.56	1346	316	441	460
2	University	314	4.37	113	62	55	84
3	Andhajan Mandal	1746	12.76	849	311	215	371
4	Himmatlal Park	781	9.57	316	156	91	218
5	Shivranjani	2873	11.36	1278	467	546	582
6	Janshi Ki Rani	469	4.51	213	86	67	103
7	Nehrunagar	2236	11.38	1087	246	446	457
8	L-Colony	330	7.69	134	75	57	64
9	Panjarapol Cross Road	856	6.10	387	184	131	154
10	Gulbai Tekra Approach	913	8.93	467	134	119	193
11	L.D. Eng. College	2135	11.36	1142	271	346	376

Table 6.8 Secondary data (25 Jan 2020, Saturday)

Sr. no	Station name	Avg. Passenger/ day(BRTS)	Avg. km of Passenger travel	2 wheeler	4 wheeler	Para transit / Taxi	Pedestrian
1	Memnagar	2632	8.65	1634	240	376	382
2	University	260	6.31	114	37	44	65
3	Andhajan Mandal	1676	13.68	837	227	189	423
4	Himmatlal Park	848	7.52	341	163	128	216
5	Shivranjani	2972	10.25	1746	371	365	490
6	Janshi Ki Rani	411	4.63	148	76	82	105
7	Nehrunagar	2325	12.75	1260	246	474	345
8	L-Colony	368	9.26	136	42	87	103
9	Panjarapol	843	7.54	386	116	157	184

	Cross Road						
10	Gulbai Tekra Approach	960	8.40	411	128	176	245
11	L.D. Eng. College	2264	12.67	1146	362	322	434

6.5.3 Comparison of Two interchanges

Two interchanges were selected via Memnagar and L by analyzing the map and location of the interchange. D. College with moderate facilities for Integration in Memnagar and L. D. College has facilities that are low in integration.

Socio economic benefits:

- The analyzed socio-economic factors are reduction of vehicle operating costs, reduction of passenger operating time depending on vehicle operating time, reduction of air pollution, reduction of accidents and reduction of physical distress due to reduced air pollution.
- The both commuters and their attitude towards different BRTS and AMTS attributes such as reliability, safety, travel comfort, affordability, availability, and transaction facility.
- Analysis of socio-economic cost benefits which estimates the benefits and costs to society.
- The project will improve the convenience and benefit of road users andFoster public transportation in the town.
- These improvements will lead to reduced journey times, reduced vehicle operating costs, and reduced pollution.
- The benefits of reducing air pollution disorders and other benefits such as improved mobility due to TOD development, higher tax revenues due to market enhancementCommercial and residential real property values.
- The greater social and economic advantages it offers to society. Consequently, the socio-economic cost benefit being realized upholds the project's viability from a socio-economic point of view.
- Ticketing, display, audio systems and other support infrastructure have been provided with stations. The stations are accessed by signalized zebra crossing at grade.

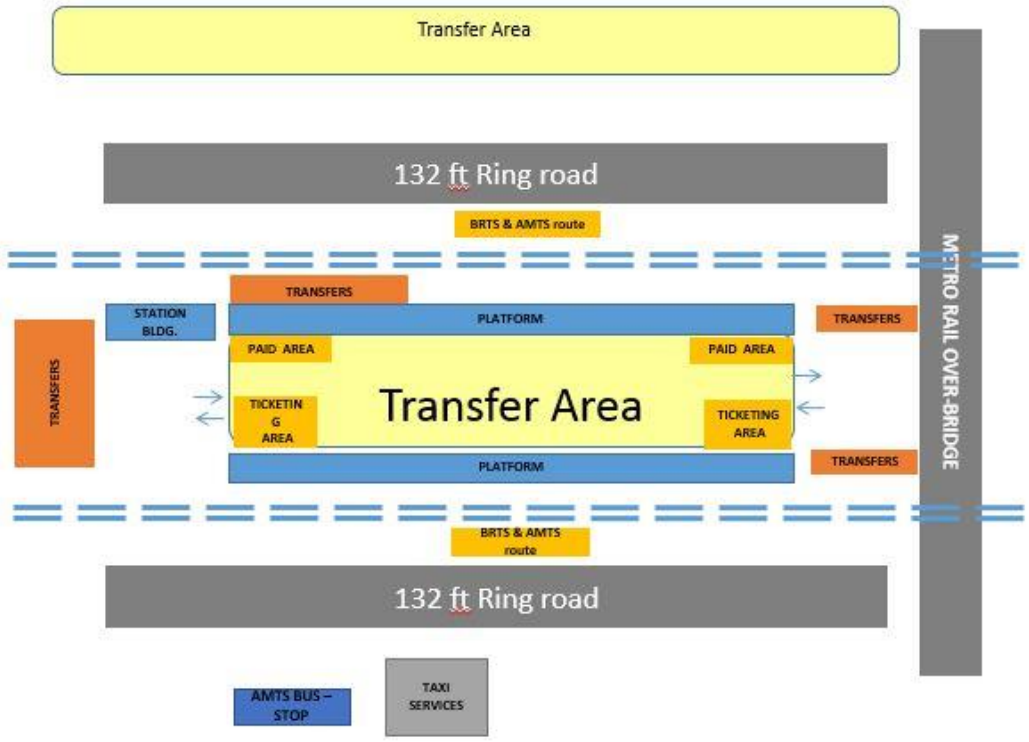


Figure 6.5 Transfers at Memnagar Interchange

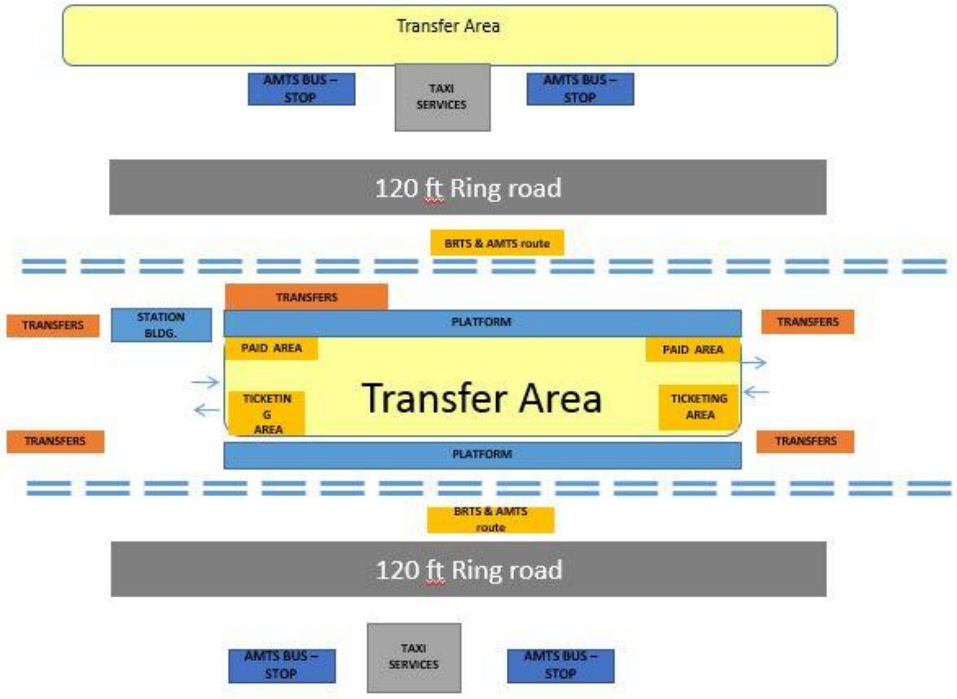


Figure 6.6 Transfers at L. D. College Interchange

Table 6.9 Coparitision of Two Interchanges (Memnagar and L. D. College)

Criteria	Interchange 1	Interchange 2
Name of the Interchange	Memnagar BRTS	L. D. College BRTS
Location	Located on 132ft Ring road, Helmet Flyover, Saurabh Society, Memnagar	Located on 120 Feet Ring Rd, Hollywood Basti, Gulbai Tekra
Surrounding land use (Major comes first)	Residential, Commercial	Commercial, Residential
Level of Physical Integration	Moderate	Low
Interchange with Proposed BRTS (AMTS)	Yes	No
Average time for Interchange	5 mins	10-15 mins
Distance from nearest bus stop/stops	150 mtrs	500 mtrs
Approach roads and linking of buses	132ft Ring road, Shivranjani to Chandkheda	120 Feet Ring Rd, Kalupur to Bopal
Parking facilities	No	No
Facilities for waiting passengers	only seating facilities provided (benches etc)	only seating facilities provided (benches etc)
Lighting conditions	Yes (Even at the foot over bridge provided for passengers) are well lit during night times	Yes
Security issues	BRTS guard will be safeguarding during the bus timings	Security guard will be present mostly all the time
Time table provision	It is provided in the station. It is important station for both the routes of MMTS (A common station)	Yes it is provided with in the station. Ideally even at bus stops this information should be provided
Availability of taxis	As the station is under bridge there is a demand of auto rickshaws	No separate provision of taxi stand is provided in the station
Provision of toilets	No	Yes, but most of the times it is not opened
Staff level help	Yes, staff helps passengers for making their trip more reliable and convenient	It is provided and separate enquiry counter solves all kinds of queries for passengers.

Regular cleaning and maintenance	The station is maintained well	The station is maintained well

6.6 Observation

The station and its vicinity are examined for assessing a station's transfers. The findings for two interchanges are found in this section viz. Memnagar, L. D. College Both are prominent stations in the city, one serving the needs of the suburb region (L. D. College), and it even serves the surrounding district commuting population. The other serves the town's long distance needs (Memnagar). The main problem is that there is no separate walkway from bus stop to get to the BRTS station. It is mixed with the main traffic and the approach road is narrow which does not provide a zebra crossing facility which is a security concern.Availability of bus stop space close to station is a matter of concern. Station information is only provided at the premises of the station, but it should ideally be displayed 150 meters before the stop. The provision of in good condition facilities such as seating and lighting. The station can be re-designed as a short-term measure to accommodate buses for a stop. (Since the existing bus stop is 200 meters away, safety concerns should be considered as a narrow road).

The second Memnagar station is the city's third most important station as it is very close to the city's Ghuma gam station, which is the city's prime station. It acts as a major stop that wants to reach Ahmedabad but doesn't want to reach Ghuma. This station was even gaining in importance as two BRTS routes emerged. A passenger can commute on both sides of the routes from this station. Even after the station's importance, its location is the principal disadvantage. Even the bus stop is very far away which acts as a passenger barrier.This gave auto rickshaws the opportunity to cater for passenger needs and even passengers are forced to take their private vehicles to the station. Encroachment is the other problem that completely occupied the other side of the station. This provides more distance for the passengers to travel. Minor shopping malls are built around the station. Here careful planning of the interstation map should be provided due to the merging of the two BRTS routes at this point, separate feeder services should be provided by AMTS to integrate the two services The main obstacles that need to be addressed in order to solve the problems are that development can be seen across the road and not on the rail side due toParking shelter is a point of concern as some of the stations do not provide shelters for vehicles.

This issue needs to be looked by railway authorities. The security issue needs to be overlooked by both the agencies to attract the ridership.

There is an immediate need for coordination between the two agencies (AMTS and BRTS) to prepare coordinated time table, signage, route information and the provision of services related to infrastructure. Bus stops adjacent to BRTS stops require allocation of space or re-designing. The immediate action for AMC to perform is providing dedicated walkways. Development towards the stations should be encouraged and revenue generation should be seen as a source of income for the railway authorities which can also support the transit system.The provision of taxi stands also ensures that in the absence of bus services, the travelers' time is not wasted. Providing feeder bus services in such a way that the residential area's influence is captured, thus discouraging private vehicles.

7 CONCLUSION AND RECOMMENDATION

7.1 Conclusion

Learning's from best practices for efficient transfers:

Drawn from various levels of transfers, it can be seen from the Bogota case that the basic first step for a public transport is to ensure that the system is integrated with itself if it is to be considered integration with other modes of transport. This type of system integration means that physical and fare integration between the various corridors, routes, and feeder services is ensured. An internally integrated system may then expand its base considerably by allowing other modes to form a seamless interconnection. The concept of vertical and horizontal transfers can be achieved by looking into the Bogota and Singapore cases; this requires efficient mix of uses.

Feeder routes should be designed to take passengers across branches from truck service terminals. Those routes should be appropriate within 500 mtrs from the start or the end of the trips. As in the case of Singapore, the routes may be in loop if the length of the route is not too long or open ends, as in the case of Bogota.

Integration has been achieved in cities such as Singapore and Hong Kong (see chapter four), and public transportation ridership in these cities is high (70% and 65%, respectively). To achieve this integration level all agencies involved in delivering urban transport needed coordination.

Efficiently handled with proper traffic regulations at grade crossings (transfers) in Seoul, and following good pedestrian design. The fare is integrated between different bus services (Blue , Green, Yellow and Red buses) and it happens with less inconvenience for the commuters at grade transfers.

Physical integration of Hong Kong is a sort of cross junction. The figure below shows the combined use of two cross-platform interchange stations at Hong kong and Prince Edward stations in Hong Kong for transfers in different directions. They are adjacent stations, and merged together.

In this type of transfer there is a single platform between the two travel directions or two side platforms among the tracks connected by level corridors. Passengers do not need to move to another level of the platform, thereby increasing the efficiency of commuting.

Building a cross-platform interchange can be expensive, due to the complexity of rail track alignment.

Physical integration in Ahmedabad – Transfers at Interchanges:

In the case of Ahmadabad, 11 interchanges were taken for transfers study, and analyzed to identify problems that impede physical integration. These transfers include the crossing of physical barriers, such as under

Bridge transfers with the least convenience to the commuters, failing to provide sufficient pedestrian measures. Hong Kong thus had the advantage of having high density around transit stations (MTRs); the majority of the population had effectively used the available transit.

The findings from the Interchanges reveal that the city basically lacks the proper implementation of plan formulation at the time of system planning (for BRTS). This can be seen from the ridership it serves. Planning was lacking for its approach roads and development along the station. When compared to bus services, train frequency is comparatively low, this acts as a barrier to using the trains.

The main reason for this is that demand for public transport is not being created in those BRTS corridors. AMTS 'failure to supply feeder service buses served as a barrier to use of the BRTS service. Facilities such as parking and housing issues are being evaluated at interchanges.

From the primary survey findings, it was found that lack of pedestrian friendly design, enough street furniture around the stations causing more inconvenience transfers, and safety issues such as pedestrian crossing and lighting conditions add to insecure nighttime feeling. Feeder buses at some stations and their scheduling are inadequate and this needs to be managed properly.

7.2 Recommendations:

It forms the basis for the need for comprehensive public transport under these conditions which can serve as one of the solutions to urban transport problems.

Establishment of SPV (Special Purpose Vehicle) with certain tasks and powers for the operation of BRTS, which involves members from all responsible organizations, will manage and coordinate facilities necessary for the transfer of good quality.

In order to increase ridership in public transport, the city's zoning laws should be integrated with the transport goals. Contrary to this, up to now planning standards only address the requirements for parking spaces in various departments but have not considered their impact on the transport network. It should be the responsibility of the developers to mitigate the effects of their activities on the transport network. Improve the commercial development of the station by providing incentives such as additional FSI and separate development control rules to promote transit-oriented development.

Fare integration should be achieved in the form of a ticket between the bus and train, so that a common ticket serves the purpose of the two modes. This ensures uniform public transportation. Special monthly schemes can be announced for students commuting by both modes, as the majority proportion of the trips produced are educational trips. Integration of tickets can be achieved through both the revenue sharing by the authorities and can be shared based on distance traveled by the user and the type of system he used. This requires huge investment as the infrastructure should be created to track the journeys of the commuters in order to achieve a sharing of revenues.

For better commuting of BRTS buses

The formal arrangement should be made between AMTS and BRTS, so picked and dropped in an arranged manner to increase system reliability.

The research showed that they attach great importance to the interchange when travelers choose to make intermodal trips. However, there are circumstances in which the characteristics of the land-use and transportation network of a city can have a significant influence on passenger choices, much more than barriers at the interchange.

Specific policy actions to reinforce best practice in interchange design were recommended:

- The planning and coordination of interchanges should be overseen by a single authority. This will help synchronize services through the interchanges and guide the public transport investment priorities.
- Authorities should consider a proposal to set up a single body to coordinate timetables, inform and ticket through
- Authorities should extend the guidance they provide to designers and operators of public transport to include good practice in the design of interchanges.

- » The role of creating a city-wide standard for the basic elements of signage schemes that would cover all modes of public transportation should be assigned to an independent agency, so that the authorities can define and enforce their proposals.
- » Prepare an operational plan for BRTS and AMTS such that they complement each other.

Pedestrianisation:

This will lead to the carriageway being planned for continuous footpaths, well-built kerbs, avoiding obstacles through utilities and encroachments and careful sanitation planning on the sidewalks. Lack of proper zebra crossings and foot signals on busy streets further prevents walking. The pedestrianization plan includes:

Affordability: The cost of providing access to pedestrians such as pedestrian bridges, underpasses and other important transit-related facilities is involved.

Esthetics (pedestrian appearance of a network): it includes elements of the beauty of the walkway, street furniture and architecture.

Directness and Connectivity: The pedestrian route is the direct route, reducing the distance traveled to the transit station.

Safety: As well as being protected from road hazards by cars, the primary concern at the transit station is pedestrian health.

Security: It requires an atmosphere where pedestrians are not vulnerable to crime or theft. Installations such as adequate street lights, lighting conditions inside the transit station and mixed use of activities will help mitigate crime and improve safety aspects.

Efficient usage of ITS (Intelligent transport systems):

Be effective use of ITS reliable and real-time information can be displayed to the commuters, which in turn allows them to prepare their travel schedule effectively. This requires a huge infrastructure which includes the installation of control rooms, a database server for real transit arrival and departure information, and station operation and display manpower. The use of ITS should also facilitate the sharing of revenues by the common Janmitra card facilities for both operators.

Future Scope

» To this document, the issue of land use and transport integration should be further analyzed as future research scope.It is useful to understand the issues surrounding the various transfers that will help us achieve different forms of integration and will greatly reduce the transportation problems facing any urban region.