SUSTAINABILITY ASSESSMENT OF AHMEDABAD BUS RAPID TRANSIT SYSTEM

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF URBAN AND RURAL PLANNING

By

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JUNE, 2012

CERTIFICATE

Certified that the report entitled **"SUSTAINABILITY ASSESSMENT OF AHMEDABAD BUS RAPID TRANSIT SYSTEM"**, which has been submitted by **Mr. TEJAS S. RAWAL**, for partial fulfilment of the requirement for the award of the degree of **Master of Urban and Rural Planning**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is his own work done by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted by him for the award of any other degree of this or any other institute.

Date: 15 May 2012

Place: Roorkee

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CANDIDATES DECLARATION

I hereby certify that this report entitled **"SUSTAINABILITY ASSESSMENT OF AHMEDABAD BUS RAPID TRANSIT SYSTEM"**, which has been submitted in partial fulfilment of the requirement for the award of the degree of **Master of Urban and Rural Planning**, submitted in the Department of Architecture and Planning, Indian Institute of Technology- Roorkee, is an authentic record of my own work carried out during the period from July 2011 to June 2012, under the supervision and guidance of **DR. V. DEVADAS ,** Department of Architecture and Planning, Indian Institute of Technology, Roorkee, India.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree of this or any other institute.

Date: 15 May 2012

Tejas Rawal

Place: Roorkee

(TEJAS S. RAWAL)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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Yes, *it's complete; objective achieved!!!* These are the first words that make their way out of my mouth as I sit back in front of my computer to attend to last minute corrections advised by my guide – Prof. V. Devadas. I would like to thank him, first of all to be my guide and secondly giving me the permission and encouragement to go ahead with the thesis. . His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my study.

"Relevant Data Collection" – is an important part of this study and there are many people and instruments right from my cell phone to Indian Railways that have played their part, in what, I sometimes used to refer as "Struggle for Independence". I am thankful to Mr. Harshad Solanki.Dy, General Manager, Ahmedabad Janmarg Ltd. for extending all their co-operation during my struggle for data collection. I also thank Mr. Chirag Shah and Mr. Khelan Modi for developing a multifaceted insight towards the research problem and scenario through their interesting discussions, which ultimately helped developing the questionnaire format for the household survey.

Data collection is of no importance, until utilized judiciously – as guided by the members of the thesis committee: Prof. R. Shankar, Prof. R.K. Jain, and Prof. Nalini Singh, Prof. R. Chandra (Thesis Coordinator) for their encouragement, insightful comments, and hard questions. I am very much thankful to them for arranging regular thesis reviews which has helped me complete my thesis within stipulated time.

On a personal note, I would like to thank my friends –

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Last but not the least; I thank my family – my parents for their unconditional support and encouragement to pursue my interests during my years of education. I dedicate this thesis to my parents. They made this work possible.

Tejas S. Rawal

LIST OF FIGURES

ABBREVIATIONS

2W	Two Wheeler
3W	Three Wheeler
AMC	Ahmedabad Municipal Corporation
AMTS	Ahmedabad Municipal Transport Service
AUDA	Ahmedabad Urban Development Authority
BRTS	Bus Rapid Transit System
CBD	Central Business District
CCTV	Colsed Circuit Television
CEPT	Center for Environmental Planning and Technology
CMVR	Central Motor Vehicle Rules
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
ECS	Equivalent Car Space
EF	Ecological Footprint
EST	Environmental Sustainable Transportation
EURF	European Union Road Federation
EWS	Economically Weaker Section
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIDB	Gujarat Infrastructure Development Board
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSRTC	Gujarat State Road Transport Corporation
GUTS	Guided Urban Transit System
Ha	Hectare
HCV	Heavy Commercial Vehicle
HIG	High Income Group
IEA	International Energy Agency
IPT	Intermediate Public Transport
IPT	Independent Public Transport
ITS	Intelligent Transportation System
JnNURM	Jawaharlal Nehru Urban Renewal Mission
km/h	Kilometer Per Hour
LCV	Light Commercial Vehicle
LIG	Low Income Group
LoS	Level of Service
LRT	Light Rail Transit
m	Meter
MIG	Medium Income Group
MoRTH	Ministry of Road Transport & Highway
MoUD	Ministry of Urban Development
MRTS	Mass Rapid Transit System
NMT	Non-Motorised Vehicle
NUTP	National Urban Transport Policy
OECD	Organisation of Economic Coordination and Development
PCU	Passenger Count Unit
PIS	Passenger Information System
PT	Public Transport
PV	Personal Vehicle
RoW	Right of Way
RTO	Regional Transport Office
SLB	Service Level Benchmark
SPV	Special Purpose Vehicle
sqkm	Square Kilometer
SUV	Sports Utility Vehicle
ULB	Urban Local Body
UMTA	Unified Metropolitan Transport Authority
UNDP	United Nations Development Programme
v/c	Volume to Capacity Ratio
WCED	World Commission on Environment and Development
WHO	World Health Organisation

EXECUTIVE SUMMARY

The research examines the impacts in terms of sustainability from a transport development project, taking the Bus Rapid Transit System (BRTS), Ahmedabad as the case study. The principal focus therefore is on the service level benchmarking of BRTS and opinion analysis of different households which indirectly affect the sustainability of the project. By this research the investigator wants to show the importance of the sustainability aspect of public transportation for sustainability of the city, to make the city more livable and importantly to make the existing service ready for the future increased demand for successful functioning of the transport system as well as the city. Following parts, summarises the summary of research, dealt in chronological order.

Aim and Objectives

The aim of the study is to access the sustainability of current situation of Ahmedabad BRTS for future high demands. Following are the objectives for the research study:

- To assess the existing condition of the transportation system.
- To study the impact of Ahmedabad Bus Rapid Transit System in the system.
- To identify the indicators and service level benchmarks for assessing the sustainability.
- To evaluate the service level benchmarks for Ahmedabad BRTS.
- To evolve a set of plausible guidelines for sustainable transportation system for Ahmedabad City.

1. Public Transportation Scenario

India is a very large country with over a billion people and nearly 50 of its cities contain populations above 1 million each. Awareness varies in these cities about the role and importance of urban transport. While large cities (comprising more than 3 million people each) are aware and active, many cities (comprising about 1 million population each) are relatively inactive. This paper describes steps being taken by the Indian Government to promote sustainable urban transport, while the author suggests the need to make cities pedestrian-friendly for quick and ongoing relief, and proposes four essential ingredients for sustainable urban transport in the long term.

2. Sustainability, Sustainable Transportation and Sustainability Assessment

The concept of sustainability includes the following features: (i) processes need to be maintained (or carried on with) over a period of time, and (ii) harvesting of resources is inevitable for processes to run. *"The systems that function proficiently competent over a time span, over specified area and which can be kept up or maintained by minimal resources are sustainable systems"*. The resources that urban transportation systems deal with are, broadly speaking, as follows: (i) Material resources such as fuel, aggregates, bitumen, etc.; (ii) Space on land, water and air; (iii) Time; (iv) People (and sometimes certain types of animals); (v) Environment and (vi) Opportunity.

The Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability. The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various

combinations) are still evolving: they include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal and other reporting systems. They are applied over a wide range of spatial and temporal scales.

3. Bus Rapid Transit System and Lessons of Delhi BRTS

BRT is "a flexible, rubber-tired rapid-transit mode that combines stations, vehicles, services, running ways, and Intelligent Transportation System (ITS) elements into an integrated system with a strong positive identity that evokes a unique image." (Levinson et al., 2003, p. 12) "BRT is high-quality, customer-orientated transit that delivers fast, comfortable and cost effective urban mobility." (Wright, 2003, p. 1) BRT is "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses" (Thomas, 2001).

Starting off as an open system has been perhaps the biggest mistake in Delhi. This has slowed the system because of (i) buses moving in and out at any point of the corridor, (ii) long halts by buses to pick up passengers and (iii) breakdowns of deteriorated buses. Other mistakes include: Small stretch, No route rationalization and network development, Bus stops at junctions, Shifting bus lanes from center to left

4. Study Area BRTS Ahmedabad

This aspect was covered under chapter 4 of the research and provided an insight into the Ahmedabad city's socio—economic and demographic profile as well as an overview of the urban transport system in Ahmedabad. Ahmedabad is a rapidly expanding city with increasing developments, urbanization supported by domestic as well as foreign direct investment. The Ahmedabad Municipal Corporation (AMC) governs an area of about 190 sq. km. and has a population of about 4.5 million.

Under the Jawaharlal Nehru urban Renewal Mission (JNNURM), the city has been granted funds for urban development and renewal. Under this mission and as an integral part of the urban transport vision for Ahmedabad city and the Ahmedabad Urban Agglomeration area, Bus Rapid Transit System (BRTS) has been proposed and executed. The project envisages at influencing all income groups of the society and especially providing access to economically weaker sections of the society and increasing mobility of lower income groups. The BRTS has been proposed to be implemented under three phases. The system shall be integrated with the proposed metro system and rail corridor. This project also included upgradation of roads and development of road infrastructure. The concept of BRTS is to encourage more people on the public transit system, which with high quality service is delivered. It is about equal access and equal sharing of road space for people. By providing a dedicated corridor within the street for BRTS vehicles, more people can travel to destination in a time that is comparable to single occupancy vehicles.

5. Service level Benchmarking

The service levels of various sustainability parameters were worked out based on MOUD's Service Level Benchmarks Guidelines. The Level of Service in various sustainability parameters for Ahmedabad BRTS has been shown in the table shown below.

LEVEL OF SERVICES OF VARIOUS SUSTAINABILITY PARAMETERS OF AHMEDABAD BRTS

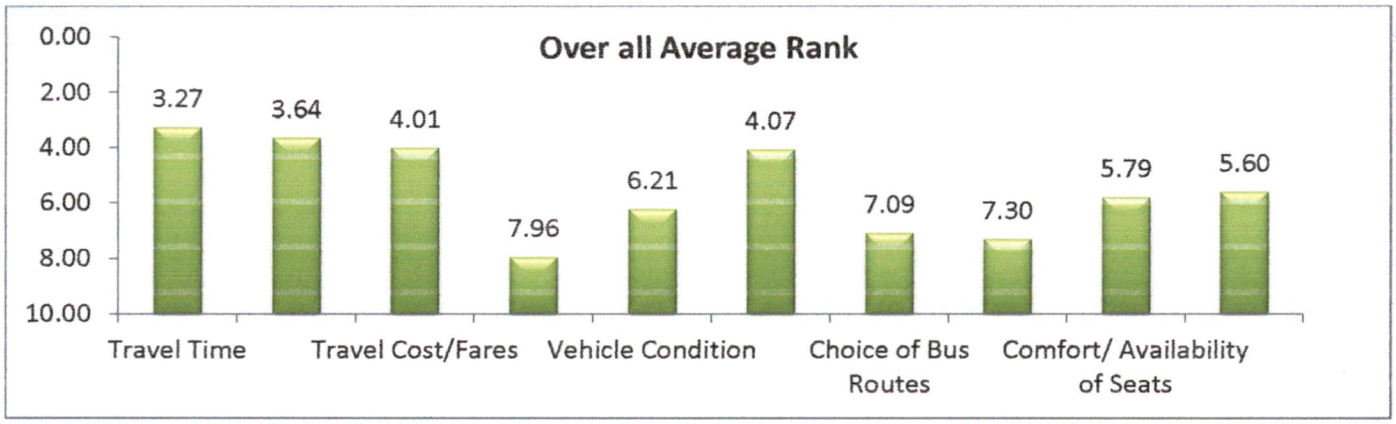
Sr. No.	Sustainable Transportation Parameters	Level Of Service
1	Public Transport Facilities	L.O.S.3
2	Pedestrian Infrastructure Facilities	L.O.S.3
3	Non Motorized Transport (NMT) Facilities	L.O.S.4
4	Level Of Usage Of Intelligent Transport System (ITS) Facilities	L.O.S.3

5	Travel Speed (Motorized And Mass Transit) Along Major Corridors	L.O.S.3
6	Availability Of Parking Spaces	L.O.S.3
7	Road Safety	L.O.S.2
8	Pollution Levels	L.O.S.2
9	Integrated Landuse-Transport System	L.O.S.3
10	Financial Sustainability Of Public Transport By Bus	L.O.S.3

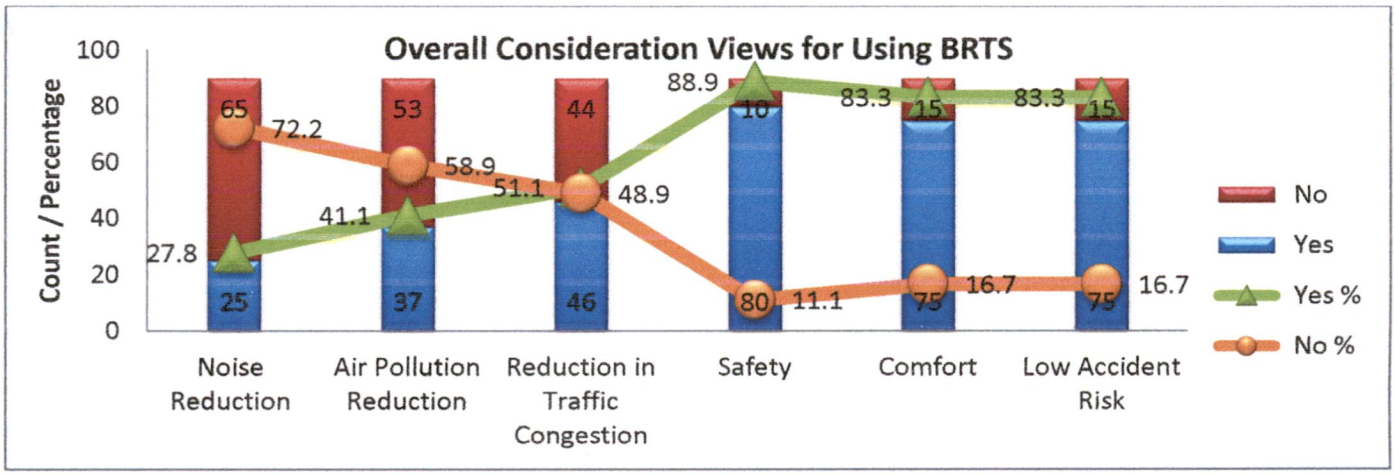
6. Household survey analysis

To support these results, household survey was carried out by the investigator for opinion on BRTS services. The opinion were taken mainly for BRTS Ranking, Considerations for choosing BRTS for Transportation, Influencing parameter to use BRTS, Willingness to pay for Improved BRTS

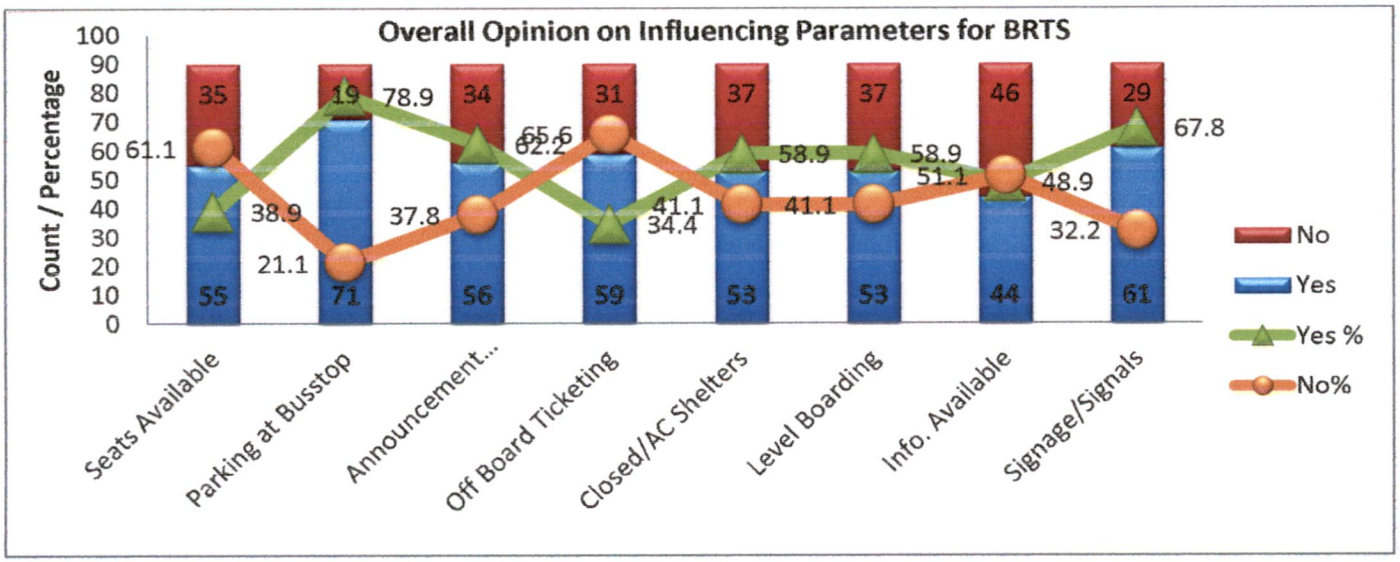
The results in overall ranking of Ahmedabad BRTS show that current BRTS functions are ranking highest in travel time, frequency of the service, and travel cost. Least ranking was observed for parking facilities, choice of bus routs and feeder services.



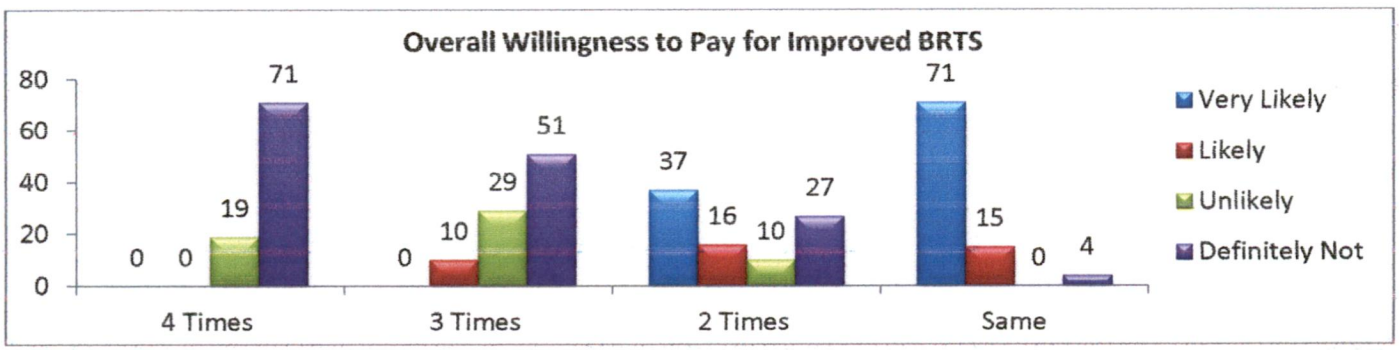
The opinion on considerations for choosing Ahmedabad BRTS had been asked to the respondents for various aspect of the sustainable public transport. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion.



The opinion on influencing parameters for Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats.



The willingness to pay for improved Ahmedabad BRTS had been asked to the respondents aiming at financial aspects of the sustainable public transport. The general observation for the willingness to pay was, majority of the respondents (71 out of 90) were in favor of paying the same as they are paying now, but few of them were also willing to pay double (37 out of 90), a very limited number of respondent wanted to pay three times (10 out of 90) the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare.



7. Major Issues Observed

- The feeder system is really weak, ant this is a major problem from user opinion point of view..
- The Phase 1 and 2 of Ahmedabad BRTS project are under construction, but largely the project is getting delayed in construction and functioning aspects. Accumulated effect of this scenario may result in to the weaker sustainability of the project.
- In pedestrian infrastructure, the major issues are observed at the junctions on the BRTS corridor. The traffic management of these junctions has to be done very carefully for the pro-pedestrian activities. In the peak hours the traffic volume is so high that the pedestrians are not given priority for crossing the roads. Another issue of pedestrian infrastructure is of footpaths, the encroachment of the footpath by hawkers and road side shop owners.
- Bicycles are the only non motorized transport in Ahmedabad. Due to the harsh hot climate, other modes of non mortised transport are not popular in the city. The issues on these facilities were mainly of encroachment and bad condition of cycle tracks. Another issue was of non availability of the cycle track along the BRTS corridor throughout, because of the varying right of way of the corridor.
- The wider scenario in Intelligent Transport System (ITS) has been observed that, passenger information system and GPS/GPRS enabled vehicles are enabled, functioning and performing well,

where as the Traffic Surveillance and Integrated Ticketing System are not yet implemented, for the better functioning of the BRTS Ahmedabad.

- The provision of parking near the BRTS bus stop has not been adequate enough for BRTS users as well as for normal traffic.
- The junctions are major unsafe locations for possible road accidents of vehicles and BRTS. Most of the road accidents along BRTS corridors are observed at junctions only.
- The BRTS system is some what sustainable currently, but if the sustainability of the system has to be improved for better long term future, then current fare system and other non fare revenue will not be adequate enough.

8. Recommendations

- Strong feeder system plan should be prepared along with existing BRTS routs to provide easy and comfortable connectivity to the BRTS bus stands. The help from Ahmedabad Municipal Transport Service (AMTS) buses can be taken for strengthening the feeder network for the BRTS. Rerouting of the AMTS will have to be done for this purpose.
- The pedestrian infrastructure viewpoint has to be considered for improving the current non-functioning and under functioning pedestrian services of BRTS. Special pedestrian under passes or foot over bridges shall be provided for the pedestrians for safe crossing and getting on the BRTS bus stand. The strict enforcement of law should be done to eradicate encroachment from the footpaths for smooth, easy and comfortable movement of the pedestrians.
- The enforcement of the law by traffic police supervision, for the cycle track has to be done very widely for general awareness of the people, the maintenance should be done regularly for the up keep of the cycle tracks, and encroachment of the dedicated tracks shall be removed.
- Traffic Surveillance and Integrated Ticketing System should be considered and improvements should be put in to action for better and long term sustainability of BRTS Ahmedabad.
- The junctions shall be treated with the signal prioritization for BRTS; this further will help in improving the sustainability of the BRTS, as more people will look forward to shift to BRTS from their other primary modes of transportation.
- The junctions shall be treated with the signal prioritization as stated above for BRTS as well as need some improvements in traffic management which significantly contribute to road safety.
- Paid parking spaces provided in the city need to be improved upon and to cater to the demand some differential parking rates for the CBD has to be adopted. The city authorities need to imitative considerable improvements measures. Municipal corporation should identify few locations for providing multi level vehicle parking, near the corridor bus stops, wherever the corporation unused land is available.
- From the opinion survey it was observed that half of the people (very likely and likely, 41.11 % + 17.78 % = 58.89 %) were in favor of the increased double fare as compared to current fare for improved system. This shows a very optimistic aspect for financial sustainability of Ahmedabad BRTS, which shall be materialised for better service.

9. Conclusion

Transport systems are among the various factors affecting the quality of life and safety in a city. The urban transport situation in large cities in India is deteriorating. Under JnNURM mission, many cities are now having modern mass transport systems. Sustainability of these modern mass transport systems are the

possible major issues of the future India. There is need to understand the sustainability aspect of public transportation for sustainability of the city, to make the city more livable and importantly to make the existing service ready for the future increased demand for successful functioning of the transport system as well as the city. Depending on the specific needs of a city, MoUD suggests benchmarking approach to improve the quality of urban transport for sustainability. Another approach that has been suggested by the author is, opinion survey no urban transport for understanding the sustainability from socio economic aspect. The identified issues and findings from these approaches can be very helpful to formulate convincing urban transport strategies. The main objective of such a strategy should be to provide and promote sustainable transit systems for people by improving the efficiency and effectiveness of the city's mass transport systems.

Chapter 1. Introduction

In the recent past, the word 'sustainability' has attained a prominent place in transportation planning, policy and other documents. It can be broadly defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their needs'. In the context of transportation, sustainability would mean developing better transportation systems, options and expectations consistent with the objective of securing future social and economic development within a sustainable environment that ensures community well-being.

Sustainable transport can be achieved through measures pertaining to transportation system management, energy management, capacity management and environmental management (Figure 1-1). Sustainable transport is also important for developing countries from the perspective of climate change, i.e. to improve carbon footprint/ ecological footprint (EF) of transportation. According to some of the studies conducted in the UK and US, it has been found that road transport emits 22–25% of the total output of carbon dioxide. These findings emphasize the need for achieving sustainability in transport not only from the mobility and safety perspective, but also from the perspective of local and global environmental issues. Also, from the responses of a recent survey of 522 stakeholders from the world's 25 major cities, it is found that the infrastructure related to transportation is the most serious challenge faced by all cities (matured, transition and emerging cities).

1.1 Identification of the Problem

India's urban population is expected to increase from 377 million in 2011 to 534 million in 2026. India has to enhance its urban infrastructure to achieve objectives of economic growth. However, most of the cities in India have inadequate infrastructure. Urban transport is one of the major infrastructures, affecting the mobility of people and economic growth of the cities.

The inadequacies in transport infrastructure are due to its sub optimal use and imbalance in modal split due to non integration of land use and transport planning. Due to inadequate city bus service, people tend to shift towards personalised modes. To improve the transport infrastructure, the Government of India approved the National Urban Transport Policy (NUTP) in April 2006.

Several initiatives have been taken up in India in this regard: Many cities have prepared Comprehensive Mobility Plans and are planning to introduce modern bus services; Bus Rapid Transit System (BRTS) is coming up in eleven cities (Ahmedabad, Visakhapatnam, Indore, Jaipur, Bhopal, Rajkot, Vijayawada, Pimpri-Chinchwad, Pune, Surat and Delhi); six cities are planning new metro rail systems (Mumbai, Bangalore, Kolkata, Chennai, Kochi, Hyderabad); and Unified Metropolitan Transport Authorities (UMTA) have been set up in two cities. The Government of India has funded 15,260 modern and intelligent transport systems enabled buses for city transport for 61 JnNURM mission cities (Singhal, B. 2010). JnNURM (Jawaharlal Nehru National Urban Renewal Miaaion) is a massive city-modernisation scheme launched by the Government of India under Ministry of Urban Development (MoUD). It envisages a total investment of over $20 billion over seven years ment to improve the quality of life and infrastructure in 61 mission cities.

The operational problems among mass transport systems, in planning and their implementation have started surfacing. For example, in case of Delhi Metro; over-crowding is a major problem which now has a ridership of over 20 lakh. Steps are being taken up to reduce over crowding by increasing the number

of coaches from 6 to 8. Once converted into eight-coach, a train can accommodate over 2,400 people per trip instead of 1800 passengers in a six coach train (Atul, M. 2009). This example provokes the investigator to think about the sustainability of the current MRT projects being proposed, planned and implemented in various cities.

Sustainability assessment is defined as assessment of proposed initiatives (projects, policies and plans) to determine whether or not approval should be given and if so under what conditions. Sustainability assessments are needed to address the economic, social and environmental interdependencies within policies, plans and projects, in order to help rationalize the decision making processes in as a broader and informed decision making (Buselich, K. 2002). Even though the sustainability assessment is done at the planning and decision making stage, the same can also be useful for determining the probable future issues in the existing system.

Considering above stated possibility of sustainability assessment, Ahmedabad Bus Rapid Transit System has been chosen as study area. Since BRT System coming up in most of the JnNURM funded cities, it is anticipated that the recommendation of this study if implemented systematically & scientifically in time, will result in a feasible sustainable BRT transportation system in the city which would pave the way for integrated development of the transport system.

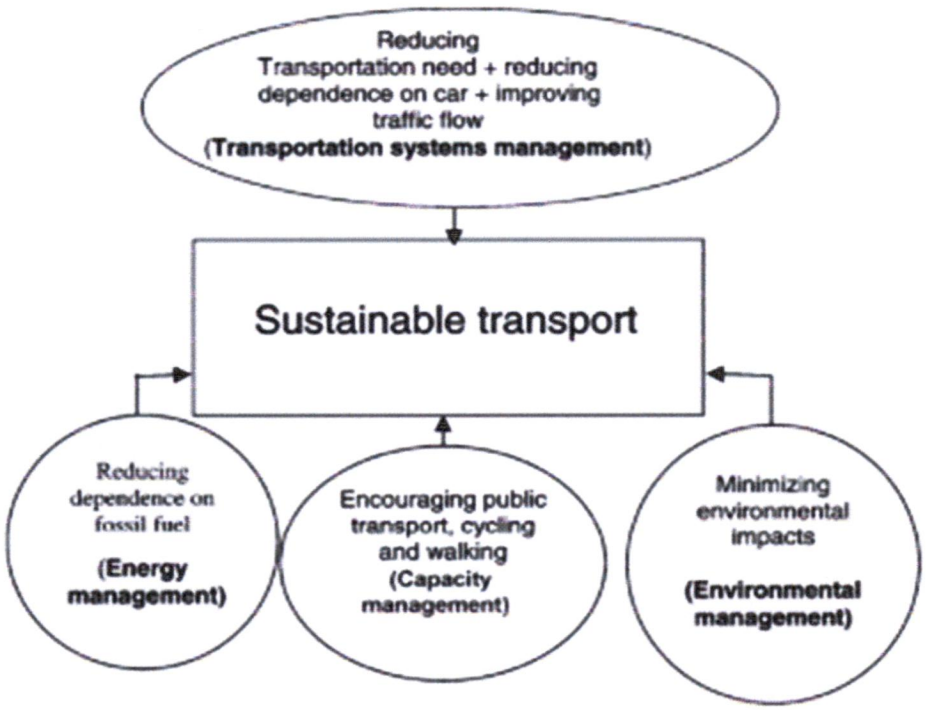


FIGURE 1-1 COMPONENTS OF SUSTAINABLE TRANSPORT

1.2 Aim and Objectives

The aim of the study is to access the sustainability of current situation of Ahmedabad BRTS for future high demands

Following are the objectives for the research study:

- Assess the existing condition of the transportation system.
- Study the impact of Ahmedabad Bus Rapid Transit System in the system.
- Identify the indicators and service level benchmarks for assessing the sustainability.
- Evaluate the service level benchmarks for Ahmedabad BRTS.

- Evolve a set of plausible recommendation for sustainable BRTS for Ahmedabad City.

1.3 Scope and Limitation

The study would be helpful for evolving plausible provisions for having the sustainable transportation systems in the study area.

The limitation for the study is: Assessment of the study area will be done based on the identified sustainability indicators and service level benchmarks. These indicators and service level benchmarks has been identified depending on availability of data.

1.4 Methodology

FIGURE 1-2 RESEARCH METHODOLOGY

The methodology adopted for the research has been shown in a flow chart in the above Figure 1-2.

Data

Secondary sources:

- Various publications of central, state, local governments
- Various publications of foreign governments
- Books, journals and news papers
- Technical journals
- Reports prepared by research scholars, universities etc., in different fields
- Reports published by various organizations
- Public records, statistics
- Other published information

Primary sources:

The methodology of primary source of data collection is discussed in below Figure 1-3. Based on this the primary data collection has been done. The indicators and service level benchmarks have been incorporated in the schedule so as to get the real-time and on site data for the study.

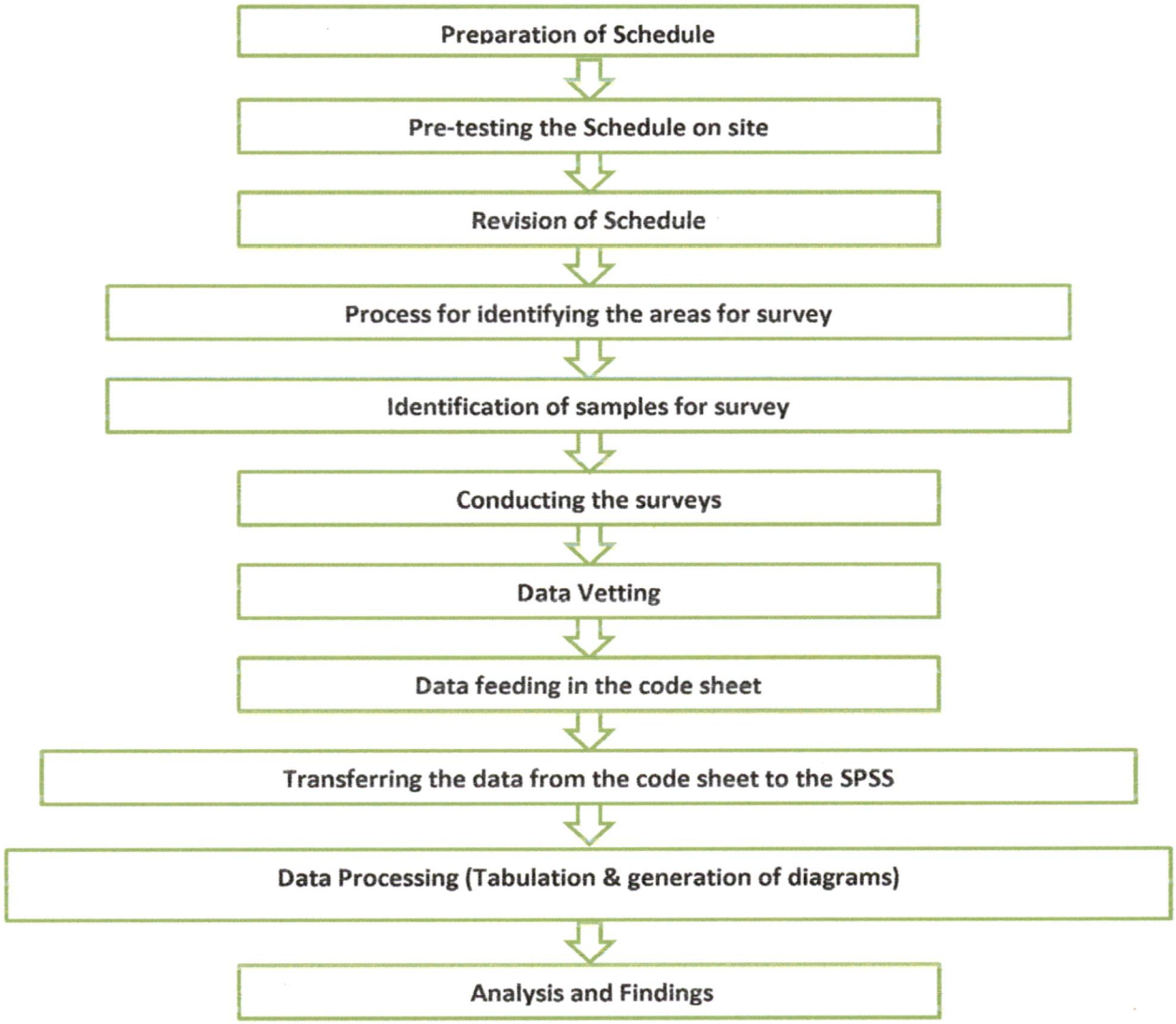


FIGURE 1-3 METHODOLOGY FOR PRIMARY SURVEY AND ANALYSIS

Tools and Techniques

Survey tools:

Relevant survey tools, such as, schedules, questionnaire has been employed.

Survey techniques:

Suitable sampling techniques has been employed for identifying relevant values of the identified indicators and service level benchmarks as well as other appropriate base data for further justification of the results.

Analytical tools:

Relevant analytical tools, such as, code sheets, computer hardware, software (Microsoft Excel, SPSS) have been used for data processing and analysis.

Analytical Techniques:

Relevant analytical techniques, such as, tabulation, graphical representation etc., has been attempted based on the requirement.

Analysis

Comprehensive analysis has been done in the interactive manner to find out the feasibility using tools and employing techniques to identify the present problems, inadequacies, probable solutions, requirements etc. for the future development. The analysis has been done basically in two parts, one being service level benchmarking of Ahmedabad BRTS and second part being analysing the household opinion survey for understanding the sustainability of the project from socio economic and travel characteristics point of view.

Results Discussions and Findings

Results of all types of analysis, such as, literature review, household survey etc., have been discussed in detail to draw inferences. Plausible findings have been drawn for evolving a set of policy guidelines for sustainable transportation.

Recommendations and conclusion

Plausible recommendations have been made to achieve sustainable development of the system (study area). The study would be concluded with the plausible recommendations.

1.5 Organisation of the Dissertation

Chapter 1 consists of introduction to the broad research area, identification of the problem, aim & objectives of the study, scope & limitations of the study and methodology adopted for the research.

Chapter 2 mainly consists of the relevant literature study done for better understanding of the research area. The chapter contains literature review of sustainable transportation, urban transportation scenario, and introduction to bus rapid transit system.

Chapter 3 deals with the national and international case studies of BRTS. Various case studies are of Brazil, Colombia, Ecuador, China, Indonesia, Japan and New Delhi, India. The New Delhi case study has been discussed in detail with its major issues in the functioning.

Chapter 4 describes the case area i.e. BRTS Ahmedabad in detail, its characteristics, features, situation before implementing the project, expected outcome of the imitative advantages, its functioning routs, operations, components of the project, strategy used to achieve the desired goals etc.

Chapter 5 consists of strategy adopted for data collection for secondary and primary data collection. Further the household data trends have been discussed in one of the section of the chapter as well as the requirements of the secondary data collection i.e. service level benchmarks.

Chapter 6 deals with analysis of primary and secondary data. Primary data analysis consist of questionnaire for household analysis dealing with questions on the socio economic parameters, trip characteristics, usage, attitude and perception of the current BRTS and other modes of public transportation services, their expectation from the public transport services, their willingness to pay for the desired service. The secondary data analysis was done based on availability of data and the service level for various parameters for BRTS were worked out.

Chapter 7 summarises the conclusions from the research. It begins with the review of some specific conclusions that emerge from the various analyses undertaken. The chapter ends with a discussion on some of the possible recommendations for better sustainability of the BRT system of Ahmedabad.

Chapter 2.
Literature Study

In literature study of the research, it has been studied in various aspects according to the need of the study area and concerned background was also studied for the same which has been included in this chapter. The title of the study suggests the major areas that are associated with the research. All that major areas as well as related areas are tried to cover under the literature study for the research topic. The major and related study areas are listed below.

- Transportation Scenario in India
  - Urbanization
  - Motorization
  - Modal share
  - Effects on mobility
  - Effects on safety
  - Effects on environment
  - Role of Government
    - Institutional structure of transport sector
    - National Urban Transport Policy
    - Demonstration Projects
    - Unified Metropolitan Transport Authority
    - Capacity Building Program
    - Mass rapid Transit and Non Motorised Transport
    - Emission Norms
- Sustainability
  - Sustainability And Sustainable transportation
  - Sustainability Assessment
  - Sustainable Transport Indicators
  - Service level Benchmark for Urban Transport
- Bus Rapid Transit System
  - Theory and evolution
  - Features of BRT System
  - Full BRT Concept
- BRTS Case Studies
  - BRT – Case Study 1: Curitiba (Brazil)
  - BRT – Case Study 2: TransMilenio, Bogota (Colombia)
  - BRT – Case Study 3: MetroBusQ, Quito (Ecuador)
  - BRT – Case Study 4: BRT, Kunming (China)
  - BRT – Case Study 5: Transjakarta, Jakarta (Indonesia)
  - BRT – Case Study 6: Nagoya (Japan)
  - BRT - Case Study 7: Delhi (India)

2.1 Transportation Scenario: India

Are current systems and trends of urban transportation in Indian cities sustainable? It is important to answer this question before discussing the problems. For this, it is important to first understand the present trends.

2.1.1 Urbanization

An urban area is an area with a high density of human-created erections compared to areas nearby. The definition of 'urban' varies in different countries. The definition of 'urban' in Indian context is: satellment having 5000 or more inhabitants, a density of 400 persons or more per Sqkm, distinct urban

features and minimum 3/4 of the adult male population employed in other than agriculture, are treated as urban areas'. (Ashish Verma, VOL. 100, NO. 9, 2010)

According to the census (Census, 2001) (Table 2-1), India has 393 towns with a population of more than 0.1 million. From the past trends of population growth in India (Table 2-2), it is expected that urban population may increase from 28% in 2001 to 58% by 2025. From the trends of the world's urban population, similar trends can be observed for developing countries compared to the developed countries (Figure 2-1).

TABLE 2-1 URBAN CONGLOMERATIONS IN INDIA

Class	Population size	Number
Class I	100,000 and above	393
Class II	50,000–100,000	401
Class III	20,000–49,999	1151
Class IV	10,000–19,999	1344
Class V	5,000–9,999	888
Class VI	Less than 5000	191
Unclassified		10

Source: (Census, 2001)

TABLE 2-2 HISTORICAL GROWTH OF POPULATION IN INDIA

Year	Population (in lakhs)	Density of population per sq. km	Average annual exponential growth rate	Percentage of urban population to total population
1901	2,384.0	77	–	10.85
1911	2,520.9	82	0.56	10.29
1921	2,513.2	81	–0.03	11.18
1931	2,789.8	90	1.04	11.99
1941	3,186.6	103	1.33	13.86
1951	3,610.9	117	1.25	17.29
1961	4,392.3	142	1.96	17.97
1971	5,481.6	177	2.22	19.91
1981	6,833.3	216	2.20	23.33
1991	8,464.2	267	2.14	25.70
2001	10,286.1	325	1.95	27.82

Source: Census figures of different years

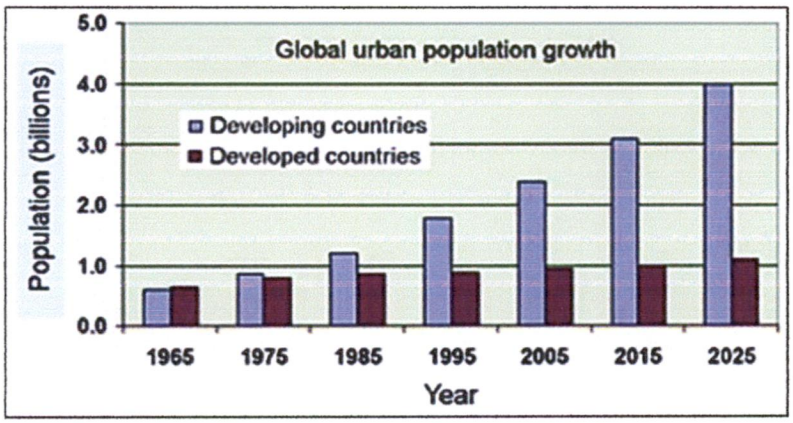


FIGURE 2-1 POPULATION GROWTH IN DEVELOPED AND DEVELOPING COUNTRIES

Source: (MOUD, 2008)

Clearly, this growth of the urban population in developing counties has a definite impact on travel demand and subsequently on urban mobility. It is clearly understood that cities are the economical contributors of the nation with their 50–60% contribution to GDP. But, the question is 'how can an urban India survive with the estimated population as indicated above'?

2.1.2 *Motorization*

Indian cities have registered high growth in registered motor vehicles (Figure 2-2). Thriving economy, ambition to own a car, inadequate public transport, the government's encouraging policies on open car market and easy loan schemes, etc. are a few causes for swelling motorization at a rapid rate. For example, Table 2-3 shows that cars and SUVs will increase 13-fold in 2035 with respect to 2005. Unfortunately, a similar growth has not been observed for bus fleets of major transport undertakings in India (Table 2-4). In fact, the size of the bus fleets has been decreasing in most of the urban transport undertakings except in Bangalore where the annual growth is about 10%.

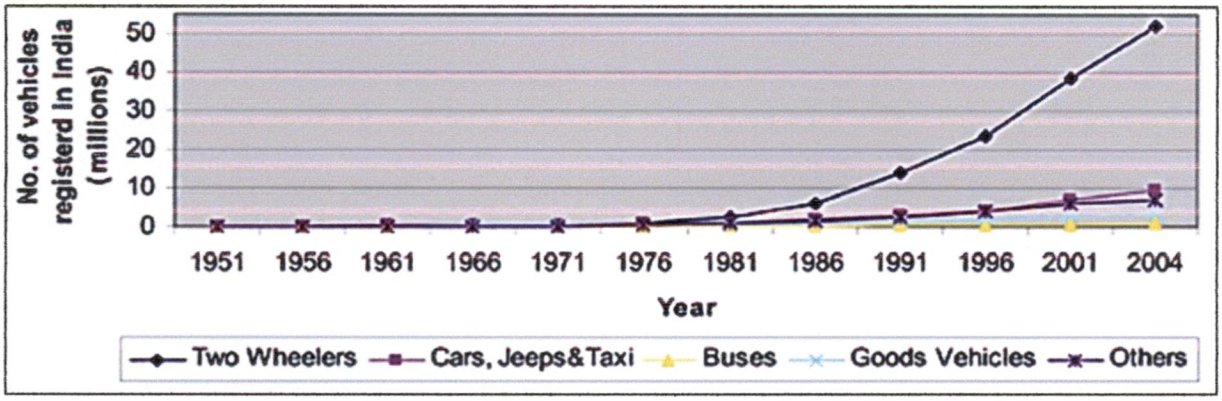


FIGURE 2-2 GROWTH OF INDIA'S MOTOR VEHICLE BY TYPE OF VEHICLE FROM 1951 TO 2004 (IN MILLIONS)

Source: (MoRTH, 1999), (MoRTH, 2000), (MoRTH, 2003)

TABLE 2-3 FORECAST OF VEHICLE POPULATIONS IN INDIA (IN MILLION VEHICLES)

Population	2005	2008	2015	2025	2035
2-W	35.8	46.1	87.7	174.1	236.4
3-W	2.3	3.0	5.3	8.8	13.1
HCV	2.4	2.9	4.6	9.1	16.2
LCV	2.4	3.2	5.7	12.5	26.9
Car, SUV	6.2	8.8	18.0	41.6	80.1
Grand total	49.1	63.9	121.3	246.1	372.7

Source: (MOUD, 2008) Note: 2-W, two-wheeler; 3-W, three-wheeler; HCV, Heavy commercial vehicles; LCV, Light commercial vehicles; SUV, Sports utility vehicles.

TABLE 2-4 GROWTH OF STATE TRANSPORT UNDERTAKING (STU) BUS FLEET IN INDIA

		Year								
City	STU	2000	2001	2002	2003	2004	2005	2006	2007	Annual Avg GR (%) (2000-07)
Mumbai	BEST	3269	3155	3075	3075	3074	3069	3075	3081	-0.8
Delhi	DTC	4916	4330	4466	2496	2905	3010	3143	2814	-7.7
Chennai	CHI-I	2353	2314	2211	2270	2253	2187	2176	2087	-1.7
Kolkata	CSTC	814	621	856	800	769	707	659	635	-3.5
Ahmedabad	AMTS	752	729	630	410	382	371	545	727	-0.5
Pune	PMT	657	664	647	662	697	764	784	752	1.9
Chandigarh	DCHNTU	393	395	404	–	–	–	405	404	0.4
Bangalore	BMTC	2110	2250	2446	2656	3062	3533	3802	3967	9.4

Source: (MOUD, 2008)

2.1.3 *Modal share*

Mode split in selected cities of India is shown in Figure 2-3. Also, Table 2-5 Existing modal split in Indian cities (as percentage of total trips) shows the existing modal split for different Indian cities based on

population size. As a general trend, with the increase in the size of the city in terms of both area and population, the modal share on public transport has been increasing.

One of the important reasons for considerable public transport (PT) mode share is the presence of a substantial percentage of captive riders in most of the Indian cities. The modal share on non-motorized transport (walk and bicycle) is also considerable; however the policy, infrastructure and facility support are extremely poor for non-motorized transport (NMT) modes in India. From a recent study by (MOUD, 2008), during 1994 to 2007, the average PT share has been reducing for cities with above two million populations (Table 2-6) and if the PT share is projected further (Table 2-7) considering the present trend of urbanization and motorization; it is further going to decrease, aggravating the imbalance in the modal split.

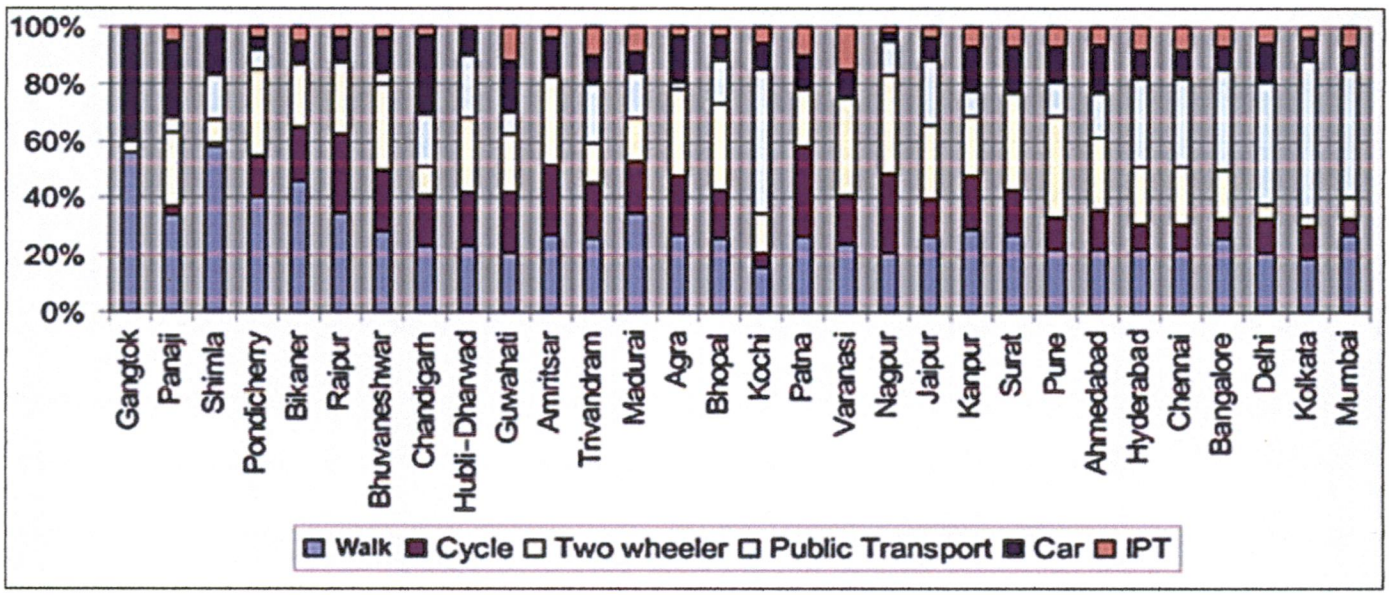


FIGURE 2-3 MODE SPLIT IN INDIAN CITIES

Source: (MOUD, 2008)

TABLE 2-5 EXISTING MODAL SPLIT IN INDIAN CITIES (AS PERCENTAGE OF TOTAL TRIPS)

City population (in millions)	Walk	Mass transport	Intermediate public transport		Car	Two-wheeler	Bicycle	Total
			Fast	Slow				
0.10–0.25	37.1	16.4	10.4	20.1	3.3	24.1	25.7	100.0
0.25–0.50	37.8	20.6	8.9	17.2	2.6	29.8	20.9	100.0
0.50–1.0	30.7	25.4	8.2	12.0	9.5	29.1	15.9	100.0
1.0–2.0	29.6	30.6	6.4	8.1	3.3	39.6	12.1	100.0
2.0–5.0	28.7	42.3	4.9	3.0	5.0	28.9	15.9	100.0
5.0+	28.4	62.8	3.3	3.7	6.1	14.8	9.4	100.0

Source: (MOUD, 2008)

TABLE 2-6 CHANGE IN PUBLIC TRANSPORT SHARE

City category	City population range (in lakhs)	WSA study, 2007 (%)	RITES study, 1994 (%)
1	<5.0	0.0–15.6	14.9–22.7
2	5.0–10.0	0.0–22.5	22.7–29.1
3	10.0–20.0	0.0–50.8	28.1–35.6
4	20.0–40.0	0.2–22.2	35.6–45.8
5	40.0–80.0	11.2–32.1	45.8–59.7
6	Above 80.0	35.2–54.0	59.7–78.7

Source: (MOUD, 2008)

TABLE 2-7 PROJECTED CHANGE IN PT SHARE AND ESTIMATED MODE SHARE FOR DIFFERENT CITY CATEGORIES

Year		2007			2011			2021			2031		
City category	Population	PT	PV + IPT	NMT	PT	PV + IPT	NMT	PT	PV + IPT	NMT	PT	PV + IPT	NMT
Category 1a	<5 lakh population with plain terrain	5	57	38	4	59	36	3	66	31	2	72	26
Category 1b	<5 lakh population with hilly terrain	8	34	58	7	37	56	5	47	48	3	57	40
Category 2	5–10 lakhs	9	39	53	8	42	50	6	51	43	5	58	36
Category 3	10–20 lakhs	13	43	44	12	46	43	10	52	38	9	57	34
Category 4	20–40 lakhs	10	47	43	9	49	42	8	51	41	8	52	40
Category 5	40–80 lakhs	22	42	36	21	45	35	15	51	34	12	54	34
Category 6	>80 lakhs	46	24	30	42	28	30	31	40	29	26	46	28

Source: (MOUD, 2008) Note: PT, Public transport; PV, Personal vehicle; IPT, Auto rickshaw; NMT, Non-motorized transport.

2.1.4 *Effects on safety*

Safety is another important goal of transportation, and as Figure 2-4 shows, it is a major worrying issue in India because of the ever-increasing trend of road fatalities. Recently, WHO revealed in its global status report on road safety that India topped in road accident fatalities. In India, the number of road deaths is increasing every year whereas in European countries such as Germany, Sweden, England, Denmark, etc., the numbers are either stagnant or reducing which indicates their higher sustainability levels (Table 2-8).

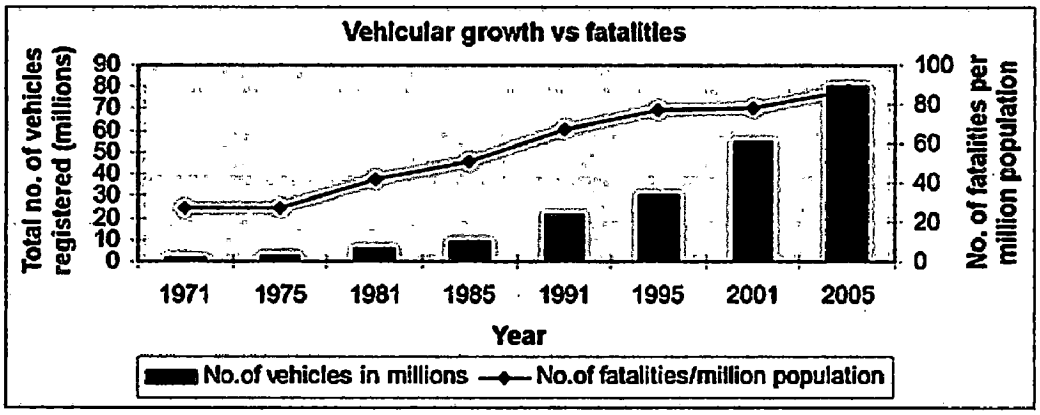


FIGURE 2-4 ROAD FATALITY TRENDS OF INDIA

Source: (MoRTH, 1999), (MoRTH, 2000), (MoRTH, 2003)

TABLE 2-8 ROAD ACCIDENTS INVOLVING INJURY, 1980–2004 (IN THOUSANDS)

Year	Germany	Sweden	Great Britain	Denmark	India
1980	412.7	15.2	257.3	12.3	153.2
1990	389.4	17	265.6	9.2	282.6
2000	382.9	15.8	233.7	7.3	391.449
2001	375.3	15.8	229	6.9	405.637
2002	362	16.9	221.7	7.1	407.497
2003	354.5	18.4	220.1	6.7	406.726
2004	339.3	18	213	6.2	429.91

Source: (EURF, 2007)

2.1.5 *Effects on environment*

If we consider the current state of sector-wise carbon emissions (Figure 2-5), it can be observed that the transport sector has a major share of 26% of total carbon emissions as compared to other sectors, such

as energy, manufacturing, residential, commercial, etc. Also, within the emissions from the transport sector, road transport has a major share of 65% as compared to rail, air and water transport. Table 2-9 and Table 2-10 show fuel consumption per day in km and emissions per day in tonnes, respectively, by different types of vehicles for different city categories.

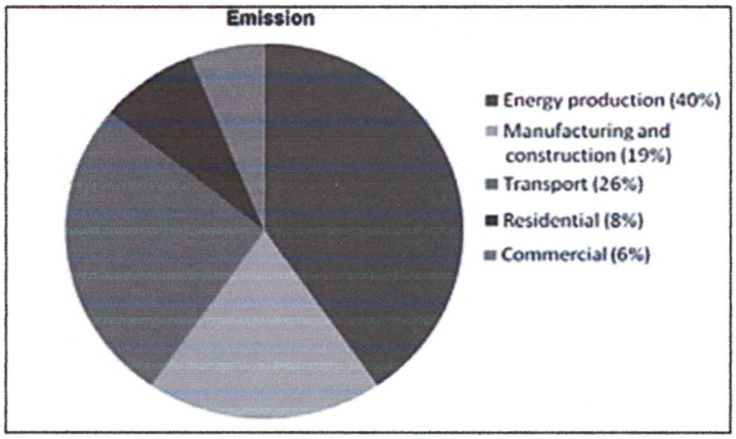


FIGURE 2-5 SECTOR-WISE CARBON EMISSIONS

Source: (IEA, 2008)

TABLE 2-9 FUEL CONSUMPTION PER DAY (KM)

City category	Car	TW	AR	Bus	Total
1	36	8	5	6	55
2	603	414	362	280	1659
3	1003	1058	602	376	3039
4	436	393	393	140	1362
5	921	901	553	833	3208
6	4782	1605	2869	7442	16,697

Source: (MOUD, 2008)

TABLE 2-10 EMISSIONS PER DAY IN TONNES

City category	Car	TW	AR	Bus	Total
1	6	3	0	0	10
2	90	133	24	21	268
3	158	342	125	27	652
4	64	127	37	9	238
5	143	300	143	60	647
6	556	365	451	375	1747

Source: (MOUD, 2008)

2.2 Role of Government

Realizing the magnitude of the problem, the central and state governments have taken up some major initiatives in the recent past to achieve sustainability in transport.

2.2.1 Institutional structure of the transport sector

The organizations and institutions in the transport sectors, their roles and functions, and the relevant acts are given in the Table 2-11.

TABLE 2-11 INSTITUTIONS INVOLVED WITH URBAN TRANSPORT IN INDIA

Organisations	Functions	Relevant acts
	Urban transport planning	
Ministry of Urban Development	Overall responsibility for urban transport policy and planning	
Land Development	Land use allocation and planning	State Development Acts

Authority, State Government		
Roads		
Transport Department, State Government	Licenses and controls all road vehicles, inspection of vehicles, fixing motor vehicle tax rates	Motor Vehicles Act 1988
Ministry of Surface Transport	Administer the Motor Vehicles Act and notify vehicle specifications as well as emission norms	Motor Vehicles Act 1988
State Transport Undertaking, State Government	Operation of bus services	Road Transport Corporations Act 1950
Public Works Department, State Government	Construction and repair of State roads	VII Schedule of the Indian Constitution (Article 246), List II (State List), Item 13
Local municipality	Construction and repair of smaller roads, road signage, traffic lights, licensing and control of non-motorised vehicles, clearing of encroachments and land use planning.	Constitution (Seventy-Fourth Amendment) Act, 1992
Police	Enforcement of traffic laws and prosecuting violators	State Police Acts
Railways		
Ministry of Railways	Own and operate urban rail transit systems wherever they exist	Railway Act, 1989
Others		
Ministry of Petroleum and Natural Gas	Regulation of prices and quality of transportation fuels	Essential Commodities Act, 1955 The Petroleum Rules, 1976
Department of Environment, State Government	Monitoring air quality	

Source: (Deb, 2009)

2.2.2 National Urban Transport Policy (NUTP)

For urban areas to be able to support the required level of economic activity, they must provide for the easy and sustainable flow of goods and people. Unfortunately, however, such flow of goods and people has been facing several problems. Most prominent among them have been the following (NUTP, 2006):

- Accessing jobs, education, recreation and similar activities is becoming increasingly time consuming. Billions of man hours are lost with people "stuck in traffic". The primary reason for this has been the explosive growth in the number of motor vehicles, coupled with limitations on the amount of road space that can be provided. For example, on an average, while the population of India's six major metropolises increased by about 1.9 times during 1981 to 2001, the number of motor vehicles went up by over 7.75 times during the same period.
- The cost of travel, especially for the poor, has increased considerably. This is largely because the use of cheaper non-motorised modes like cycling and walking has become extremely risky, since these modes have to share the same right of way with motorized modes. Further, with population growth, cities have tended to sprawl and increased travel distances have made non-motorized modes impossible to use. This has made access to livelihoods, particularly for the poor, far more difficult.
- Travel in the city has become more risky with accident rates having gone up from 1.6 lakh in 1981 to over 3.9 lakh in 2001. The number of persons killed in road accidents has also gone up from 28,400 to over 80,000 during the same period. This again has tended to impact the poor more severely as many of those killed or injured tend to be cyclists, pedestrians or pavement dwellers.
- Increased use of personal vehicles has led to increased air pollution.

Unless the above problems are remedied, poor mobility can become a major dampener to economic growth and cause the quality of life to deteriorate. A policy is, therefore, needed on the approach to dealing with this rapidly growing problem as also offer a clear direction and a framework for future action.

Vision (NUTP, 2006)

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

Objectives

The objective of this policy is to ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents to jobs, education, recreation and such other needs within our cities. (NUTP, 2006)

This is sought to be achieved by (NUTP, 2006):

- Incorporating urban transportation as an important parameter at the urban planning stage rather than being a consequential requirement
- Encouraging integrated land use and transport planning in all cities so that travel distances are minimized and access to livelihoods, education, and other social needs, especially for the marginal segments of the urban population is improved
- Improving access of business to markets and the various factors of production
- Bringing about a more equitable allocation of road space with people, rather than vehicles, as its main focus
- Encourage greater use of public transport and non-motorized modes by offering Central financial assistance for this purpose
- Enabling the establishment of quality focused multi-modal public transport systems that are well integrated, providing seamless travel across modes
- Establishing effective regulatory and enforcement mechanisms that allow a level playing field for all operators of transport services and enhanced safety for the transport system users
- Establishing institutional mechanisms for enhanced coordination in the planning and management of transport systems
- Introducing Intelligent Transport Systems for traffic management
- Addressing concerns of road safety and trauma response
- Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements, etc.
- Building capacity (institutional and manpower) to plan for sustainable urban transport and establishing knowledge management system that would service the needs of all urban transport professionals, such as planners, researchers, teachers, students, etc
- Promoting the use of cleaner technologies
- Raising finances, through innovative mechanisms that tap land as a resource, for investments in urban transport infrastructure

- Associating the private sector in activities where their strengths can be beneficially tapped
- Taking up pilot projects that demonstrate the potential of possible best practices in sustainable urban transport. The NUTP has now become the guiding document for all urban transport improvements in Indian cities. In addition to that it also suggests various modes of transportation for supporting the sustainable transportation system for the city.

2.2.3 MRT and NMT

MRT systems are the backbone of the city PT system and an essential feature of sustainable transport. Similarly, NMT are the most environment friendly and sustainable modes of urban transport. Presently, however, MRT and NMT facilities in Indian cities are inadequate both in quality and quantity. The Government of India, therefore, is financially supporting MRT and NMT projects in Indian cities.

There are seven cities with populations in excess of 4 million. Nearly 100 kilometres of MRT is operating in Delhi with another 250 kilometres of Metro rail under construction in the first five cities. Two other cities are actively planning their rail transit systems. In addition, 11 cities are introducing BRT while two more cities have them in the planning stage. (Singhal, 2010) In order to improve bus services in Indian cities, the Government has recently sanctioned, under JNNURM, nearly 16,000 buses to the 61 JNNURM cities.

As far as Non Motorized Transport (NMT) is concerned, some cities have started providing dedicated lanes for bicycles and improving pedestrian facilities. The design of the cycle rickshaw has been improved and a definite role is being assigned to it (Rajvanshi, 2002). For example, in Ahmedabad BRTS road cross-section the bicycle lane on the both sides have been designed and implemented for smooth and conflict free flow of traffic as well as bicycle riders.

2.3 Sustainability

2.3.1 Definitions

There are many definitions of sustainability, sustainable development and sustainable transport. It is sometimes defined merely as environmental sustainability, concerned only with pollution reduction and environment conservation. However it is increasingly defined more broadly to accommodate other goals. Below are examples of broad sustainability definitions:

- Sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987)
- "Sustainability is equity and harmony extended into the future, a careful journey without an endpoint, a continuous striving for the harmonious co-evolution of environmental, economic and socio-cultural goals." (The Many Meanings of Sustainability, Vol 9, No. 4, May)
- "The common aim of sustainable development] must be to expand resources and improve the quality of life for as many people as heedless population growth forces upon the Earth, and do it with minimal prosthetic dependence. (Wilson, 1998)
- A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable. (ECMT, 2004)
- "...sustainability is not about threat analysis; sustainability is about systems analysis. Specifically, it is about how environmental, economic, and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation." (TRB, 1997)

- Sustainability is: "the capacity for continuance into the long term future. Anything that can go on being done on an indefinite basis is sustainable. Anything that cannot go on being done indefinitely is unsustainable.". (CST) 2004
- Environmentally Sustainable Transportation (EST) is: Transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes. (OECD, 1998)
- "A sustainable community is one that is economically, environmentally, and socially healthy and resilient. It meets challenges through integrated solutions rather than through fragmented approaches that meet one of those goals at the expense of the others. And it takes a long-term perspective— one that's focused on present and future, well beyond the next budget or election cycle." (ISC, 1997)

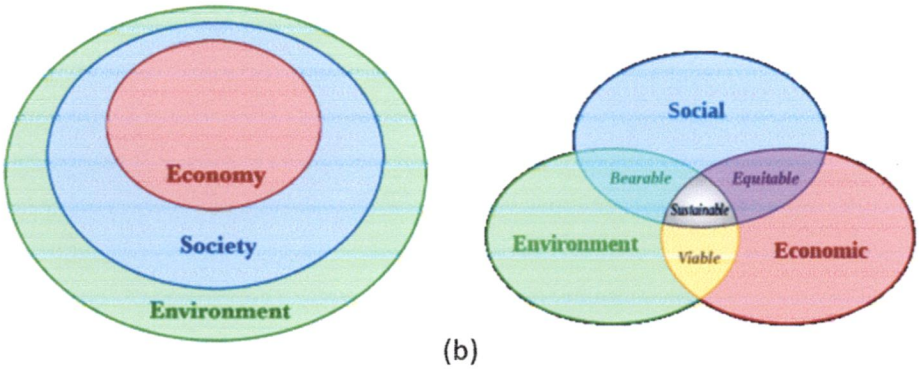


FIGURE 2-6 SUSTAINABILITY CONCEPT

Figure 2-6(a) indicating the relationship between the three pillars of sustainability suggesting that both economy and society are constrained by environmental limits. Figure 2-6(b) shows the scheme of sustainable development: at the confluence of three constituent parts (Wikipedia, 2000)

2.3.2 Sustainability and Sustainable Transportation

The concept of sustainability includes the following features: (i) processes need to be maintained (or carried on with) over a period of time, and (ii) harvesting of resources is inevitable for processes to run. *"The systems that function proficiently competent over a time span, over specified area and which can be kept up or maintained by minimal resources are sustainable systems"*. (Chakroborty, 2011) Of course, the word competent is used in a broader sense than it is generally used while describing efficiency of engineering systems. It must be accepted that engineering interventions (like infrastructure) which affect the society at large and use significant resources cannot be viewed and evaluated in isolation and must be looked at as a part of the habitat; that is, the efficiency of such systems must be defined in a more inclusive manner.

Thus three aspects are important to the creation of a sustainable urban transportation system. As mentioned before, these are: (i) the habitat of which the transportation system is a part; (ii) the resources that such a system will need to harvest, and (iii) the measure of efficiency that should be employed to evaluate such a system. In this context the definition of sustainable transportation as put forward by the European Union Council of Ministers of Transport is particularly important to note. Hence, this definition, as quoted in 'Sustainable Transportation & TDM' (TDM, 2010) is reproduced here.

'A sustainable transportation system is one that:

1. Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.
2. Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.
3. Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

Another way of looking at the above definition is that it tries to enunciate, although not exhaustively, the basic principles which will lead to an efficient transportation system over space and time.

2.3.3 Sustainability Assessment

Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability. The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various combinations) are still evolving: they include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal and other reporting systems. They are applied over a wide range of spatial and temporal scales.

Some of the best known and most widely used sustainability measures include corporate sustainability reporting, Triple Bottom Line accounting, and estimates of the quality of sustainability governance for individual countries using the Environmental Sustainability Index and Environmental Performance Index.

2.3.3.1 Sustainability Indicators And Their Function

Sustainability indicators can provide information on any aspect of the interplay between the environment and socio-economic activities. Building strategic indicator sets generally deals with just a few simple questions: what is happening? (descriptive indicators), does it matter and are we reaching targets? (performance indicators), are we improving? (efficiency indicators), are measures working? (policy effectiveness indicators), and are we generally better off? (total welfare indicators).

2.3.3.2 Metrics At The Global Scale

United Nations Indicators

The United Nations has developed extensive sustainability measurement tools in relation to sustainable development as well as a System of Integrated Environmental and Economic Accounting.

Benchmarks, indicators, indexes, auditing etc.

In the last couple of decades there has arisen a crowded toolbox of quantitative methods used to assess sustainability — including measures of resource use like life cycle assessment, measures of consumption like the ecological footprint and measurements of quality of environmental governance like the Environmental Performance Index. The following is a list of quantitative "tools" used by sustainability scientists - the different categories are for convenience only as defining criteria will intergrade. It would be

too difficult to list all those methods available at different levels of organisation so those listed here are at for the global level only.

1. **Benchmarks**

A benchmark is a point of reference for a measurement. Once a benchmark is established it is possible to assess trends and measure progress. Baseline global data on a range of sustainability parameters is available at list of global sustainability statistics and 2010 Biodiversity Indicators Partnership

2. **Indexes**

A sustainability index is an aggregate sustainability indicator that combines multiple sources of data. There is a Consultative Group on Sustainable Development Indices

- Air Quality Index
- Child Development Index
- Corruption Perceptions Index
- Democracy Index
- Environmental Performance Index
- Emergy Sustainability Index
- Education Index
- Environmental Sustainability Index
- Environmental Vulnerability Index
- GDP per capita
- Gini coefficient
- Gender Parity Index
- Gender-related Development Index
- Gender Empowerment Measure
- Gross national happiness
- Genuine Progress Indicator
- Gross National Product
- Happy Planet Index
- Human Development Index
- Legatum Prosperity Index
- Index of Sustainable Economic Welfare
- Life Expectancy Index
- Sustainable Governance Indicators. The Status Index ranks 30 OECD countries in terms of sustainable reform performance
- Sustainable Society Index
- Water Poverty Index

3. **Metrics**

Many environmental problems ultimately relate to the human effect on those global biogeochemical cycles that are critical to life. Over the last decade monitoring these cycles has become a more urgent target for research:

- water cycle
- carbon cycle
- phosphorus cycle
- nitrogen cycle
- sulphur cycle
- oxygen cycle

4. **Auditing**

Sustainability auditing and reporting are used to evaluate the sustainability performance of a company, organization, or other entity using various performance indicators. Popular auditing procedures available at the global level include:

- ISO 14000
- ISO 14031

- Natural Step
- Triple Bottom Line Accounting

5. **Reporting**
   - Global Reporting Initiative Global Reporting Initiative modelling and monitoring procedures. Many of these have only just been developed.
   - State of the Environment reporting provides general background information on the environment and is progressively including more indicators.
   - European sustainability
6. **Accounting**

Some accounting methods attempt to include environmental costs rather than treating them as externalities

- Green accounting
- Sustainable Value
- Sustainability economics

2.3.4 Sustainable Transportation Indicators

The use of indicators in transportation is not, of course, new. We use levels of service (LOS) to measure roadway system performance, internal and economic rates of return (IRR, ERR) to estimate investment effectiveness, etc. Indicators in transportation from a critical component of what Meyer and Miller (2001) call "performance-based transportation planning" (see Figure 2-7).

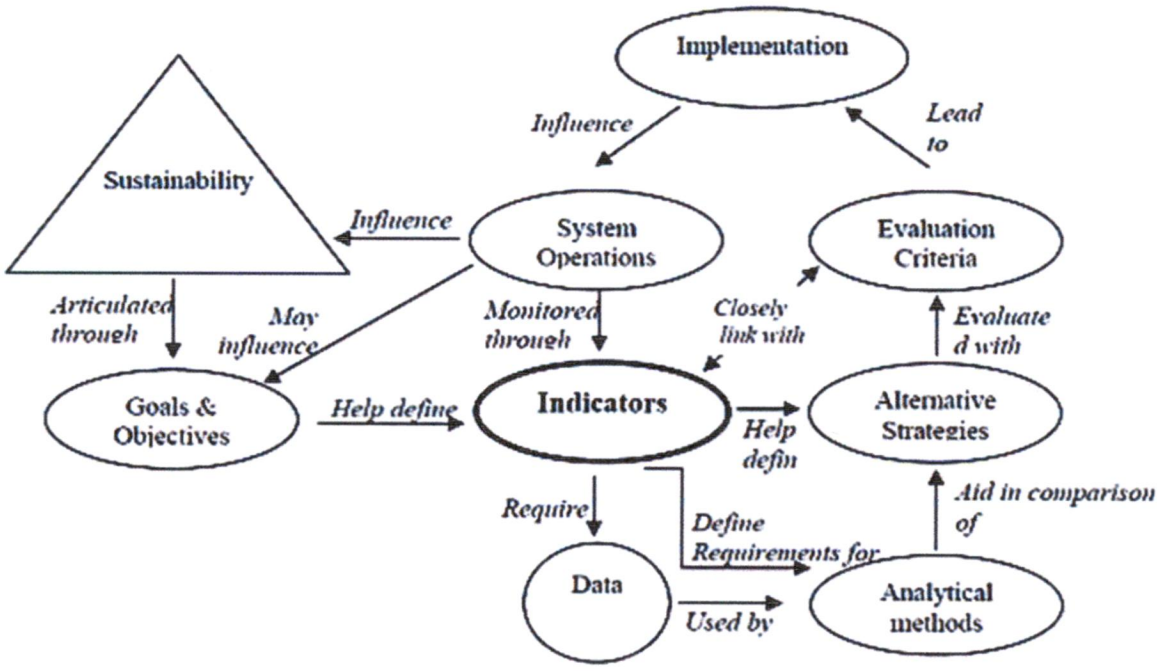


FIGURE 2-7 THE ROLE OF INDICATORS IN THE TRANSPORTATION PLANNING PROCESS

Source: Adapted from (Meyer, et al., 2001)

In such a planning approach, indicators, quite logically, tie closely to project evaluation criteria As we would expect, in the face of the boundary discussion above, indicators will vary depending on the spatial and temporal scale of the analysis and on the ultimate goals, although common indicators can often apply to several different goals and/or scales of analysis.

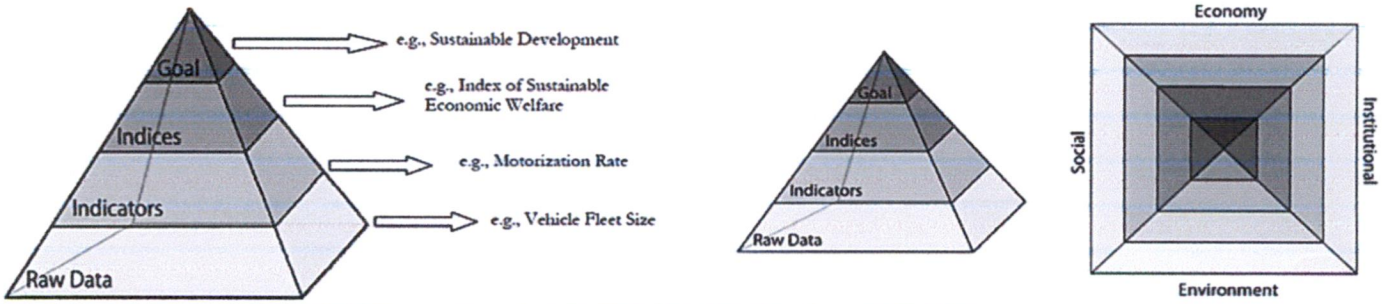


FIGURE 2-8 THE INFORMATION HIERARCHY THROUGH THE SUSTAINABLE INDICATOR PRISM

Source: (Zegras, et al., 2004)

It might be useful to situate performance-based transportation planning, sustainable transportation, and the role of indicators within the hierarchy of the Sustainable Indicator Prism (Figure 2-8). The top of the pyramid represents the goals and objectives, with the performance measures (indicators of varying degrees of specificity), building from raw data at the pyramid's base towards composite indices which converge towards the goals at the top.

2.3.5 Service Level Benchmarks for Urban Transport

2.3.5.1 Introduction

The challenges of the urban sector in India are growing rapidly, and government agencies at various levels are taking steps to address the gaps in service delivery. One of the important steps towards this is introduction of appropriate systems for information management, performance monitoring, and benchmarking.

Benchmarking is now well recognized as an important mechanism for introducing accountability in service delivery. It can help Urban Local Bodies (ULBs) and other agencies in identifying performance gaps and effecting improvements through the sharing of information and best practices, ultimately resulting in better services to the people.

Ministry of Urban Development (MoUD) wants to address institutional and operational aspects for ensuring long term sustainability of the benchmarking activity. Accordingly all JNNURM mission cities are advised to undertake the process of service level benchmarking. In addition, the initiative will facilitate development of Performance Improvement Plans using information generated by the benchmarking exercise. It will address both, performance monitoring for internal decision making and reporting to higher levels of government and external stakeholders.

2.3.5.2 Need

System for measuring performance of urban transport activities and taking further action on them has not been institutionalized in urban agencies. It is therefore important that the basic minimum standard set of performance benchmarks are commonly understood and used by all stakeholders. Depending on the specific needs of a city, performance parameters can be defined and used to improve the quality of urban transport.

2.3.5.3 Objective And Approach

The following areas need to be focused for the assessment of overall level of service:

- Quality and financial sustainability of public transport
- Pedestrian / NMT safety and infrastructure facilities

- ITS facilities in a city
- Land use transport integration
- Parking system and pollution levels in a city

To facilitate comparison between cities and changes in performance over time, it is important that the performance levels are monitored against set benchmarks. It is in this context, that the MoUD has initiated an exercise to define Service Level Benchmarks (SLBs).

Benchmarking is a long term process which involves a number of successive steps as shown in the 'benchmarking wheel' below.

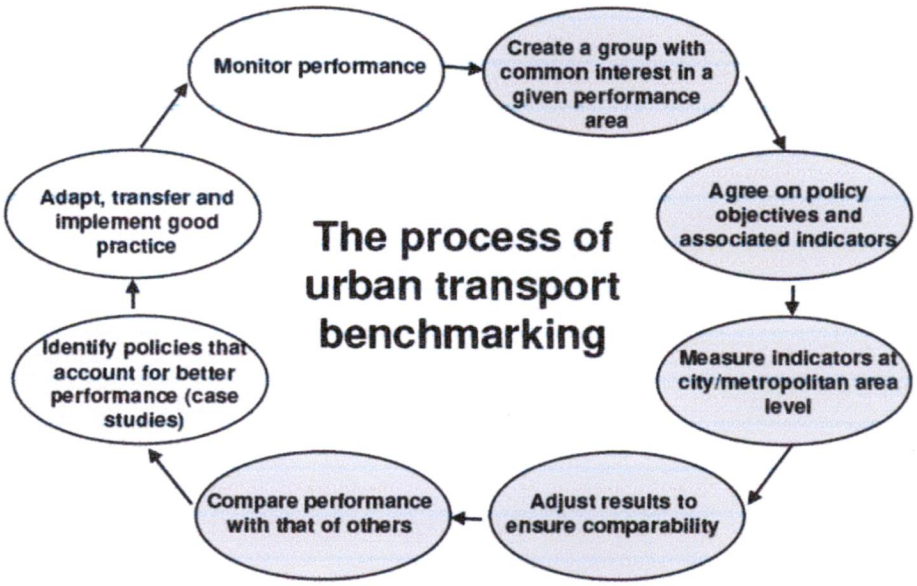


FIGURE 2-9 BENCHMARKING WHEEL

MoUD constituted a 'Core Group' comprising of experts from various institutions under chairmanship of Sh. S.K Lohia, the then Director (Urban Transport) and now OSD (MRTS) to arrive at the SLBs. Drawing on the experiences of various initiatives in measuring service level performance, the Core Group arrived at a set of performance benchmarks for urban transport. After much deliberation, the benchmarks, their definitions, means of measurement, frequency and reporting etc. were finalized.

2.3.5.4 Performance Benchmarks For Urban Transport

Service level performance benchmarks have been identified for the following areas of intervention:

- Public transport facilities
- Pedestrian infrastructure facilities
- Non Motorized Transport (NMT)facilities
- Level of usage of Intelligent Transport System (ITS) facilities
- Travel speed (Motorized and Mass Transit) along major corridors
- Availability of parking spaces
- Road safety
- Pollution levels
- Integrated land use transport system
- Financial sustainability of public transport

The parameters highlight the performance as would be monitored by the 'Urban Local Bodies' / 'Development Authority'/ Parastatal Agency. These performance measurements will need to be carried out

by the service delivery agencies themselves, reported to higher levels of management and also disseminated widely. Clear definitions and methodologies are expected to eliminate bias in measurement and reporting.

Typically, four levels of service (LoS) have been specified, viz. .1., .2., .3., and .4. with .1. being highest LoS and .4. being lowest to measure each identified performance benchmark . Therefore, the goal is to attain the service level 1.

Comparison of the various service level benchmarks of different countries has been done in the following table. The comparison was done between the components covered in service level benchmarks of India and Chinese Standards, European Standards, & Canadian Standards.

TABLE 2-12 COMPARISON OF SERVICE LEVEL BENCHMARKS OF INDIAN AND OTHER COUNTRIES STANDARDS

SR.NO	INDICATOR	Ministry Of Urban Development **India**	**China** Urban Sustainable Transport Research Centre	**European** Commission Directorate General For Energy & Transport	Victoria Transport Policy Institute **Canada**
1	**PUBLIC TRANSPORTATION**	☑	☑	☑	☑
1	Presence of Organized Public Transport System in Urban Area	☑	☑	-	☑
2	Availability of Public Transport	☑	-	-	☑
3	Service Coverage of Public Transport	☑	-	-	-
4	Average waiting time for Public Transport users (Frequency of P.T)	☑	-	-	☑
5	Level of Comfort in Public Transport (Crowding)	☑	-	-	-
6	% of Fleet as per Urban Bus Specification	☑	-	-	-
2	**AVAILABILITY OF PEDESTRIAN FACILITIES**	☑	☑	☑	☑
1	Signalized intersection delay	☑	-	-	-
2	Street Lighting (Lux)	☑	-	-	-
3	% of City Covered	☑	-	-	☑
3	**AVAILABILITY OF NON MOTORIZED VEHICLE (NMV) FACILITIES**	☑	☑	☑	☑
	Presence of NMV track	☑	☑	☑	☑
1	% of city covered with NMV	☑	☑	-	☑
2	Encroachment on NMV roads by Vehicle Parking (%)	☑	-	-	-
3	NMT Parking facilities at Interchanges (%)	☑	-	☑	-
4	**LEVEL OF USAGE OF INTELLIGENT TRANSPORT SYSTEM(ITS)FACILITIES**				
1	Availability of Traffic Surveillance	☑	-	☑	-
2	Passenger Information System (PIS)	☑	-	☑	-
3	Global Positioning System / GPRS	☑	-	☑	-
4	Signal Synchronization	☑	-	☑	-
5	Integrated Ticketing System	☑	-	☑	-
5	**TRAVEL SPEED(MOTORIZED AND MASS TRANSIT)ALONG MAJOR CORRIDORS**				
1	Travel speed of Personal vehicles along key corridors / Public transport vehicles	☑	-	-	-
6	**ROAD SAFETY**	☑	☑	☑	☑
1	Fatality rate per 100000 population	☑	-	-	-
2	Fatality rate for pedestrian and NMT (%)	☑	-	-	-
7	**AVAILABILITY OF PARKING SPACES**	☑	☑	☑	☑
1	Availability of paid public parking spaces	☑	-	-	-
2	Difference in Maximum and Minimum Parking Fee in the City	☑	-	-	-

8	POLLUTION LEVELS	☑	☑	☑	☑
1	Avg. pollution in the city	☑	-	-	-
9	INTEGRATED LANDUSE-TRANSPORT SYSTEM	☑	☑	☑	☑
1	Population Density	☑	-	-	-
2	Mixed Land-use Zoning	☑	-	-	-
3	Intensity of Development - Citywide	☑	-	-	-
4	Intensity of Development along Transit Corridors	☑	-	-	-
5	Road network Pattern and Completeness	☑	-	-	-
6	Road Density	☑	-	-	-
7	% Network with Exclusive ROW for transit (for > 1 million population as per 2001 census)	☑	-	-	-
10	FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS	☑	☑	☑	☑
1	Extent of Non Fare Revenue	☑	-	-	-
2	Staff per bus ratio	☑	-	-	-
3	Operating Ratio	☑	-	-	-

2.4 Bus Rapid Transit System

2.4.1 Introduction

Bus Rapid Transit (BRT) is a high-quality bus-based transit system that delivers fast, comfort able, and cost-effective urban mobility through the provision of segregated right-of-way infra structure, rapid and frequent operations, and excellence in marketing and customer service. BRT essentially emulates the performance and amenity characteristics of a modern rail-based transit system but at a fraction of the cost. A BRT system will typically cost 4 to 20 times less than a light rail transit (LRT) system and 10 to 100 times less than a metro system.

Several previous documents have also contributed definitions for BRT. These include:

- BRT is "a flexible, rubber-tired rapid-transit mode that combines stations, vehicles, services, running ways, and Intelligent Transportation System (ITS) elements into an integrated system with a strong positive identity that evokes a unique image." (Levinson et al., 2003, p. 12)
- "BRT is high-quality, customer-orientated transit that delivers fast, comfortable and cost effective urban mobility." (Wright, 2003, p. 1)
- BRT is "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses" (Thomas, 2001).

2.4.2 Features of BRT

BRT can be defined more precisely through an analysis of the features offered by the system. While few systems have achieved status as a complete BRT system, the recognition of the key characteristics can be invaluable to system designers and developers. The following is a list of features found on some of the most successful BRT systems implemented to date:

1) Physical infrastructure

- Segregated busways or bus-only roadways, predominantly in the median of the roadway;
- Existence of an integrated "network" of routes and corridors;
- Enhanced stations that are convenient, comfortable, secure, and weather-protected;

- Stations provide level access between the plat form and vehicle floor;
- Special stations and terminals to facilitate easy physical integration between trunk routes, feeder services, and other mass transit systems (if applicable);

2) Operations

- Frequent and rapid service between major origins and destinations;
- Ample capacity for passenger demand along corridors;
- Rapid boarding and alighting
- Pre-board fare collection and fare verification;

3) Business and institutional structure

- Entry to system restricted to prescribed operators under a reformed business and administrative structure (i.e., "closed system");
- Competitively-bid and wholly-transparent processes for awarding all contracts and concessions;
- Efficient management resulting in the elimination or minimisation of public—sector subsidies towards system operations;
- Independently operated and managed fare collection system;
- Quality control oversight from an independent entity I agency.

4) Technology

- Low-emission vehicle technologies;
- Low-noise vehicle technologies;
- Automatic fare collection and fare verification technology;
- System management through centralized control center, utilizing applications of Intelligent Transportation Systems (ITS) such as automatic vehicle location;
- Signal priority or grade separation at intersections.

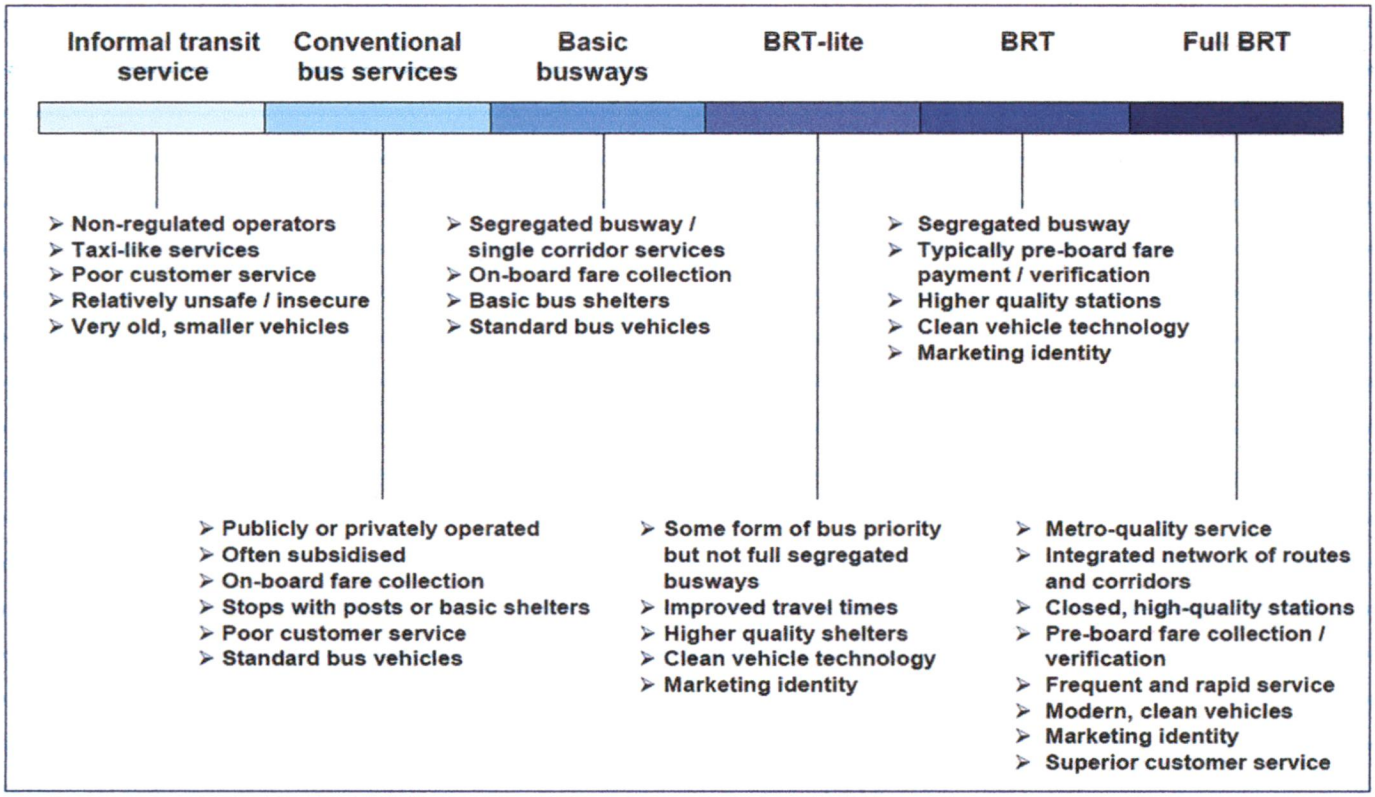
5) Marketing and customer service

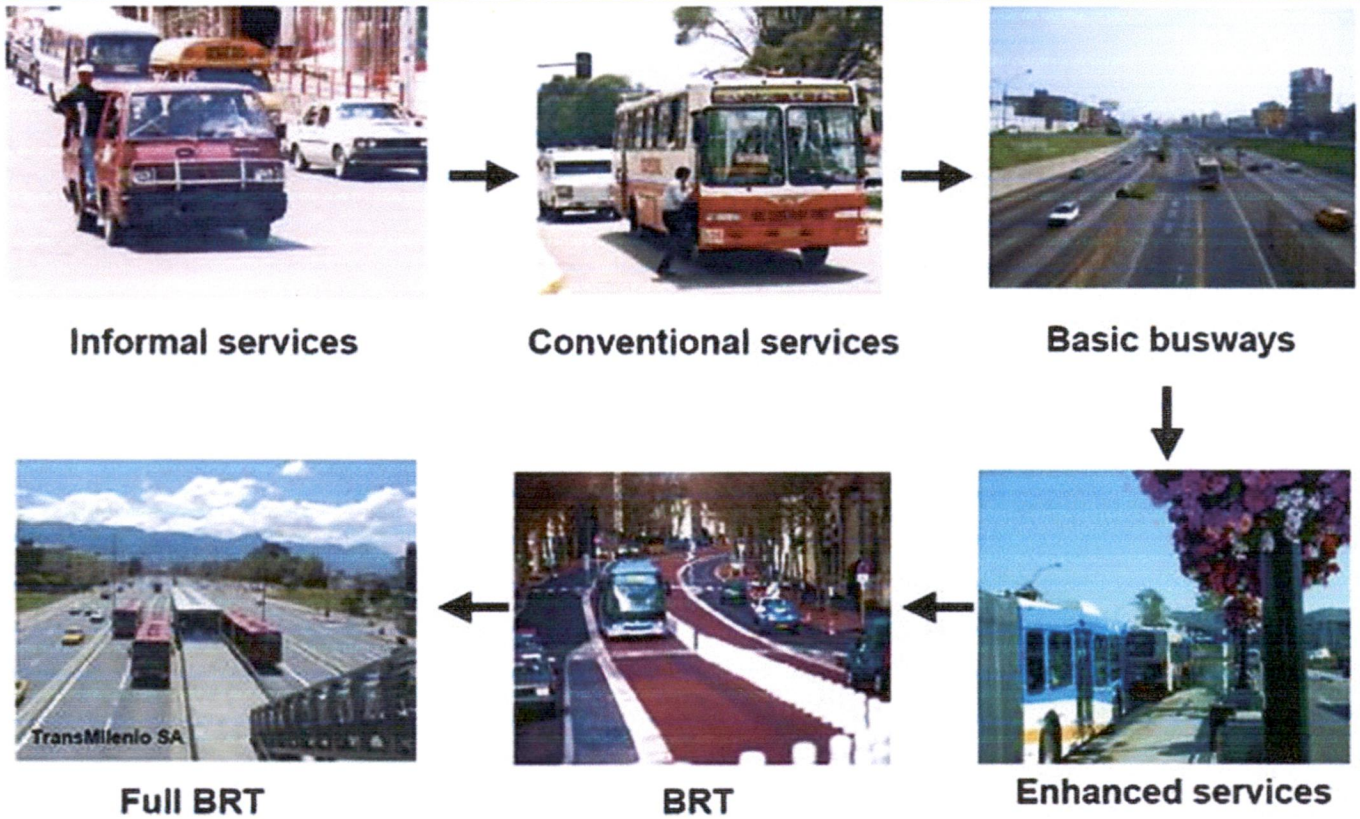
- Distinctive marketing identity for system;
- Excellence in customer service and provision of key customer amenities;
- Ease of access between system and other urban mobility options (such as walking, bicycles, taxis, paratransit, private mororised vehicles, etc.);
- Special provisions to ease access for physically disadvantaged groups, such as children, the elderly, and the physically disabled;
- Clear route maps, signage, and/or real-time information displays that are visibly placed within stations and/or vehicles.

2.4.3 Full Bus Rapid Transit

The difficulty in providing a precise definition of BRT sterns from the wide-variety of systems currently in operation. Rather than representing a discrete set of qualities, the various BRT systems form more of a spectrum of possibilities. A range of local factors affect the extent to which a complete package of BRT attributes is achieved. These factors may include local preferences and culture, population density, distribution of trips, climate, geography, topography, available financial resources, local technical capacity and knowledge, existing business and institutional structures, and, perhaps most importantly, the degree of existing political will to implement a high—quality system.

FIGURE 2-10 THE QUALITY SPECTRUM OF TYRE BASED PUBLIC TRANSPORT





The concept of "full BRT" will reside as the top tier. A system providing exemplary levels of public transport service and encompassing the most critical features of BRT will be recognized as achieving "full BRT" status. In this case, a "full" BRT system is defined as systems with the following minimum characteristics:

- Segregated busways or bus-only roadways over the majority of the length of the system's trunk I city centre corridors;
- Location of the busways in the median of the roadway rather than in the curb lane;
- Existence of an integrated "network" of routes and corridors;

- Enhanced stations that are convenient, comfortable, secure, and weather-protected;
- Stations provide level access between the platform and vehicle floor;
- Special stations and terminals to facilitate physical integration between trunk routes, feeder services, and other mass transit systems (if applicable);
- Pre-board fare collection and fare verification; . Fare- and physical-integration between routes, corridors, and feeder services;
- Entry to system restricted to prescribed operators tinder a reformed business and administrative structure ("closed system");
- Distinctive marketing identity for system.

Chapter 3.
Case Studies

The following sheets provide case studies that have been implemented internationally around the world. These case studies provide models on which to prepare similar designs and provide lessons on factors causing success or failure. A summary of lessons from such case studies is provided below in Table 3-1.

TABLE 3-1 CASE STUDIES OF BRT SYSTEMS AROUND THE WORLD

City	Country	System Name	Comment
Curitiba	Brazil	BRT	The first BRT system in the world and still one of the world's best-regulated bus systems
Bogota	Colombia	TransMilenio	Bus system similar to that of Curitiba with a few improvements, emerging over a period of three years
Quito	Ecuador	MetroBusQ	One of the first successful modern bus system projects in Latin America
Kunming	China	BRT	The first BRT system in the People'S Republic of China
Jakarta	Indonesia	Transjakarta	The first BRT system in south Asia (opened in 2004)
Nagoya	Japan	BRT	The first and most well-known BRT system in japan

Lessons to be learned from International BRT Systems

- Mass transit system with a high frequency service can capture 'repressed demand.'
- Trunk and feeder systems with terminals are essential elements of a high capacity BRT system.
- Coordination of BRT development with land use planning enables commercial development along the busways. As a result, the system becomes convenient for commuters and economically viable.
- The establishment of a company for planning and administration largely owned by the municipality can significantly contribute to a successful implementation of BRT system, as exemplified by Curitiba.
- The establishment of a single authority in transport planning and management is critical to building a successful integrated system. For example, a Transport Planning and Management Unit was set up in Quito and staffed by young professionals with assistance from international experts. This unit successfully guided the introduction of the BRT scheme.
- Segregated bus lanes can actually improve the flow of traffic in the remaining carriageway. In the Quito BRT scheme, despite the loss of the carriageway for general traffic due to bus lanes, traffic flow was observed to improve in the remaining carriageway due to the removal of stopping buses from the general flow. This also contributed to public acceptance of the scheme.
- BRT can be built in a relatively short time. A typical time frame for the design, building and operation of a BRT Route is around one to two years, while metro tends to take around 10 years to design, build and put into service. This reduces the risk of work stopping when the city administration changes hands.
- In terms of capital cost, BRT presents a very strong advantage over other modes. Also, given the right incentives and organization, private bus companies can finance the bus fleets and cover operating costs through adequate fare collection.

3.1 BRT – Case Study 1: Curitiba (Brazil)

BRT, Curitiba (Brazil) – The First BRT System in the world and World's Best-Regulated Bus Systems

TABLE 3-2 SUMMARY STATEMENT OF BRT, CURITIBA (BRAZIL)

Summary of the System	
Capacity	-
Users (whole system)	1.9–2.1 million passengers per day
Segregated busways on trunk roads	58km
Headway	90 seconds (peak period)
Number of Buses	1,550–1,600 (whole system)
Bus vehicle capacity per unit	270 passengers (trunk bus)
Infrastructure cost	US$1.5 million/km
Ticket price	US$0.55

City Characteristics

- Curitiba has an area of 430 km2, an urban population of 1,788,559, and a population density of 4,159/km2. (2006)
- The city has been planned to limit central area growth and to encourage commercial service sector growth along structural transport arteries (five busways radiating out from the city center).
- Blocks along busways have a plot ratio of 400%. The farther from the trunk roads the block is, the less its plot ration.
- Curitiba's GDP per capita is US$8,000, compared to the national average of about US$5,000.

BRT Scheme Characteristics:

Five BRT trunk line routes, segregated busways of total 58km, run along five structural axes of the city. Moreover, the overall citywide bus operation includes: (i) 340 bus lines; (ii) 1,550–1,600 buses; (iii) 1,100 km of bus routes; and (iv) 26 major and moderate size integration interchange terminals.

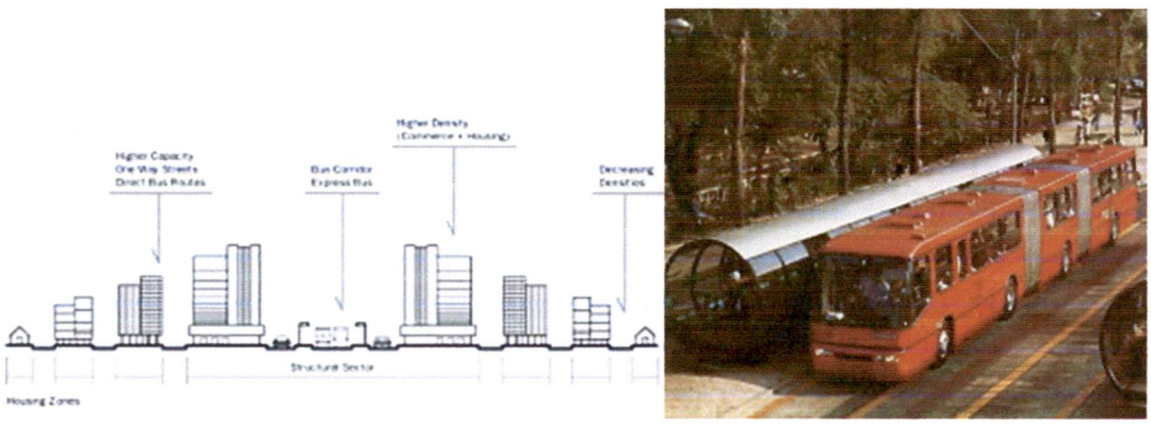


FIGURE 3-1 ROAD CROSS SECTION AND VIEW OF BUS STOP

Various Types of Buses for Different Trip Patterns: There are several kinds of buses operated, painted in different colors, as follows: (i) "Express" buses operated on the segregated busways, which are the trunk lines (red/orange); (ii) "Direct" buses, which are speedy services stopping at limited bus stations (grey/silver); (iii) "Inter-Direct" buses (green); (iv) "Feeder" buses, which feed to/from terminals and stop serving "Express" or "Direct" buses (orange); (v) "Conventional" buses operating regular services on normal

roads where other services are not justified (yellow); (vi) "Circular center" serving the CBD (white); and (vii) "Metropolitan" serving destinations outside of the city (blue). This whole structure forms the trunk and feeder system of Curitiba.

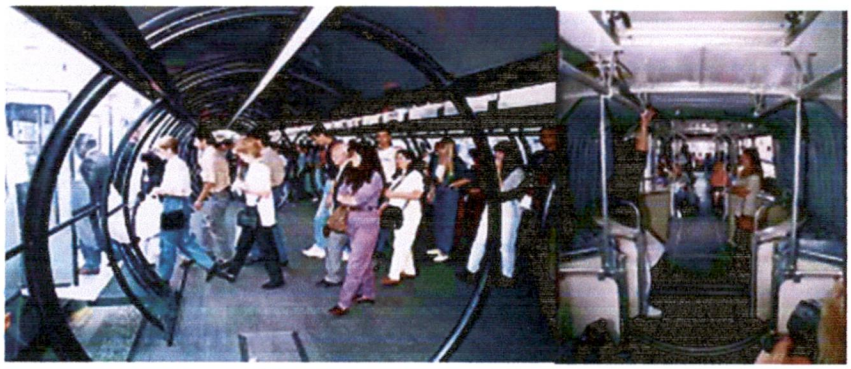


FIGURE 3-2 PASSENGERS BOARDING AT A TUBE STATION AND INTERNAL VIEW OF THE BI-ARTICULATED BUS UNIT

3.2 BRT – Case Study 2: TransMilenio, Bogota (Colombia)

TransMilenio, Bogota (Colombia): Bus System Similar to that of Curitiba with a Few Improvements, Emerging over a Period of Three Years

TABLE 3-3 SUMMARY STATEMENT OF TRANSMILENIO, BOGOTA (COLOMBIA)

Summary of the System	
Capacity	45,000 passengers per hour per direction
Users (whole system)	800,000 passengers per day
Segregated busways on trunk roads	85 km
Headway	2–3 minutes (peak period)
Number of Buses	600–700 (whole system)
Bus vehicle capacity per unit	160 passengers (trunk bus)
Infrastructure cost	US$7.6 million/km (average of Phase 1 and 2)
Ticket price	US$0.40

City Characteristics

- Bogota has an area of 1,587 km2, an urban population of 6,778,691, and a population density of 22,300/km2.
- The city is surrounded by mountains.
- The urban layout dates back to colonial times with a square layout adopted from Spain.
- Colombia's GDP per capita (2006) is US$8,600.

BRT Scheme Characteristics:

The whole system, consisting of four phases, was planned to cover 95% of the urban area over a period of 28 years, to meet the mobility needs of a majority of the population. It is a trunk and feeder system as well as closed system, including a trunk route extension of 388 km to serve 5.5 million passengers/day. In 2002–2003, TransMilenio phase 1, comprising three trunk corridors with a total length of 42km and seven feeder routes with a length of 346km, started to operate. Phase 2 consisting of three trunk corridors, a total of 43 km, opened in 2005. Transmilenio is now planning a third phase of trunk lines with the goal of having at least 80% of the city population within 500 m of a trunk line.

FIGURE 3-3 EXPRESS SERVICE ON TRUNK LINE

Bus Supply Control by Intelligent Transport System: An Intelligent Transport System (ITS) is one of the elements enabling the effective operation of TransMilenio, which operates a control center that supervises services. Each articulated bus is equipped with a GPS and a processing unit that reports its location every six seconds. The control center also receives information from turnstiles that report the number of passengers entering and leaving. The supply of buses and service demand are then coordinated and contingencies managed in real time.

3.3 BRT – Case Study 3: MetroBusQ, Quito (Ecuador)

MetroBusQ, Quito (Ecuador): First Successful Modern Bus System Projects in Latin America

TABLE 3-4 SUMMARY STATEMENT OF METROBUSQ, QUITO

Summary of the System	
Capacity	Line 1: 8,000 passengers per hour per direction Line 2: 6,000 passengers per hour per direction
Users (whole system)	170,000 passengers per day
Segregated busways on trunk roads	Line 1: 16.1 km Line 2: 9 km Line 3: 21.46 km
Headway	Line 1: 90 seconds (peak period) Line 2: 2 minuets (peak period) Line 3: 4 minuets (peak period)
Number of Buses	Line 1: 113 Line 2: 42 Line 3: 17
Bus vehicle capacity per unit	174 passengers (trunk bus)
Infrastructure cost (Line 1 "trolley bus system" includes vehicle cost.)	Line 1: 5.1 million/km Line 2: 1.2 million/km Line 3: 2.3 million/km
Ticket price	US$0.25

City Characteristics

- Quito has an area of 290km2, an urban population of 1,504,991, and a population density of 5,190/km2
- The shape of the city is generally linear, approximately 30km long and 4–10km wide due to its location in a narrow valley, 2800m above sea level.
- The historical center of Quito has been a World Cultural Heritage Site since 1978.
- Ecuador's GDP per capita (2005) is US$4,300 with Quito Municipality at US$3,536.

FIGURE 3-4 VIEWS OF BUS STANDOFF METROBUSQ

BRT Scheme Characteristics:

Three BRT trunk line routes now run in roughly parallel corridors in Quito's main urbanized area with feeder bus systems. The first to be implemented was the "Quito Trolebus" (a trolleybus system). The second and third were the "Ecova" and "Central-Norte" corridors, both of which are served with diesel buses. A dedicated Transport Planning and Management Unit (UPGT) was established to plan and guide the introduction of the integrated BRT scheme.

3.4 BRT – Case Study 4: Transjakarta, Jakarta (Indonesia)

Transjakarta, Jakarta (Indonesia): The First BRT system in South Asia (opened in 2004)

TABLE 3-5 SUMMARY STATEMENT OF TRANSJAKARTA, JAKARTA (INDONESIA)

Summary of the System	
Capacity	2,700 persons/hour/ direction
Users (whole system)	65,000 passengers per day (no feeder system)
Segregated busways on trunk roads	12.9km (2004)
Headway	2–3 minutes (peak period)
Number of Buses	56 (no feeder system)
Bus vehicle capacity per unit	83 passengers
Infrastructure cost	US$1.0 million/km
Ticket price	US$ 0.30

City Characteristics

- Jakarta is the capital and largest city of Indonesia with the ninth largest urban population density in the world.
- Jakarta has an area of 661.52km2, an urban population of 8,792,000, and a population density of 13,300/km2.
- Road traffic is very congested, especially during peak hours because of the city's high population density.
- Indonesia's GDP per capita (2006) is US$3,900.

BRT Scheme Characteristics:

The projected trunk busway network consists of seven corridors. The first corridor opened in 2004 with a 12.9km fully segregated median busway. The system is a closed trunk system without a functioning feeder system. Scheme Cost: Corridor 1: US$1 million/km.

3.5 BRT – Case Study 5: Nagoya (Japan)

BRT, Nagoya (Japan): The First and Most Well-Known BRT System in Japan

TABLE 3-6 SUMMARY STATEMENT OF BRT, NAGOYA (JAPAN)

Summary of the System	
Capacity	-
Users (whole system)	500,000 Passengers/day
Segregated busways on trunk roads	Guideway Bus: exclusive guideways 6.8km; busways on the roads 5.1km Key Route Bus Line 1: 6.75 km Key Route Bus Line 2: 9.2 km
Headway	Guideway Bus: 3–5 minutes (peak period) Key Route Bus Line 1: 3–5 minutes (peak period) Key Route Bus Line 2: 1–2 minutes (peak period)
Number of Buses	Guideway Bus: 25 Key Route Bus Line 1: 29 Key Route Bus Line 2: 52
Bus vehicle capacity per unit	Guideway Bus: 64 passengers Key Route Bus Line 1: 77 passengers Key Route Bus Line 2: 73 passengers
Infrastructure cost	Guideway Bus: US$ 26 million/km Key Route Bus Line 1: US$ 0.6 million/km Key Route Bus Line 2: US$ 2.3 million/km
Ticket price	Guideway Bus: US$ 1.7 – US$ 5.5 Key Route Bus: US$ 1.7

City Characteristics

- Nagoya is the third largest city in Japan following Tokyo and Osaka with an area of 326.45km2, an urban population of 2,225,866, and a population density of 6,818/km2
- Unlike most cities in Japan, Nagoya has a wide, grid road network with 3–5 lanes on each side.
- The development of metro in Nagoya started much later than other major Japanese cities.
- Japan's GDP per capita (2006) is US$33,100

BRT Scheme Characteristics:

Raised Exclusive Guideway – Guideway Buses: The buses run on the raised exclusive guideway (busway) above the roads with a high speed of 30kph, automatically guided by electricity in the city center. In the suburbs, where traffic is less, they run on existing roads as do other buses. The total route is 11.9km, 6.8km of which is exclusive guideway.

Source: Nagoya Guideway Bus Corporation

Source: Compiled from Maps of Nagoya Municipality

FIGURE 3-5 VIEW AND NETWORK OF BRT, NAGOYA GUIDEWAY BUS SYSTEM

3.6 BRT - Case Study 6: Delhi (India)

Delhi BRT Planning

- 1995: CPCB commissions a Study for reducing vehicular pollution in Delhi , final report recommends segregates bicycle lanes and bus lanes submitted in 1997.
- 1997: Transport Department of GNCTD commissions a study for planning safe bicycle transport in Delhi.
- 1998: Study submitted to GNCTD indicating exclusive bicycle lanes are required on all arterial roads to improve flow and safety of all. Designs for Vikas Marg and Wazirabad corridors prepared
- 2002 (JANUARY): DTC organises an International Workshop in collaboration with IDFC and SIAM. A consensus emerged that Delhi should plan for BRT corridors in Delhi
- 2002 (MAY): Chief Minister GNTCD appoints a Committee under the Chairmanship of the Chief Secretary to examine all possible options for planning for sustainable transport in Delhi.
- 2002 (SEPT): Committee submits report and recommends that dedicated central lanes be established public transport on six corridors of Delhi.
- 2004: Contract awarded to RITES to prepare detailed plans for BRT for six corridors with construction details for the first corridor. Order placed for first 6 low floor buses for Delhi.
- 2005: Transport Department (GNCTD) organises an international workshop to examine design details for the first corridor. The national and international experts review the details and examine the corridor and their suggestions are incorporated in the designs.
- 2006: GNTCD establishes Delhi Integrated Multi-Modal Transit System (DIMTS), a Special Purpose Vehicle to oversee the establishment of public transport systems in Delhi.
- 2006 (Oct): Construction of the first corridor starts.
- 2006-2007: All details of the project examined by EPCA in several meetings with all stakeholders and suggestions incorporated. 6 km corridor scheduled for inauguration in 2008

Strategic Errors and Design Flaws in Delhi BRTS

Starting off as an open system has been perhaps the biggest mistake in Delhi. This has slowed the system because of (i) buses moving in and out at any point of the corridor, (ii) long halts by buses to pick up passengers and (iii) breakdowns of deteriorated buses. Other mistakes include:

Small stretch: Operations have started on a small stretch of 6 km, yielding minimal advantages to most commuters, because only a small part of commuters' trips (often much less than 6 km) is on the dedicated corridor.

No route rationalization and network development: No comprehensive route rationalization was carried out. Bus routes remain the same as before. Further, different corridors being studied are disjointed and do not constitute a good network.

Bus stops at junctions: Since bus stops are at the intersection, the number of waiting lanes available for mixed traffic is significantly reduced, resulting in a slowdown of traffic. Also, with bus stops on the left side of approaching buses-rather than on the median-avoidable infrastructure has been created and transfers to new routes have become difficult for passengers.

Shifting bus lanes from centre to left: Delhi started off the right way by having bus lanes at the centre, as is the case the world over. Central lanes minimize interference from the turning traffic as well as slow-moving traffic, which are rampant on the left lanes. Buses in the central lane, being a radically different concept, however led to opposition from the public who are used to using buses on the left lane. The problem arose mainly because of the absence of a sustained awareness campaign that crossing roads to

access or exit from BRTS bus stops can be made safe by use of signals. Shifting the BRTS corridor to the left, as is being considered, may defeat the objective of BRTS.

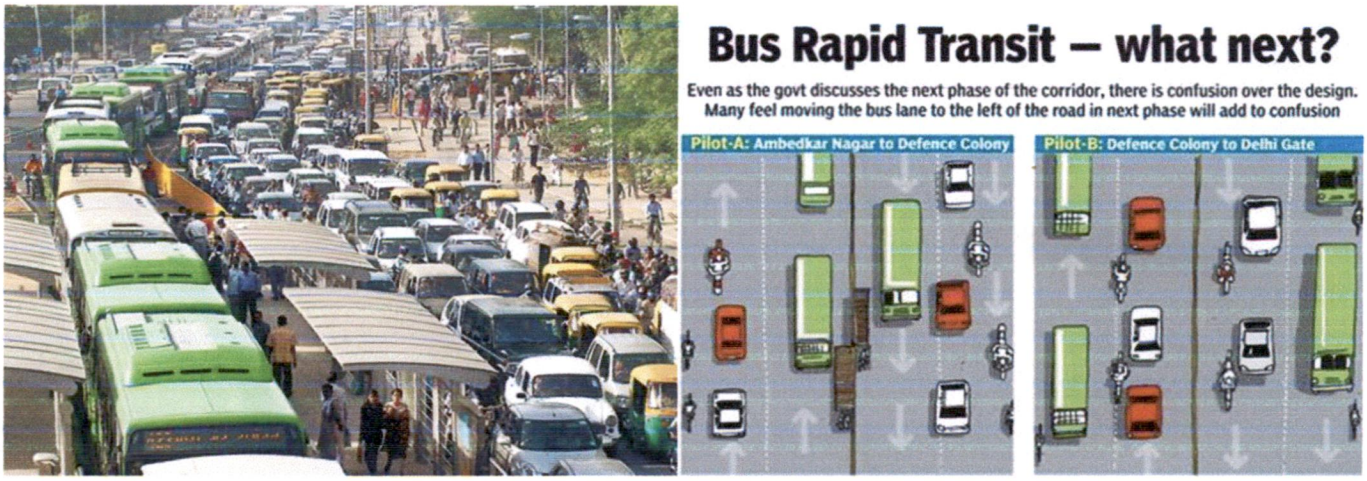


FIGURE 3-6 VIEW OF TRAFFIC CONGESTION AND ILLUSTRATION OF SHIFT OF BRT LANE TO THE LEFT

Chapter 4.
Profile of Study area: BRTS Ahmedabad

Ahmedabad BRTS is a highly ambitious rapid transport system developed by Gujarat Infrastructure Development Board (GIDB) for the city of Ahmedabad, recognizing that no single mode would cater to the mobility needs of the city and that 'Bus' forms the most critical segment of the public transport system in the Ahmedabad city. GIDB has thereby entrusted the system design task to CEPT University. A part of first corridor connecting Pirana to R.T.O. was opened to public on October 14, 2009 by Chief Minister of Gujarat Narendra Modi.

4.1 Context

The city of Ahmedabad, founded in 1411 AD as a walled city on the eastern bank of the river Sabarmati, the commercial capital of Gujarat is now the seventh largest metropolis in India and the largest in the state. With a population of 6 million (2001) within an area of 466 sq. kms, the city is preparing for the emerging challenges, more importantly in terms of sustaining its contributions to the growth of Gujarat State. It accounts for 25% of the State's urban population; 20% of the State's GDP (2001), and also has one of the largest informal sectors. Ahmedabad with its strong industrial base continues to be an attractive destination for investments. Its population is likely to rise to 11 Million by 2035. While the area is likely to increase from the present 440 sq. kms 1000 sq. kms by 2035, sustenance of this growth is possible only with the development of an efficient rapid mass transit system

The density pattern presented below indicates the spatial expansion is limited to contiguous areas around AMC. The walled city is one of the most densely populated areas in the study area, and it has reached levels of saturation. The new outgrowths have been in the western parts of the city in the AUDA jurisdiction with people preferring to stay in the peripheral areas where they could avail of better infrastructure facilities. The zones along the 132' Ring Road and Naroda - Narol Highway have seen a higher level of physical development in the last few years. It also appears that most of the eastern part and a few parts in the southwest and northwest have higher densities.

Of the total AUDA area of 1294.65 sq. km, nearly 50 percent is built up. Water bodies and wastelands cover 12 percent and 17 percent of area respectively. Industries cover 9 percent of the area (Refer Figure 2-3 and Map 2-4). As per the State Government Policy, no major industrial development within 24 kms of AMC limit is permitted in AUDA area. Considering existing development conditions a certain area for industrial use is designated for light industry as well as for general industry, along with existing industries at Vatwa, Naroda and Odhav (all lying within AMC), which forms nearly 10.38 percent.

As per existing land use (1997), more than one third (36%) of the total area is under residential use, followed by 15 percent of the area under the industries (Refer Figure 4-1). Large tracts of land (23.44%) are lying vacant, mostly in the newly acquired area of the AMC. Only 9.5 percent of the total area is under transportation network as against the norm of 15-18 per cent. as specified by UDPFI norms.

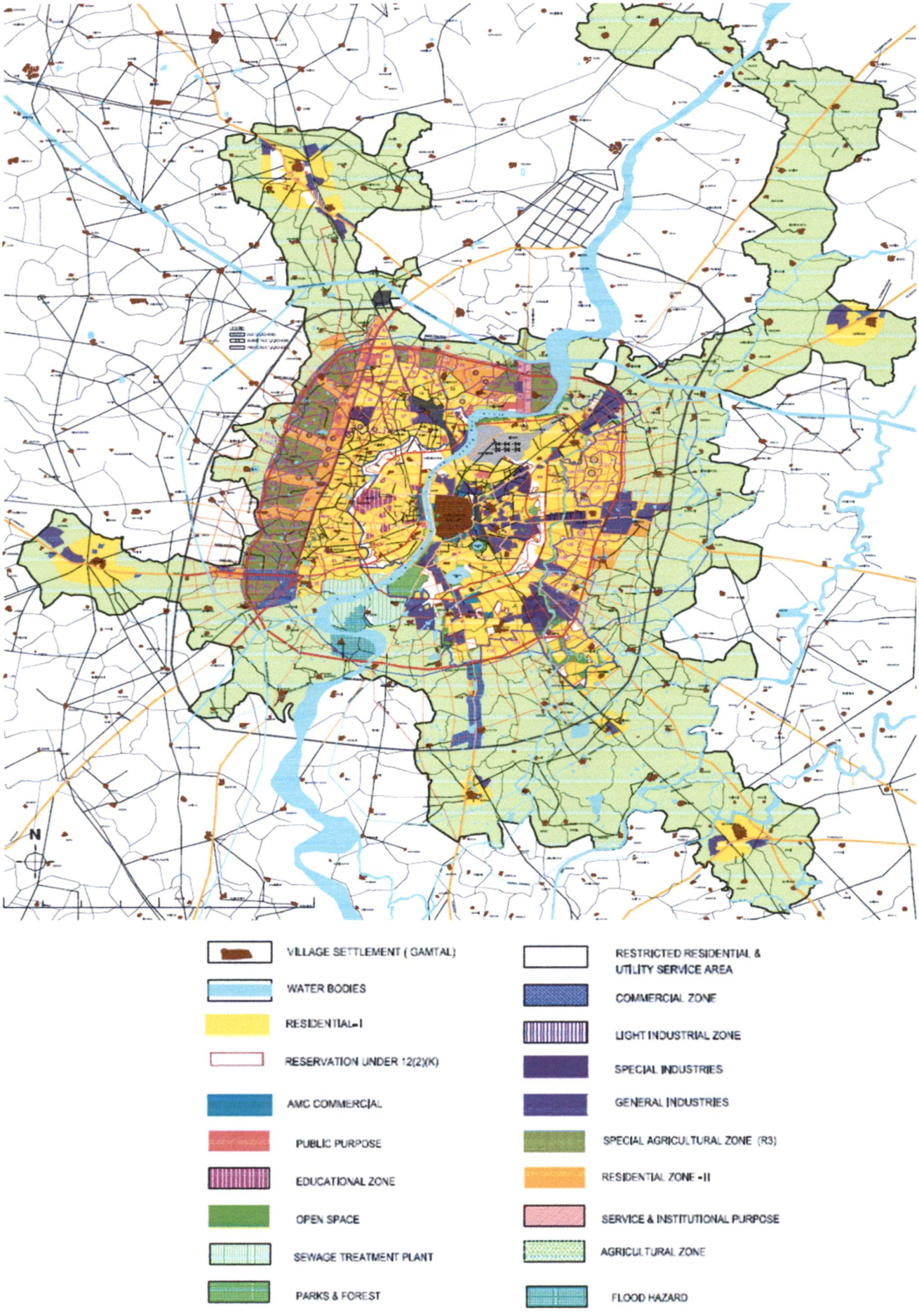


FIGURE 4-1 LAND USE MAP OF AHMEDABAD

4.2 Situation before Implementation of the Project

4.2.1 Transport System before the Start of the Project

Ahmedabad is a compact city characterised by mixed land uses, high density development and balanced street network system with well developed 5 ring and 17 radials. Total road length is about 2400 kms. There are 7 bridges to connect the eastern part of the city with west. Sixteen rail-over/under bridges enable crossing the railway lines at appropriate places.

Two wheelers, both motorised and bicycles dominate the traffic on the streets of Ahmedabad. The city has 22 lakh registered vehicles of which two wheelers are about 73%. As per the household survey (CEPT, 2006), 8 lakh bicycles are in operation in the city accounting for 19% of the total trips. The share of four wheelers is still low. They constitute to about 12.5% of the total vehicles and 3% of total trips.

The culture of organised public transport operations dates back to pre-independence era. The Ahmedabad Municipal Corporation (AMC) has been running a well organised public transportation system known as Ahmedabad Municipal Transport Service (AMTS). However, due to resource crunch and operational inefficiencies of teh system, the fleet size got reduced to 450 in the year 2005. As a result, significant loss in patronage was experienced. Average daily ridership in 2005 was 3.5 lakh. While the share of public transport declined, the share of Auto rickshaw increased. In the city, there were about 35000 auto rickshaws operating catering to 10% of total trips. As most of these were using adulterated fuel, air quality was affected significantly. As a result the city of Ahmedabad figured as one of the top 3 cities in the list of 88 critically polluted cities of India.

AMTS with a fleet of about 1000 caters to about 8.29 lakh passengers every day. AMC undertook a restructuring exercise during 2006 and invited private operators to operate on gross contract basis leading to doubling of fleet size, with half owned by AMTS and the remaining half hired on gross contract basis. Through concerted efforts AMC undertook fuel switch operations. Today all buses and auto rickshaws in the city are operated on CNG, contributing to significant lowering of pollution load from transport sector.

The compactness of the city, mixed land use and balanced road network appear to have succeeded in keeping trip length short (average trip length in Ahmedabad is 5.5 kms). Further the balanced transport network and predominance of two wheelers limits excessive concentration at any one part making city relatively less congested. It is important to recognise that short trips and less congested streets appear to make city streets safe without compromising on mobility.

Average travel times are in the range of 15-20 minutes. The road fatalities, in the year 2009, are 202. This is comparable to those observed in the world cities of similar size. The city has also made significant gains in the air quality status. Being a part of 88 critically sensitive lists of cities as identified by the Central Pollution Control Board CPCB), topping the list in 2003, today the city has managed to reach a position where it is reported that this year CPCB is considering taking the city out of the list.

4.2.2 Problems and Needs Addressed by the Project

In a developing country like India, transport nuances-planning follow development. The various factors which lead to the selection of Bus Rapid transit system in the city of Ahmedabad are as follows:

- No strong CBD;
- Highly randomized development with localized trips;
- Urban pull – spreading out;

- Need for decongestion;
- Flexibility in routing;
- Easily expandable;
- Scope for both low density and high density passenger movement;
- Project implementation easier;
- Wider reach;
- Leverages the full scope for public space and accessibility improvement;
- Can be operated according to the city ethos; and
- Environment friendly.

4.2.3 Reason for Adoption of BRTS

The Government of Gujarat had declared 2005 the 'Year of Urban Development' (Shaheri Vikas Varsh). During this particular year, the urban development department undertook various initiatives to resolve urban issues such as traffic management, and the introduction and enhancement of a city transport system. The Gujarat Infrastructure Development Board (GIDB), AMC and Ahmedabad Urban Development Authority (AUDA) jointly drafted a comprehensive urban mobility plan keeping in mind the needs of Ahmedabad as a mega city, and included in it, the implementation of the BRTS and the planning of the regional rail and metro for future years.

CEPT University was assigned the work of the preparing of a Detailed Project Report (DPR) for the implementation of the BRTS project in Ahmedabad. Meanwhile, the government of India announced the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for urban development and the AMC submitted its proposal to the government of India for the BRTS project, which was the first of its kind in the country. As approved by the ministry of urban development, the AMC is now implementing the BRTS project in a phased manner. The BRTS project was approved in November 2006 and work on the project commenced in 2007. The urban mobility plan provides choices to the people in the case of their mobility, in terms of different modes such as the AMTS, BRTS and the suburban rail or metro, all of which complement each other.

4.3 Expected Outcome of the Initiatives

Connectivity to important origins and destinations

The proposed BRT network connects the important origins and destinations and transit points like Railway stations, regional bus terminals, university areas, industrial areas, residential (LIG, MIG, EWS), commercial hubs of the city and recreational public spaces.

Catalyst for Area Development

During phase-1, while existing and potential demand were prime considerations for selection of the corridors, BRT infrastructure with a projected future demand was considered as a critical part of the corridor selections. The corridor passes through areas having many vacant mill lands on the eastern part of city, with a scope for future development. The transformations have begun to occur and the BRT acted as a catalyst for future development as shown in the images below. The open lands of university areas and major junctions on the 132 feet ring road have transformed into University convention hall, commercial malls and buildings. Hence, it can be said that supply creates its own demand. After four months of BRT operations, around 42, 500 passengers use BRT every day on this corridor from RTO to Kankaria (18 kms).

Low Income and Low Accessibility Zones

The corridor also provides connectivity to the lower income housing areas and increases accessibility for the lower and middle income groups. The system is for the poor as much as it is for the rich and the elite class of people. The stretch between Pirana to Shah-Alam that connects the western part to the eastern part of the city was recently opened up for operations and was well received by the citizens. People's acceptance and respect towards the high quality infrastructure gets reflected.

Availability of Right of Way

As the concept was being implemented for the first time, often the availability of RoW and ease of implementation took precedence over demand. The different right of ways available on BRT roads were 60 m, 45 m, 40 m, 36 m, 30m, 24 m and 18 m (in Kalupur area).

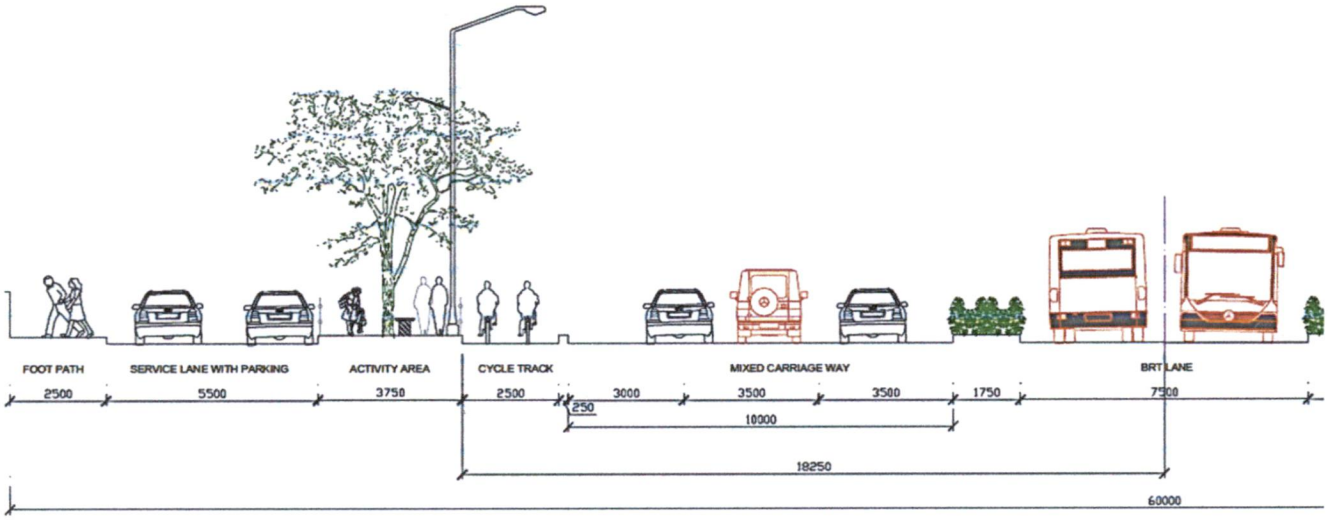


FIGURE 4-2 TYPICAL CROSS SECTION OF 60 M ROW BRT CORRIDOR ROAD

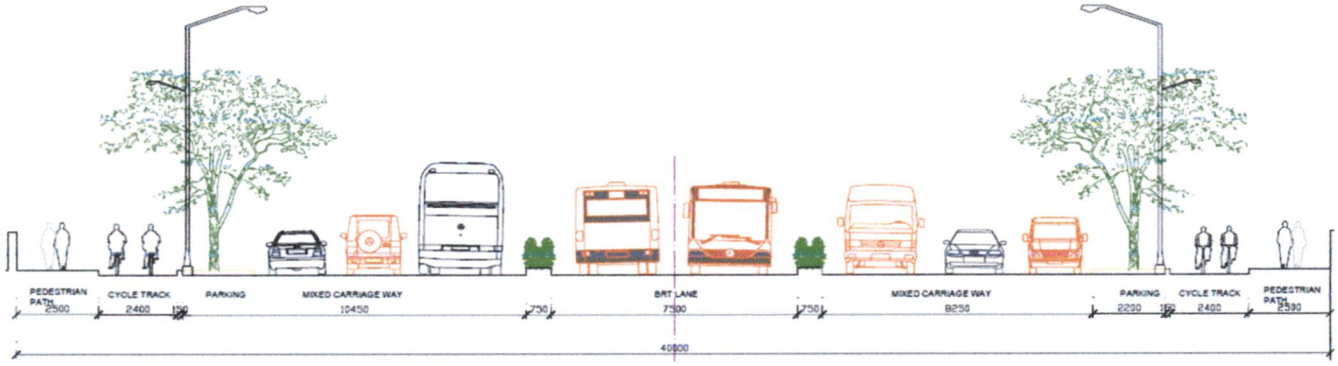


FIGURE 4-3 TYPICAL CROSS SECTION OF 40 M ROW BRT CORRIDOR ROAD

Connect Busy Places but Avoid Busy Roads

Connecting inner city areas with BRT network meant creating bottlenecks on the already congested roads. The aim was to connect the busy public destinations and hence while selecting roads along potential BRT corridor, 'Connect busy places but avoid busy roads', has been the policy. Figure below shows a BRTS route connecting like law garden, C.G. road, Gujarat College but avoiding busy and congested roads (shown in dotted lines).

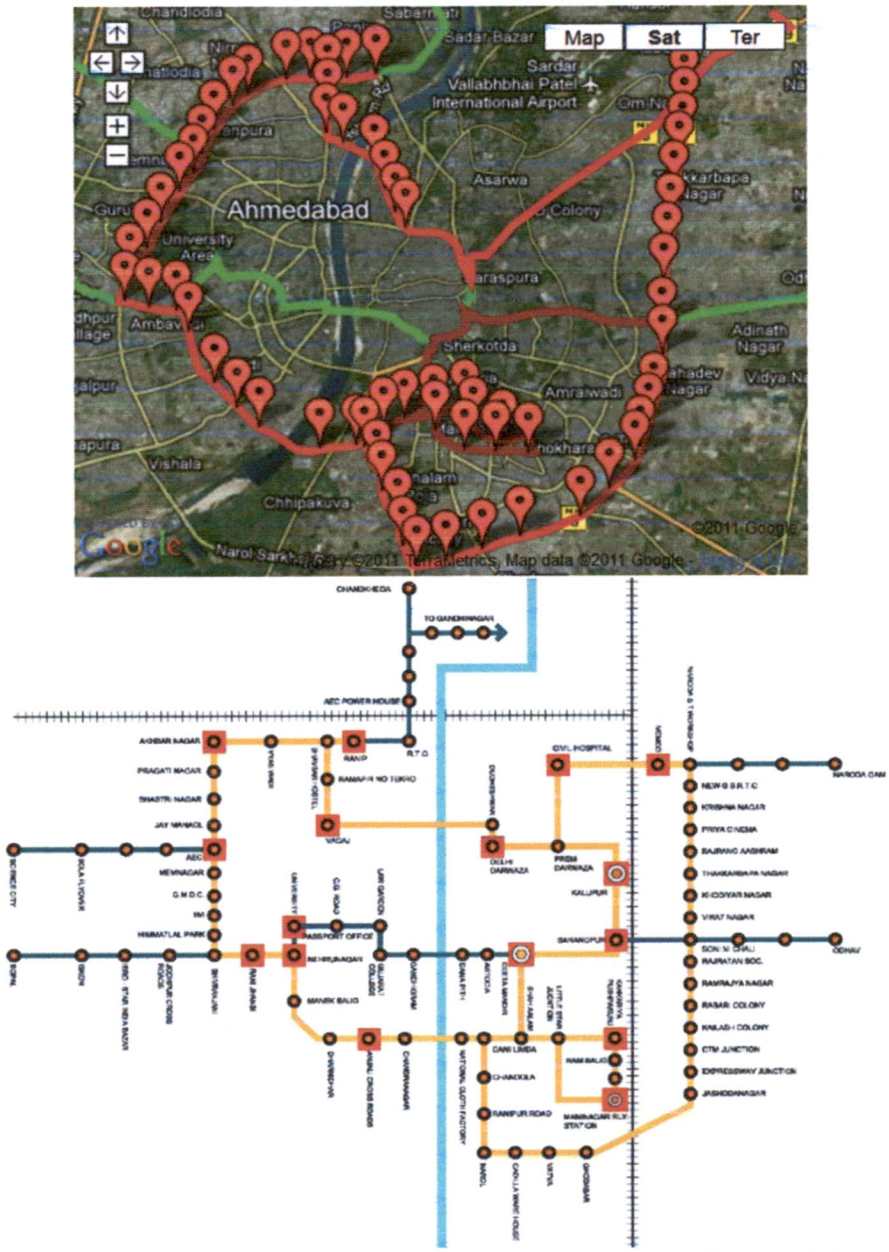


FIGURE 4-4 CURRENT FUNCTIONING ROUTE AND SIMPLIFIED TRANSIT MAP

Chapter 5.
Service Level Benchmarking

The collection consisted of primary and secondary data in Ahmedabad. For primary data collection, a household survey was conducted along the corridor corresponding to the integrated Phase I and Phase II of the BRTS project in Ahmedabad. Various secondary data sources have also been referred to in the study. These are the reports conducted as feasibility studies and working papers published for the Integrated Public Transport Project (IPTS), Ahmedabad, Bus Rapid Transit Project (BRTS), Ahmedabad and the MRTS Study, Ahmedabad.

Secondary Data

The secondary data collected during the fieldwork related to the following:

1. ***Interviews***

Interviews were conducted with the project heads and other officials working in the project. These included, Prof. H.M. Shivanand Swamy, Project-in-charge, Mr Harshad Solanki.Dy, General Manager, Ahmedabad Janmarg Ltd. and others. BRTS Project and Mr. Sandeep, BRTS Project team official.

2. ***Design Report on Bus Rapid Transit System, Ahmedabad (2005. 2008)***

The working papers on Conceptual Design of the System, Environmental Impact Assessment Report, Economic Analysis, Vehicle Technology, Bus Station Design, Land Use Restructuring, Road Utilities, Road Way Design and Junction Management along with the Ahmedabad BRTS Project Design report.

3. ***Environment Task Report, IPTS Feasibility Study ,Ahmedabad (2002)***

The report highlights the IPTS feasibility with regard to the environmental and social conditions in the city. It also touches upon the pollution and vehicular emission data in the city.

4. ***Socio-Economic and Land use Studies. IPTS Feasibility Study, Ahmedabad***

This section of the IPTS feasibility study gives a reflection of the socio-economic variables in the base year, 2001 and the projected variables in 2035. According to these secondary data source the economic aspect of questionnaire was formulated for the survey.

Primary Data

Household surveys were conducted in few areas to study the socio-economic and household characteristics of the urban population in Ahmedabad. The survey also included questions regarding their travel behavior and how they perceive the BRTS project in the city. The survey also included a choice set to study the willingness of the people to shift to BRTS from their current mode for their current trips.

1. ***Survey area selection:***

The unit of study is the Household. Total of 90 Households were surveyed for the primary data collection. Here the study area is limited to BRTS, therefore those household were selected, that are situated near the BRTS's functioning routs to understand the behavior of the common people who are directly affected by this new project. The households were located within 15 mins of walking distance from the BRTS functioning rout's Bus stand.

2. *Sampling Strategy*

The surveyed households had all four income group populations. The areas resided by different income groups were identified based on reconnaissance survey, talking to the local people, and visual interpretation using satellite imagery.

A total of ninety households were surveyed, primarily located close to the functioning BRTS project. The houses were randomly selected from the identified clusters of income group houses. The Household was surveyed, only if the respondent was the head of the household or eldest in the family present but more than 20 years of age.

3. *Household Survey Questionnaire Design*

The survey questionnaire consisted of questions on the socio economic parameters, trip characteristics, usage, attitude and perception of the current BRTS and other modes of public transportation services, their expectation from the public transport services, their willingness to pay for the desired service.

- Socio-economic parameters

The data collected includes household information such as household size, monthly household income, occupation of an individual, sex, age and household vehicle assets ownership and availability.

- Travel characteristics

The study collects travel/trip data for all the major travel trips i.e. educational and work trips depending upon whether a person is a worker or a student. The questionnaire includes questions on origin, destination, trip length, travel time, mode used for the trip and expenses per trip.

- Opinion and Attitude on Public Transport (BRTS)

This section of the questionnaire aims at gaining an insight into peoples' opinion towards public transport system especially BRTS, their preference towards the attributes they feel important for and expect from public transport systems and their willingness to pay for these additional attributes as facilities. Options in terms of factors of existing fares for buses are given for selection.

5.1 Requirements of Secondary Data

The identification of the indicators has been derived for the Ministry of Urban Development Guidelines for service level benchmarking for the urban transport. Here the guidelines are formulated for urban transport as a whole. To accommodate these guidelines to the research area context i.e. BRTS Ahmedabad, some parameters were excluded and some parameters were modified. Following are the requirements for data collection from the secondary sources for benchmarking the service level

TABLE 5-1 REQUIREMENTS FOR SERVICE LEVEL BENCHMARKS

SR.NO	INDICATORS	DATA REQUIRED	UNIT	REMARKS
		1. PUBLIC TRANSPORT SYSTEM		
1	Presence of Organized Public Transport System in Urban Area	Total number of buses operating on road /Total number of buses operating under the ownership of STU/SPV or under some concession agreement	no	Intercity buses would not be included
2	Availability of Public Transport	No of Buses/ train coaches available in a city on any day/ Total Population of the city	no	
3	Service Coverage of Public Transport	Total length in route kms of the corridors along with public transport systems ply in the city/ Area of the urban limits of the city.	route kms/ sq.km	corridors along which the service frequency is one hour or less should only be consider
4	Average waiting time for Public Transport users	Identify key corridors collect data of *waiting time for passengers boarding the bus calculate the avg.waiting time create a frequency distribution Take LOS at Where it crosses 50% mark	%	morning & evening peak hour and off peak hour in both directions
5	Level of Comfort in Public Transport	Passenger count on bus at key identified routes/ Seats available in the bus	no	morning & evening peak hour and off peak hour in both directions
6	% of Fleet as per Urban Bus Specification	Total number of buses in the city / Total number of buses as per urban bus specification in the city	no	Door closing for bus movement is Mandatory
		2. PEDESTRAIN FACILITIES		
1	Signalized intersection delay	Avg.waiting time of pedestrian at intersection / Total number of pedestrian at Signalized intersection	secs no	At Peak Hours
2	Street Lighting (Lux)	Total length of roads Calculate lux level		Arterial/major road
3	% of City Covered	Total length of footpath in a city/ Total length of road network	km	minimium width 1.2m
		3. AVAILABILITY OF NON MOTORIZED VEHICLE (NMV) FACILITIES		
1	% of city covered with NMV	Total Length of NMT network/ Total length of road network	km	
2	Encroachment on NMV roads by Vehicle Parking (%)	Total length of the Parking on Cycle Track / Total length of NMT network	km	
3	NMT Parking facilities at Interchanges (%)	Total no. of interchanges having bicycle parking/ Total no. of interchanges	no	

SR.NO	INDICATORS	DATA REQUIRED	UNIT	REMARKS
		4. Level of Usage of Intelligent Transport System (ITS) facilities		
1	Availability of Traffic Surveillance	total no. of bus stations on BRTS terminals, metro stations having CCTVs / total no. of bus stations on BRTS, terminals, metro stations etc	No	Security,incidence management real time information regarding pedestrian flow
2	Passenger Information System (PIS)	total no. of bus stops, terminals, metro stations having PIS / total no. of bus stops, terminals, metro stations	No	PIS is the key information link between transportation operators and the travelling public
3	Global Positioning System / GPRS	No. of Public Transport Vehicles with functional onboard GPS , GPRS and connected to common control center / Total no. of Public Transport Vehicles	No	GPS determines the user's position operators can regulate bus movements.
4	Signal Synchronization	No. of signals which are synchronized in th city/ Total no. of signalized intersections	No	Helps in reducing congestion and stopping time at each intersection
5	Integrated Ticketing System	Total Number of modes in the city (Buses, IPT, Metro etc) which have integrated ticketing system / Total Number of modes in the city (Buses, IPT, Metro etc)	No	A single common ticket which can be used across all modes of public transport. ie. To have complete integration across all operators of same modes and across all modes
		5. TRAVEL SPEED (MOTORIZED AND MASS TRANSIT) ALONG MAJOR CORRIDORS		
1	Travel speed of Personal vehicles along key corridors / Public transport vehicles	arterial speed=(3600*L)/(running time*L)+delay time		
		6. ROAD SAFETY		
1	Fatality rate per 100000 population	Total number of fatalities recorded in road accidents within city limits in the given calendar year *100000 / Population	No	Reduce fatality to 4 persons or below per 100000 Records of facilitites from police records
2	Fatality rate for pedestrian and NMT (%)	Total number of fatalities recorded as persons who were pedestrians or on NMV, in roadaccidents within city limits in given year/ Total number of fatalities recorded in road accidents within city limits in the given calendar year	No	Reduce fatality rates to less than 40%

SR.NO	INDICATORS	DATA REQUIRED	UNIT	REMARKS
		7. AVAILABILITY OF PARKING SPACES		
1	Availability of paid public parking spaces	Total available on street Paid parking spaces in (Equivalent Car Spaces) ECS allotted for all vehicles / Total available on street parking spaces in (Equivalent Car Spaces) ECS allotted for all vehicles	ECS	50% of on street parking should be 'paid parking' Paid vs Free
2	Difference in Maximum and Minimum Parking Fee in the City	Maximum parking fee being charged per 10 hours in the city/ Minimum parking fee being charged per 10 hours in the city	rs	Difference between Max & Min should be at least 2:1
		8. POLLUTION LEVELS		
1	Avg. pollution in the city	High Volume air sampler could be used to measure the pollution level	-	
		9. INTEGRATED LANDUSE-TRANSPORT SYSTEM		
1	Population Density	Total developed area/ Population of current year	Ha no	
2	Mixed Land-use Zoning	Landuse along major transit corridors based on Master Plan/Development plan(500 meters approx on either side) Update the above on observational survey(500meters on both side)	Ha	calculate non-Residential landuse (%) ie. Mixed landuse
3	Intensity of Development - Citywide	Floor space Index (applicable to most part of the city, i.e new developed area) as per Master Plan/DP.	no	
4	Intensity of Development along Transit Corridors	FSI along transit corridors/ FSI along transit corridors as per masterplan , DP	no	
5	Road network Pattern and Completeness	No of rings roads Extent of completion (Qualitative)	_	Both Existing and proposed network
6	Road Density	Overall road network length/ developed area	kms/ sq.kms	Road length having ROW 7m and above
7	% Network with Exclusive ROW for transit (for > 1 million population as per 2001 census)	Total network with exclusive BRT/Metro/LRT /Total urban road and rail network	kms	Road length having ROW 7m and above

SR.NO	INDICATORS	DATA REQUIRED	UNIT	REMARKS
10. FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS				
1	Extent of Non Fare Revenue	Revenue collections per annum from non-fare related sources/ Total revenue per annum from all sources	rs	
2	Staff per bus ratio	Calculate the total staff of bus operation and maintenance/ Calculate the total number of buses	no	only public operators
3	Operating Ratio	Calculate cost of bus/ Calculate earning of bus	Rs.	Cost Includes capital cost, operation, maintenance cost & manpower Earning Includes Fare revenue & Non fare revenue
4	Affordability	Avg. Expenditures on PT/ Avg. Per capita Income by PT users	Rs.	

5.2 Service Level Benchmarking

System for measuring performance of urban transport activities and taking further action on them has not been institutionalized in urban agencies. It is therefore important that the basic minimum standard set of performance benchmarks are commonly understood and used by all stakeholders. Depending on the specific needs of a city, performance parameters can be defined and used to improve the quality of urban transport.

The same need of measuring the performance has been visualized for Ahmedabad BRTS. Keeping in mind the needs and requirement of a bus rapid transit system, the identification of the indicators has been resulted for the Ministry of Urban Development Guidelines for service level benchmarking for the urban transport. Here the guidelines are formulated for urban transport as a whole. To accommodate these guidelines to the research area context i.e. BRTS Ahmedabad, some indicators were excluded and some were modified.

5.2.1 Detailed Calculations

5.2.1.1 Public Transport Facilities

It indicates the city-wide level of services provided by public transport systems during peak hours (8 to 12 noon & 4 to 8 pm). Public Transport systems will only include rail, or organized bus based systems. Public Transport systems are characterized by - Fixed origins and destinations; Fixed routes and schedules; Fixed stoppage points; and Fixed fares. Public Transport therefore does not include Intermediate Public Transport (IPTs) such as shared RTVs, auto-rickshaws, three-wheelers, tempos, shared taxi or other such vehicles providing point-to-point services.

1. Presence of Organized Public Transport System in Urban Area: Within the first year, all JnNURM cities to establish Organized Public Transport System and by second year all 2 lakh plus population cities (as per 2001 census) to establish the same.
2. Extent of Supply / Availability of Public Transport: Within the first two years, all million plus cities but less than 4 million to increase public transit supply to service level 3 or above. All 4 million plus cities to increase supply to service level 2 or above.
3. Service Coverage of Public Transport in the city (Bus route network density): All million plus cities but less than 4 million to increase their public transit coverage at least supply to service level 3 or above. All 4 million plus cities to increase the service coverage to service level 2 or above.
4. Average waiting time for Public Transport users: All million plus cities to maintain average waiting time for public transport users to be a maximum of 12 minutes or below within 2 years.
5. Level of Comfort in Public Transport (Crowding): In all million plus cities, with in 2 years, the level of service should be 3 or above
6. Percentage Fleet as per Urban Bus Specifications: All million plus cities to have atleast 25% of their fleet as per urban bus specifications by the end of first year.

TABLE 5-2 LEVEL OF SERVICE FOR PUBLIC TRANSPORT FACILITIES CALCULATION TABLE

1	PUBLIC TRANSPORT FACILITIES				
1.1	Presence of Organized Public Transport System in Urban Area	Total Busses	BRT Busses	%	LoS
	Over all (BRTS-112 + AMTS-759)	871	871	100	LOS1
1.2	Availability of Public Transport	No of Buses	Total Population	Ratio per 1000 population	LoS
	BRTS	112	57,17,658	0.019	LOS4
	AMTS	759	57,17,658	0.132	LOS4

	TOTAL	871	57,17,658	0.152	LOS4
1.3	Service Coverage of Public Transport in the city	Total length of PT corridor(kms)	Area of Urban Limits	Service Coverage	LoS
	BRTS	53.24	475	0.112	LOS4
	AMTS	549	475	1.155	LOS1
	TOTAL	602.24	475	1.267	LOS1
1.4	Average Waiting Time for Public Transport Users			In Mins	LoS
	BRTS			6	LOS2
	AMTS			24	LOS4
1.5	Level of Comfort in Public Transport [Load factor (passengers per seat)]	Passenger Count	Number of Seats	Load factor (passengers/ seat)	LoS
	BRTS	79	34	2.323	LOS3
	AMTS	91	36	2.527	LOS4
1.6	% of Fleet as per Urban Bus Specifications	Total Busses	Buses as per Urban Bus Specification	% Fleet as per Urban Specification	LoS
	BRTS	112	112	100	LOS1
	AMTS	759	89	11.725	LOS4
Over all LoS of Public Transport facilities				**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
1	**PUBLIC TRANSPORT FACILITIES**							
1.1	Presence of Organized Public Transport System in Urban Area	>=60	40-60	20-40	<20	100.00	LOS1	4+4+4+3+1 =17
1.2	Availability of Public Transport							L.O.S.3
	BRTS	>=0.60	0.40-0.60	0.20-0.40	<0.20	0.02	LOS4	
	AMTS					0.13	LOS4	
1.3	Service Coverage of Public Transport in the city							
	BRTS	>=1	0.7-1	0.3-0.7	<0.3	0.11	LOS4	
	AMTS					1.16	LOS1	
1.4	Average Waiting Time for PT Users							
	BRTS	<=4	4-6	6-10	>10	24.00	LOS4	
	AMTS					6.00	LOS2	
1.5	Level of Comfort in PT [Load factor (passengers/ seat)]							
	BRTS	<=1.5	1.5-2.0	2.0-2.5	>2.5	2.32	LOS3	
	AMTS					2.53	LOS4	
1.6	% of Fleet as per Urban Bus Specifications							
	BRTS	75-100	50-75	25-50	<=25	100.00	LOS1	
	AMTS					11.73	LOS4	

The City has a public transport system which may need considerable improvements in terms of supply of buses / coaches and coverage as most parts of the city are not served by it. The frequency of the services available needs improvements. The system provided is not comfortable as there is considerable over loading.

5.2.1.2 Pedestrian Infrastructure Facilities

It indicates the percentage of road length along the arterial and major road network or Public Transport corridors and at intersection that has adequate barrier free pedestrian facilities. The indicators to calculate the adequate pedestrian facilities are as follows:

1. Signalized intersection delay (%): All million plus cities to target level of service 2
2. Street Lighting (Lux): All million plus cities to target level of service 2
3. Percentage of City Covered with footpaths (wider than 1.2 mtrs): All million plus cities to target level of service 2.

TABLE 5-3 LEVEL OF SERVICE FOR PEDESTRIAN INFRASTRUCTURE FACILITIES CALCULATION TABLE

2	**PEDESTRIAN INFRASTRUCTURE FACILITIES**				
2.1	Signalized intersection pedestrian delay	Average waiting time of pedestrian at intersection (Sec)			
	Signalized intersection 1	28			
	Signalized intersection 2	63		Average	LoS
	Signalized intersection 3	50		50.5	LOS3
	Signalized intersection 4	61			
	Over all				
2.2	Street Lighting(Lux)	Lux		Average	LoS
	BRTs Corridor				
	Sample 1	30.2			
	Sample 2	35.1		31.3	LOS1
	Sample 3	28.6			
	Mixed Traffic Lane (Ashram Road)				
	Sample 1	14.8			
	Sample 2	20.7		17.3	LOS4
	Sample 3	16.4			
2.3	% of Foot path Coverage	Road Netrwork Length	Foothpath Length	%	LoS
	Over all road network (Excluding BRT)(Roads less than 18 m not considered)	380	135	35.52	LOS3
	BRTs Corridor	53.24	32	60.10	LOS2
Overall Level of Service of Pedestrian Infrastructure facilities				**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
2	**PEDESTRIAN INFRASTRUCTURE FACILITIES**							
2.1	Signalized intersection pedestrian delay (Sec)	<25	25-50	50-75	>=75	50.50	LOS3	3+4+3 =10
2.2	Street Lighting(Lux)							3+1+2 =6
	BRTs Corridor	>30	25-30	20-25	<20	31.30	LOS1	L.O.S.3 L.O.S.2
	Mixed Traffic Lane (Ashram Road)	As per IS 1940:1970 codes Lux level for single/dual lane carriageway should be >25 -35				17.30	LOS4	
2.3	% of Foot path Coverage							
	Over all road network (Excluding BRT)(Roads less than 18 m not considered)	>=75	50-75	25-50	<25	35.53	LOS3	
	BRTs Corridor					60.11	LOS2	

The City has pedestrian facilities which may need considerable improvements. The pedestrian facilities at intersections, availability of footpath etc needs improvements as also many parts of the city are not served by it.

5.2.1.3 Non Motorized Transport (Nmt) Facilities

Indicates the percentage of dedicated cycle track / lane along the arterial & sub arterial road network or public transport corridors with a minimum of 2.5 m width. It is characterized by continuous length, encroachment on NMT lanes, and parking facilities. All JnNURM cities to have NMT tracks on all major roads with in a year. The indicators to calculate the adequate NMT facilities are as follows:

1. NMT Coverage (% network covered): At least 25% network with in a year. The width of pedestrian path and cycle track can be combined if the roads are too narrow
2. Encroachment on NMT roads by Vehicle parking (%): Target should be to have not more than 30% of NMV roads encroached i.e. LoS of 3 with in 1 year.
3. NMT parking facilities at Interchanges (%): Create NMT parking near all major bus stops, terminals and railway stations with in a year.

TABLE 5-4 LEVEL OF SERVICE FOR NON MOTORIZED TRANSPORT (NMT) FACILITIES CALCULATION TABLE

3	NON MOTORIZED TRANSPORT (NMT) FACILITIES				
3.1	% NMT network covered	Corridor Length	NMT enabled Length	%	LoS
		53.24	6.80	12.77	LOS4
3.2	Encroachment on NMV roads by Vehicle Parking (%)	Encroachment Length	NMT enabled Length	%	LoS
		4.40	6.80	64.71	LOS4
3.3	NMT Parking facilities at Interchanges (%)	total no. of interchanges	Interchanges having NMT parking facilities	%	LoS
		26.00	12.00	46.15	LOS3
Overall Level of Service (LoS) of Non Motorized facilities (NMV)				L.O.S. 4	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
3	NON MOTORIZED TRANSPORT (NMT) FACILITIES							
3.1	% NMT network covered	>=50	50-25	25-15	<15	12.77	LOS4	4+4+3=11
3.2	Encroachment on NMV roads by Vehicle Parking (%)	<=10	10-20	20-30	>3	64.71	LOS4	L.O.S.4
3.3	NMT Parking facilities at Interchanges (%)	>=75	50-75	25-50	<25	46.15	LOS3	

The city lacks adequate NMT facilities

5.2.1.4 Level Of Usage Of Intelligent Transport System (ITS) Facilities

ITS refers to efforts to add information and communications technology to transport infrastructure and vehicles in an effort to manage factors that typically are at odds with each other, such as vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation times and fuel consumption. GPS/GPRS systems are required so as to cover all the public transport and intermediate public transport vehicles on the "National public transport helpline" besides the use for operational efficiencies. The indicators to calculate the usage of ITS facilities in the city are as follows:

1. Availability of Traffic Surveillance: In all Million plus Cities, all transit stations and all transit terminals will be equipped with CCTVs (Year-1) and all signalized intersections by year 2.
2. Passenger Information System (PIS): In all Million plus Cities, major bus stops, all rapid transit stations and all transit terminals will be equipped with PIS system (Year-1).

3. Usage of Global Positioning System: All new transit vehicles will be equipped with GPS systems. Older transit vehicles in these cities will be covered with GPS system in Year 2. Intermediate public transport systems will be covered with GPS in the years 2 to 3.
4. Signal Synchronization: In all million plus cities, in the first 2 years, all the junctions on major roads will be synchronized (50% in year1 and 50% in year 2).
5. Integrated Ticketing System: In all million plus cities, all public transit systems and subsystems will be covered Automatic Ticketing System in the next 3 years. All cities with Metro/BRT to introduce integrated ticketing system during the next 3 years.

TABLE 5-5 LEVEL OF SERVICE FOR INTELLIGENT TRANSPORT SYSTEM (ITS) FACILITIES CALCULATION TABLE

4	LEVEL OF USAGE OF INTELLIGENT TRANSPORT SYSTEM (ITS) FACILITIES				
4.1	Availability of Traffic Surveillance	Entities having CCTV on the Transport corridor Bus stops	Total intersections, bus stops, terminals etc.	%	LoS
		0.00	67.00	0.00	LOS4
4.2	Passenger Information System (PIS)	Entities having PIS on the Transport corridor	Total bus, bus stops etc	%	LoS
		179.00	179.00	100.00	LOS1
4.3	Global Positioning System / GPRS	No of Buses having GPS/GPRS	Total Buses	%	LoS
		112	112	100	LOS1
4.4	Signal Synchronization	No. of Signals Sync	Total Signals	%	LoS
		0.00	165.00	0.00	LOS4
4.5	Integrated Ticketing System			0.00	LOS4
Overall Level of Service of usage of Intelligent Transport System (ITS)				**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
4	LEVEL OF USAGE OF INTELLIGENT TRANSPORT SYSTEM (ITS) FACILITIES							
4.1	Availability of Traffic Surveillance	>=75	50-75	25-50	<25	0.00	LOS4	4+1+1+4 +4=14
4.2	Passenger Information System (PIS)	>=75	50-75	25-50	<25	100.00	LOS1	L.O.S.3
4.3	Global Positioning System / GPRS	>=75	50-75	25-50	<25	100.00	LOS1	
4.4	Signal Synchronization	>=75	50-75	25-50	<25	0.00	LOS4	
4.5	Integrated Ticketing System	>=75	50-75	25-50	<25	0.00	LOS4	

The city has bare minimum ITS facilities and may need considerable improvements terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as many parts of the city are nor served by it

5.2.1.5 Travel Speed (Motorized And Mass Transit) Along Major Corridors

This level of service provides an indication of effective travel time or speed of Public or private vehicles by taking into account indications of congestion or traffic density. This level of service is along corridors, and not indicative of overall level of service from origin to destination. Level of service (LoS) may be measured along key corridors and then aggregated for the city.

- Year 1 target is to arrest worsening of the situation in the initial period
- Subsequently target to improve the service conditions to a reasonable level

Level of Service is defined in terms of average travel speed of all through vehicles on the key corridors. It is strongly influenced by the number of vehicles along the corridor, number of signals per kilometer and the average intersection delay. The speed of motorized vehicles can be improved by segregating public transport and non motorized vehicles through dedicated lanes or lane demarcation wherever possible.

TABLE 5-6 LEVEL OF SERVICE FOR TRAVEL SPEED ALONG MAJOR CORRIDORS CALCULATION TABLE

5	TRAVEL SPEED (MOTORIZED AND MASS TRANSIT) ALONG MAJOR CORRIDORS		
5.1	Travel speed of Personal vehicles along key corridors	Speed (Km/Hr)	LoS
	Travel Speed by Private Vehicles		
	On BRT corridor	35.0	LOS1
	On Non BRTS Road	25.0	LOS2
5.2	Travel speed by Public Transport		
	By BRTs bus	26.0	LOS1
	By AMTS bus	12.0	LOS3
Overall Level of Service of Travel speed along major corridors		**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
5	TRAVEL SPEED (MOTORIZED AND MASS TRANSIT) ALONG MAJOR CORRIDORS							
5.1	Travel Speed by Private Vehicles							1+1=2 3+2=5
	On BRT corridor	>=30	25-30	15-25	<15	35.00	LOS1	L.O.S.2 L.O.S.3
	On Non BRTS Road					25.00	LOS2	
5.2	Travel speed by Public Transport							
	By BRTs bus	>=20	15-20	10-15	<10	26.00	LOS1	
	By AMTS bus					12.00	LOS3	

Significant approach delays and average travel speed of 1/3 the free flow speed or lower. Such conditions causing a combination of one or more reasons such as high signal density, extensive queuing at critical intersections and inappropriate signal timing.

5.2.1.6 Availability Of Parking Spaces Facilities

It indicates the restriction on free parking spaces for all vehicles in a city. The indicators to calculate the parking facilities are as follows:

1. Availability of paid public parking spaces (%): To cover at least 50% of on street public parking spaces under 'paid parking'.
2. Difference in Maximum and Minimum Parking Fee in the City: To keep maximum and minimum parking fee difference to at least 2:1 (Parking rate to be computed two hourly).

TABLE 5-7 LEVEL OF SERVICE FOR AVAILABILITY OF PARKING SPACES FACILITIES CALCULATION TABLE

6	AVAILABILITY OF PARKING SPACES				
6.1	Availability of paid public parking spaces	Total Paid Parking available (ECS)	Total Parking Available (ECS)	%	LoS
		700	2900	24.14	LOS4
6.2	Ratio of Maximum and Minimum Parking Fee in the City	Maximum Parking fee for 2 Hours	Minimum Parking fee for 2 Hours	Ratio	LoS
		10	2	5.00	LOS1
Overall Level of Service (LoS) for Parking Space				**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
6	AVAILABILITY OF PARKING SPACES							
6.1	Availability of paid public parking spaces	>=75	50-75	25-50	<25	24.14	LOS4	4+1=5
6.2	Ratio of Maximum and Minimum Parking Fee in the City	>4	2-4	1-2	1	5.00	LOS1	L.O.S.3

Paid parking spaces provided in the city need to be improved upon and to cater to the demand some differential parking rates for the CBD have been adopted. The city authorities need to imitative considerable improvements measures.

5.2.1.7 Road Safety

With increasing road traffic, many cities are witnessing rising level of accidents, leading to rising levels of injuries and fatalities. Level of fatality is an indication of road safety. Road design and available road infrastructure, traffic management and other such reasons significantly contribute to road safety. Therefore fatality rate should be monitored. The benchmark for the same is zero, as ideally fatalities and injuries out of accidents should be brought down to nil. Within the number of accidents, the vulnerable road users are pedestrians and persons with non-motorised vehicles. It is therefore, critical to monitor the extent to which such road users are impacted within the overall set of road users. The benchmark value for the same is also zero. The indicators to calculate the LoS of road safety is as follows:

1. Fatality rate per lakh population: To bring down fatality rates to 2 persons per lakh or below in all million plus cities within two years.
2. Fatality rate for pedestrian and NMT (%): To bring down fatality rates for pedestrian and NMT such that the share comes down to less than 40% within two years.

TABLE 5-8 LEVEL OF SERVICE FOR ROAD SAFETY CALCULATION TABLE

7	ROAD SAFETY				
7.1	Fatality rate per lakh population	Total number of fatalities recorded in road accidents	Total Population	Ratio	LoS
	2010-11	194	57,17,658	3.39	LOS2
7.2	Fatality rate for pedestrian and NMT (%)	Total number of fatalities recorded for pedestrians or NMT	Total number of fatalities recorded in road accidents	%	LoS
	2010-11	30	188	15.96	LOS1
Overall Level of Service (LoS) for Road Safety City-wide				**L.O.S. 2**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
7	Road Safety							
7.1	Fatality rate per lakh population	<=2 persons	2-4 persons	4-6 persons	>6 persons	3.39	LOS2	2+1=3
7.2	Fatality rate for pedestrian and NMT (%)	<=20	20-40	40-60	>60	15.96	LOS1	L.O.S.2

Need some improvements in road design and available road infrastructure, traffic management and in other such reasons which significantly contribute to road safety.

5.2.1.8 Pollution Levels

This indicator indicates the Level of air Pollutants in the city i.e. average level of pollution in urban areas. The indicator to calculate the pollution levels is Annual Mean Concentration Range (µg/m3).

TABLE 5-9 LEVEL OF SERVICE FOR POLLUTION LEVELS CALCULATION TABLE

8	POLLUTION LEVELS		
		Levels	LoS
8.1	Level of SO2	21	LOS1
8.2	Level of Oxides of Nitrogen	36	LOS1
8.3	Level of SPM	340	LOS2
8.4	Level of RSPM (Size less than 10 microns)	98	LOS3
Overall Level of Service (LoS) for Pollution levels		**L.O.S. 2**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
8	POLLUTION LEVELS							
8.1	Level of SO2	0-40	40-80	80-120	>120	21.00	LOS1	1+1+2+3=7
8.2	Level of Oxides of Nitrogen	0-40	40-80	80-120	>120	36.00	LOS1	L.O.S.2
8.3	Level of SPM	0-180	180-360	360-540	>540	340.00	LOS2	
8.4	Level of RSPM (Size less than 10 microns)	0-40	40-80	80-120	>120	98.00	LOS3	

Need some improvements in emission standards, checking pollution etc.

5.2.1.9 Integrated Landuse-Transport System

It Indicates the effectiveness of land use-transport arrangements and Identify the level of integrated land use transport system expected to result in overall trip reduction and mode shift in favor of public transit The indicators to calculate the Land use transport integration are as follows:

1. Population Density - Gross (Persons/Developed Area in hectare)
2. Intensity of Development city wide - (Floor Space Index - Master Plan/DP)
3. Intensity of development along transit corridor- Ratio of FSI on Transit corridor to city FSI (provision as per Master Plan / Development Plan/ Any other policy)
4. Clear pattern and Complete network
5. Area under roads (%)
6. Proportion of network having exclusive ROW for Transit

TABLE 5-10 LEVEL OF SERVICE FOR INTEGRATED LANDUSE TRANSPORT SYSTEM CALCULATION TABLE

9	INTEGRATED LANDUSE-TRANSPORT SYSTEM				
9.1	Population Density	Total Area	Population	Density	LoS
		475	57,17,658	120.37	LOS4
9.2	Intensity of Development – Citywide	FSI			LoS
		1.8			LOS2
9.3	Intensity of Development along Transit Corridors	Over all FSI	FSI along transit corridor	Ratio	LoS
		1.8	1.8	1	LOS4
9.4	Road Network Pattern and Completeness	No of radials & rings/ grid network	14 radials & 4 rings good & complete pattern	LOS	LOS2
9.5	% of Area under Roads	Over all Area	Area under Road	%	LoS
		475	55.42	11.66	LOS3
9.6	% Network with Exclusive ROW for transit	Total urban road	Total network with exclusive ROW	%	LoS
		2771	53.42	1.92	LOS4
Overall Level of Service (LoS) for Land Use Transport Integration				**L.O.S. 3**	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
9	INTEGRATED LANDUSE-TRANSPORT SYSTEM							
9.1	Population Density	>=175	150-175	125-150	<125	120.37	LOS4	4+2+4+2+3+4=19
9.3	Intensity of Development – Citywide	>=2	1.5-2.0	1.0-1.5	<1	1.80	LOS2	L.O.S.3
9.4	Intensity of Development along Transit Corridors	>=3	2-3	1.5-2	<1.5	1.00	LOS4	
9.5	Road Network	Clear	Some what	Some what	No clear	14	LOS2	

	Pattern and Completeness	pattern (ring radial or grid-iron) and complete network	clear pattern (ring-radial or grid-iron) but somewhat incomplete network	unclear pattern and incomplete network	pattern incomplete/ sparse network	radials & 4 rings good & complete pattern		
9.6	% of Area under Roads	>=15	12-15	10-12	<10	11.67	LOS3	
9.7	% Network with Exclusive ROW for transit	>=30	20-30	10-20	<10	1.93	LOS4	

Faint coherence between city structure and public transport system

5.2.1.10 Financial Sustainability Of Public Transport By Bus

The indicators to calculate the financial sustainability of public transport by bus is as follows:

1. Extent of Non-fare Revenue (%): All city transit system operators to achieve a minimum of 20% and above share.
2. Staff /bus ratio: To keep at a level as defined in LoS 2 or above.
3. Operating Ratio: To take the operating ratio to atleast 1.

TABLE 5-11 LEVEL OF SERVICE FOR FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT CALCULATION TABLE

10	FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS				
10.1	Extent of Non Fare Revenue	Revenue collections per annum from non-fare related sources	Total revenue per annum from all sources	%	LoS
	For BRTS		432	12.65	LOS3
10.2	Staff per bus ratio	total staff of bus operation and maintenance	total number of buses	Ratio	LoS
		1103	112	9.84	LOS4
10.3	Operating Ratio	cost / bus/day (Rs.)	earning /bus/day	Operating Ratio	LoS
		8035.71	9375	0.85	LOS2
The Overall LoS for Financial Sustainability of Public Transport				L.O.S. 3	

SR.NO	INDICATOR	Level of Service Range				VALVE	RESULT	Over all Level of Service
		LOS 1	LOS 2	LOS 3	LOS 4			
10	FINANCIAL SUSTAINABILITY OF PUBLIC TRANSPORT BY BUS							
10.1	Extent of Non Fare Revenue	>=40	20-40	10-20	<10	12.66	LOS3	3+4+2=9
10.2	Staff per bus ratio	<=5.5	5.5-8.0	8.0-10	>10	9.85	LOS4	L.O.S.3
10.3	Operating Ratio	<=0.7	0.7-1	1-1.5	>1.5	0.86	LOS2	

The public transport of a city is financially sustainable but needs considerable improvements

Chapter 6.
Household Opinion Survey

6.1 Trends of Primary Data

6.1.1 Interrelation of Type of Household and Total Household Income

TABLE 6-1 INTERRELATION OF TYPE OF HOUSEHOLD AND TOTAL HOUSEHOLD INCOME

Total Household Income	Type of Household									
	Slum		Chali		Apartment		Bungalow		Total	
	Count	Table N %	Count	Table N %	Count	Table N %	Count	Table N %	Count	Table N %
Less than 2500	4	4.4	7	7.8	0	.0	0	.0	11	12.2
2500 - 5000	1	1.1	5	5.6	0	.0	0	.0	6	6.7
5000 - 10000	2	2.2	2	2.2	8	8.9	0	.0	12	13.3
10000 - 15000	2	2.2	0	.0	15	16.7	0	.0	17	18.9
more than 15000	0	.0	0	.0	5	5.6	16	17.8	21	23.3
No Response	1	1.1	3	3.3	18	20.0	1	1.1	23	25.6
Total	10	11.1	17	18.9	46	51.1	17	18.9	90	100.0

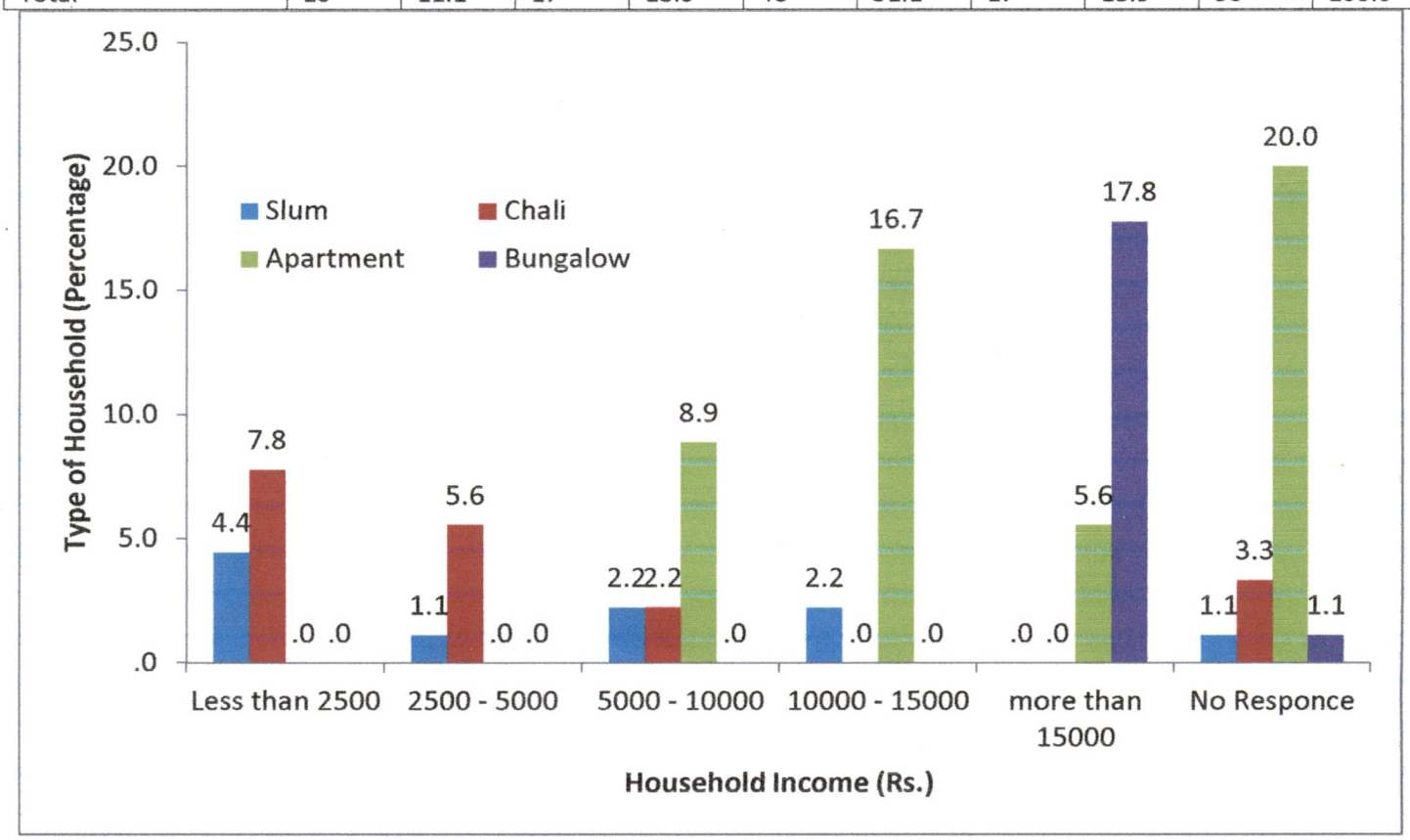


FIGURE 6-1 INTERRELATION OF TYPE OF HOUSEHOLD AND TOTAL HOUSEHOLD INCOME

The households of various categories and range of household income interrelations have been shown in the Figure 6-1 and Table 6-1.The non-respondents are maximum i.e. 23 in number and amounting for 25.6% of the total 90 households. The major contributing numbers of various other household income categories are 23.3 % for income more than Rs. 15000, 18.9 % for income from Rs. 10000 to Rs. 15000, 13.3% for income from Rs. 5000 to Rs. 10000, 6.7% for income from Rs. 2500 to Rs. 5000 and lastly 12.2 % for income less than 2500. It has been observed that HIG and MIG were dominating in Apartment and Bungalow type of household, where as Slum and Chali were essentially consisting LIG and EWS categories of household income group.

6.1.2 *Interrelation of Household income and Distance to Work Place/ School*

TABLE 6-2 INTERRELATION OF HOUSEHOLD INCOME AND DISTANCE TO WORK PLACE/ SCHOOL

Distance to workplace/ school	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No Response	Total	Total%
<= 2.0	2	2	4	5	6	4	23	25.6
2.1 - 5.0	4	1	1	2	5	8	21	23.3
5.1 - 8.0	4	1	3	6	7	8	29	32.2
8.1 - 11.0	0	1	1	3	3	3	11	12.2
11.1 - 14.0	1	1	0	1	0	0	3	3.3
14.1+	0	0	2	0	0	0	2	2.2
Total	11	6	12	17	21	23	90	100.0

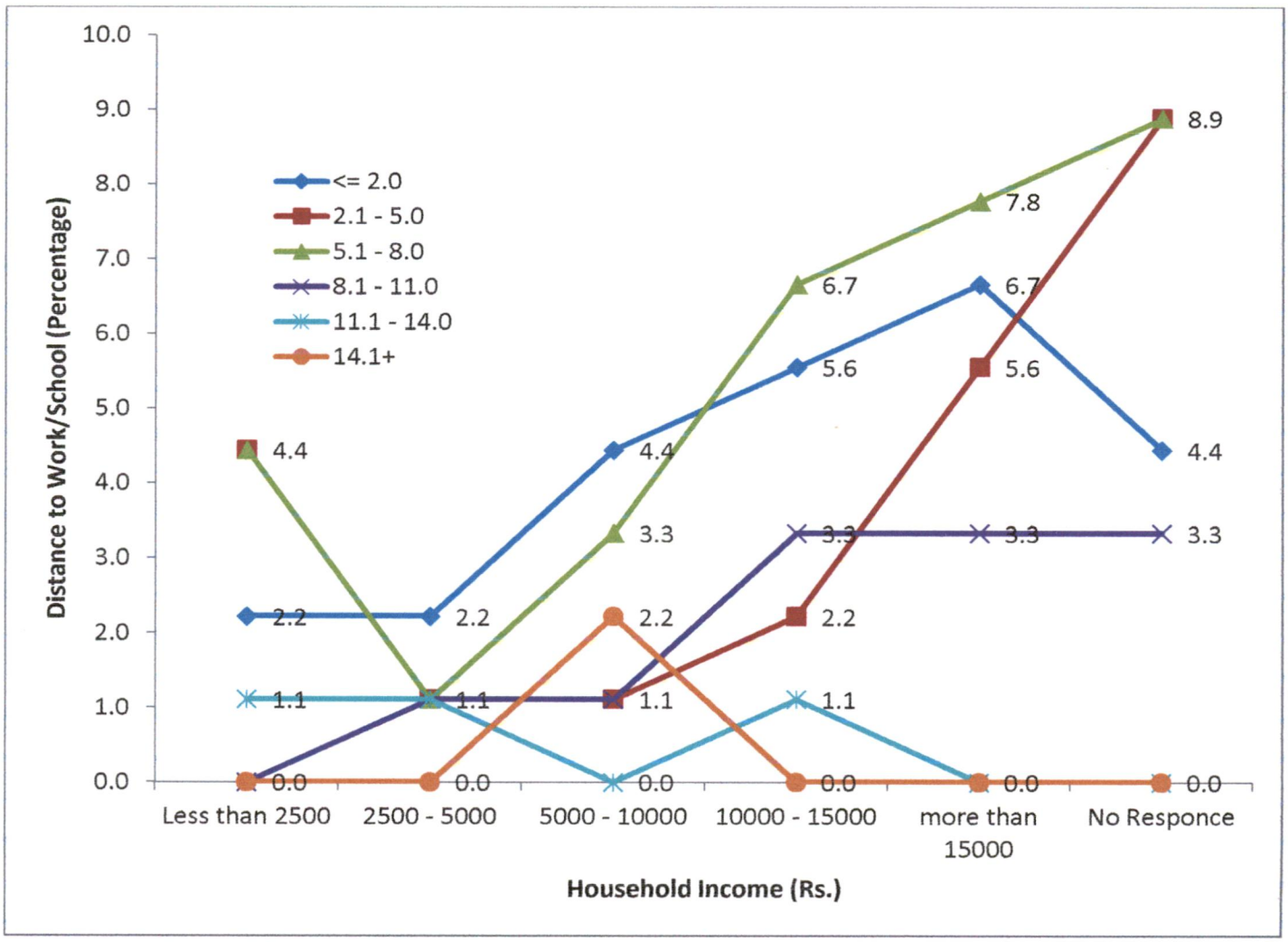


FIGURE 6-2 INTERRELATION OF HOUSEHOLD INCOME AND DISTANCE TO WORK PLACE/ SCHOOL

From the Table 6-2 and Figure 6-2 it is observed that the majority of the household income of all ranges has average distance of 5 to 8 km to work place or school. This shows the average trip length of the city dwellers. The higher income group travels the most to their work place or school. Where as the income group of Rs. 2500 to 5000 travels the least.

6.1.3 *Interaction of Household income and Primary Mode of Transportation*

TABLE 6-3 INTERACTION OF HOUSEHOLD INCOME AND PRIMARY MODE OF TRANSPORTATION

Primary Mode Used for Traveling	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No Response	Total	Total %
Walk	1	1	3	2	0	2	9	10.0
Two-Wheelers	0	0	3	7	5	8	23	25.6
Car	0	0	0	0	9	1	10	11.1
AMTS Bus	1	0	2	1	0	4	8	8.9
BRTS BUS	4	3	3	5	5	4	24	26.7
Auto Rickshaw	1	0	1	2	2	1	7	7.8
Bicycle	4	2	0	0	0	3	9	10.0
Total	11	6	12	17	21	23	90	100.0

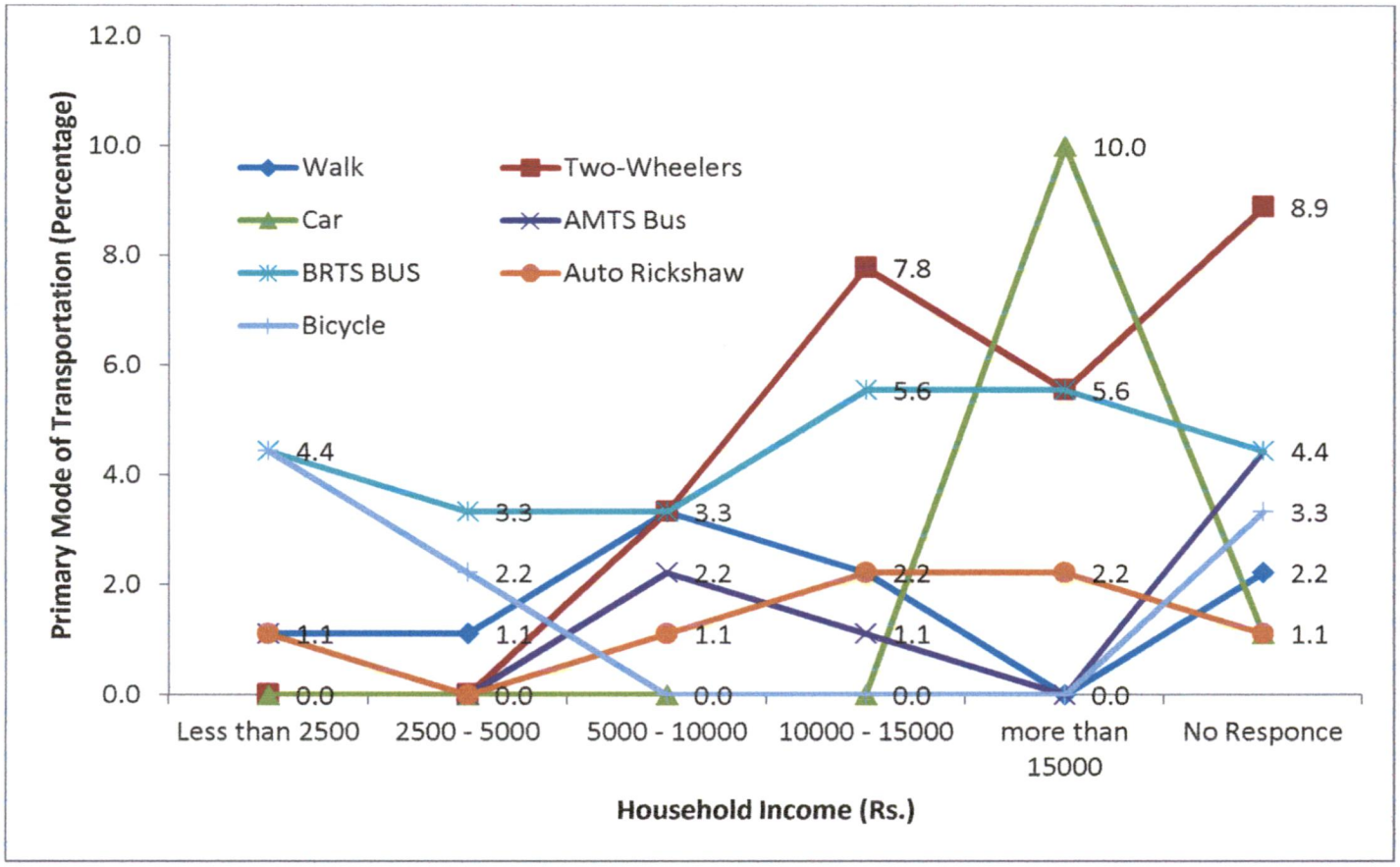


FIGURE 6-3 INTERACTION OF HOUSEHOLD INCOME AND PRIMARY MODE OF TRANSPORTATION

To reach the work place or school the household respondents use various modes of transportation, which is shown in Figure 6-3 and Table 6-3. Majority of the various modes of transportation is two wheeler and BRTS users that vary in vale in different categories of household income. The main reason for high values of BRTS users can be because of the household covered under the survey are hardly 5 to 10 mins walking distance from the nearby bus stop. The car users are comparatively less but the values are quite high in HIG or household income more than 15000, where as there are no walkers in this income category. Bicycle users are quite significant in household having lesser income levels that is LIG and EWS. The reason behind this can be higher cost and maintenance of two wheelers and non affordability of public transport because of lesser income.

6.1.4 *Interrelation of Household income and Time taken by Primary Mode*

TABLE 6-4 INTERRELATION OF HOUSEHOLD INCOME AND TIME TAKEN BY PRIMARY MODE

Time Taken by Primary Mode in Mins	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No Response	Total	Total %
<= 15	3	2	4	5	9	8	31	34.4
16 - 30	7	2	3	8	10	13	43	47.8
31 - 45	1	2	4	4	2	2	15	16.7
46+	0	0	1	0	0	0	1	1.1
Total	11	6	12	17	21	23	90	100.0

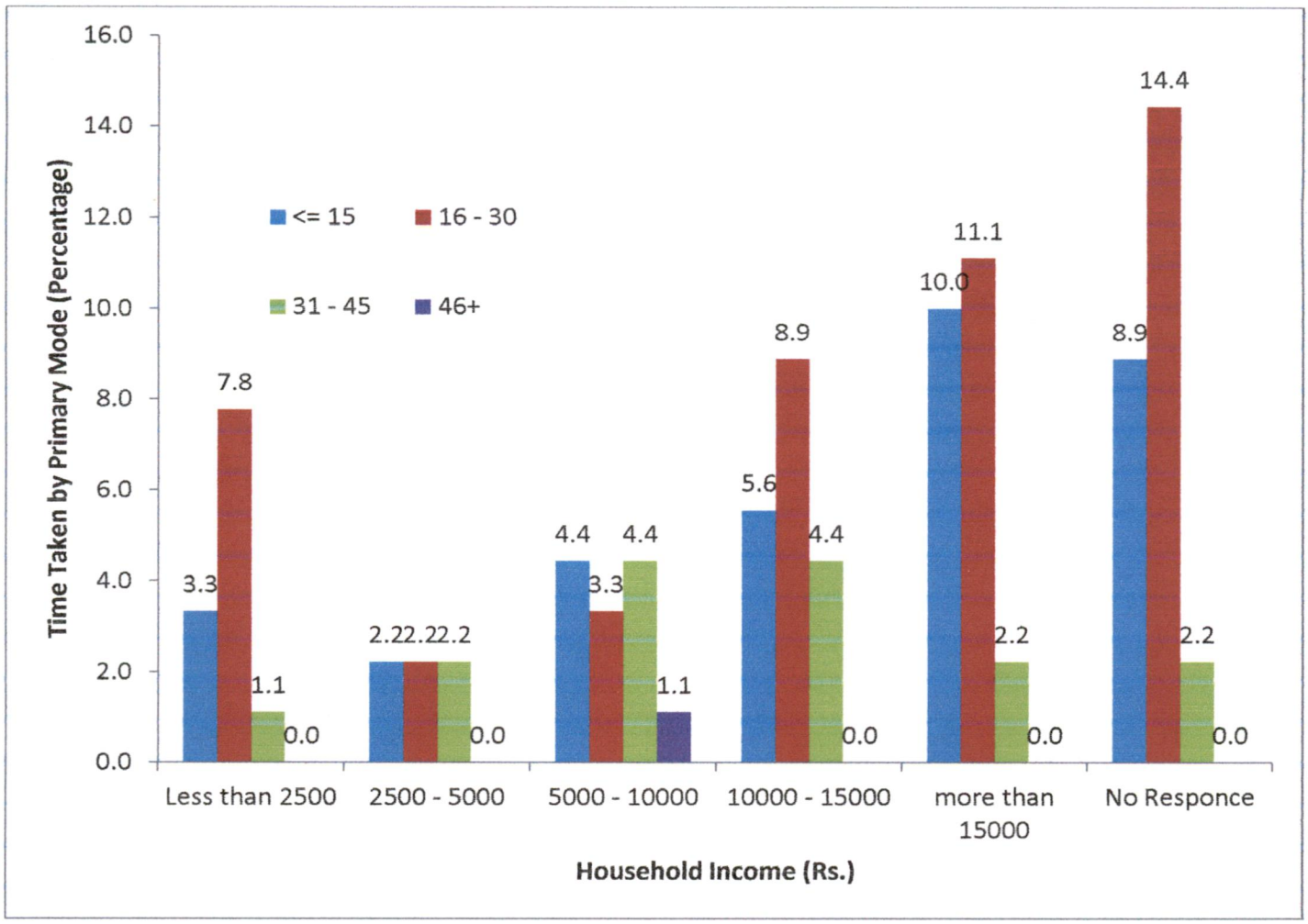


FIGURE 6-4 INTERRELATION OF HOUSEHOLD INCOME AND TIME TAKEN BY PRIMARY MODE

The results shown in Table 6-4 and Figure 6-4, reveals that majority of the respondents travel for about 15 to 30 mins using their primary mode of transportation to reach their work place or school. As discussed in the distance to work place comparison the same scenario is seen in this parameter also. The income group of more than 15000 respondents (21#) spends 15 to 30 mins traveling. For this the reason can be the wide usage of cars in this income group. It is well understood that a car takes double the time compared to a two wheeler to reach a common destination from the same origin because of the city traffic condition.

6.1.5 *Interrelation of Household income and Approx. Cost Per Trip*

TABLE 6-5 INTERRELATION OF HOUSEHOLD INCOME AND APPROX. COST PER TRIP

Approx. Cost per Trip for primary mode in Rs.	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No Response	Total	Total %
<= 10	5	2	3	7	9	7	33	45.8
11 - 20	1	1	2	3	2	7	16	22.2
21 - 30	0	0	2	2	4	2	10	13.9
31+	0	0	2	3	6	2	13	18.1
Total	6	3	9	15	21	18	72	100.0

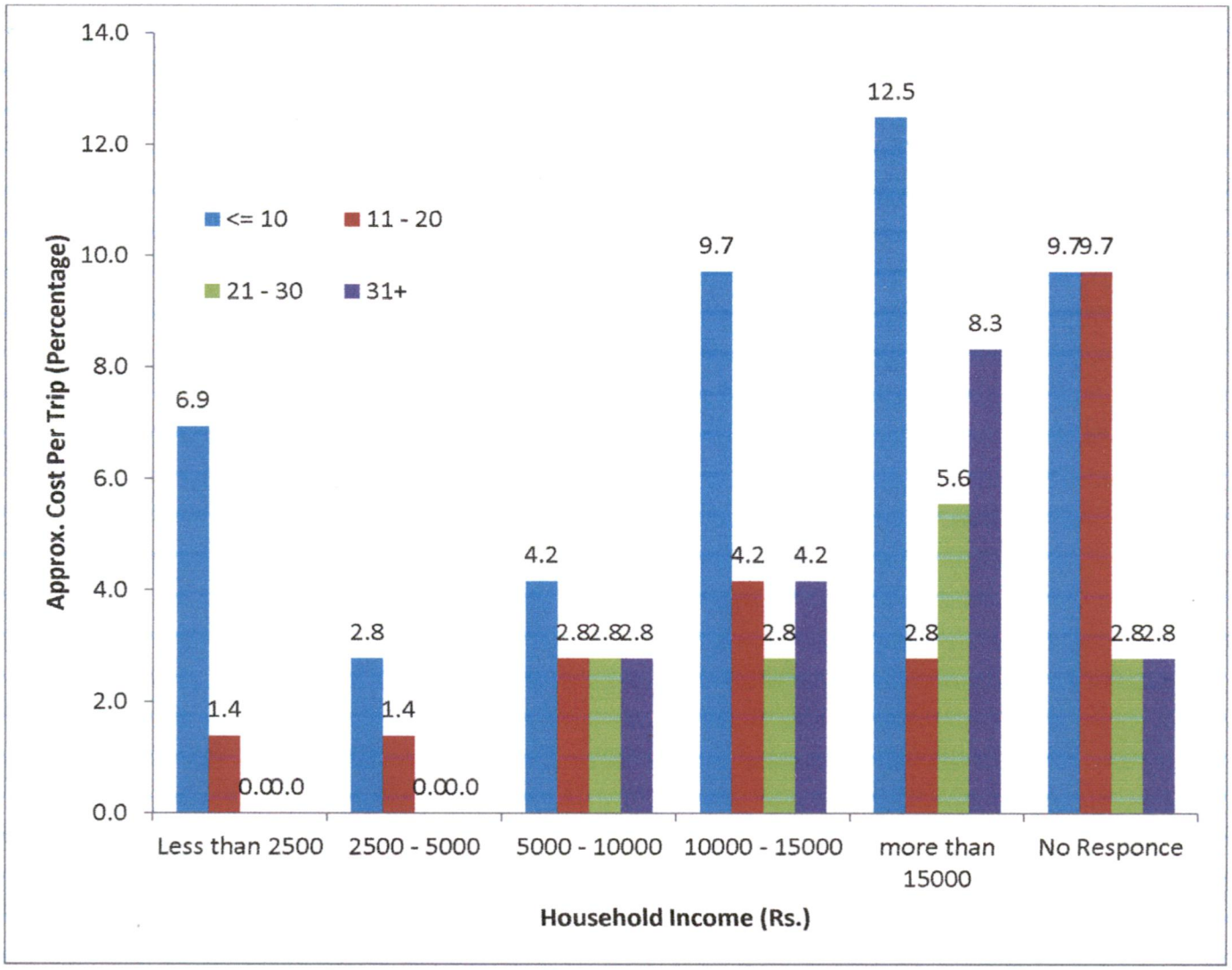


FIGURE 6-5 INTERRELATION OF HOUSEHOLD INCOME AND APPROX. COST PER TRIP

In terms of cost per trip by primary mode, the higher income group having range of more than Rs. 15000 spend the most in all the category ranges of cost per trip. This scenario can bee seen in Figure 6-5 and Table 6-5. In the over all scenario the per trip cost having lesser and equal to Rs. 10 were observed maximum in consisting all the segments of income levels ,i.e. 45.8%. After that the second highest values are under the cost per trip of Rs. 11 to 20, i.e. 22.2%.

6.1.6 *Interrelation of Household Income and Household Expenditure (Monthly)*

TABLE 6-6 INTERRELATION OF HOUSEHOLD INCOME AND HOUSEHOLD EXPENDITURE (MONTHLY)

Monthly Household Expenditure	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No response	Total	Total %
<= 2500	10	0	0	0	0	0	10	11.1
2501 - 5000	0	6	0	0	0	0	6	6.7
5001 - 7500	0	0	5	0	0	0	5	5.6
7501 - 10000	0	0	2	15	0	0	17	18.9
10001 - 12500	0	0	2	1	15	0	18	20.0
12501+	0	0	0	0	4	0	4	4.4
No response	1	0	3	1	2	23	30	33.3
Total	11	6	12	17	21	23	90	100.0

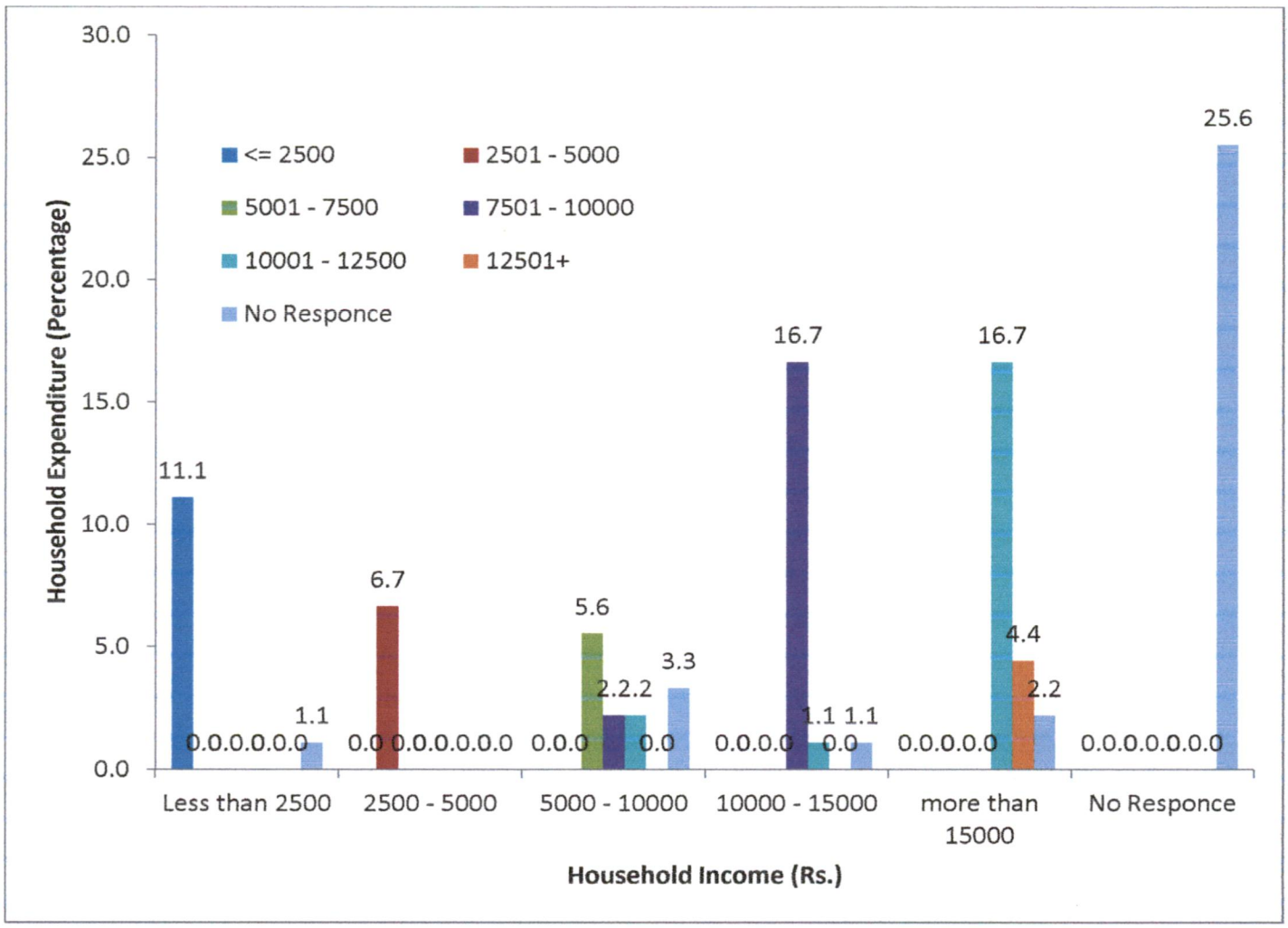


FIGURE 6-6 INTERRELATION OF HOUSEHOLD INCOME AND HOUSEHOLD EXPENDITURE (MONTHLY)

House hold income and household expenditure are always related. From the Figure 6-6 and Table 6-6 it can be seen that as the household income increases the household expenditure also increases in the respective manner. The over all percentage of household expenditure in 7501 – 10000 and 10000 – 12500 range is more compared to other ranges. This indicates towards the higher spending capacity of the higher middle class and higher class of people in the city.

6.1.7 *Interrelation of Household Income and Usage Frequency of Public Transport*

TABLE 6-7 INTERRELATION OF HOUSEHOLD INCOME AND USAGE FREQUENCY OF PUBLIC TRANSPORT

Frequency of Public Transp. Usage	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No response	Total	Total%
Daily	6	3	6	8	7	9	39	43.3
Weekly	1	2	1	4	5	5	18	20.0
Monthly	2	0	4	3	3	7	19	21.1
Never	2	1	1	2	6	2	14	15.6
Total	11	6	12	17	21	23	90	100.0

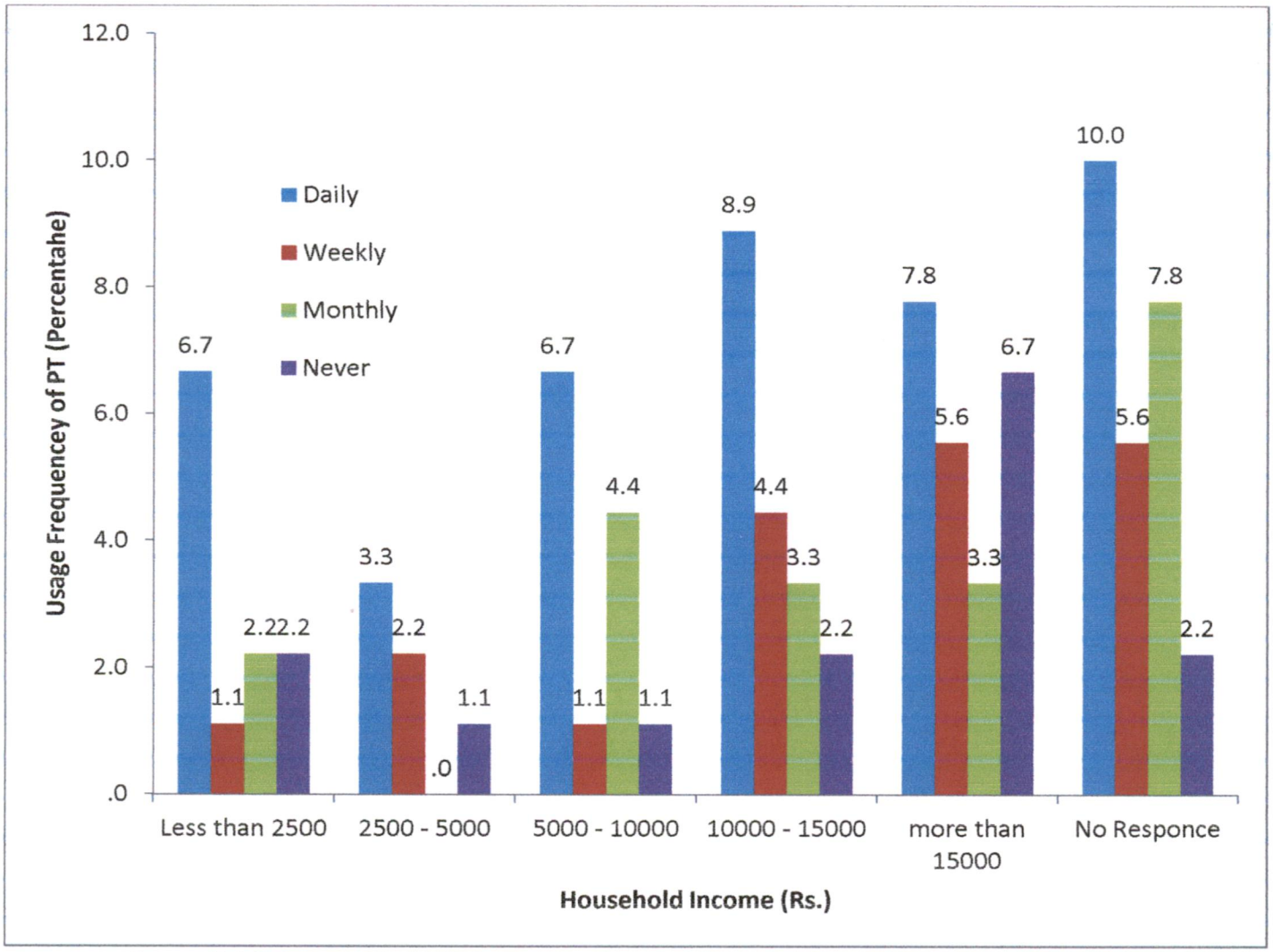


FIGURE 6-7 INTERRELATION OF HOUSEHOLD INCOME AND USAGE FREQUENCY OF PUBLIC TRANSPORT

In terms of frequency for travelling by public transport, the daily users are the most, amounting for 43.3 %, second highest users (21.1%) travel in public transport monthly and slightly lesser than the monthly users the weekly users (20%) are also toping the chart for usage frequency. The results are discussed in Table 6-7 and Figure 6-7 for interrelation between household income and frequency usage of public transport. The income level category of Rs. 10000 to Rs. 15000 is having highest values for daily usage. The higher income level category more than Rs. 15000, has the maximum percentage of non-users of public transport under frequency of usage category 'never'.

6.1.8 *Interrelation of Household Income and Type of Public Transport Used*

TABLE 6-8 INTERRELATION OF HOUSEHOLD INCOME AND TYPE OF PUBLIC TRANSPORT USED

Type of PT Used	Less than 2500	2500 - 5000	5000 - 10000	10000 - 15000	more than 15000	No response	Total	Total
None	2	1	1	2	6	2	14	15.6
AMTS	2	1	2	2	2	7	16	17.8
BRTS	6	4	7	9	6	8	40	44.4
Auto Rickshaw	1	0	2	4	7	6	20	22.2
Total	11	6	12	17	21	23	90	100.0

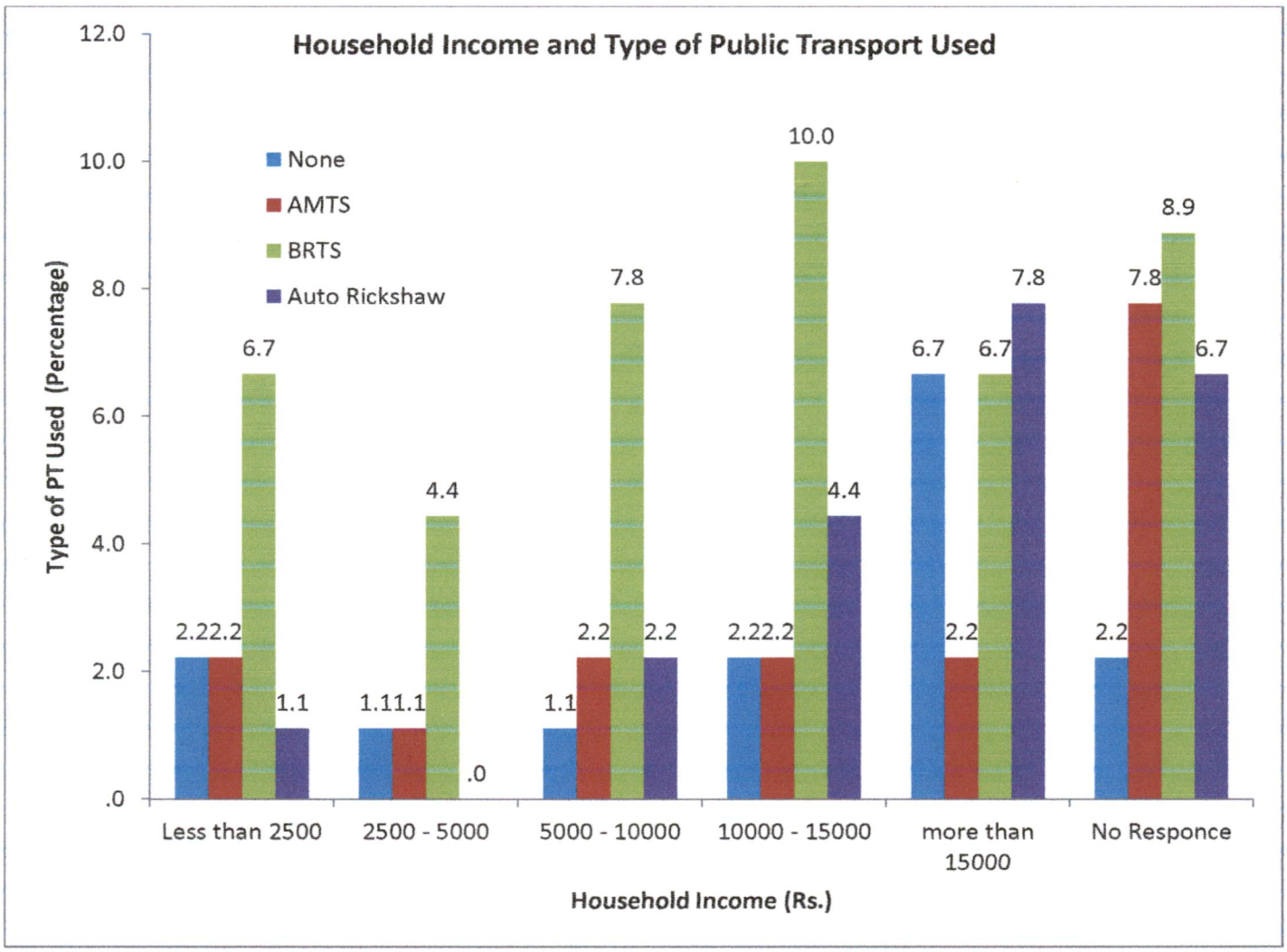


FIGURE 6-8 INTERRELATION OF HOUSEHOLD INCOME AND TYPE OF PUBLIC TRANSPORT USED

For the type of public transport users the BRTS is the first priority for the surveyed respondents, as 44.4 % of the total respondents responded for BRTS for type of public transportation used. This scenario is well understood from the Figure 6-8 and Table 6-8. The survey results show that second favorite public transport for the surveyed 90 respondents is Auto rickshaw. This is due to the normal AMTS city bus has been re-routed after the BRTS routs have been started functioning. The results also show that about 15.6 % respondents do not use public transport of any type. Those are mainly dependent on their personal vehicles.

6.2 Primary Data Analysis: Household Survey Analysis

As discussed in data collection chapter the collected data is further analyzed in four parts of opinion and attitude parameters towards BRTS for better understanding and to derive the social sustainability scenario. These four parts of opinion and attitude parameters towards BRTS are listed below:

1. BRTS Ranking
2. Considerations for choosing BRTS for Transportation
3. Influencing parameter to use BRTS
4. Willingness to pay for BRTS

6.2.1 BRTS Ranking

The ranking of Ahmedabad BRTS is given to various functional aspects of the system. Further all the functional aspects' ranking is derived based on socio-economic parameters and travel characteristics.

TABLE 6-9 OVERALL RANKING OF BRTS IN VARIOUS PARAMETERS

	Mean
Travel Time	3.27
Frequency	3.64
Travel Cost/Fares	4.01
Feeder Service	7.96
Vehicle Condition	6.21
Safety/ Security	4.07
Choice of Bus Routes	7.09
Free Parking close to bus stop	7.30
Comfort/ Availability of Seats	5.79
Info of the service	5.60

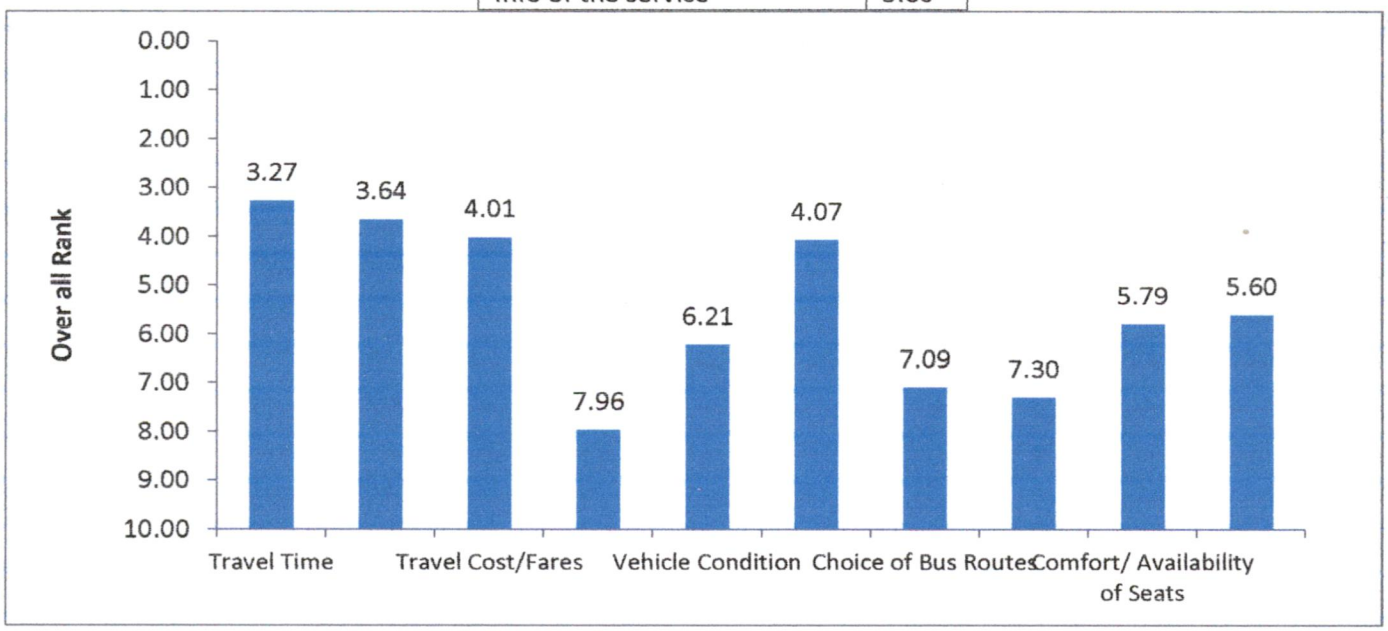


FIGURE 6-9 OVERALL RANKING OF BRTS IN VARIOUS PARAMETERS

Over all ranking of Ahmedabad BRTS is given in the above shown Table 6-9 and Figure 6-9. The results in figure and table show that current BRTS functions are ranking highest in travel time, frequency of the service, and travel cost. Least ranking was observed for parking facilities, choice of bus routs and feeder services.

6.2.1.1 Ranking Based On Primary Mode For Travelling

TABLE 6-10 RANKING BASED ON PRIMARY MODE FOR TRAVELLING

Rank	Primary Mode Used for Traveling						
	Walk	Two-Wheelers	Car	AMTS Bus	BRTS BUS	Auto Rickshaw	Bicycle
	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Travel Time	4	3	2	3	3	3	3
Frequency	4	4	3	3	3	4	4
Travel Cost/Fares	4	4	4	5	4	5	4
Feeder Service	9	8	8	9	8	7	8
Vehicle Condition	4	7	7	6	6	7	6
Safety/ Security	4	3	4	4	5	4	3
Choice of Bus Routes	8	7	8	6	7	7	7
Parking close to bus stop	8	7	9	7	7	7	8
Comfort/ Availability of Seats	6	6	5	6	6	7	6
Info of the service	6	6	6	6	6	4	6

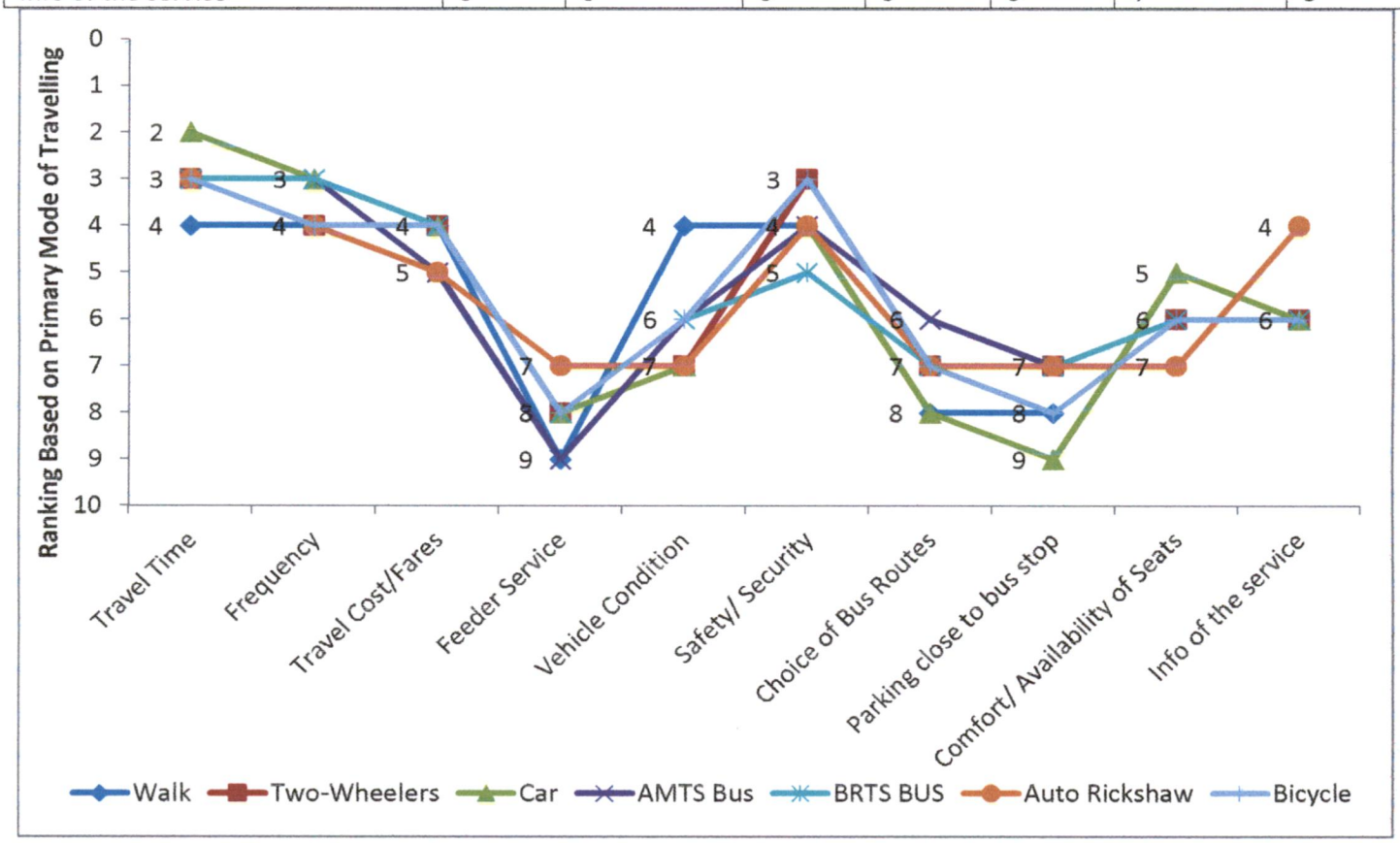


FIGURE 6-10 RANKING BASED ON PRIMARY MODE FOR TRAVELLING

Based on the primary mode of transportation the ranking for various parameters are discussed in Table 6-10 and Figure 6-10. This has been observed that the car user as their primary mode, ranked travel time highest, as they are not able to drive as fast as BRTS in the normal traffic lane. For two wheelers the safety has been the prime concern as the majority of the accidents involve two wheelers. In terms of feeder service the auto rickshaw users ranked it quite higher compared to others as the respondents using auto have accessibility to the BRTS service quite better.

6.2.1.2 Ranking Based On Time Taken By Primary Mode For Transportation

TABLE 6-11 RANKING BASED ON TIME TAKEN BY PRIMARY MODE FOR TRANSPORTATION

Rank	Time Taken by Primary Mode in Mins			
	<= 15	16 - 30	31 - 45	46+
	Mean	Mean	Mean	Mean
Travel Time	3	3	3	2
Frequency	4	4	3	3
Travel Cost/Fares	4	4	4	1
Feeder Service	8	8	7	9
Vehicle Condition	6	6	7	8
Safety/ Security	4	4	5	4
Choice of Bus Routes	7	7	7	7
Parking close to bus stop	8	7	6	10
Comfort/ Availability of Seats	6	6	6	6
Info of the service	6	5	6	5

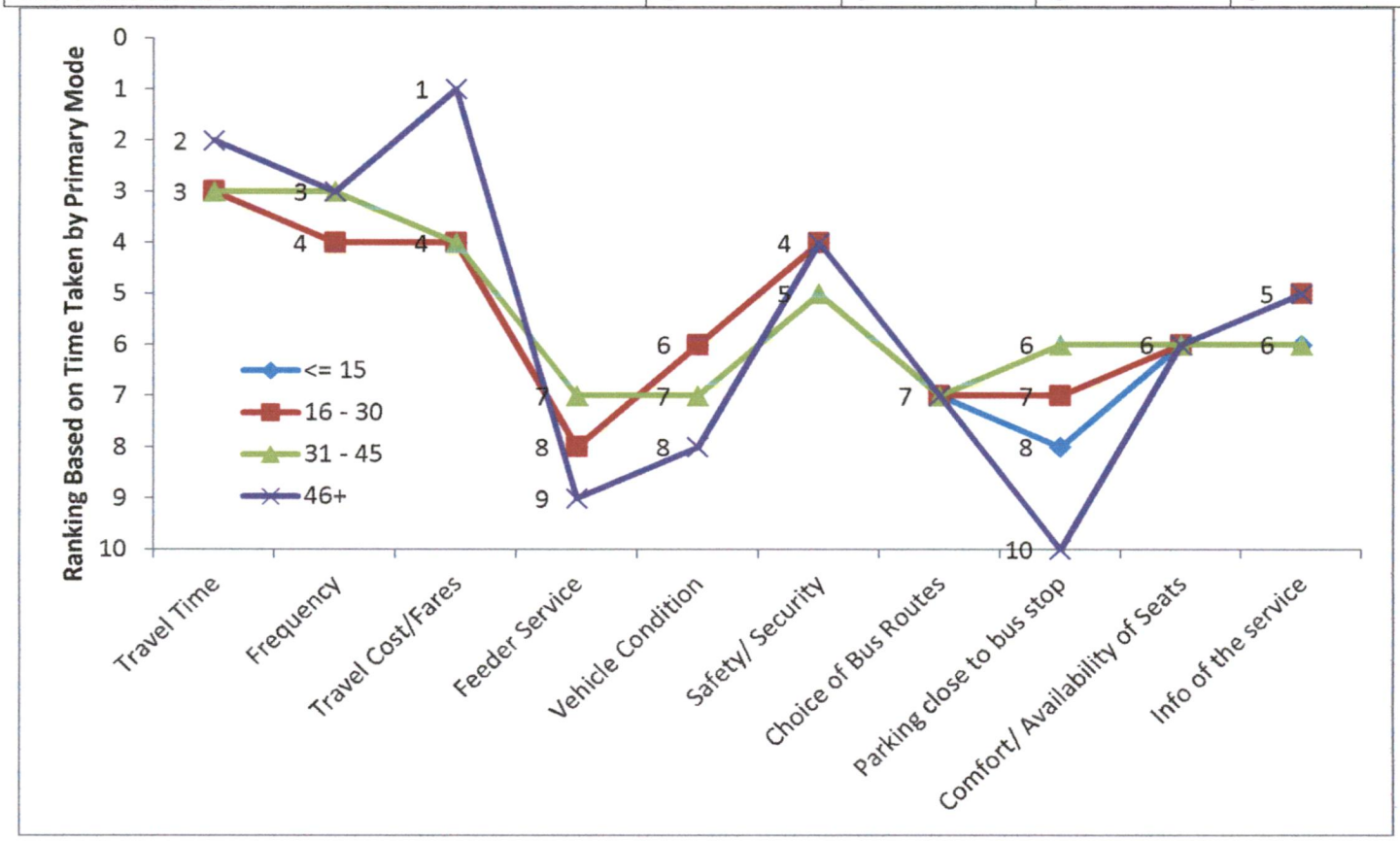


FIGURE 6-11 RANKING BASED ON TIME TAKEN BY PRIMARY MODE FOR TRANSPORTATION

Based on the time taken by the primary mode for travel the ranking results are discussed in Figure 6-11 and Table 6-11. The more deviating category of the time taken by the primary mode for travelling is more than 46 mins. It has ranked travel cost the highest; the reason behind this can be the cost of travelling by BRTS is comparatively lesser than other types of transportation modes like car, two wheeler and auto rickshaw. At the same time the same respondents have ranked feeder service and provision of parking least, ranking 9 and 10 respectively. They also have ranked vehicle condition less. In case of choice of bus routs all the categories of time taken by the primary mode of transport have ranked 7 which might be because of the limited numbers of roads have the BRTS service accommodated in their ROW.

6.2.1.3 Ranking Based On Approx. Cost Per Trip Using Primary Mode

TABLE 6-12 RANKING BASED ON APPROX. COST PER TRIP USING PRIMARY MODE

Rank	Approx Cost per Trip for using primary mode in Rs.			
	<= 10	11 - 20	21 - 30	31+
	Mean	Mean	Mean	Mean
Travel Time	3	3	3	4
Frequency	3	4	4	4
Travel Cost/Fares	4	4	5	4
Feeder Service	8	8	7	7
Vehicle Condition	6	7	7	6
Safety/ Security	5	4	4	4
Choice of Bus Routes	7	7	8	8
Parking close to bus stop	7	7	7	6
Comfort/ Availability of Seats	6	6	5	7
Info of the service	6	6	5	5

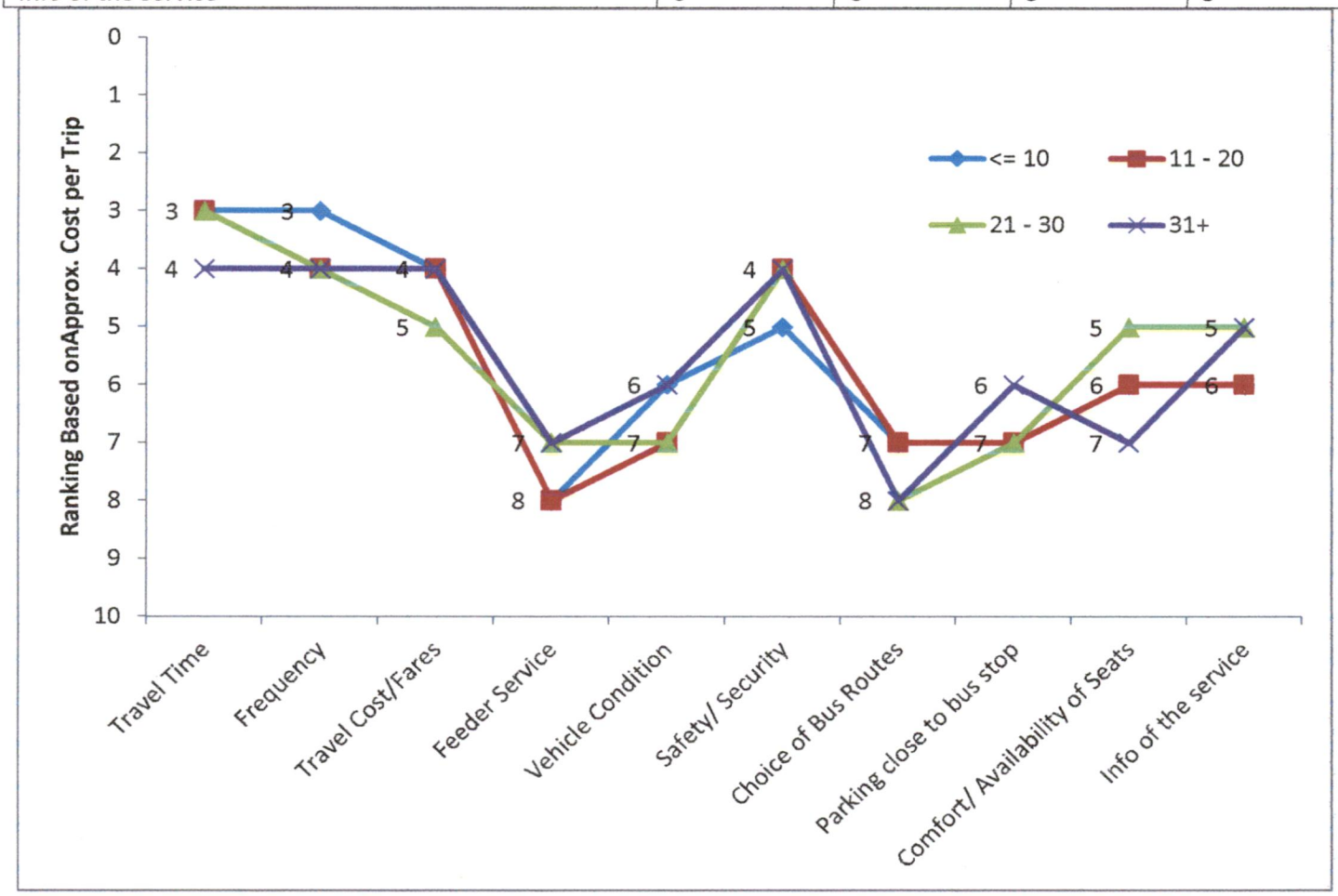


FIGURE 6-12 RANKING BASED ON APPROX. COST PER TRIP USING PRIMARY MODE

The general scenario observed was same that parking and feeder service were least ranked, travel time, safety and frequency were ranked highest, but the results were so fluctuating in almost all the categories of approximate cost per trip by using primary mode of transportation. The results can be seen in above shown Table 6-12 and Figure 6-12

6.2.1.4 Ranking Based On Frequency Of Public Transport Usage

TABLE 6-13 RANKING BASED ON FREQUENCY OF PUBLIC TRANSPORT USAGE

Rank	Frequency of Public Transport usage			
	Daily	Weekly	Monthly	Never
	Mean	Mean	Mean	Mean
Travel Time	3	3	3	3
Frequency	3	3	5	4
Travel Cost/Fares	4	4	4	4
Feeder Service	8	7	9	8
Vehicle Condition	6	7	6	7
Safety/ Security	5	5	2	4
Choice of Bus Routes	7	7	7	8
Parking close to bus stop	7	7	8	8
Comfort/ Availability of Seats	6	6	5	5
Info of the service	5	6	6	5

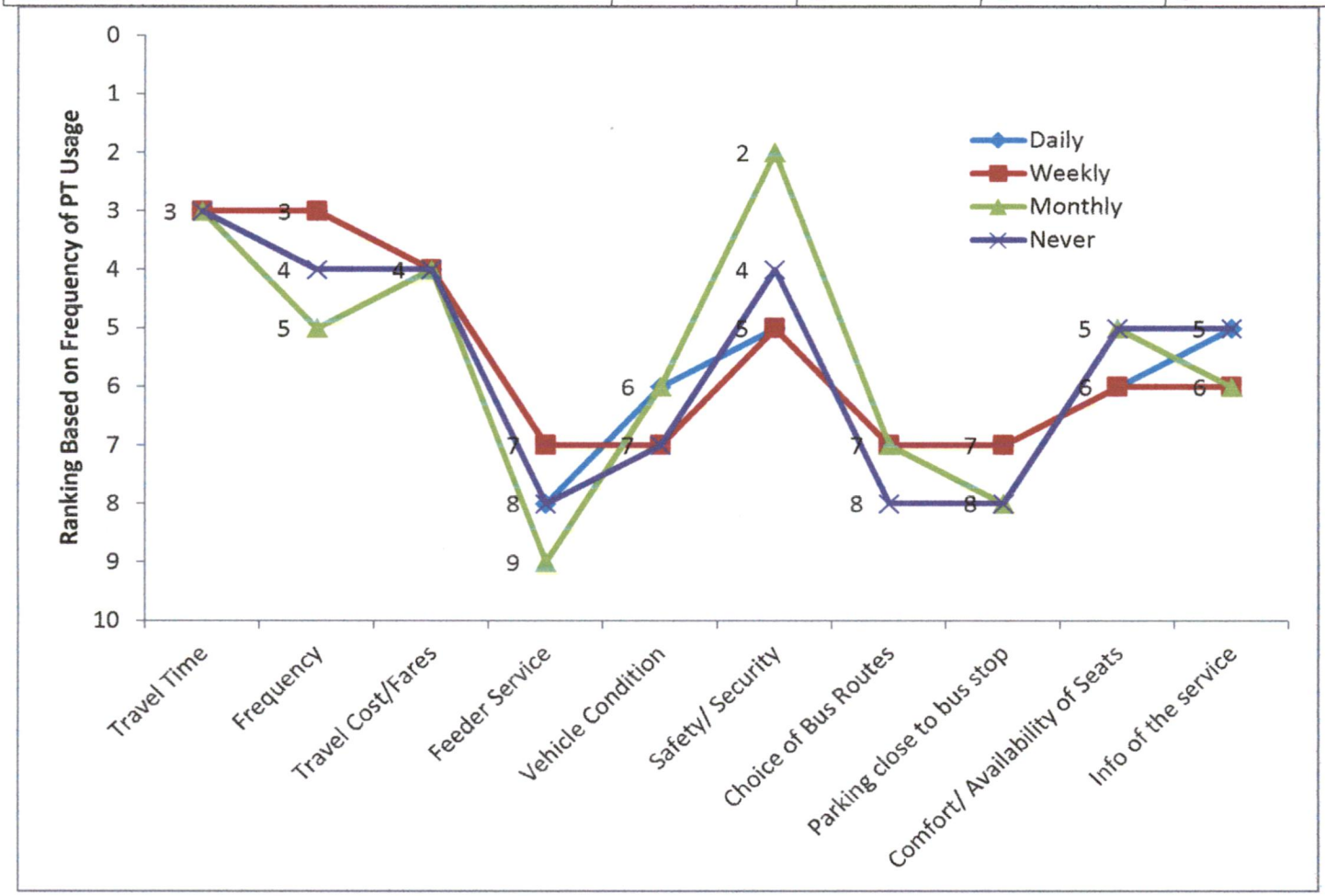


FIGURE 6-13 RANKING BASED ON FREQUENCY OF PUBLIC TRANSPORT USAGE

The ranking based on frequency of public transport usage is shown in Figure 6-13 and Table 6-13. The monthly users/ occasional users found BRTS most safe, but the feeder service most worst. In terms of frequency they were still a little selective, and ranked it lesser compared to other frequency respondents. The major concern points for non users of public transport were feeder system, choice of routs and parking.

6.2.1.5 Ranking Based On Public Transport Used

TABLE 6-14 RANKING BASED ON PUBLIC TRANSPORT USED

Rank	Type of PT Used			
	None	AMTS	BRTS	Auto Rickshaw
	Mean	Mean	Mean	Mean
Travel Time	3	2	3	4
Frequency	4	3	3	4
Travel Cost/Fares	4	4	4	5
Feeder Service	8	9	8	8
Vehicle Condition	7	6	6	7
Safety/ Security	4	4	5	3
Choice of Bus Routes	8	7	7	7
Parking close to bus stop	8	8	7	7
Comfort/ Availability of Seats	5	6	6	6
Info of the service	5	7	6	5

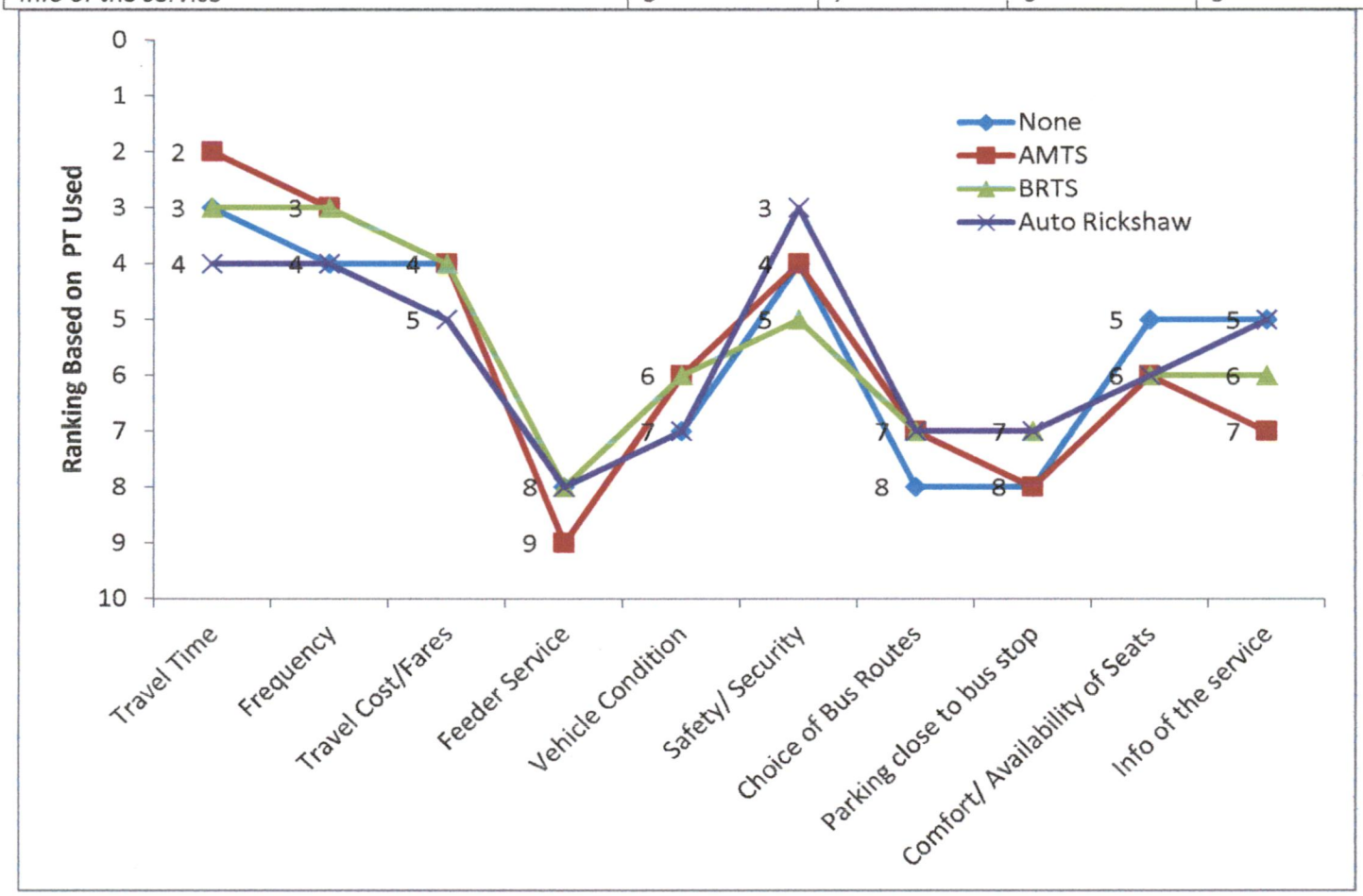


FIGURE 6-14 RANKING BASED ON PUBLIC TRANSPORT USED

The ranking based in type of public transport used has been shown in the above Table 6-14 and Figure 6-14. The Ahmedabad Municipal Transport Service users are most impressed by travel time, frequency, travel cost, safety and some what by vehicle condition and availability of seats in BRTS Ahmedabad, where as the Auto rickshaw users were impressed by the information availability, travel time, safety and frequency.

6.2.2 *Considerations for choosing BRTS for Transportation*

The opinion on considerations for choosing Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. Further all the aspects' considerations are derived based on socio-economic parameters and travel characteristics.

TABLE 6-15 OVER ALL OPINION FOR CONSIDERATION ON CHOOSING BRTS

Noise Reduction	Yes	25
	No	65
Air Pollution Reduction	Yes	37
	No	53
Reduction in Traffic Congestion	Yes	46
	No	44
Safety	Yes	80
	No	10
Comfort	Yes	75
	No	15
Low Accident Risk	Yes	75
	No	15

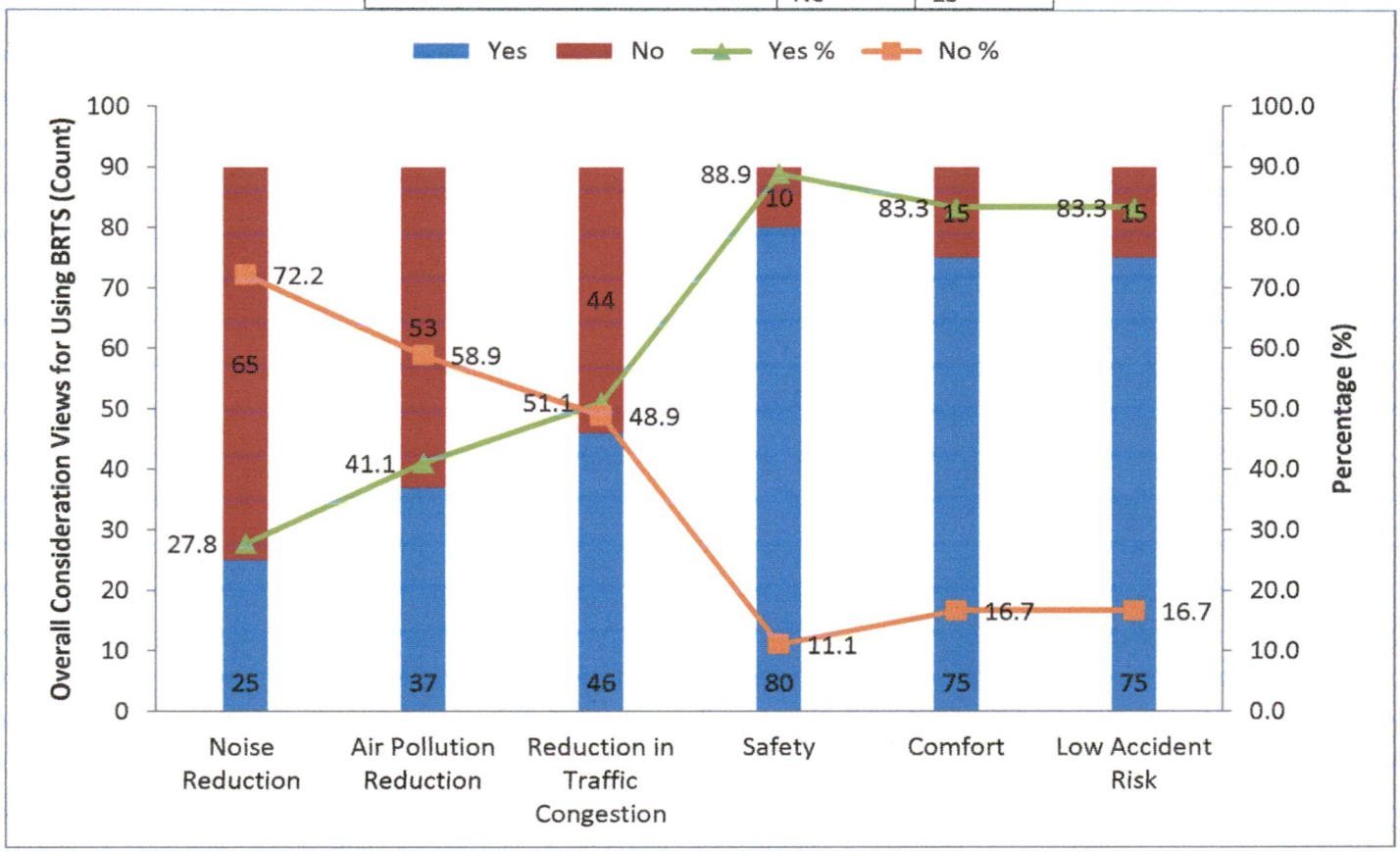


FIGURE 6-15 OVER ALL OPINION FOR CONSIDERATION ON CHOOSING BRTS

The opinion on considerations for choosing Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. The above shown Figure 6-15 and Table 6-15 discusses the results for the same. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion.

6.2.2.1 Considerations Based On Primary Mode Used For Traveling

TABLE 6-16 CONSIDERATIONS BASED ON PRIMARY MODE USED FOR TRAVELING

Considerations		Primary Mode Used for Traveling						
		Walk	Two-Wheelers	Car	AMTS Bus	BRTS BUS	Auto Rickshaw	Bicycle
Noise Reduction	Yes	2	6	4	1	8	3	1
	No	7	17	6	7	16	4	8
Air Pollution Reduction	Yes	5	9	4	2	11	4	2
	No	4	14	6	6	13	3	7
Reduction in Traffic Congestion	Yes	5	10	6	5	11	5	4
	No	4	13	4	3	13	2	5
Safety	Yes	8	22	10	8	19	6	7
	No	1	1	0	0	5	1	2
Comfort	Yes	7	21	9	6	21	4	7
	No	2	2	1	2	3	3	2
Low Accident Risk	Yes	7	18	7	7	22	5	9
	No	2	5	3	1	2	2	0

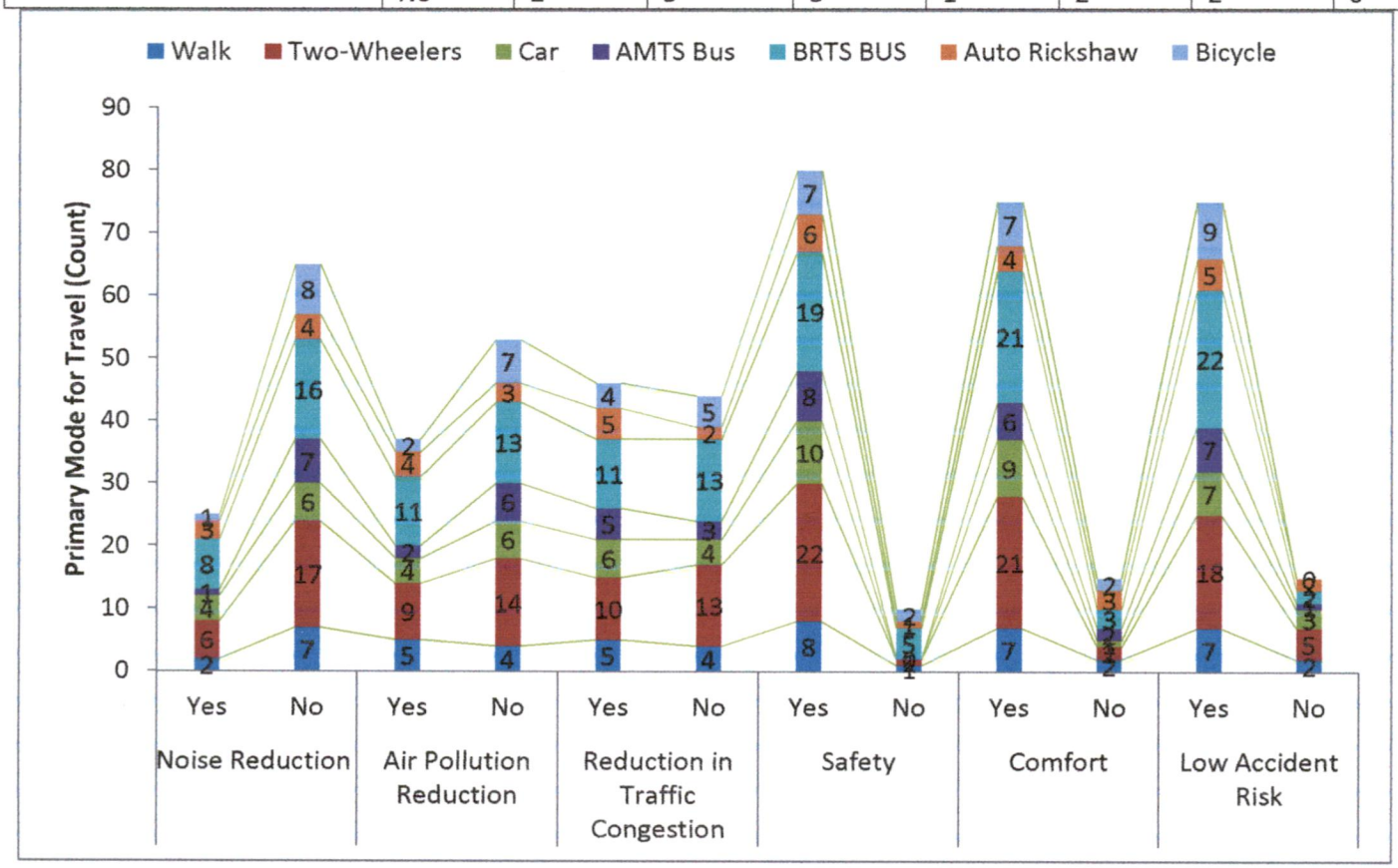


FIGURE 6-16 CONSIDERATIONS BASED ON PRIMARY MODE USED FOR TRAVELING

Primary mode of traveling for the respondent, point of view the responses for different considerations of all the various primary transportation mode categories are shown in Figure 6-16 and Table 6-16. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion. In the surveyed samples the numbers of two wheeler users were maximum; therefore the response was the strongest amongst all the categories of primary mode of transportation for the respondents.

6.2.2.2 Considerations Based On Time Taken By Primary Mode

TABLE 6-17 CONSIDERATIONS BASED ON TIME TAKEN BY PRIMARY MODE

Considerations		Time Taken by Primary Mode in Mins			
		<= 15	16 - 30	31 - 45	46+
		Count	Count	Count	Count
Noise Reduction	Yes	9	14	2	0
	No	22	29	13	1
Air Pollution Reduction	Yes	14	19	4	0
	No	17	24	11	1
Reduction in Traffic Congestion	Yes	14	24	7	1
	No	17	19	8	0
Safety	Yes	28	38	13	1
	No	3	5	2	0
Comfort	Yes	24	35	15	1
	No	7	8	0	0
Low Accident Risk	Yes	26	37	12	0
	No	5	6	3	1

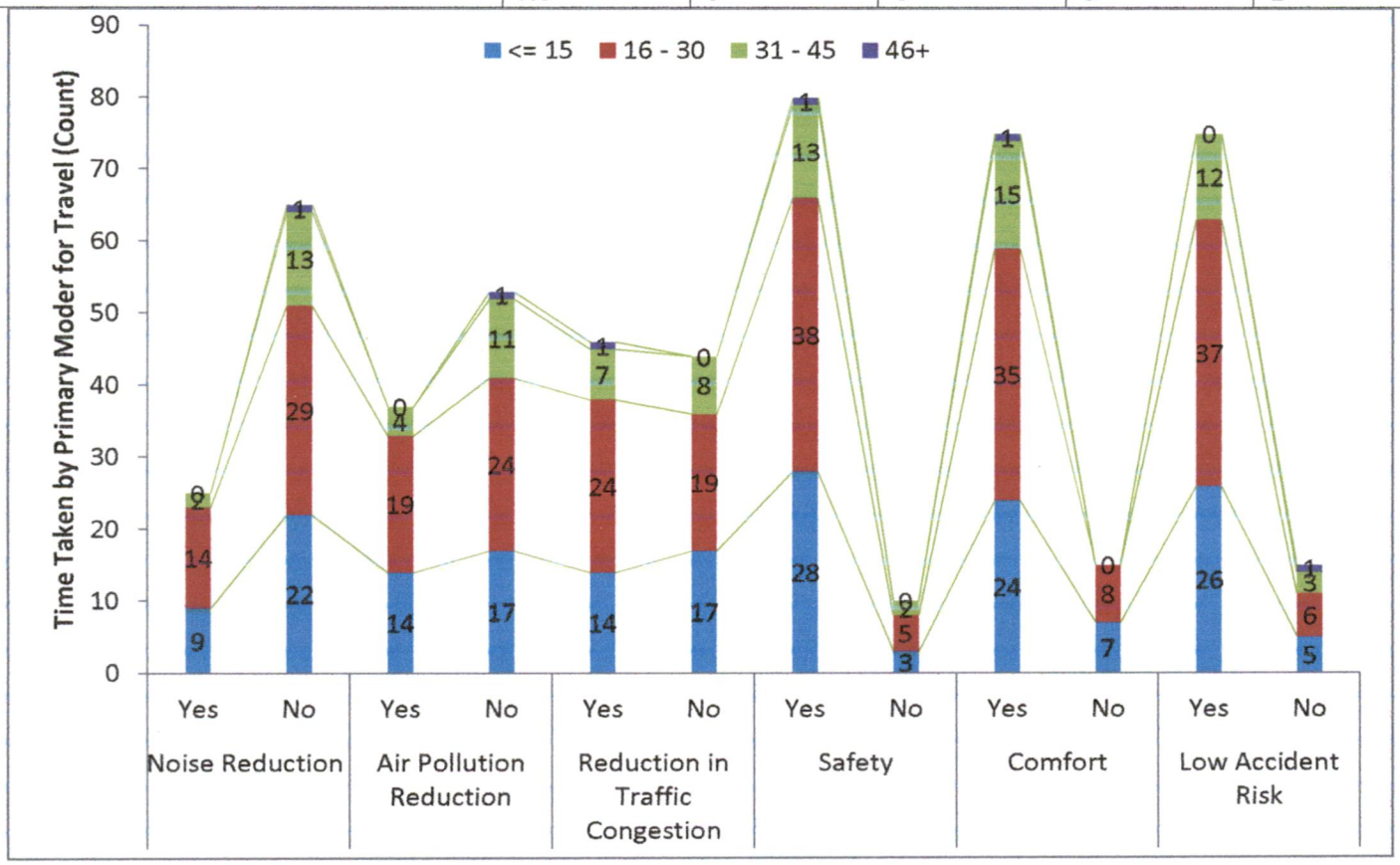


FIGURE 6-17 CONSIDERATIONS BASED ON TIME TAKEN BY PRIMARY MODE

Time taken by primary mode for traveling for the respondent, point of view the responses for different considerations of all the various time taken categories are shown in Figure 6-17 and Table 6-17. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion. In the surveyed samples the number of travellers traveling for 16 mins to 30 mins were maximum; therefore the response was the strongest amongst all the categories of time taken by the primary mode of transportation for the respondents.

6.2.2.3 Considerations Based On Approx. Cost Per Trip For Using Primary Mode

TABLE 6-18 CONSIDERATIONS BASED ON APPROX. COST PER TRIP FOR USING PRIMARY MODE

		Approx. Cost per Trip for using primary mode in Rs. (Binned)			
		<= 10	11 - 20	21 - 30	31+
Noise Reduction	Yes	11	4	5	2
	No	22	12	5	11
Air Pollution Reduction	Yes	13	6	8	3
	No	20	10	2	10
Reduction in Traffic Congestion	Yes	16	7	6	8
	No	17	9	4	5
Safety	Yes	28	14	10	13
	No	5	2	0	0
Comfort	Yes	26	14	8	13
	No	7	2	2	0
Reduction in Traffic Congestion	Yes	29	14	8	8
	No	4	2	2	5
Safety					

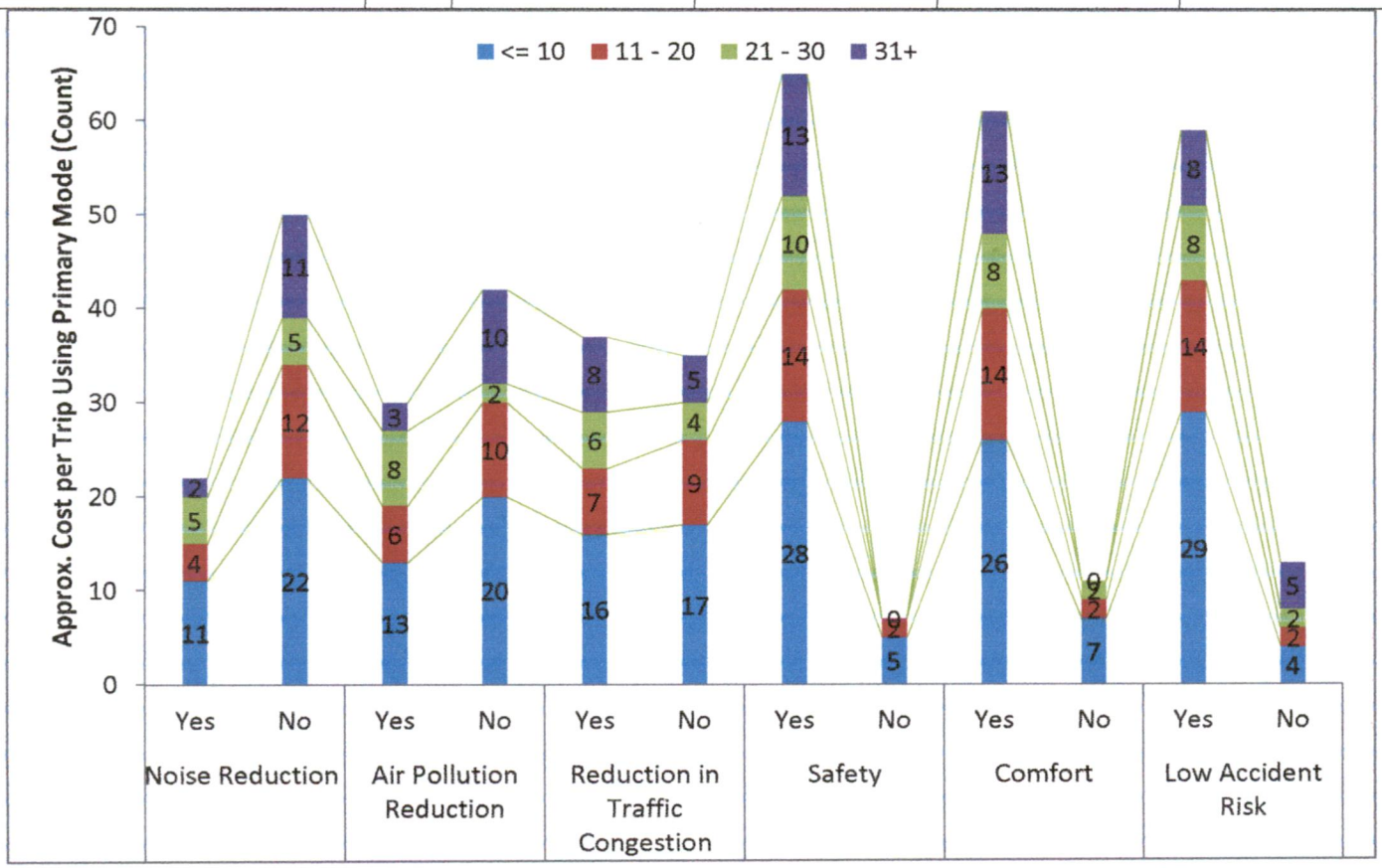


FIGURE 6-18 CONSIDERATIONS BASED ON APPROX. COST PER TRIP FOR USING PRIMARY MODE

Approximate cost per trip using primary mode for traveling for the respondent, point of view the responses for different considerations of all the various cost level categories are shown in Table 6-18 and Figure 6-18. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion. In the surveyed samples the numbers of travellers spending about Rs. 10 were maximum; therefore their response was the strongest amongst all the categories of approximate cost per trip using primary mode for traveling for the respondent.

6.2.2.4 Considerations Based On Frequency Of Usage Of Public Transport

TABLE 6-19 CONSIDERATIONS BASED ON FREQUENCY OF USAGE OF PUBLIC TRANSPORT

Considerations		Frequency of usage			
		Daily	Weekly	Monthly	Never
Noise Reduction	Yes	12	5	3	5
	No	27	13	16	9
Air Pollution Reduction	Yes	17	8	5	7
	No	22	10	14	7
Reduction in Traffic Congestion	Yes	21	8	10	7
	No	18	10	9	7
Safety	Yes	33	17	18	12
	No	6	1	1	2
Comfort	Yes	31	17	15	12
	No	8	1	4	2
Low Accident Risk	Yes	34	15	15	11
	No	5	3	4	3

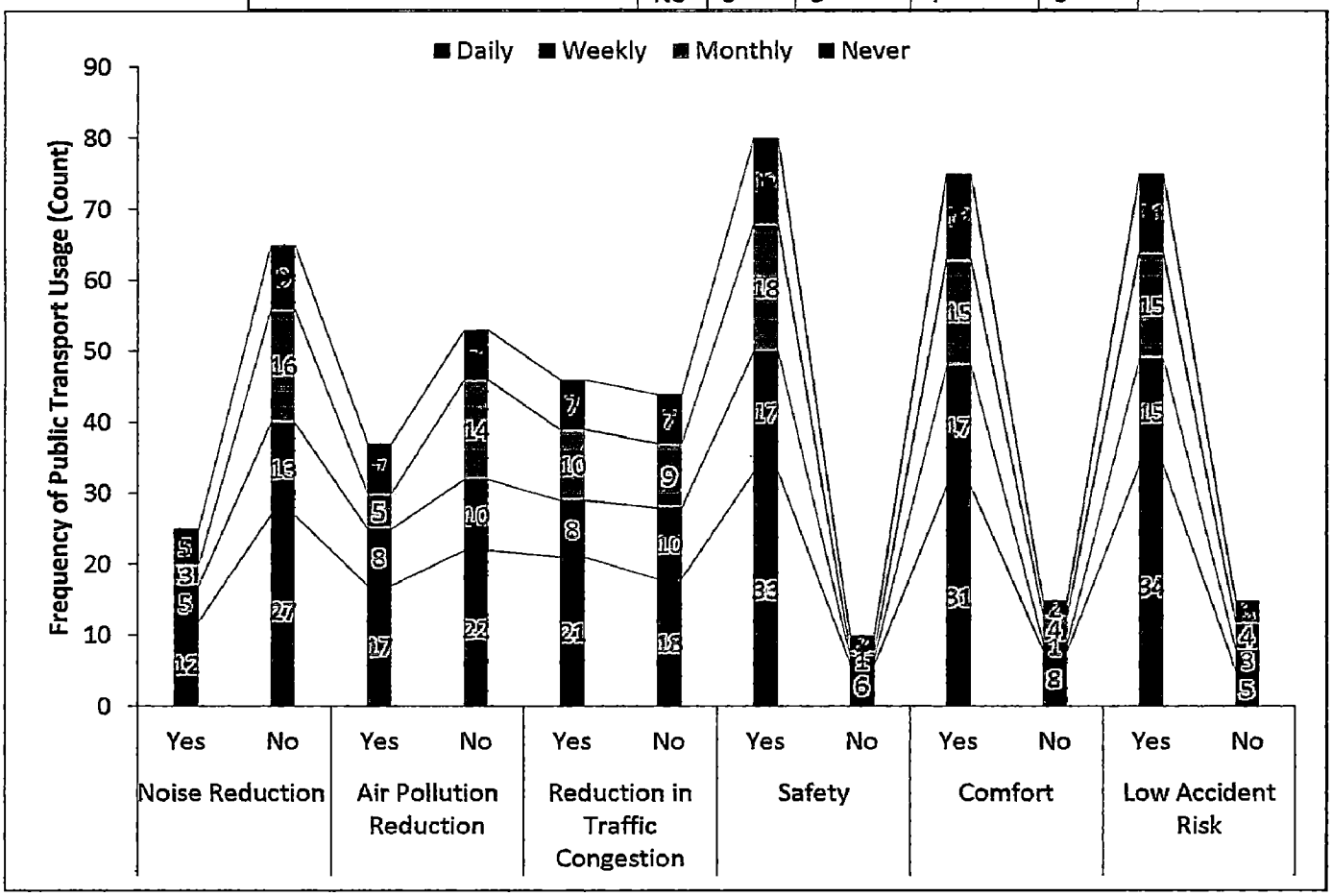


FIGURE 6-19 CONSIDERATIONS BASED ON FREQUENCY OF USAGE OF PUBLIC TRANSPORT

Frequency of usage of public transport, point of view the responses for different considerations of all the various frequency of usage of public transport categories are shown in Table 6-19 and Figure 6-19. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion. In the surveyed samples the numbers of respondents using public transport with daily frequency were maximum; therefore their response was the strongest amongst all the categories of frequency of usage of public transport for the respondent.

6.2.2.5 Considerations Based On Type Of Public Transport Used

TABLE 6-20 CONSIDERATIONS BASED ON TYPE OF PT USED

Considerations		Type of PT Used			
		None	AMTS	BRTS	Auto Rickshaw
Noise Reduction	Yes	5	2	12	6
	No	9	14	28	14
Air Pollution Reduction	Yes	7	4	18	8
	No	7	12	22	12
Reduction in Traffic Congestion	Yes	7	9	20	10
	No	7	7	20	10
Safety	Yes	12	16	34	18
	No	2	0	6	2
Comfort	Yes	12	12	35	16
	No	2	4	5	4
Low Accident Risk	Yes	11	14	35	15
	No	3	2	5	5

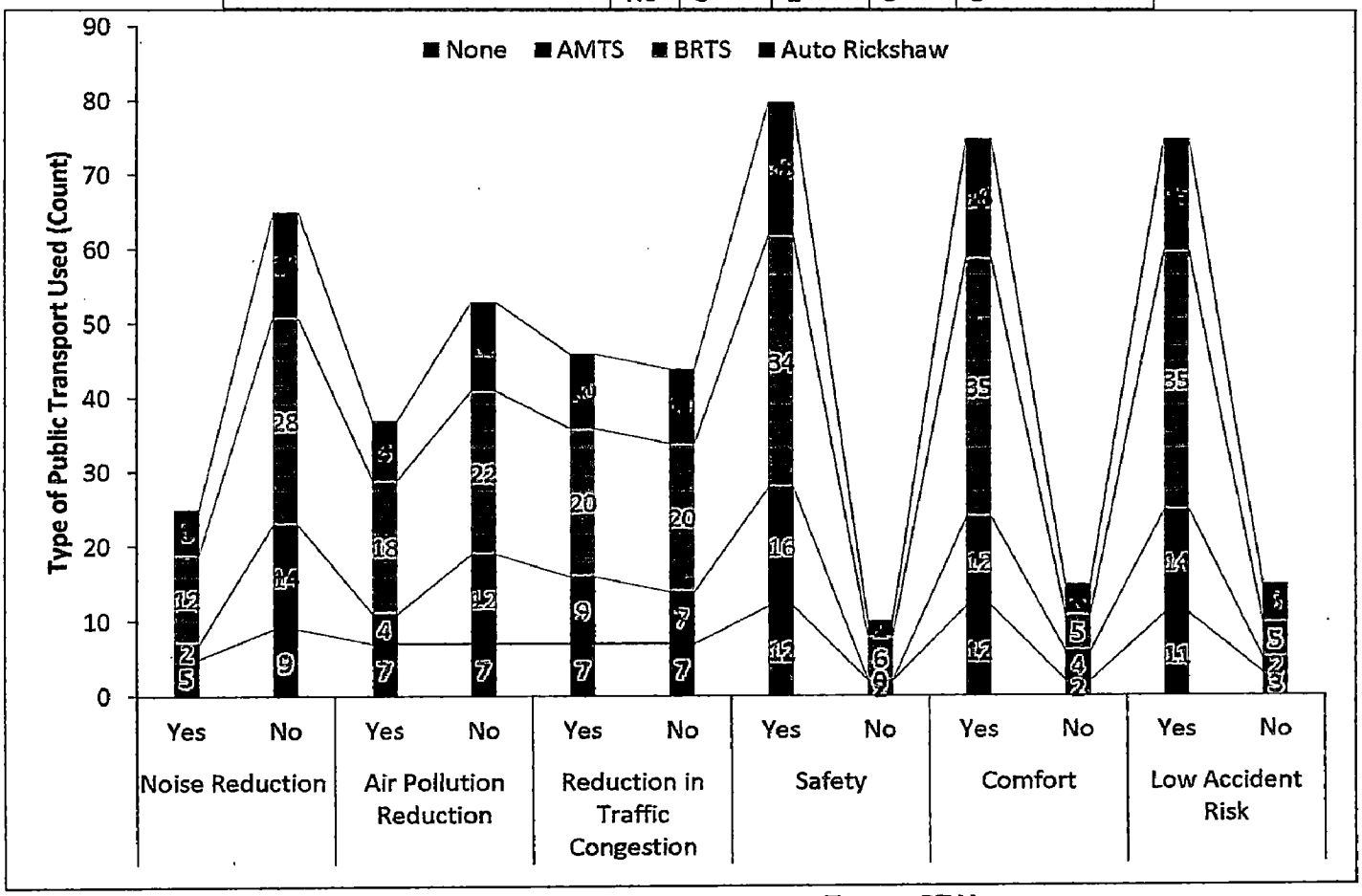


FIGURE 6-20 CONSIDERATIONS BASED ON TYPE OF PT USED

Type of usage of public transport, point of view the responses for different considerations of all the various types of usage of public transport categories are shown in Figure 6-20 and Table 6-20. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion. In the surveyed samples the numbers of respondents using BRTS as regular public transport were maximum; therefore their response was the strongest amongst all the categories of types of usage of public transport for the respondent.

6.2.3 *Influencing Parameters for BRTS*

The opinion on influencing parameters for Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. Further all the aspects of influencing parameters are derived based on socio-economic parameters and travel characteristics.

TABLE 6-21 OVERALL OPINION ON INFLUENCING PARAMETERS FOR BRTS

Parameters		Count	Table N %
Seats Available	Yes	55	61.1
	No	35	38.9
Parking at Bus stop	Yes	71	78.9
	No	19	21.1
Announcement System	Yes	56	62.2
	No	34	37.8
Off Board Ticketing	Yes	31	34.4
	No	59	65.6
Closed/AC Shelters	Yes	53	58.9
	No	37	41.1
Level Boarding	Yes	53	58.9
	No	37	41.1
Info. Available	Yes	44	48.9
	No	46	51.1
Signage/Signals	Yes	61	67.8
	No	29	32.2

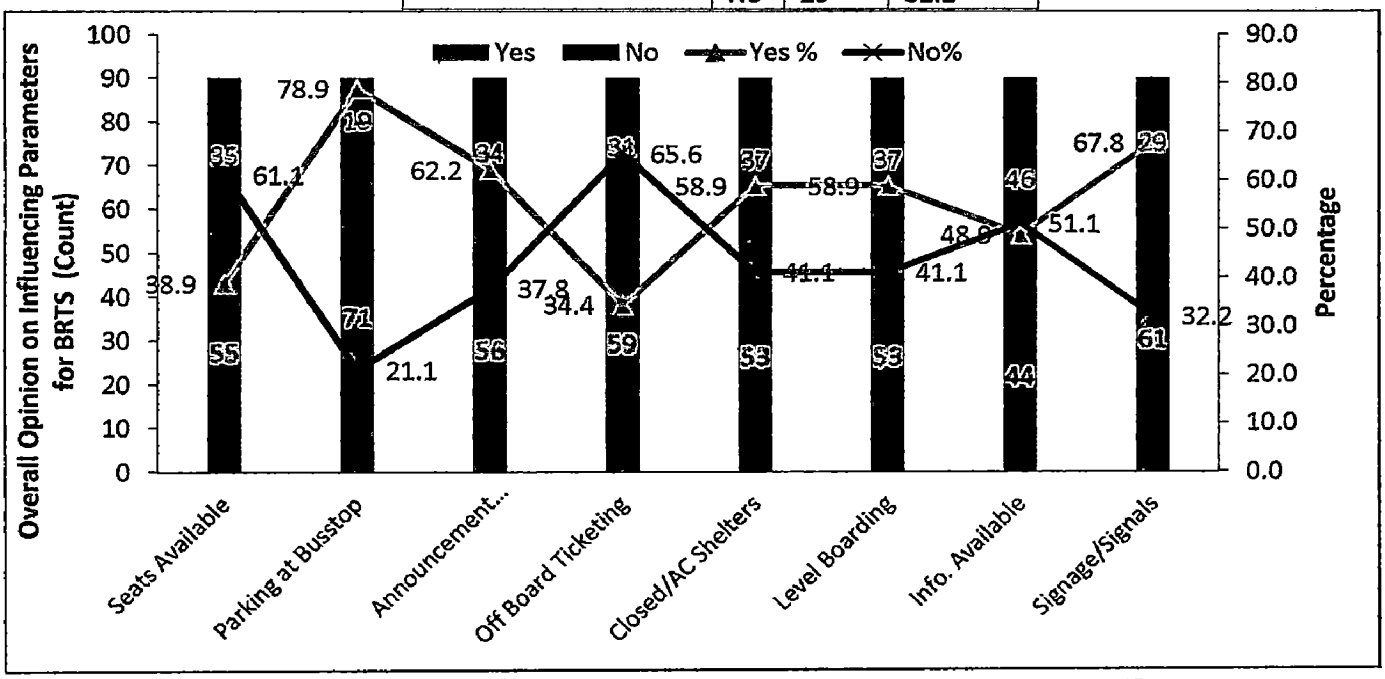


FIGURE 6-21 OVERALL OPINION ON INFLUENCING PARAMETERS FOR BRTS

The opinion on influencing parameters for Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. The above shown Figure 6-21 and Table 6-21 discusses the results for the same. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats..

6.2.3.1 Influencing Parameters And Primary Mode Used For Traveling

TABLE 6-22 INFLUENCING PARAMETERS AND PRIMARY MODE USED FOR TRAVELING

Parameters		Primary Mode Used for Traveling						
		Walk	Two-Wheelers	Car	AMTS Bus	BRTS BUS	Auto Rickshaw	Bicycle
Seats Available	Yes	5	15	6	5	15	4	5
	No	4	8	4	3	9	3	4
Parking at Bus stop	Yes	8	22	7	6	16	4	8
	No	1	1	3	2	8	3	1
Announcement System	Yes	6	14	4	5	18	3	6
	No	3	9	6	3	6	4	3
Off Board Ticketing	Yes	4	16	4	4	16	6	9
	No	5	7	6	4	8	1	0
Closed/AC Shelters	Yes	5	13	7	4	18	1	5
	No	4	10	3	4	6	6	4
Level Boarding	Yes	5	15	8	4	14	4	3
	No	4	8	2	4	10	3	6
Info. Available	Yes	3	13	2	4	11	5	8
	No	6	10	8	4	13	2	1
Signage/Signals	Yes	7	16	4	4	19	4	7
	No	2	7	6	4	5	3	2

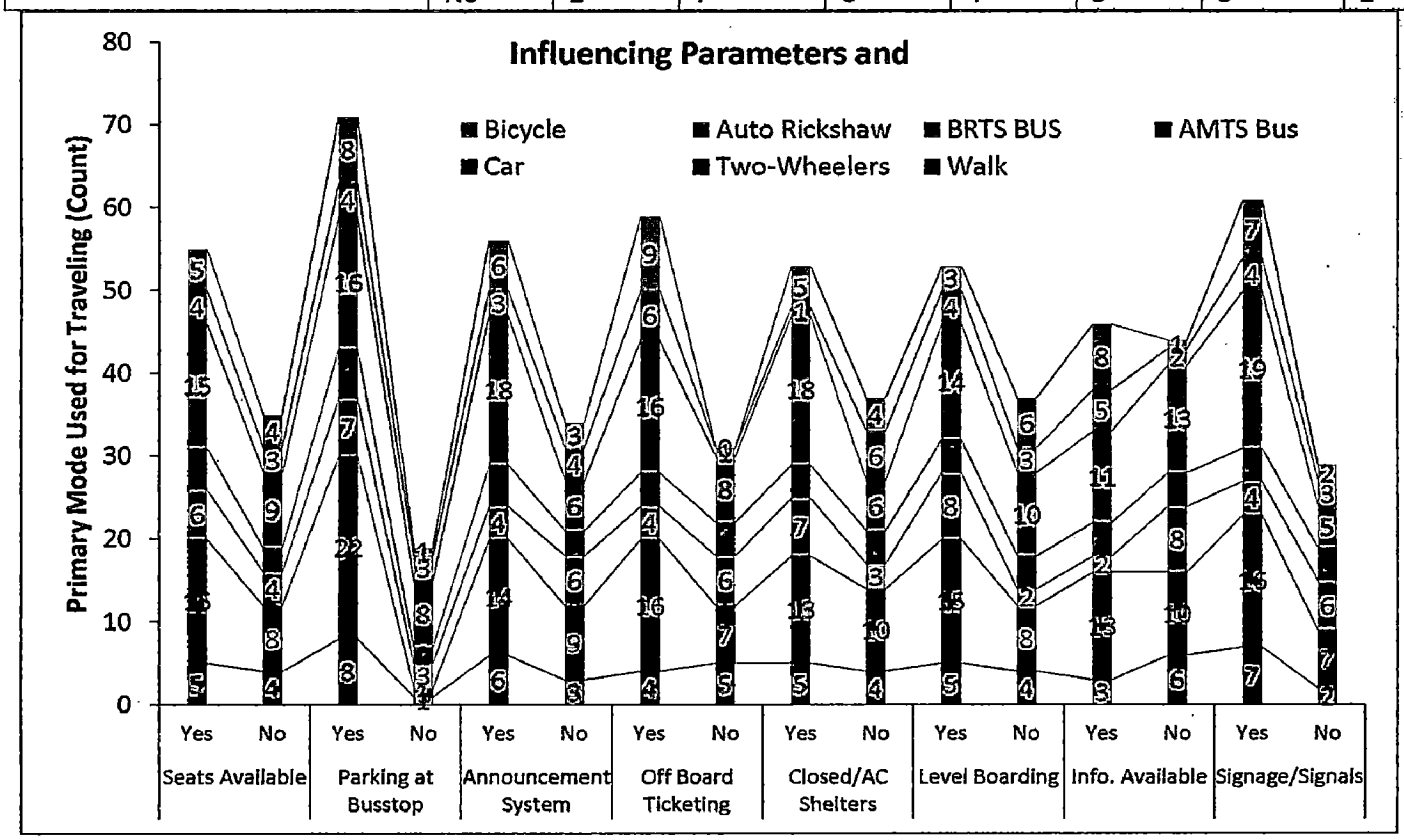


FIGURE 6-22 INFLUENCING PARAMETERS AND PRIMARY MODE USED FOR TRAVELING

Primary mode of traveling for the respondent, point of view the responses for influencing parameters of all the various primary transportation mode categories are shown in Table 6-22 and Figure 6-22. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats. In the surveyed samples the numbers of two wheeler users were maximum; therefore the response was the strongest amongst all the categories of primary mode of transportation for the respondents.

6.2.3.2 Influencing Parameters And Time Taken By Primary Mode

TABLE 6-23 INFLUENCING PARAMETERS AND TIME TAKEN BY PRIMARY MODE

Parameters		Time Taken by Primary Mode in Mins			
		<= 15	16 - 30	31 - 45	46+
Seats Available	Yes	21	23	10	1
	No	10	20	5	0
Parking at Bus stop	Yes	23	35	12	1
	No	8	8	3	0
Announcement System	Yes	17	28	11	0
	No	14	15	4	1
Off Board Ticketing	Yes	18	30	10	1
	No	13	13	5	0
Closed/AC Shelters	Yes	17	25	11	0
	No	14	18	4	1
Level Boarding	Yes	14	27	11	1
	No	17	16	4	0
Info. Available	Yes	15	23	8	0
	No	16	20	7	1
Signage/Signals	Yes	20	30	11	0
	No	11	13	4	1

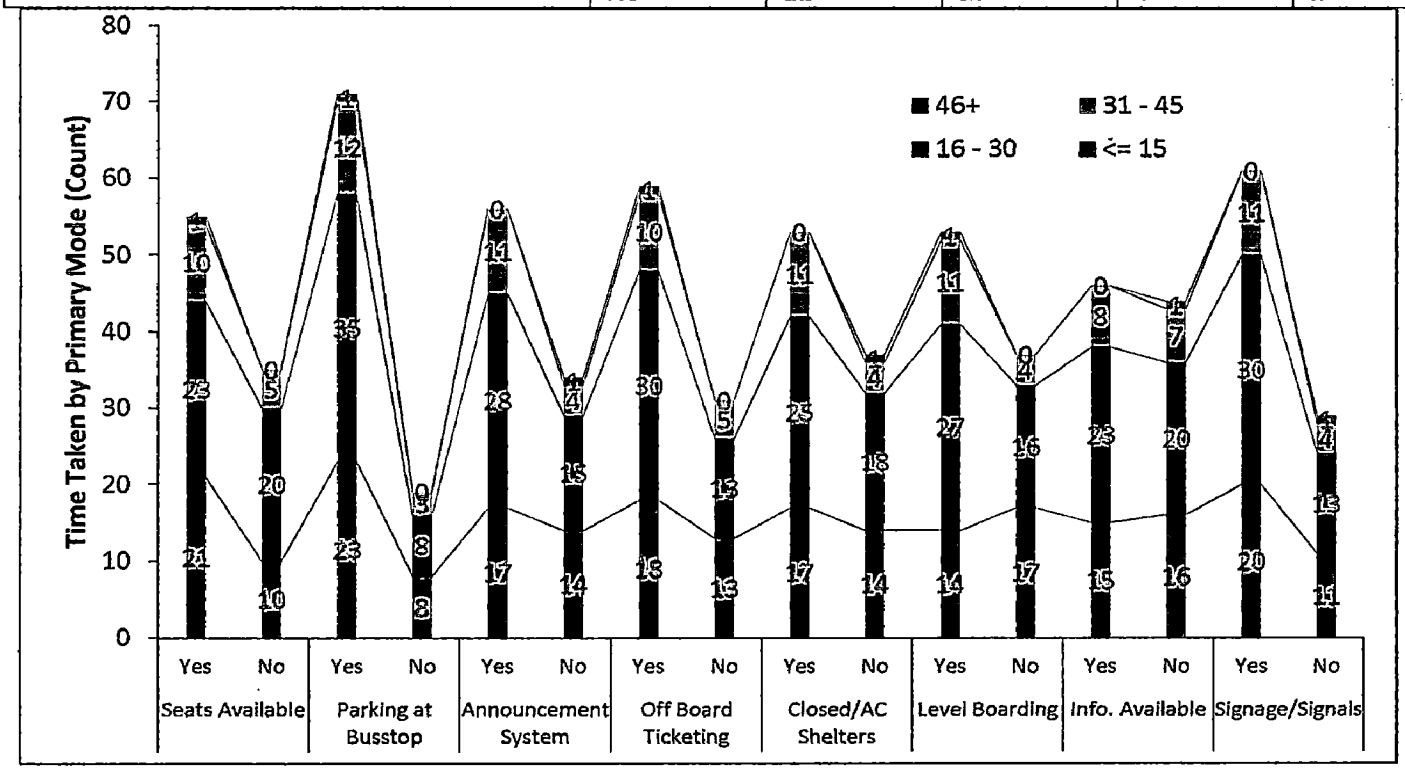


FIGURE 6-23 INFLUENCING PARAMETERS AND TIME TAKEN BY PRIMARY MODE

Time taken by primary mode for traveling for the respondent, point of view the responses for influencing parameters of all the various time taken categories are shown in Table 6-23 and Figure 6-23. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats. In the surveyed samples the numbers of travellers traveling for 16 mins to 30 mins were maximum; therefore the response was the strongest amongst all the categories of time taken by the primary mode of transportation for the respondents.

6.2.3.3 Influencing Parameters And Approx. Cost Per Trip For Using Primary Mode

TABLE 6-24 INFLUENCING PARAMETERS AND APPROX. COST PER TRIP FOR USING PRIMARY MODE

Parameters		Approx. Cost per Trip for using primary mode in Rs.			
		<= 10	11 - 20	21 - 30	31+
Seats Available	Yes	21	11	3	10
	No	12	5	7	3
Parking at Bus stop	Yes	22	13	10	10
	No	11	3	0	3
Announcement System	Yes	22	10	5	7
	No	11	6	5	6
Off Board Ticketing	Yes	23	9	5	9
	No	10	7	5	4
Closed/AC Shelters	Yes	18	12	5	8
	No	15	4	5	5
Level Boarding	Yes	18	8	7	12
	No	15	8	3	1
Info. Available	Yes	16	10	5	4
	No	17	6	5	9
Signage/Signals	Yes	22	12	6	7
	No	11	4	4	6

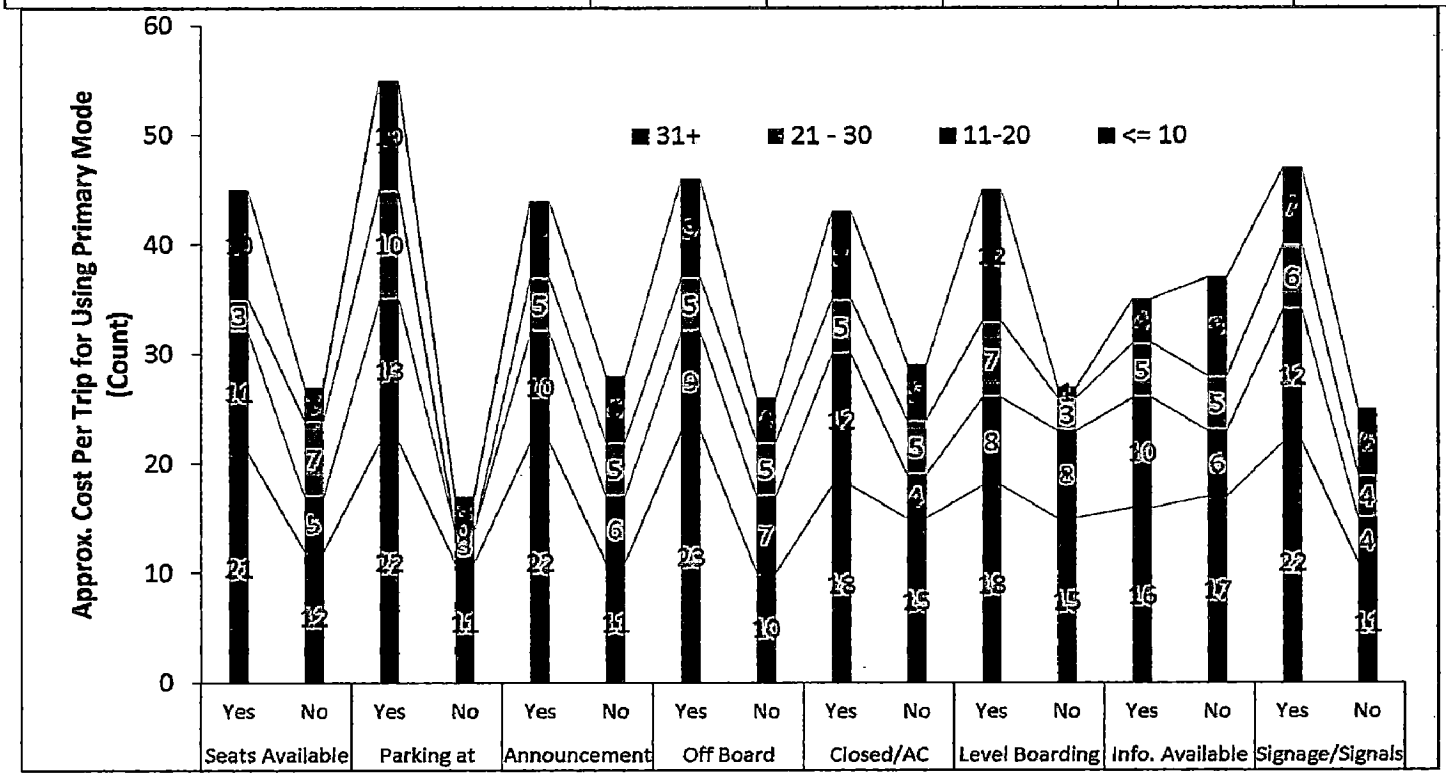


FIGURE 6-24 INFLUENCING PARAMETERS AND APPROX. COST PER TRIP FOR USING PRIMARY MODE

Approximate cost per trip using primary mode for traveling for the respondent, point of view the responses for influencing parameters of all the various cost level categories are shown in Table 6-24 and Figure 6-24. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats. In the surveyed samples the numbers of travellers spending about Rs. 10 were maximum; therefore their response was the strongest amongst all the categories of approximate cost per trip using primary mode for traveling for the respondent.

6.2.3.4. Influencing Parameters And User Frequency Usage Of Public Transport

TABLE 6-25 INFLUENCING PARAMETERS AND USER FREQUENCY USAGE OF PUBLIC TRANSPORT

Parameters		User Frequency usage of PT			
		Daily	Weekly	Monthly	Never
Seats Available	Yes	24	11	10	10
	No	15	7	9	4
Parking at Bus stop	Yes	26	16	17	12
	No	13	2	2	2
Announcement System	Yes	26	11	11	8
	No	13	7	8	6
Off Board Ticketing	Yes	26	13	13	7
	No	13	5	6	7
Closed/AC Shelters	Yes	23	11	10	9
	No	16	7	9	5
Level Boarding	Yes	22	9	10	12
	No	17	9	9	2
Info. Available	Yes	20	13	11	2
	No	19	5	8	12
Signage/Signals	Yes	27	14	13	7
	No	12	4	6	7

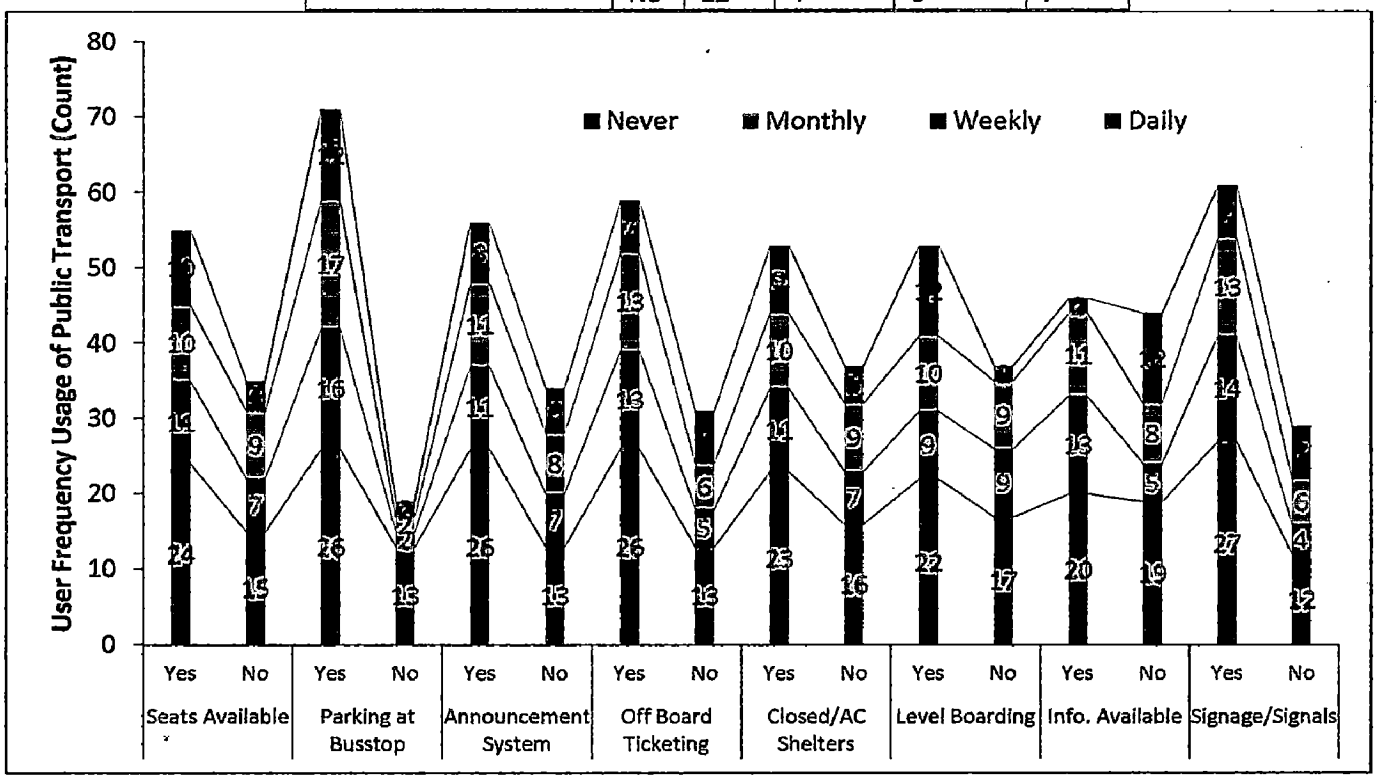


FIGURE 6-25 INFLUENCING PARAMETERS AND USER FREQUENCY USAGE OF PUBLIC TRANSPORT

Frequency of usage of public transport, point of view the responses for influencing parameters of all the various frequency of usage of public transport categories are shown in Table 6-25 and Figure 6-25. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats. In the surveyed samples the numbers of respondents using public transport with daily frequency were maximum; therefore their response was the strongest amongst all the categories of frequency of usage of public transport for the respondent.

6.2.3.5 Influencing Parameters And Type Of Public Transport Used

TABLE 6-26 INFLUENCING PARAMETERS AND TYPE OF PUBLIC TRANSPORT USED

Parameters		Type of PT Used			
		None	AMTS	BRTS	Auto Rickshaw
Seats Available	Yes	10	9	22	14
	No	4	7	18	6
Parking at Bus stop	Yes	12	14	32	13
	No	2	2	8	7
Announcement System	Yes	8	11	29	8
	No	6	5	11	12
Off Board Ticketing	Yes	7	11	24	17
	No	7	5	16	3
Closed/AC Shelters	Yes	9	7	27	10
	No	5	9	13	10
Level Boarding	Yes	12	9	21	11
	No	2	7	19	9
Info. Available	Yes	2	10	22	12
	No	12	6	18	8
Signage/Signals	Yes	7	10	32	12
	No	7	6	8	8

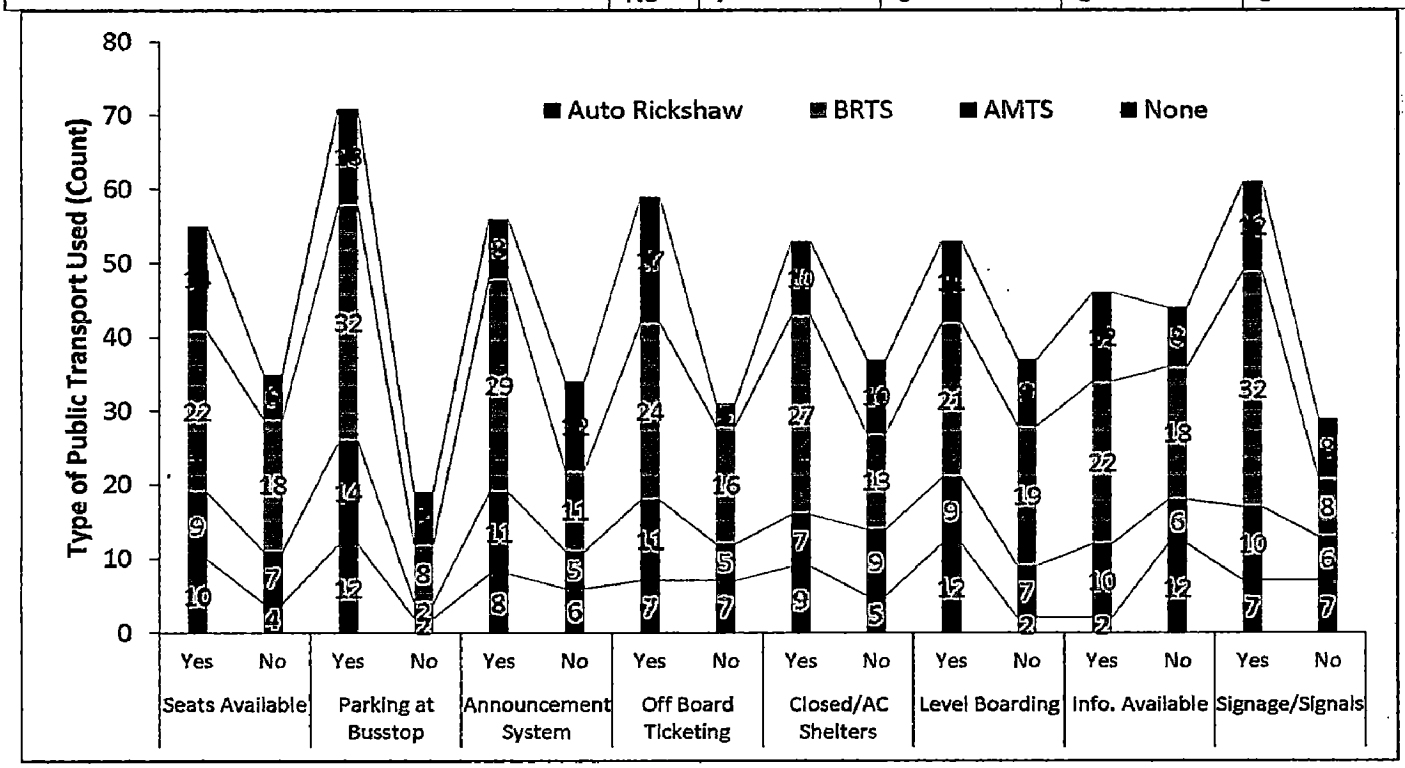


FIGURE 6-26 INFLUENCING PARAMETERS AND TYPE OF PUBLIC TRANSPORT USED

Type of usage of public transport, point of view the responses for influencing parameters of all the various types of usage of public transport categories are shown in Table 6-26 and Figure 6-26. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats. In the surveyed samples the numbers of respondents using BRTS as regular public transport were maximum; therefore their response was the strongest amongst all the categories of types of usage of public transport for the respondent.

6.2.4 *Willingness to Pay for Improving BRTS*

The opinion on willingness to pay for Improving Ahmedabad BRTS had been asked to the respondents for financial aspects of the sustainable public transport. Further all the willingness aspects are derived based on socio-economic parameters and travel characteristics.

TABLE 6-27 OVERALL WILLINGNESS TO PAY FOR IMPROVING BRTS

Willingness to Pay	4 Times	3 Times	2 Times	Same
Very Likely	0	0	37	71
Likely	0	10	16	15
Unlikely	19	29	10	0
Definitely Not	71	51	27	4
Total	90	90	90	90

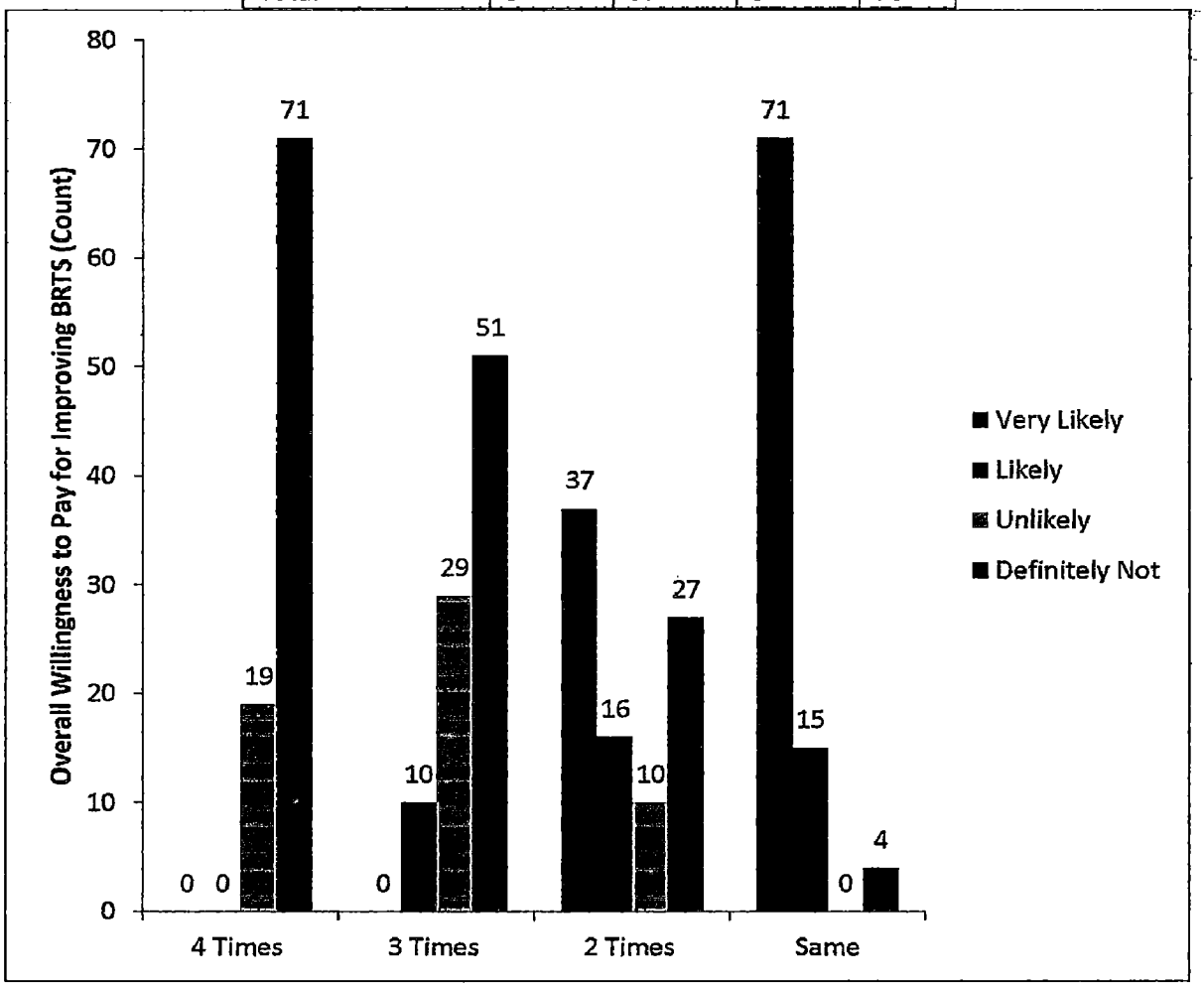


FIGURE 6-27 OVERALL WILLINGNESS TO PAY FOR IMPROVING BRTS

The overall willingness to pay for Ahmedabad BRTS had been asked to the respondents for financial aspects of the sustainable public transport. The results are discussed in the above shown Figure 6-27 and Table 6-27. The general observation for the willingness to pay was, majority of the respondents (71 out of 90) were in favor of paying the same as they are paying now, but few of them were also willing to pay double(53 out of 90), a very limited number of respondent wanted to pay three times (10 out of 90) the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare.

6.2.4.1 Willingness To Pay And Primary Mode Used For Traveling

TABLE 6-28 WILLINGNESS TO PAY AND PRIMARY MODE USED FOR TRAVELING

Willingness		Primary Mode Used for Traveling						
		Walk	Two-Wheelers	Car	AMTS Bus	BRTS BUS	Auto Rickshaw	Bicycle
4 Times Current Bus Fare	Unlikely	1	6	4	2	5	0	1
	Definitely Not	8	17	6	6	19	7	8
3 Times Current Bus Fare	Very Likely	0	0	0	0	0	0	0
	Likely	1	2	2	2	2	0	1
	Unlikely	2	7	5	3	8	3	1
	Definitely Not	6	14	3	3	14	4	7
2 Times Current Bus Fare	Very Likely	7	7	6	4	9	2	2
	Likely	1	5	1	2	5	1	1
	Unlikely	1	2	1	2	1	1	2
	Definitely Not	0	9	2	0	9	3	4
Same as Current Bus Fare	Very Likely	9	17	9	7	19	4	6
	Likely	0	5	0	1	4	2	3
	Unlikely	0	0	0	0	0	0	0
	Definitely Not	0	1	1	0	1	1	0

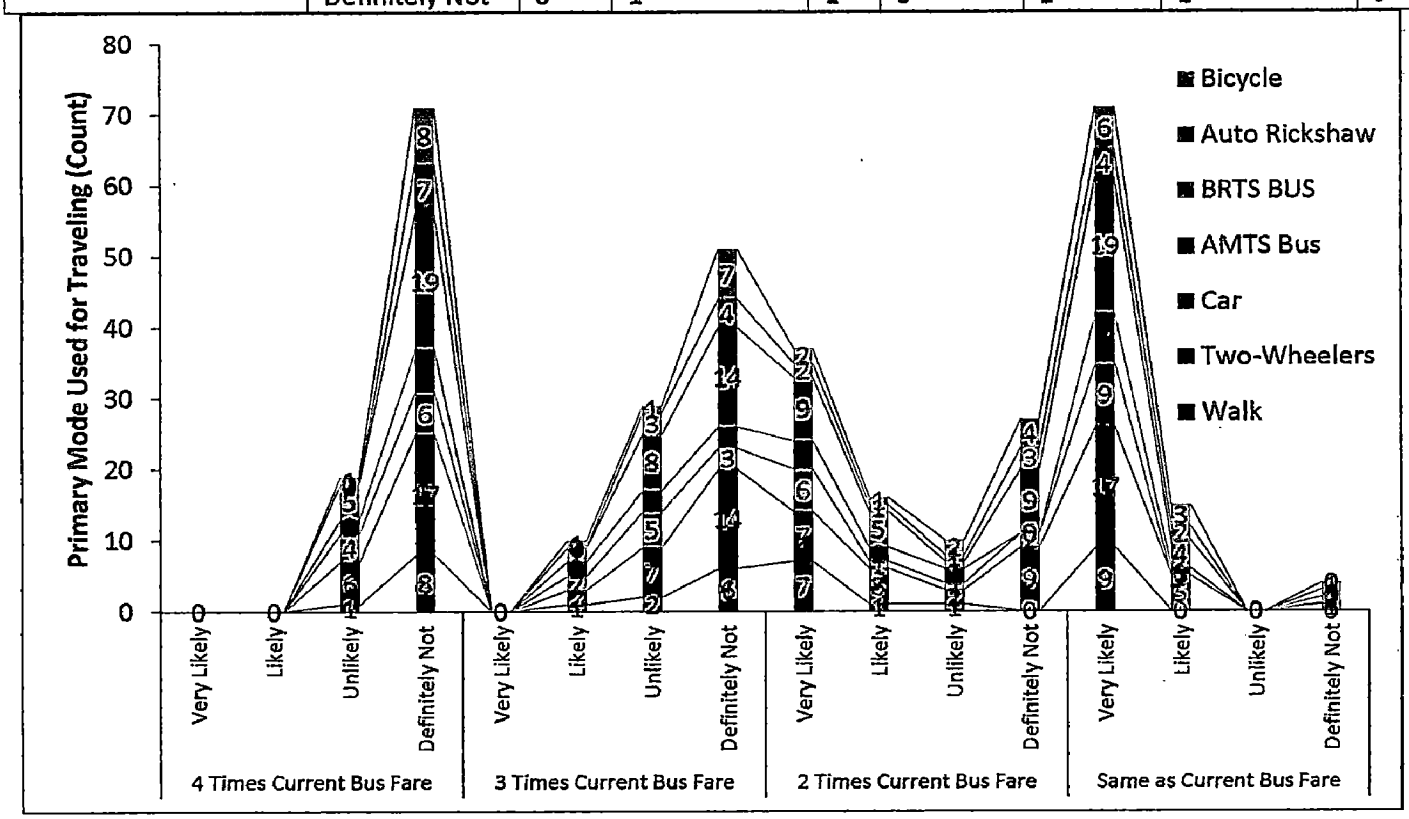


FIGURE 6-28 WILLINGNESS TO PAY AND PRIMARY MODE USED FOR TRAVELING

Primary mode of traveling for the respondent, point of view the responses for willing ness to pay of all the various primary transportation mode categories are shown in Table 6-28 and Figure 6-28. The general observation for the willingness to pay was, majority of the respondents were in favor of paying the same as they are paying now, but few of them were also willing to pay double, a very limited number of respondent wanted to pay three times the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare. In the surveyed samples the numbers of two wheeler users were maximum; therefore the response was the strongest amongst all the categories of primary mode of transportation for the respondents.

6.2.4.2 Willingness To Pay And Time Taken By Primary Mode

TABLE 6-29 WILLINGNESS TO PAY AND TIME TAKEN BY PRIMARY MODE

Willingness		Time Taken by Primary Mode in Mins (Binned)					
		<= 15	16 - 30	31 - 45	46+	No Response	Total
4 Times Current Bus Fare	Unlikely	6	9	4	0	0	19
	Definitely Not	25	34	11	1	0	71
3 Times Current Bus Fare	Very Likely	0	0	0	0	0	0
	Likely	2	3	5	0	0	10
	Unlikely	12	14	3	0	0	29
	Definitely Not	17	26	7	1	0	51
2 Times Current Bus Fare	Very Likely	13	17	7	0	0	37
	Likely	10	5	1	0	0	16
	Unlikely	4	6	0	0	0	10
	Definitely Not	4	15	7	1	0	27
Same as Current Bus Fare	Very Likely	25	33	12	1	0	71
	Likely	5	8	2	0	0	15
	Unlikely	0	0	0	0	0	0
	Definitely Not	1	2	1	0	0	4

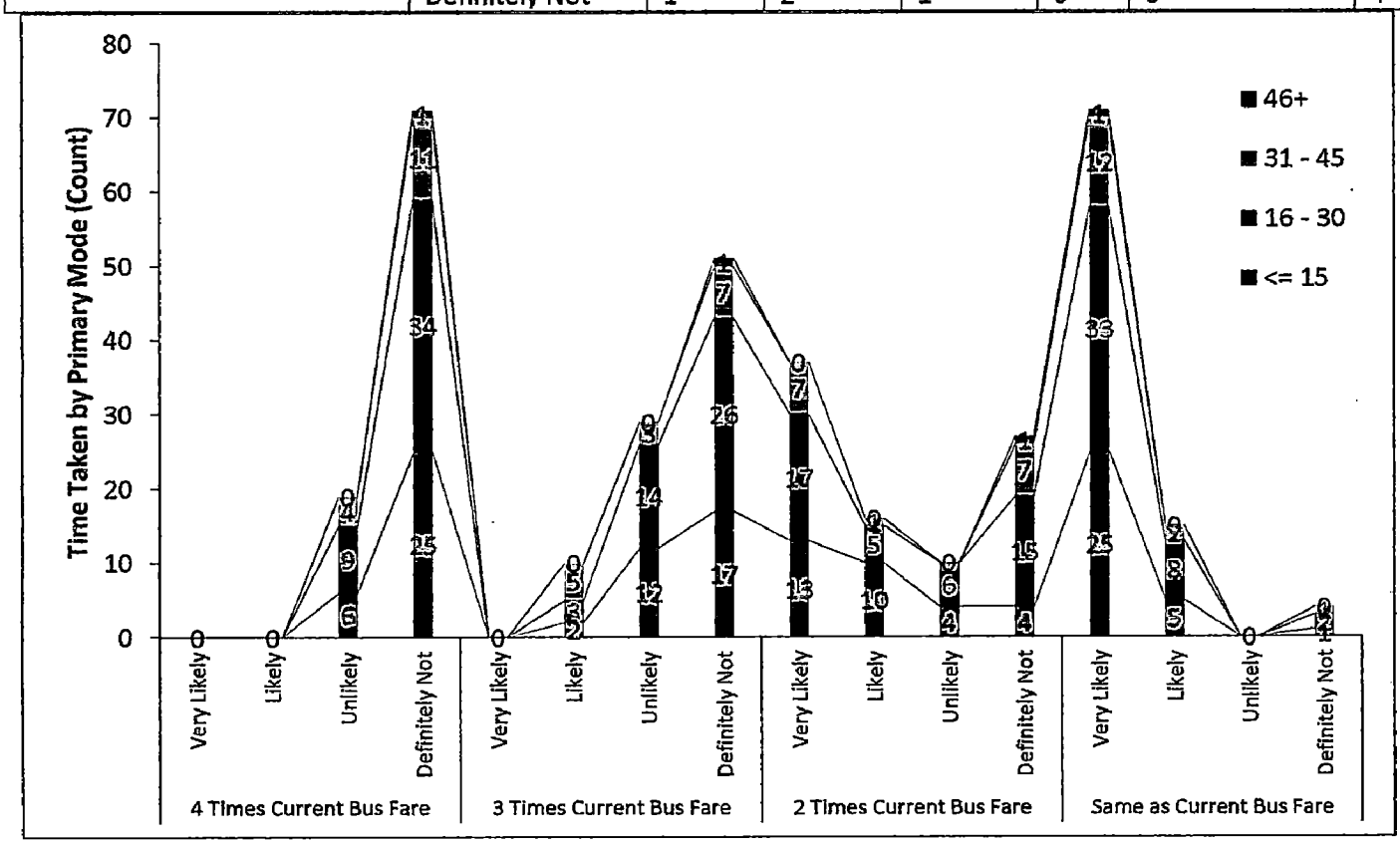


FIGURE 6-29 WILLINGNESS TO PAY AND TIME TAKEN BY PRIMARY MODE

Time taken by primary mode for traveling for the respondent, point of view the responses for willing ness to pay meters of all the various time taken categories are shown in Table 6-29 and Figure 6-29. The general observation for the willingness to pay was, majority of the respondents were in favor of paying the same as they are paying now, but few of them were also willing to pay double, a very limited number of respondent wanted to pay three times the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare. In the surveyed samples the numbers of travellers traveling for 16 mins to 30 mins were maximum; therefore the response was the strongest amongst all the categories of time taken by the primary mode of transportation for the respondents.

6.2.4.3 Willingness To Pay And Approx. Cost Per Trip For Using Primary Mode

TABLE 6-30 WILLINGNESS TO PAY AND APPROX. COST PER TRIP FOR USING PRIMARY MODE

Willingness		Approx. Cost per Trip for using primary mode in Rs.			
		<= 10	11 - 20	21 - 30	31+
4 Times Current Bus Fare	Unlikely	6	4	3	4
	Definitely Not	27	12	7	9
3 Times Current Bus Fare	Very Likely	0	0	0	0
	Likely	2	2	1	3
	Unlikely	12	5	5	4
	Definitely Not	19	9	4	6
2 Times Current Bus Fare	Very Likely	11	5	5	7
	Likely	8	5	1	0
	Unlikely	4	2	0	1
	Definitely Not	10	4	4	5
Same as Current Bus Fare	Very Likely	25	12	7	12
	Likely	6	4	2	0
	Unlikely	0	0	0	0
	Definitely Not	2	0	1	1

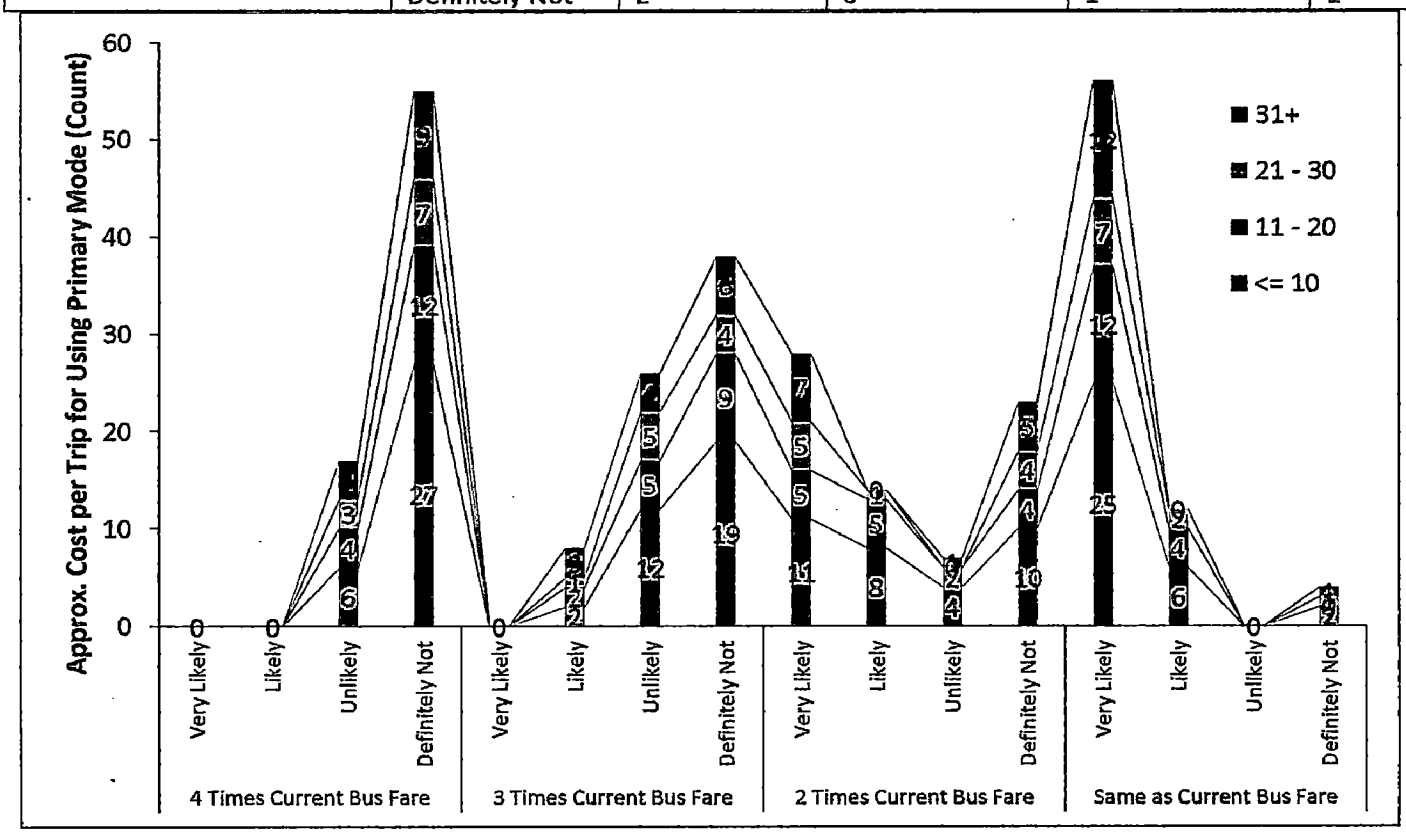


FIGURE 6-30 WILLINGNESS TO PAY AND APPROX. COST PER TRIP FOR USING PRIMARY MODE

Approximate cost per trip using primary mode for traveling for the respondent, point of view the responses for willing ness to pay of all the various cost level categories are shown in Table 6-30 and Figure 6-30. The general observation for the willingness to pay was, majority of the respondents were in favor of paying the same as they are paying now, but few of them were also willing to pay double, a very limited number of respondent wanted to pay three times the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare. In the surveyed samples the numbers of travellers spending about Rs. 10 were maximum; therefore their response was the strongest amongst all the categories of approximate cost per trip using primary mode for traveling for the respondent.

6.2.4.4 Willingness To Pay And User Frequency Usage Of Public Transport

TABLE 6-31 WILLINGNESS TO PAY AND USER FREQUENCY USAGE OF PUBLIC TRANSPORT

Willingness		User Frequency Usage of Public Transport			
		Daily	Weekly	Monthly	Never
4 Times Current Bus Fare	Unlikely	7	4	3	5
	Definitely Not	32	14	16	9
3 Times Current Bus Fare	Very Likely	0	0	0	0
	Likely	4	3	1	2
	Unlikely	14	7	4	4
	Definitely Not	21	8	14	8
2 Times Current Bus Fare	Very Likely	15	11	8	3
	Likely	8	3	1	4
	Unlikely	4	1	4	1
	Definitely Not	12	3	6	6
Same as Current Bus Fare	Very Likely	30	14	15	12
	Likely	7	3	3	2
	Unlikely	0	0	0	0
	Definitely Not	2	1	1	0

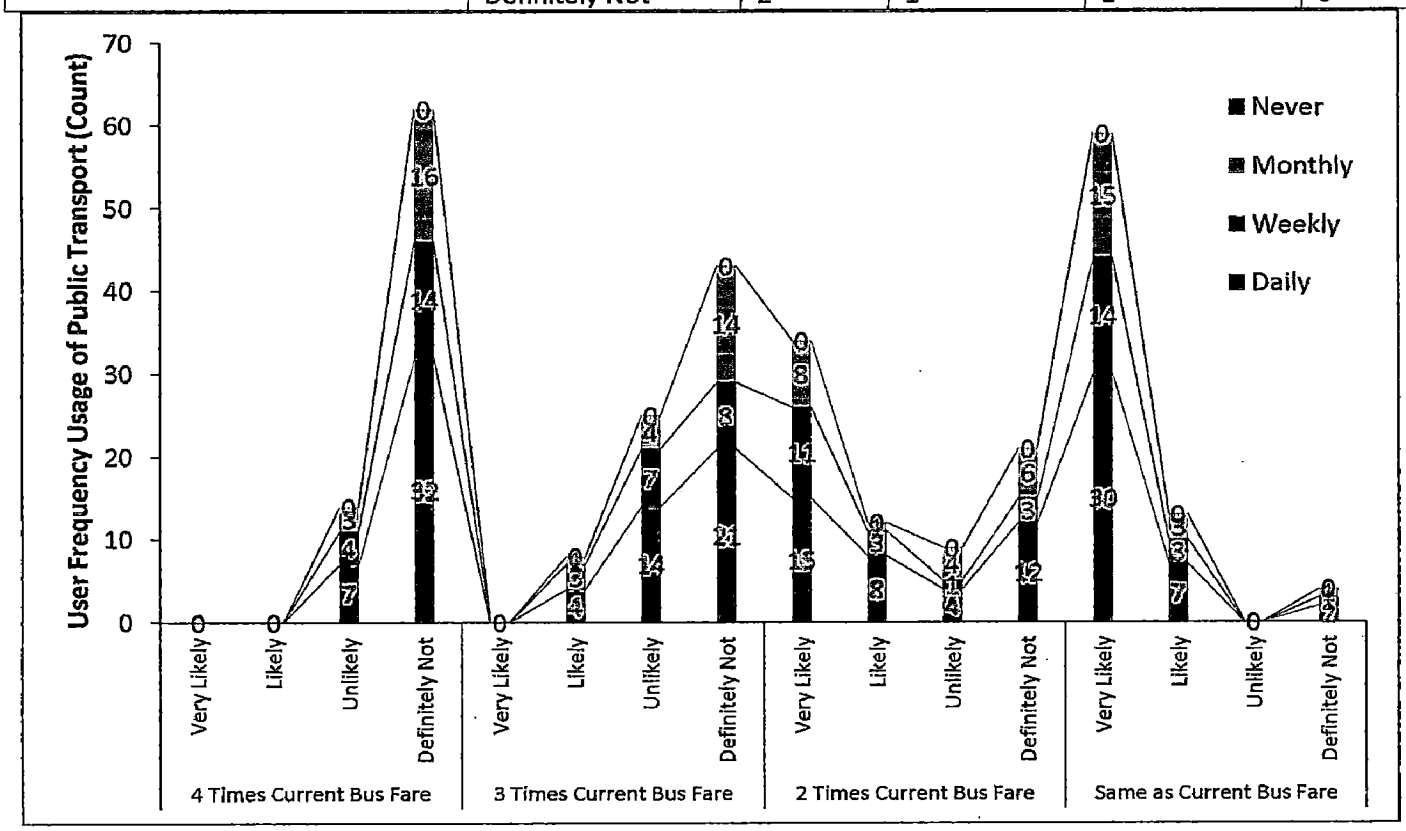


FIGURE 6-31 WILLINGNESS TO PAY AND USER FREQUENCY USAGE OF PUBLIC TRANSPORT

Frequency of usage of public transport, point of view the responses for willing ness to pay of all the various frequency of usage of public transport categories are shown in Table 6-31 and Figure 6-31. The general observation for the willingness to pay was, majority of the respondents were in favor of paying the same as they are paying now, but few of them were also willing to pay double, a very limited number of respondent wanted to pay three times the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare. In the surveyed samples the numbers of respondents using public transport with daily frequency were maximum; therefore their response was the strongest amongst all the categories of frequency of usage of public transport for the respondent.

6.2.4.5 Willingness To Pay And Type Of Public Transport Used

TABLE 6-32 WILLINGNESS TO PAY AND TYPE OF PUBLIC TRANSPORT USED

Willingness		Type of PT Used				
		None	AMTS	BRTS	Auto Rickshaw	Total
4 Times Current Bus Fare	Unlikely	5	5	6	3	19
	Definitely Not	9	11	34	17	71
3 Times Current Bus Fare	Very Likely	0	0	0	0	0
	Likely	2	4	3	1	10
	Unlikely	4	4	13	8	29
	Definitely Not	8	8	24	11	51
2 Times Current Bus Fare	Very Likely	3	7	18	9	37
	Likely	4	2	7	3	16
	Unlikely	1	4	2	3	10
	Definitely Not	6	3	13	5	27
Same as Current Bus Fare	Very Likely	12	13	32	14	71
	Likely	2	3	6	4	15
	Unlikely	0	0	0	0	0
	Definitely Not	0	0	2	2	4

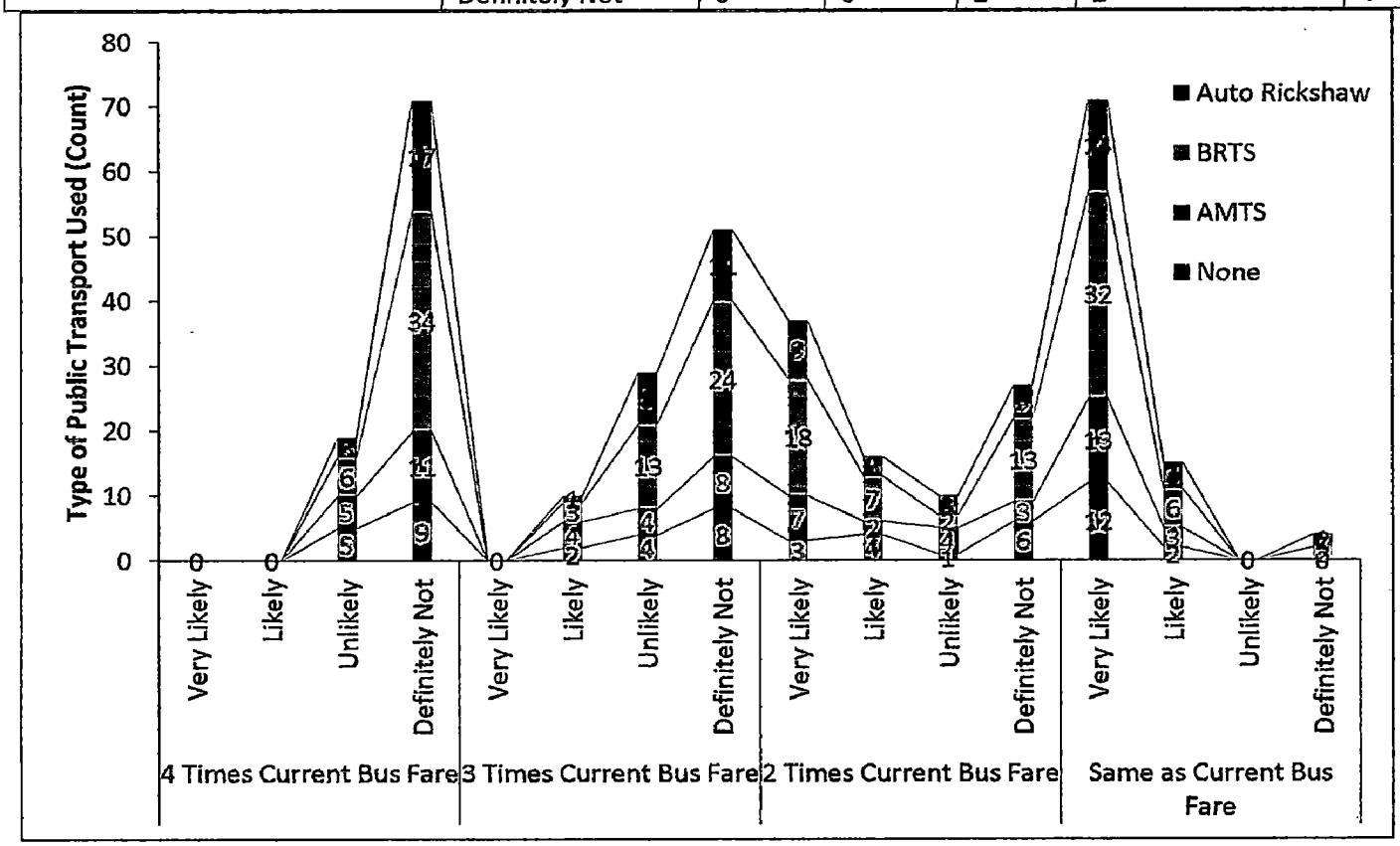


FIGURE 6-32 WILLINGNESS TO PAY AND TYPE OF PUBLIC TRANSPORT USED

Type of usage of public transport, point of view the responses for willing ness to pay of all the various types of usage of public transport categories are shown in Table 6-32 and Figure 6-32. The general observation for the willingness to pay was, majority of the respondents were in favor of paying the same as they are paying now, but few of them were also willing to pay double, a very limited number of respondent wanted to pay three times the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare. In the surveyed samples the numbers of respondents using BRTS as regular public transport were maximum; therefore their response was the strongest amongst all the categories of types of usage of public transport for the respondent.

Chapter 7. Conclusion and Recommendations

The research examines the impacts in terms of sustainability from a transport development project, taking the Bus Rapid Transit System (BRTS), Ahmedabad as the case study. The distribution of impacts across the income groups, affects different households differently, according to their socio—economic characteristic and their location. The principal focus therefore is on the service level benchmarking of BRTS and opinion analysis of different households which indirectly affect the sustainability of the project.

This chapter summarises the conclusions from the research. It begins with the review of some specific conclusions that emerge from the various analyses undertaken. The chapter ends with a discussion on some of the possible recommendations for better sustainability of the BRT system of Ahmedabad.

7.1 Specific Conclusions

Following paragraphs summarises the conclusions of research sections dealt in chronological order

7.1.1 Public Transportation Scenario

India is a very large country with over a billion people and nearly 50 of its cities contain populations above 1 million each. Awareness varies in these cities about the role and importance of urban transport. While large cities (comprising more than 3 million people each) are aware and active, many cities (comprising about 1 million population each) are relatively inactive. The steps are being taken by the Indian Government to promote sustainable urban transport, while the author suggests the need to make cities pedestrian-friendly for quick and ongoing relief, and proposes four essential ingredients for sustainable urban transport in the long term.

7.1.2 Sustainability, Sustainable Transportation and Sustainability Assessment

The concept of sustainability includes the following features: (i) processes need to be maintained (or carried on with) over a period of time, and (ii) harvesting of resources is inevitable for processes to run. *"The systems that function proficiently competent over a time span, over specified area and which can be kept up or maintained by minimal resources are sustainable systems".*

The resources that urban transportation systems deal with are, broadly speaking, as follows: (i) Material resources such as fuel, aggregates, bitumen, etc.; (ii) Space on land, water and air; (iii) Time; (iv) People (and sometimes certain types of animals); (v) Environment and (vi) Opportunity.

The Sustainability measurement is a term that denotes the measurements used as the quantitative basis for the informed management of sustainability. The metrics used for the measurement of sustainability (involving the sustainability of environmental, social and economic domains, both individually and in various combinations) are still evolving: they include indicators, benchmarks, audits, indexes and accounting, as well as assessment, appraisal and other reporting systems. They are applied over a wide range of spatial and temporal scales.

7.1.3 Bus Rapid Transit System and Lessons of Delhi BRTS

BRT is "a flexible, rubber-tired rapid-transit mode that combines stations, vehicles, services, running ways, and Intelligent Transportation System (ITS) elements into an integrated system with a strong positive identity that evokes a unique image." (Levinson et al., 2003, p. 12) "BRT is high-quality, customer-orientated transit that delivers fast, comfortable and cost effective urban mobility." (Wright, 2003, p. 1) BRT is "a rapid

mode of transportation that can combine the quality of rail transit and the flexibility of buses" (Thomas, 2001).

Starting off as an open system has been perhaps the biggest mistake in Delhi. This has slowed the system because of (i) buses moving in and out at any point of the corridor, (ii) long halts by buses to pick up passengers and (iii) breakdowns of deteriorated buses. Other mistakes include: Small stretch, No route rationalization and network development, Bus stops at junctions, Shifting bus lanes from center to left

7.1.4 Study Area BRTS Ahmedabad

This aspect was covered under chapter 4 of the research and provided an insight into the Ahmedahad city's socio—economic and demographic protile as well as an overview of the urban transport system in Ahmedahad. Ahmedahad is a rapidly expanding city with increasing developments, urbanization supported by domestic as well as foreign direct investment. The Ahmedabad Municipal Corporalion (AMC) governs an area of about 190 sq. km. and has a population of about 4.5 million.

Under the Jawaharlal Nehru urban Renewal Mission (JNNURM), the city has been granted funds for urban development and renewal. Under this mission and as an integral part of the urban transport vision for Ahmedahad city and the Ahmedabad Urban Agglomeration area, Bus Rapid Transit System (BRTS) has been proposed and executed. The project envisages at influencing all income groups of the society and especially providing access to economically weaker sections of the society and increasing mobility of lower income groups. The BRTS has been proposed to be implemented under three phases. The system shall be integrated with the proposed metro system and rail corridor. This project also included upgradation of roads and development of road infrastructure. The concept of BRTS is to encourage more people on the public transit system, which with high quality service is delivered. It is about equal access and equal sharing of road space for people. By providing a dedicated corridor within the street for BRTS vehicles, more people can travel to destination in a time that is comparable to single occupancy vehicles such as cars, two wheelers.

7.1.5 Service level Benchmarking and household survey analysis

7.1.5.1 Overall Findings of the Research

The service levels of various sustainability parameters were worked out based on MOUD's Service Level Benchmarks Guidelines for Ahmedabad BRTS. The Level of Service in various sustainability parameters for Ahmedabad BRTS has been shown in the table shown below.

TABLE 7-1 LEVEL OF SERVICES OF VARIOUS SUSTAINABILITY PARAMETERS OF AHMEDABAD BRTS

Sr. No.	Sustainability Parameters	Level Of Service
1	Public Transport Facilities	L.O.S.3
2	Pedestrian Infrastructure Facilities	L.O.S.3
3	Non Motorized Transport (NMT) Facilities	L.O.S.4
4	Level Of Usage Of Intelligent Transport System (ITS) Facilities	L.O.S.3
5	Travel Speed (Motorized And Mass Transit) Along Major Corridors	L.O.S.3
6	Availability Of Parking Spaces	L.O.S.3
7	Road Safety	L.O.S.2
8	Pollution Levels	L.O.S.2
9	Integrated Landuse-Transport System	L.O.S.3
10	Financial Sustainability Of Public Transport By Bus	L.O.S.3

To support these results, household survey was carried out by the investigator for opinion on BRTS services. The opinion were taken mainly for BRTS Ranking, Considerations for choosing BRTS for Transportation, Influencing parameter to use BRTS, Willingness to pay for BRTS

The results in overall ranking of Ahmedabad BRTS show that current BRTS functions are ranking highest in travel time, frequency of the service, and travel cost. Least ranking was observed for parking facilities, choice of bus routs and feeder services.

The opinion on considerations for choosing Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. The general observation was that, the respondents were considering safety, comfort and low accident risk at a higher ground compared to other aspects like noise reduction, air pollution and reduction in traffic congestion.

The opinion on influencing parameters for Ahmedabad BRTS had been asked to the respondents for various aspects of the sustainable public transport. The general observation was that, the respondents were considering parking provision, signage and signals, off board ticketing at a higher ground compared to other aspects like information availability, closed and AC shelters, level boarding, and availability of seats.

The overall willingness to pay for Ahmedabad BRTS had been asked to the respondents for financial aspects of the sustainable public transport. The general observation for the willingness to pay was, majority of the respondents (71 out of 90) were in favor of paying the same as they are paying now, but few of them were also willing to pay double (37 out of 90), a very limited number of respondent wanted to pay three times (10 out of 90) the current pay if good service is provided, and again majority of the respondents were against bus fare of four times the current bus fare.

7.2 Major Issues Observed

- The feeder system is really weak, ant this is a major problem from user opinion point of view..
- The Phase 1 and 2 of Ahmedabad BRTS project are under construction, but largely the project is getting delayed in construction and functioning aspects. Accumulated effect of this scenario may result in to the weaker sustainability of the project.
- In pedestrian infrastructure, the major issues are observed at the junctions on the BRTS corridor. The traffic management of these junctions has to be done very carefully for the pro-pedestrian activities. In the peak hours the traffic volume is so high that the pedestrians are not given priority for crossing the roads. Another issue of pedestrian infrastructure is of footpaths, the encroachment of the footpath by hawkers and road side shop owners.
- Bicycles are the only non motorized transport in Ahmedabad. Due to the harsh hot climate, other modes of non mortised transport are not popular in the city. The issues on these facilities were mainly of encroachment and bad condition of cycle tracks. Another issue was of non availability of the cycle track along the BRTS corridor throughout, because of the varying right of way of the corridor.
- The wider scenario in Intelligent Transport System (ITS) has been observed that, passenger information system and GPS/GPRS enabled vehicles are enabled, functioning and performing well, where as the Traffic Surveillance and Integrated Ticketing System are not yet implemented, for the better functioning of the BRTS Ahmedabad.
- The provision of parking near the BRTS bus stop has not been adequate enough for BRTS users as well as for normal traffic.
- The junctions are major unsafe locations for possible road accidents of vehicles and BRTS. Most of the road accidents along BRTS corridors are observed at junctions only.

- The BRTS system is some what sustainable currently, but if the sustainability of the system has to be improved for better long term future, then current fare system and other non fare revenue will not be adequate enough.

7.3 Recommendations

- Strong feeder system plan should be prepared along with existing BRTS routs to provide easy and comfortable connectivity to the BRTS bus stands. The help from Ahmedabad Municipal Transport Service (AMTS) buses can be taken for strengthening the feeder network for the BRTS. Rerouting of the AMTS will have to be done for this purpose.
- The pedestrian infrastructure viewpoint has to be considered for improving the current non-functioning and under functioning pedestrian services of BRTS. Special pedestrian under passes or foot over bridges shall be provided for the pedestrians for safe crossing and getting on the BRTS bus stand. The strict enforcement of law should be done to eradicate encroachment from the footpaths for smooth, easy and comfortable movement of the pedestrians.
- The enforcement of the law by traffic police supervision, for the cycle track has to be done very widely for general awareness of the people, the maintenance should be done regularly for the up keep of the cycle tracks, and encroachment of the dedicated tracks shall be removed.
- Traffic Surveillance and Integrated Ticketing System should be considered and improvements should be put in to action for better and long term sustainability of BRTS Ahmedabad.
- The junctions shall be treated with the signal prioritization for BRTS; this further will help in improving the sustainability of the BRTS, as more people will look forward to shift to BRTS from their other primary modes of transportation.
- The junctions shall be treated with the signal prioritization as stated above for BRTS as well as need some improvements in traffic management which significantly contribute to road safety.
- Paid parking spaces provided in the city need to be improved upon and to cater to the demand some differential parking rates for the CBD has to be adopted. The city authorities need to imitative considerable improvements measures. Municipal corporation should identify few locations for providing multi level vehicle parking, near the corridor bus stops, wherever the corporation unused land is available.
- From the opinion survey it was observed that half of the people (very likely and likely, 41.11 % + 17.78 % = 58.89 %) were in favor of the increased double fare as compared to current fare for improved system. This shows a very optimistic aspect for financial sustainability of Ahmedabad BRTS, which shall be materialised for better service.

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ANNEXURES

Annexure 1 Household Survey Questionnaire Format

Area Location: Date:

Housing type (slum/chali/plot/apartment/bungalow) Remarks:

Housing Condition: (old/new/Dilapidated /kutcha/pucca) Remarks:

1. Information of Household and Family Members

A) Name of the respondent:_____

B) Address: _____

C) House ownership: Owned / Rented

D) Number of family members (household size): _____

E) Total Household Income (Rs./month): Rs. _____

Sr. No	Relation with the Respondent	Gender	Age	Highest Education attained	Occupation	Distance Workplace/ School	Destination Location/address of work/ school)	Modes Used	Primary mode used	Time Taken by primary mode	Approximate cost per trip for using Primary Mode	Income (Rs./ month)
1												
2												
3												
4												
5												

Codes:

Gender	Code
Male	M
Female	F
Relationship with Respondent	**Code**
Wife	1
Husband	2
Children (son/daughter)	3
Daughter-in-law	4
Father/Mother	5
Other (Specify)	6
Highest Education Attained	**Code**
Literate	1
Upto Class 1 (per-primary)	2
Class 1-5 (primary)	3
Class 5-10 (Secondary)	4
Class 10-12 (Higher Secondary)	5
Vocational Training/ Polytechnic	6
Graduate	7
Post-Graduate/ Technical Education	8
Income	**Code**
<2500	1
2500-5000	2
5000-10000	3
10000-15000	4
>15000	5

Occupation	Code
Government Service	1
Private Service	2
Business	3
Labourer/ Daily Wages/Maids/Guard/Drivers	4
Unemployed	5
Student	6
Housewife	7
Other (Specify)	8
Mode/Primary mode	**Code**
Walk	1
Two-wheeler	2
Car	3
AMTS Bus	4
BRTS Bus	5
Auto Rickshaw	6
Shared Auto	7
Bicycle	8
Other (Specify)	9

2. Vehicle Ownership

Type	No. of Vehicles	Owned/ Available	How often used (per Day od par Week)
Car/Jeep			
Scooter/motorcycle/moped			
Bicycle			
No Vehicle			

3. Monthly Expenditure of Household

Total Household Expenditure (Rs.)	Expenditure on Public Transport (Rs.)	Expenditure on Maintenance/ Fuel of owned Vehicles (Rs.)

4. Names and Distances of Market/ Shopping area and Recreation area.

	Market/ Shopping Area	Recreation Area
Name		
Distance (Km)		

5. Public Transport (includes BRTS Buses/ AMTS Buses/ Auto-rickshaw)

A) Do you use Public Transport? Yes/ No (tick)

B) If yes, how often do you use Public Transport?

	BRTS	AMTS Buses	Auto-Rickshaw
Daily			
Once a week			
Once a month			
Never			

C) What is your opinion on the following components of Ahmedabad BRTS?

Please Rank the Following components in 1-10 rank range

Sr. No.	Ahmedabad BRTS Parameters	Rank
1	Travel Time	
2	Frequency	
3	Travel Cost/Fares	
4	Feeder Service	
5	Vehicle Condition	
6	Safety/ Security	
7	Choice of Bus Routes	
8	Parking close to bus stop	
9	Comfort/ Availability of Seats	
10	Info of the service	

D) What factors other than above, e.g. environment etc. do you consider when deciding upon Ahmedabad BRTS?

Sr. No.	Considerations	Yes	No
1	Noise Reduction		
2	Air Pollution Reduction		
3	Reduction in Traffic Congestion		
4	Safety		
5	Comfort		
6	Low Accident Risk		

E) Would the following influence your decision to use Public Transport System/Bus services?

Sr. No.	Influencing Components	Yes	No
1	Seats Available		
2	Parking at Busstop		
3	Announcement System		
4	Off Board Ticketing		
5	Closed/AC Shelters		
6	Level Boarding		
7	Info. Available		
8	Signage/Signals		

F) Willingness to pay for desirable improved Ahmedabad BRTS services (as discussed above)

How much are you willing to pay for the above mentioned improved services?

Sr. No.	Willingness to Pay	Very Likely	Likely	Unlikely	Definitely Not
1	4 Times the current bus fare				
2	3 Times the current bus fare				
3	2 Times the current bus fare				
4	Same as the current bus fare				

Annexure II: Household Survey Data Sheet

Sr No.	Housetype	Condition	Ownership	HHsize	HHincome	Gender	Age	Education	Occupation
1	Bunglow	Old	Owned	3	more than 15000	Male	63	Higher Secondary	Business
2	Apartment	Old	Owned	4	10000 - 15000	Male	45	Graduate	Pvt. Service
3	Apartment	New	Owned	5	more than 15000	Male	24	Post-Graduate	Student
4	Bunglow	Old	Owned	5	more than 15000	Male	No Responce	Graduate	Govt. Service
5	Chali	Old	Rented	3	5000 - 10000	Male	33	Higher Secondary	Business
6	Apartment	New	Owned	4	5000 - 10000	Female	36	Secondary	Housewife
7	Apartment	New	Owned	No Responce	No Responce	Male	40	Graduate	Pvt. Service
8	Bunglow	Old	Owned	No Responce	No Responce	Male	42	Graduate	No Responce
9	Chali	Old	Owned	5	2500 - 5000	Male	28	Literate	Labourer
10	Apartment	Old	Owned	4	5000 - 10000	Female	30	Graduate	Housewife
11	Apartment	New	Owned	3	10000 - 15000	Female	No Responce	Higher Secondary	Unemployed
12	Bunglow	Old	Owned	4	more than 15000	Female	46	Post-Graduate	Pvt. Service
13	Apartment	Old	Owned	1	5000 - 10000	Male	58	Graduate	Pvt. Service
14	Bunglow	Old	Rented	3	more than 15000	Male	76	Graduate	Pvt. Service
15	Apartment	New	Owned	3	10000 - 15000	Male	37	Graduate	Pvt. Service
16	Apartment	New	Owned	1	No Responce	Male	No Responce	Graduate	Pvt. Service
17	Bunglow	New	Rented	2	more than 15000	Female	29	Graduate	Housewife
18	Apartment	Old	Rented	1	5000 - 10000	Male	31	Graduate	Pvt. Service
19	Bunglow	New	Owned	No Responce	more than 15000	Male	22	Graduate	Student
20	Slum	Dilapidated	Rented	4	Less than 2500	Male	39	Vocational Training/ Polytechnic	Labourer
21	Bunglow	Old	Owned	4	more than 15000	Female	64	Literate	Housewife
22	Apartment	Old	Owned	5	No Responce	Male	15	Secondary	Student
23	Apartment	Old	Owned	No Responce	No Responce	Female	36	Graduate	Housewife
24	Apartment	Old	Owned	3	10000 - 15000	Male	19	Higher Secondary	Student
25	Apartment	Old	Owned	3	more than 15000	Female	39	Post-Graduate	Business
26	Chali	Dilapidated	Owned	5	2500 - 5000	Male	46	Literate	Business
27	Apartment	Old	Rented	5	No Responce	Male	34	Graduate	Business
28	Apartment	New	Owned	5	more than 15000	Female	37	Graduate	Business
29	Chali	Dilapidated	Owned	No Responce	Less than 2500	Female	No Responce	Graduate	Housewife
30	Apartment	New	Rented	2	5000 - 10000	Female	27	No Responce	Housewife
31	Chali	Dilapidated	Rented	1	Less than 2500	Male	25	Primary	Pvt. Service
32	Chali	Dilapidated	Rented	4	2500 - 5000	Male	38	Higher Secondary	Labourer
33	Chali	Dilapidated	Rented	3	5000 - 10000	Male	44	Higher Secondary	Pvt. Service
34	Slum	Pucca	Rented	5	Less than 2500	Male	53	Literate	Labourer
35	Apartment	Old	Owned	2	No Responce	Male	45	Graduate	Pvt. Service
36	Bunglow	New	Owned	1	more than 15000	Male	78	Post-Graduate	Pvt. Service
37	Chali	Dilapidated	Rented	No Responce	No Responce	Male	50	Graduate	Pvt. Service
38	Slum	Dilapidated	Rented	3	Less than 2500	Male	41	Higher Secondary	Govt. Service
39	Slum	Dilapidated	No Responce	4	2500 - 5000	Female	58	Higher Secondary	Pvt. Service
40	Chali	Dilapidated	Owned	5	Less than 2500	Female	No Responce	Literate	Business
41	Slum	Dilapidated	Owned	5	10000 - 15000	Male	61	Pre-Primary	Business
42	Apartment	Old	Owned	4	No Responce	Male	58	Post-Graduate	Business
43	Apartment	Old	Owned	2	10000 - 15000	Male	35	Graduate	Pvt. Service
44	Apartment	Old	Owned	No Responce	No Responce	Male	39	No Responce	Business
45	Apartment	New	Owned	3	5000 - 10000	Female	No Responce	Post-Graduate	Pvt. Service
46	Bunglow	New	Owned	5	more than 15000	Male	42	Graduate	Pvt. Service
47	Chali	Dilapidated	Rented	4	Less than 2500	Male	51	Literate	Pvt. Service
48	Apartment	Old	Owned	3	No Responce	Male	60	Graduate	Business
49	Apartment	Old	Owned	5	10000 - 15000	Female	35	No Responce	Housewife
50	Apartment	Old	Owned	4	No Responce	Female	39	Higher Secondary	Housewife
51	Slum	Kutcha	Rented	4	5000 - 10000	Male	45	Literate	Labourer
52	Slum	Pucca	Rented	6	10000 - 15000	Male	29	Pre-Primary	Labourer
53	Apartment	New	Owned	2	10000 - 15000	Male	32	Pre-Primary	Business
54	Apartment	New	Owned	No Responce	No Responce	Male	24	Graduate	Student
55	Apartment	Old	Owned	3	10000 - 15000	Male	37	Graduate	Business
56	Bunglow	Old	Owned	3	more than 15000	Female	36	Pre-Primary	Housewife
57	Apartment	Old	Owned	5	No Responce	Female	No Responce	Graduate	Housewife
58	Chali	Old	Rented	No Responce	No Responce	Male	45	Pre-Primary	Business
59	Bunglow	New	Rented	6	more than 15000	Male	37	Graduate	Pvt. Service
60	Apartment	New	Rented	No Responce	No Responce	Male	33	Vocational Training/ Polytechnic	Pvt. Service
61	Slum	Kutcha	Rented	4	Less than 2500	Male	29	Higher Secondary	Business
62	Apartment	Old	Owned	2	No Responce	Male	49	Graduate	Business
63	Apartment	Old	Owned	3	10000 - 15000	Male	60	Graduate	Business
64	Slum	Dilapidated	Rented	3	5000 - 10000	Male	52	Vocational Training/ Polytechnic	Labourer
65	Apartment	Old	Rented	5	5000 - 10000	Female	75	Literate	Housewife
66	Apartment	Old	Rented	3	10000 - 15000	Female	No Responce	Pre-Primary	Housewife
67	Chali	Dilapidated	No Responce	No Responce	No Responce	Male	60	Higher Secondary	Labourer
68	Apartment	New	Owned	5	No Responce	Male	41	Higher Secondary	Labourer
69	Slum	Dilapidated	No Responce	4	No Responce	Male	20	Graduate	Student
70	Apartment	Old	Owned	6	10000 - 15000	Male	34	Graduate	Business
71	Apartment	Old	Owned	1	5000 - 10000	Male	22	Graduate	Student
72	Chali	Kutcha	No Responce	4	2500 - 5000	Female	35	Higher Secondary	Govt. Service
73	Apartment	New	Owned	2	more than 15000	Female	46	Graduate	Business
74	Apartment	New	Owned	No Responce	No Responce	Male	No Responce	Graduate	Govt. Service
75	Apartment	New	Owned	1	10000 - 15000	Male	37	Graduate	Pvt. Service
76	Bunglow	New	Owned	2	more than 15000	Male	37	Graduate	Govt. Service
77	Chali	Dilapidated	No Responce	5	Less than 2500	Male	51	Graduate	Pvt. Service
78	Chali	Dilapidated	No Responce	3	2500 - 5000	Female	No Responce	Literate	Housewife
79	Chali	Dilapidated	No Responce	4	Less than 2500	Female	60	Primary	Housewife
80	Bunglow	New	Owned	4	more than 15000	Female	66	Primary	Housewife
81	Bunglow	Old	Owned	5	more than 15000	Female	64	Secondary	Housewife
82	Bunglow	Old	Owned	5	more than 15000	Female	No Responce	Higher Secondary	Pvt. Service
83	Chali	Dilapidated	Owned	4	Less than 2500	Male	51	Secondary	Labourer
84	Apartment	Old	Owned	No Responce	No Responce	Male	34	Graduate	Pvt. Service
85	Apartment	New	Owned	4	10000 - 15000	Male	45	Graduate	Govt. Service
86	Apartment	New	Rented	4	10000 - 15000	Male	20	Graduate	Student
87	Apartment	New	Rented	4	more than 15000	Male	No Responce	Graduate	Govt. Service
88	Apartment	New	Rented	No Responce	No Responce	Female	37	Post-Graduate	Housewife
89	Apartment	New	Owned	4	10000 - 15000	Female	28	Graduate	Business
90	Bunglow	Old	Owned	2	more than 15000	Male	68	Post-Graduate	Business

Annexure II: Household Survey Data Sheet

Sr No.	Distance	PrimaryMode	TimeTaken	CostOfTrip	CarJeep	TwoWheeler	Bicycle	VehUsage	HHExpenditure	TrnsExp	VehMaintainance
1	10	Car	40	55	Yes	No	No	Daily	13500	No Responce	3500
2	6	BRTS BUS	25	7	Yes	Yes	No	Once a Week	8400	400	No Responce
3	8	Two-Wheelers	30	28	No	Yes	No	Daily	11800	No Responce	1800
4	4.5	BRTS BUS	20	5	Yes	No	No	Daily	10300	300	No Responce
5	6	Two-Wheelers	25	21	No	Yes	No	Daily	7200	No Responce	1200
6	1	Walk	10	0	No	Yes	No	Once a Week	6000	No Responce	No Responce
7	7	BRTS BUS	30	8	No	Yes	No	Daily	No Responce	No Responce	No Responce
8	6	Two-Wheelers	25	21	No	Yes	No	Daily	No Responce	No Responce	No Responce
9	12	Bicycle	45	0	No	No	Yes	Daily	3000	No Responce	No Responce
10	1	Walk	10	0	No	Yes	No	Once a Week	8000	No Responce	No Responce
11	1	Walk	10	0	No	Yes	No	Once a Week	8000	No Responce	No Responce
12	6	Car	30	33	Yes	No	No	Daily	12000	No Responce	2000
13	5	BRTS BUS	20	6	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
14	7	BRTS BUS	30	8	No	No	Yes	Once a Week	No Responce	No Responce	No Responce
15	9	Two-Wheelers	35	32	No	Yes	No	Daily	10000	No Responce	2000
16	4	BRTS BUS	15	5	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
17	1	Car	10	6	Yes	No	No	Daily	10400	No Responce	400
18	8	BRTS BUS	35	9	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
19	3	Two-Wheelers	15	11	No	Yes	No	Daily	No Responce	No Responce	No Responce
20	3	Bicycle	20	0	No	No	Yes	Daily	1500	No Responce	No Responce
21	2	BRTS BUS	15	2	Yes	Yes	Yes	Daily	10120	120	No Responce
22	4	Two-Wheelers	15	14	No	Yes	No	Daily	No Responce	No Responce	No Responce
23	1	Walk	10	0	Yes	No	Yes	Daily	No Responce	No Responce	No Responce
24	6	BRTS BUS	25	7	No	Yes	No	No Responce	8500	500	No Responce
25	3	Car	15	17	Yes	No	No	Daily	11000	No Responce	1000
26	8	Bicycle	30	0	No	No	Yes	Daily	3000	No Responce	No Responce
27	9	Two-Wheelers	35	32	No	Yes	No	Daily	No Responce	No Responce	No Responce
28	4	Car	20	22	Yes	No	No	Daily	11400	No Responce	1400
29	1	Walk	10	0	No	No	No	Daily	No Responce	No Responce	No Responce
30	1	Walk	10	0	No	Yes	No	Daily	No Responce	No Responce	No Responce
31	6	Bicycle	25	0	No	No	Yes	Daily	1500	No Responce	No Responce
32	10	BRTS BUS	40	12	No	No	Yes	Daily	3700	700	No Responce
33	30	Two-Wheelers	60	85	No	Yes	No	Daily	11000	No Responce	5000
34	14	BRTS BUS	45	16	No	No	Yes	Daily	2500	1000	No Responce
35	9	AMTS Bus	25	14	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
36	8	Two-Wheelers	20	28	No	Yes	No	Daily	11700	No Responce	1700
37	6	Bicycle	20	0	No	No	Yes	Daily	No Responce	No Responce	No Responce
38	7	BRTS BUS	20	8	No	No	Yes	Once a Week	2000	500	No Responce
39	1	Walk	10	0	No	No	Yes	Daily	3000	No Responce	No Responce
40	5	BRTS BUS	20	6	No	Yes	Yes	Daily	1900	400	No Responce
41	6	Two-Wheelers	25	21	No	Yes	Yes	Daily	9300	No Responce	1300
42	4	Car	20	22	Yes	No	No	Daily	No Responce	No Responce	No Responce
43	5	Two-Wheelers	20	18	No	Yes	No	Daily	9100	No Responce	1100
44	7	AMTS Bus	30	11	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
45	10	Auto Rickshaw	40	40	No	Yes	No	Once a Week	12400	2400	No Responce
46	6	Two-Wheelers	25	21	Yes	Yes	Yes	Daily	11300	No Responce	1300
47	8	Bicycle	30	0	No	No	Yes	Daily	1500	No Responce	No Responce
48	9	Auto Rickshaw	35	36	No	Yes	No	Once a Week	No Responce	No Responce	No Responce
49	1	Walk	10	0	No	Yes	No	Daily	No Responce	No Responce	No Responce
50	2	Two-Wheelers	10	7	No	Yes	No	Daily	No Responce	No Responce	No Responce
51	15	BRTS BUS	40	20	No	No	No	No Responce	7200	1200	No Responce
52	11	Two-Wheelers	35	39	No	Yes	No	Daily	10500	No Responce	2500
53	8	Two-Wheelers	20	28	No	Yes	No	Daily	9700	No Responce	1700
54	5	Two-Wheelers	20	18	No	Yes	No	Daily	No Responce	No Responce	No Responce
55	6	AMTS Bus	20	9	No	Yes	No	Once a Week	8600	600	No Responce
56	2	Two-Wheelers	10	7	No	Yes	No	Daily	10500	No Responce	500
57	1	Walk	10	0	No	Yes	Yes	Once a Week	No Responce	No Responce	No Responce
58	8	BRTS BUS	20	9	No	No	Yes	Once a Week	No Responce	No Responce	No Responce
59	9	Car	30	50	Yes	No	No	Daily	13000	No Responce	3000
60	7	AMTS Bus	20	11	No	No	No	No Responce	No Responce	No Responce	No Responce
61	6	Bicycle	25	0	No	No	Yes	Daily	1500	No Responce	No Responce
62	4	Two-Wheelers	15	14	No	Yes	No	Daily	No Responce	No Responce	No Responce
63	2	BRTS BUS	10	2	No	No	No	No Responce	8200	200	No Responce
64	18	AMTS Bus	40	15	No	No	Yes	Once a Week	7000	1000	No Responce
65	1	AMTS Bus	10	2	No	Yes	No	Once a Week	6200	200	No Responce
66	1	Auto Rickshaw	10	4	No	Yes	No	Once a Week	8300	300	No Responce
67	5	Bicycle	20	0	No	No	Yes	Daily	No Responce	No Responce	No Responce
68	5	BRTS BUS	20	6	Yes	Yes	No	Once a Week	No Responce	No Responce	No Responce
69	7	Bicycle	30	0	No	No	Yes	Daily	No Responce	No Responce	No Responce
70	4	Two-Wheelers	20	14	No	Yes	No	Daily	8900	No Responce	900
71	8	Two-Wheelers	30	28	No	Yes	No	Daily	7700	No Responce	1700
72	5	BRTS BUS	20	6	No	No	No	No Responce	3400	400	No Responce
73	9	Car	35	50	Yes	No	No	Daily	13000	No Responce	3000
74	6	AMTS Bus	25	9	No	Yes	Yes	Daily	No Responce	No Responce	No Responce
75	12	BRTS BUS	45	14	No	Yes	No	Once a Week	8900	900	No Responce
76	6	Car	25	33	Yes	No	No	Daily	12000	No Responce	2000
77	5	BRTS BUS	20	6	No	No	Yes	Daily	1900	400	No Responce
78	1	BRTS BUS	10	2	No	No	No	No Responce	3200	200	No Responce
79	1	Auto Rickshaw	10	10	No	Yes	No	Daily	2100	600	No Responce
80	1	Auto Rickshaw	10	10	No	Yes	No	Once a Week	10600	600	No Responce
81	1	Auto Rickshaw	10	10	No	Yes	No	Daily	10600	600	No Responce
82	8	Car	30	44	Yes	No	No	Daily	12640	No Responce	2640
83	4	AMTS Bus	15	6	No	No	No	No Responce	1900	400	No Responce
84	3	Two-Wheelers	15	11	No	Yes	No	Daily	No Responce	No Responce	No Responce
85	9	Two-Wheelers	35	32	No	Yes	No	Daily	10000	No Responce	2000
86	6	BRTS BUS	25	7	No	Yes	No	Once a Week	8500	500	No Responce
87	4	BRTS BUS	15	5	Yes	Yes	No	Once a Week	10300	300	No Responce
88	1	Two-Wheelers	10	10	No	Yes	No	Daily	No Responce	No Responce	No Responce
89	1	Auto Rickshaw	10	10	No	Yes	No	Daily	8600	600	No Responce
90	2	BRTS BUS	10	2	Yes	Yes	No	Once a Week	10200	200	No Responce

Annexure II: Household Survey Data Sheet

Sr No.	ShpDist	RecDist	PTUse	PTUseFre	PTType	RnkTrvlTime	RnkFre	RnkTrvlCost	RnkFreePrkng	RnkVehCondition	RnkSafety	RnkBusRouts
1	0.5	2	No	Never	None	2	1	3	8	6	4	10
2	1	6	Yes	Daily	BRTS	4	3	5	8	6	7	1
3	1	4	No	Never	None	3	4	2	1	10	5	7
4	0.5	3	Yes	Daily	BRTS	1	3	2	7	6	4	9
5	0.5	5	Yes	Weekly	BRTS	3	1	2	10	4	5	8
6	0.5	1	Yes	Monthly	BRTS	1	6	4	7	5	3	10
7	0.4	3	Yes	Daily	BRTS	1	2	7	8	9	3	4
8	0.9	5	No	Never	None	4	6	5	8	9	1	10
9	0.8	2	Yes	Weekly	AMTS	1	2	3	6	4	8	5
10	0.8	4	Yes	Monthly	Auto Rickshaw	2	1	3	10	5	4	9
11	1	3	Yes	Monthly	Auto Rickshaw	5	7	6	10	2	1	8
12	1	5	Yes	Weekly	AMTS	2	1	4	10	3	5	9
13	1	6	Yes	Daily	BRTS	3	1	2	10	4	5	8
14	1	4	Yes	Daily	BRTS	6	5	7	10	3	1	8
15	1	5	No	Never	None	7	9	8	10	4	1	6
16	0.5	3	Yes	Daily	BRTS	1	2	3	5	8	4	7
17	0.5	2	Yes	Weekly	BRTS	2	3	1	9	10	8	7
18	0.7	6	Yes	Daily	BRTS	1	2	7	10	8	3	6
19	1	4	Yes	Weekly	Auto Rickshaw	4	8	1	9	6	2	3
20	0.5	3	No	Never	None	8	7	5	4	6	2	9
21	0.5	5	Yes	Daily	BRTS	9	2	3	8	1	10	5
22	1	2	Yes	Monthly	AMTS	1	3	2	8	7	4	9
23	1	4	Yes	Weekly	Auto Rickshaw	10	3	9	7	8	5	4
24	1	6	Yes	Daily	BRTS	1	2	3	5	6	4	8
25	1	6	No	Never	None	1	3	2	8	7	4	9
26	0.4	4	Yes	Weekly	BRTS	1	2	6	5	10	4	9
27	0.3	1	Yes	Monthly	BRTS	1	2	7	10	8	3	6
28	1.5	5	Yes	Weekly	Auto Rickshaw	1	2	6	5	10	4	9
29	0.3	2	Yes	Monthly	BRTS	2	4	3	10	5	1	8
30	0.7	3	Yes	Monthly	BRTS	2	3	1	10	4	6	8
31	0.1	4	Yes	Monthly	AMTS	4	5	1	10	2	3	8
32	0.1	5	Yes	Daily	BRTS	1	2	7	10	8	3	6
33	0.6	2	No	Never	None	2	3	1	9	8	4	7
34	0.4	1	Yes	Daily	BRTS	3	2	1	7	6	10	9
35	1	6	Yes	Daily	AMTS	1	4	2	10	5	6	8
36	1.2	4	Yes	Monthly	Auto Rickshaw	5	7	6	9	8	1	4
37	1	1	Yes	Monthly	Auto Rickshaw	5	7	6	9	8	1	4
38	0.1	5	Yes	Daily	BRTS	6	4	7	10	5	1	9
39	0.3	25	No	Never	None	1	3	2	10	5	4	8
40	0.2	3	Yes	Daily	BRTS	2	3	1	6	7	5	8
41	1	7	No	Never	None	2	1	3	8	4	10	9
42	0.5	4	Yes	Monthly	Auto Rickshaw	6	5	7	10	3	1	8
43	0.6	5	Yes	Monthly	BRTS	7	9	8	10	4	1	6
44	1	2	Yes	Daily	AMTS	1	2	3	5	8	4	7
45	0.8	1	Yes	Daily	Auto Rickshaw	2	3	1	9	10	8	7
46	1.8	3	Yes	Monthly	AMTS	1	2	7	10	8	3	6
47	0.4	5	Yes	Weekly	BRTS	4	8	1	9	6	2	3
48	0.5	4	Yes	Daily	Auto Rickshaw	8	7	5	4	6	2	9
49	0.5	1	Yes	Weekly	BRTS	9	2	3	8	1	10	5
50	1.2	6	Yes	Monthly	BRTS	1	3	2	8	7	4	9
51	0.5	2	Yes	Daily	BRTS	10	3	9	7	8	5	4
52	0.7	3	Yes	Weekly	Auto Rickshaw	1	2	3	5	6	4	8
53	0.5	7	Yes	Weekly	AMTS	1	3	2	8	7	4	9
54	1	4	Yes	Weekly	BRTS	1	2	6	5	10	4	9
55	0.8	44	Yes	Daily	AMTS	1	2	7	10	8	3	6
56	1	33	No	Never	None	1	2	6	5	10	4	9
57	0.5	4	Yes	Monthly	Auto Rickshaw	2	4	3	10	5	1	8
58	1	1	Yes	Daily	BRTS	1	4	2	10	5	6	8
59	1	No Responce	Yes	Monthly	Auto Rickshaw	5	7	6	9	8	1	4
60	0.6	3	Yes	Daily	AMTS	5	7	6	9	8	1	4
61	0.2	4	No	Never	None	6	4	7	10	5	1	9
62	1	3	Yes	Weekly	BRTS	1	3	2	10	5	4	8
63	1	5	Yes	Daily	BRTS	2	3	1	6	7	5	8
64	0.5	1	Yes	Daily	AMTS	2	1	3	8	4	10	9
65	0.5	3	Yes	Daily	AMTS	6	5	7	10	3	1	8
66	0.7	1	Yes	Daily	Auto Rickshaw	7	9	8	10	4	1	6
67	1	2	Yes	Weekly	AMTS	1	2	3	5	8	4	7
68	0.5	4	Yes	Daily	BRTS	2	3	1	9	10	8	7
69	0.4	6	Yes	Monthly	AMTS	1	2	7	10	8	3	6
70	0.6	2	Yes	Monthly	BRTS	4	8	1	9	6	2	3
71	1	1	Yes	Monthly	BRTS	8	7	5	4	6	2	9
72	0.5	3	Yes	Daily	BRTS	9	2	3	8	1	10	5
73	0.8	4	No	Never	None	1	3	2	8	7	4	9
74	0.5	5	Yes	Daily	AMTS	4	3	5	8	6	7	1
75	1	4	Yes	Daily	BRTS	3	4	2	1	10	5	7
76	1.2	4	No	Never	None	1	3	2	7	6	4	9
77	0.4	3	Yes	Daily	BRTS	3	1	2	10	4	5	8
78	0.3	1	Yes	Daily	BRTS	1	6	4	7	5	3	10
79	0.2	2	Yes	Daily	Auto Rickshaw	1	2	7	8	9	3	4
80	0.9	4	Yes	Daily	Auto Rickshaw	4	6	5	8	9	1	10
81	0.9	4	Yes	Daily	Auto Rickshaw	1	2	3	6	4	8	5
82	0.9	3	Yes	Weekly	Auto Rickshaw	2	1	3	10	5	4	9
83	0.3	4	Yes	Daily	AMTS	1	2	7	10	8	3	6
84	1	2	No	Never	None	4	8	1	9	6	2	3
85	0.7	1	Yes	Weekly	BRTS	8	7	5	4	6	2	9
86	7	4	Yes	Daily	BRTS	9	2	3	8	1	10	5
87	1.5	3	Yes	Daily	BRTS	1	3	2	8	7	4	9
88	1	4	Yes	Weekly	Auto Rickshaw	10	3	9	7	8	5	4
89	0.7	1	Yes	Daily	Auto Rickshaw	1	2	3	5	6	4	8
90	1.5	5	Yes	Daily	BRTS	1	3	2	8	7	4	9

Annexure II: Household Survey Data Sheet

Sr No.	RnkSchedule	RnkComfort	RnkInfo	ConNoise	ConAirPollu	ConTrffcCong	ConSafety	ConComfort	ConAccident	InfParking	InfInfoAvailable	InfAnouncemnt
1	9	5	7	No	No	No	Yes	Yes	No	No	Yes	Yes
2	2	9	10	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
3	8	9	6	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
4	10	5	6	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
5	9	6	7	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
6	9	2	8	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
7	5	10	6	No	No	No	Yes	Yes	Yes	No	Yes	Yes
8	7	2	3	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
9	10	9	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
10	7	8	6	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
11	9	3	4	No	No	No	No	Yes	Yes	Yes	Yes	No
12	8	7	6	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13	9	6	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
14	9	2	4	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
15	5	3	2	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
16	10	9	6	No	No	No	Yes	Yes	Yes	Yes	No	No
17	6	4	5	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
18	5	4	9	No	No	No	No	Yes	Yes	Yes	Yes	Yes
19	5	7	10	No	No	No	Yes	Yes	Yes	Yes	Yes	No
20	3	10	1	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
21	6	7	4	No	No	Yes	Yes	Yes	Yes	Yes	No	No
22	10	5	6	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
23	1	6	2	No	No	Yes	Yes	Yes	No	No	Yes	No
24	10	9	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
25	10	5	6	Yes	Yes	No	Yes	No	Yes	Yes	No	No
26	8	3	7	No	No	No	Yes	Yes	Yes	No	Yes	Yes
27	5	4	9	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
28	8	3	7	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
29	9	6	7	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
30	9	7	5	No	No	Yes	Yes	Yes	Yes	No	Yes	No
31	9	7	6	No	No	Yes	Yes	No	Yes	No	Yes	No
32	5	4	9	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
33	10	6	5	No	No	Yes	Yes	Yes	No	Yes	Yes	No
34	8	4	5	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes
35	7	9	2	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No
36	10	2	3	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
37	10	2	3	No	No	Yes	Yes	No	Yes	Yes	No	No
38	8	3	2	Yes	Yes	Yes	No	No	No	Yes	No	Yes
39	9	6	7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
40	10	9	4	No	No	No	Yes	Yes	Yes	Yes	No	Yes
41	5	6	7	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
42	9	2	4	No	No	Yes	Yes	Yes	No	Yes	Yes	No
43	5	3	2	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
44	10	9	6	No	No	No	Yes	Yes	No	No	Yes	Yes
45	6	4	5	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
46	5	4	9	Yes	Yes	Yes	Yes	No	Yes	No	Yes	
47	5	7	10	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
48	3	10	1	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
49	6	7	4	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
50	10	5	6	No	No	No	Yes	Yes	Yes	No	Yes	Yes
51	1	6	2	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
52	10	9	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
53	10	5	6	No	Yes	Yes	Yes	Yes	No	No	Yes	Yes
54	8	3	7	No	No	No	No	Yes	Yes	Yes	Yes	No
55	5	4	9	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
56	8	3	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
57	9	6	7	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
58	7	9	2	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
59	10	2	3	No	No	No	Yes	Yes	Yes	Yes	No	No
60	10	2	3	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
61	8	3	2	No	No	No	No	Yes	Yes	Yes	Yes	Yes
62	9	6	7	No	No	No	Yes	Yes	Yes	Yes	Yes	No
63	10	9	4	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
64	5	6	7	No	No	Yes	Yes	Yes	Yes	Yes	No	No
65	9	2	4	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
66	5	3	2	No	No	Yes	Yes	Yes	No	No	Yes	No
67	10	9	6	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
68	6	4	5	Yes	Yes	No	Yes	No	Yes	Yes	No	No
69	5	4	9	No	No	No	Yes	Yes	Yes	No	Yes	Yes
70	5	7	10	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
71	3	10	1	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
72	6	7	4	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
73	10	5	6	No	No	Yes	Yes	Yes	Yes	No	Yes	No
74	2	9	10	No	No	Yes	Yes	No	Yes	No	Yes	No
75	8	9	6	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
76	10	5	6	No	No	Yes	Yes	Yes	No	Yes	Yes	No
77	9	6	7	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes
78	9	2	8	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No
79	5	10	6	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
80	7	2	3	No	No	Yes	Yes	No	Yes	Yes	No	No
81	10	9	7	Yes	Yes	Yes	No	No	No	Yes	No	Yes
82	7	8	6	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
83	5	4	9	No	No	No	Yes	Yes	Yes	Yes	No	Yes
84	5	7	10	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
85	3	10	1	No	No	Yes	Yes	Yes	No	Yes	Yes	No
86	6	7	4	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
87	10	5	6	No	No	No	Yes	Yes	No	No	Yes	Yes
88	1	6	2	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
89	10	9	7	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
90	10	5	6	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

Annexure II: Household Survey Data Sheet

Sr No.	InfOffBrd	InfAirCndtn	InfLowStp	InfSitting	InfSign	Pay4	Pay3	Pay2	PayS
1	No	Yes	Yes	No	Yes	Unlikely	Unlikely	Very Likely	Very Likely
2	Yes	Yes	Yes	No	No	Definitely Not	Unlikely	Very Likely	Very Likely
3	Yes	No	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
4	Yes	Yes	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
5	No	No	Yes	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
6	No	No	No	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
7	No	No	No	Yes	Yes	Unlikely	Unlikely	Likely	Very Likely
8	No	Yes	Yes	No	Yes	Unlikely	Likely	Very Likely	Very Likely
9	Yes	Yes	Yes	Yes	Yes	Unlikely	Likely	Very Likely	Very Likely
10	Yes	No	No	Yes	Yes	Unlikely	Unlikely	Very Likely	Very Likely
11	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
12	Yes	No	Yes	No	Yes	Unlikely	Likely	Very Likely	Very Likely
13	Yes	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
14	Yes	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
15	Yes	No	Yes	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
16	Yes	Yes	Yes	No	Yes	Unlikely	Unlikely	Very Likely	Very Likely
17	No	No	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
18	Yes	No	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
19	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Likely	Likely
20	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Likely	Very Likely
21	Yes	No	No	Yes	No	Definitely Not	Likely	Likely	Likely
22	No	No	No	No	No	Definitely Not	Definitely Not	Unlikely	Very Likely
23	Yes	No	Yes	Yes	Yes	Definitely Not	Unlikely	Likely	Very Likely
24	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
25	No	Yes	Yes	No	No	Unlikely	Unlikely	Likely	Very Likely
26	Yes	No	No	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
27	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
28	No	Yes	Yes	No	No	Definitely Not	Unlikely	Very Likely	Very Likely
29	No	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
30	No	Yes	Yes	No	No	Definitely Not	Likely	Very Likely	Very Likely
31	Yes	Yes	Yes	Yes	No	Definitely Not	Definitely Not	Unlikely	Very Likely
32	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
33	Yes	No	Yes	No	No	Definitely Not	Definitely Not	Definitely Not	Very Likely
34	No	Yes	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
35	Yes	Yes	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
36	Yes	No	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
37	Yes	No	No	Yes	No	Definitely Not	Definitely Not	Unlikely	Likely
38	Yes	No	No	Yes	No	Definitely Not	Definitely Not	Definitely Not	Definitely Not
39	No	Yes	Yes	No	No	Definitely Not	Definitely Not	Unlikely	Very Likely
40	No	Yes	Yes	No	No	Definitely Not	Definitely Not	Likely	Very Likely
41	No	Yes	Yes	No	No	Unlikely	Unlikely	Likely	Very Likely
42	Yes	Yes	No	Yes	No	Definitely Not	Definitely Not	Definitely Not	Definitely Not
43	Yes	No	Yes	Yes	Yes	Definitely Not	Definitely Not	Unlikely	Likely
44	No	Yes	Yes	No	Yes	Unlikely	Unlikely	Very Likely	Very Likely
45	Yes	Yes	Yes	No	No	Definitely Not	Unlikely	Very Likely	Very Likely
46	Yes	No	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
47	Yes	Yes	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
48	No	No	Yes	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
49	No	No	No	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
50	No	No	No	Yes	Yes	Unlikely	Unlikely	Likely	Very Likely
51	No	Yes	Yes	No	Yes	Unlikely	Likely	Very Likely	Very Likely
52	Yes	Yes	Yes	Yes	Yes	Unlikely	Likely	Very Likely	Very Likely
53	Yes	No	No	Yes	Yes	Unlikely	Unlikely	Very Likely	Very Likely
54	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
55	Yes	No	Yes	No	Yes	Unlikely	Likely	Very Likely	Very Likely
56	Yes	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
57	Yes	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
58	Yes	No	Yes	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
59	Yes	Yes	Yes	No	Yes	Unlikely	Unlikely	Very Likely	Very Likely
60	No	No	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
61	Yes	No	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
62	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Likely	Likely
63	Yes	Yes	No	Yes	Yes	Definitely Not	Definitely Not	Likely	Very Likely
64	Yes	No	No	Yes	No	Definitely Not	Likely	Likely	Likely
65	No	No	No	No	No	Definitely Not	Definitely Not	Unlikely	Very Likely
66	Yes	No	Yes	Yes	Yes	Definitely Not	Unlikely	Likely	Very Likely
67	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
68	No	Yes	Yes	No	No	Unlikely	Unlikely	Likely	Very Likely
69	Yes	No	No	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
70	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
71	No	Yes	Yes	No	No	Definitely Not	Unlikely	Very Likely	Very Likely
72	No	Yes	Yes	No	Yes	Definitely Not	Definitely Not	Very Likely	Very Likely
73	No	Yes	Yes	No	No	Definitely Not	Likely	Very Likely	Very Likely
74	Yes	Yes	Yes	Yes	No	Definitely Not	Definitely Not	Unlikely	Very Likely
75	Yes	Yes	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
76	Yes	No	Yes	No	No	Definitely Not	Definitely Not	Definitely Not	Very Likely
77	No	Yes	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
78	Yes	Yes	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely
79	Yes	No	No	No	Yes	Definitely Not	Definitely Not	Definitely Not	Very Likely
80	Yes	No	No	Yes	No	Definitely Not	Definitely Not	Unlikely	Likely
81	Yes	No	No	Yes	No	Definitely Not	Definitely Not	Definitely Not	Definitely Not
82	No	Yes	Yes	No	No	Definitely Not	Definitely Not	Unlikely	Very Likely
83	No	Yes	Yes	No	No	Definitely Not	Definitely Not	Likely	Very Likely
84	No	Yes	Yes	No	No	Unlikely	Unlikely	Likely	Very Likely
85	Yes	Yes	No	Yes	No	Definitely Not	Definitely Not	Definitely Not	Definitely Not
86	Yes	No	Yes	Yes	Yes	Definitely Not	Definitely Not	Unlikely	Likely
87	No	Yes	Yes	No	Yes	Unlikely	Unlikely	Very Likely	Very Likely
88	Yes	Yes	Yes	No	No	Definitely Not	Unlikely	Very Likely	Very Likely
89	Yes	No	Yes	Yes	Yes	Definitely Not	Definitely Not	Definitely Not	Likely
90	Yes	Yes	No	Yes	Yes	Definitely Not	Unlikely	Very Likely	Very Likely