THE ROLE OF BUS RAPID TRANSIT IN IMPROVING PUBLIC TRANSFER LEVELS OF SERVICE, PARTICULARLY FOR THE URBAN POOR USERS OF PUBLIC TRANSPORT

A case of Cape Town, South Africa

Due Date: May 2011

Prepared by:
Lorita Maunganidze (MNGLOR002)
Cape Town
South Africa

Prepared for:
Professor Romano Del Mistro
Faculty of Engineering and the Built Environment
Transport Studies Programme
University of Cape Town
South Africa

In partial fulfilment of the requirements for the degree of Master of Philosophy in Transport Studies offered by the Department of Civil Engineering in the Faculty of Engineering and the Built Environment at the University of Cape Town.
PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is to use another’s work and pretend that it is one’s own.
2. I have used the Harvard convention for citation and referencing. Each contribution to, and quotation in, this research project from the work(s) of other people has been attributed, and has been cited and referenced.
3. This research project is my own work.
4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

Name: Lorita L. Maunganidze (MNGLOR002)

Signature ______________________________

Date __________________________________
ACKNOWLEDGEMENTS

A number of people made great contributions that made a difference not only to this thesis but also to my own personal and professional development.

First and foremost, my special thank you goes to my supervisor, Professor Romano Del Mistro. As a supervisor, Romano has been an outstanding source of inspiration: thorough, critical, zealous, challenging, thoughtful, and knowledgeable. He expected a great deal but also gave a great deal in return. I am also very grateful towards him for allowing me to use data from the survey on travel patterns of households conducted for African Centre of Excellence for Studies in Public and Non-motorised Transport (ACET) in Cape Town during 2010.

I also would like to thank Gerhard Hitge and Jo-Anne Smetherham of the City of Cape Town who, in their various capacities, have proved invaluable to this thesis. They have provided important input, insights and assistance in data generation.

It goes without saying that my friends and especially my loving family merit special thanks for their unreserved and unwavering support, patience, encouragement, understanding, and for being a constant source of joy, happiness, and comfort. They all continue to make it easier for me to fulfill my purpose and calling.
The current level of service provision of public transport in Cape Town, as in other cities in South Africa, is inadequate and ineffective in meeting user needs (Clark, 2000; CoCT, 2006; CoCT, 2010a; CoCT, 2010b; Wilkinson, 2008). The ‘current [very limited, modally fragmented] commuter based service’ (Wilkinson, 2008) characterized by poor performance in terms of travel times, reliability, capacity, safety and security and so on (CoCT, 2006) are evidence of the inadequacy and ineffectiveness. The foregoing severe shortcomings of the existing public transport service barely meet the definition of a system, and create daily hardship for thousands of residents, especially poorer communities living far from major centres of employment, higher order commercial and social facilities (Cape Argus, 2009; Creamer Media’s Engineering News, 2009; CoCT, 2008; Wilkinson, 2002 and 2008). However, the BRT-based IRT system has recently been proposed as a ‘quick fix’ solution to these public transport problems (Cape Argus, 2009). To this effect, this research aimed to assess the role that can be played by BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town.

In order to assess the role played by BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town, the current condition and the effect of changing to IRT were examined together. The study made use of data obtained from the database of the ACET Household Survey (conducted in Cape Town during 2010) and the data generated through a desktop survey. The comparative analysis of current levels of public transport services versus predicted BRT-based IRT service levels basically applied a “with” and “without” BRT test as the basic criterion for measuring the changes that can be brought about to public transport service levels through changing to the BRT-based IRT system. The parameters that were tested include; walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement.

The outcome of the broad comparative analysis indicated that the BRT-based IRT system is not clearly beneficial to the urban poor in the area of service levels improvements. The research concluded that while the poor commuters may benefit from more accessible, frequent and fast IRT services as well as reduced travel times, ironically, these will be more expensive and in some cases unaffordable to them and therefore of no benefit to them. The research also established that the poor are likely to be worse-off than the other income groups in terms of all the service levels under investigation. This indicates that the change to IRT is likely not going to contribute much in terms of addressing social equity issues as the urban poor will largely remain marginalized. However, the study observed that the success of IRT in delivering benefits primarily to the urban poor is contingent
upon adopting appropriate measures to rationalize the BRT-based IRT system, as indicated in the recommendations.
TABLE OF CONTENTS

PLAGIARISM DECLARATION ........................................................................................................ II

ACKNOWLEDGEMENTS ........................................................................................................... III

EXECUTIVE SUMMARY .......................................................................................................... IV

LIST OF ANNEXES ................................................................................................................ IX

LIST OF TABLES .................................................................................................................... IX

LIST OF FIGURES .................................................................................................................. IX

1. INTRODUCTION ................................................................................................................ 1
   1.1 Introduction and Background ....................................................................................... 1
   1.2 Problem statement ....................................................................................................... 2
   1.3 Aim ............................................................................................................................... 2
   1.4 Objectives .................................................................................................................... 3
   1.5 Research questions ...................................................................................................... 3
   1.6 Hypothesis ................................................................................................................... 3
   1.7 Research methodology ............................................................................................... 3
   1.8 Organization of the Report ........................................................................................ 4
   1.9 Conclusion .................................................................................................................. 5

2. LITERATURE REVIEW ...................................................................................................... 6
   2.1 Introduction .................................................................................................................. 6
   2.2 Typical characteristics of the urban poor ..................................................................... 6
   2.3 Typical characteristics of the urban poor’s transport situation .................................... 7
      2.3.1 Typical characteristics of the urban poor’s settlement patterns that influence their
            transport situation ...................................................................................................... 7
      2.3.2 Restricted transport modal choice of the urban poor ............................................ 7
      2.3.3 Heavy transport costs burden borne by the urban poor ....................................... 8
      2.3.4 Vulnerability to traffic accidents, crime and overcrowding of the urban poor ....... 9
   2.4 Impacts of the urban poor’s transport problems on their livelihoods ......................... 9
   2.5 The crucial role of public transport in the lives of the urban poor ................................. 11
   2.6 Problems and characteristics of road-based public transport systems in developing
countries .............................................................................................................................. 12
   2.7 Appeal of BRT for developing world cities .................................................................. 13
   2.8 Conceptual clarification of BRT .................................................................................. 14
      2.8.1 Rapid transit concept .............................................................................................. 14
      2.8.2 Bus Rapid Transit (BRT) concept ......................................................................... 14

The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users
Case of Cape Town, South Africa
3. BRT elements, system performance and system benefits ........................................ 15
   2.9.1 Major Elements of BRT ................................................................. 15
   2.9.2 BRT System Performance attributes ................................................ 16
   2.9.3 BRT System Benefits ................................................................. 18
   2.9.4 Effects of BRT Elements on System Performance ............................. 18
   2.9.5 Experience with BRT System Performance ...................................... 28
2.10 What BRT is and what it is not ........................................................................ 29
   2.10.1 What BRT is .................................................................................. 29
   2.10.2 What BRT is not ............................................................................ 30
2.11 Common BRT System Features ..................................................................... 31
2.12 Problems and characteristics of Cape Town’s public transport system ............. 31
2.13 Cape Town’s Integrated Rapid Transit (IRT) System ...................................... 33
   2.13.1 What an Integrated Rapid Transit (IRT) system is ............................... 33
   2.13.2 How different the IRT is from existing services ................................. 33
   2.13.3 What the IRT comprises of ............................................................. 34
   2.13.4 Implications of implementing the IRT for passengers .......................... 34
   2.13.5 The IRT Network ......................................................................... 35
   2.13.6 Salient IRT project information ....................................................... 37
2.14 Conclusion ..................................................................................................... 38

3. RESEARCH METHODOLOGY ......................................................................... 39
3.1 Introduction ........................................................................................................ 39
3.2 Literature review ............................................................................................... 39
3.3 Data Analysis .................................................................................................... 39
   3.3.1 Data source and sampling method ..................................................... 40
   3.3.2 Market segmentation method ............................................................ 40
   3.3.3 Sample data generation method ....................................................... 41
   3.3.4 Comparative analyses method .......................................................... 45
3.4 Conclusion ....................................................................................................... 46

4. DATA ANALYSIS AND PRESENTATION .................................................. 47
4.1 Introduction ........................................................................................................ 47
4.2 All commuters .................................................................................................... 47
   4.2.1 Effect of changing to IRT: in general ............................................... 47
   4.2.2 Effect of current condition on change: total walking distance .............. 50
   4.2.3 Effect of current condition on change: total in-vehicle distance .......... 51
   4.2.4 Effect of current condition on change: total trip distance ................. 52
5. The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users

Case of Cape Town, South Africa

Page viii

5.1 Introduction ........................................................................................................ 88
5.2 Summary of findings and conclusion ................................................................ 88
5.3 Recommendations .......................................................................................... 90
5.3.1 Key issues to be firstly addressed ................................................................. 90
5.3.2 Measures to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport .............................................. 91
5.4 Areas for further research ............................................................................... 93
5.5 Conclusion ....................................................................................................... 94
LIST OF ANNEXURES

Annex A: The full IRT route network map
Annex B: The IRT fare level list
Annex C: The estimated total project system cost of implementing Phase 1A
Annex D: The amended roll-out of Phase 1A

LIST OF TABLES

Table 1: Summary of which elements directly affect each attribute of system performance
Table 2: Summary of Effects of Running Way Elements on System Performance
Table 3: Summary of Effects of Station Elements on System Performance
Table 4: Summary of Effects of Vehicle Elements on System Performance
Table 5: Summary of Effects of Fare Collection Elements on System Performance
Table 6: Summary of Effects of Intelligent Transport System Elements on System Performance
Table 7: Summary of Effects of Service and Operations Plan Elements on System Performance
Table 8: Summary of Effects of Branding Elements on System Performance
Table 9: Market Segmentation of the 100 Commuter Trips
Table 10: Effect of changing to IRT: in general
Table 11: Effect of changing to IRT on poor commuters
Table 12: Effect of changing to IRT: by income
Table 13: Effect of changing to IRT: by race
Table 14: Effect of changing to IRT: by current main public transport mode
Table 15: Effect of changing to IRT: by age
Table 16: Effect of changing to IRT: by gender

LIST OF FIGURES

Figure 1: Research Methodology
Figure 2: BRT elements, system performance and system benefits
Figure 3: Integrated Rapid Transit map
Figure 4: Effect of current condition on change: total walking distance
Figure 5: Effect of current condition on change: total in-vehicle distance
Figure 6: Effect of current condition on change: total trip distance
Figure 7: Effect of current condition on change: total walking time
Figure 8: Effect of current condition on change: total waiting time
Figure 9: Effect of current condition on change: total in-vehicle time
Figure 10: Effect of current condition on change: total trip time
Figure 11: Effect of current condition on change: in-vehicle speed
Figure 12: Effect of current condition on change: trip speed
Figure 13: Effect of current condition on change: total fare cost (with distance-based IRT fare)
Figure 14: Effect of current condition on change: total fare cost (with flat IRT fare)
Figure 15: Effect of changing to IRT: by income
Figure 16: Effect of changing to IRT: by race
Figure 17: Effect of changing to IRT: by current main mode
Figure 18: Effect of changing to IRT: by age
Figure 19: Effect of changing to IRT: by gender

Box

Box 1: A profile of the urban poor
1. **INTRODUCTION**

1.1 **Introduction and Background**

This is a study on “The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users of public transport: A case of Cape Town, South Africa”. Bus Rapid Transit (BRT) has been defined in BRT Implementation Guidelines as *a flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity* (Levinson et al, 2003 cited in Diaz et al, 2004 and Diaz, 2009). It is important to note that BRT is the latest “buzz word” within the public transit community and has been promoted as the economic and practical solution to improving existing public transport systems (Jarzab et al, 2002; Wright, 2004). Moreover, it is increasingly becoming a global phenomenon synonymous with quality public transport (CoCT, 2006 and 2008).

Actually, the trend towards the implementation of public transport level of service improvement programmes based on BRT technology that incorporate existing paratransit operations has been occurring dramatically in a number of cities around the world, particularly in Latin America (Schalekamp et al, 2009; Wright, 2004). Drawing inspiration from these global developments, the city of Cape Town (among other South African cities) has, of late, planned an Integrated Rapid Transit (IRT) system that also relies on the introduction of BRT and incorporate existing formal bus and paratransit operations (CoCT, 2006; Schalekamp and Behrens, 2009; Schalekamp et al, 2009). This national initiative emerged in 2006, coinciding with the announcement of South Africa as host of the 2010 FIFA World Cup, as a renewed thrust to revitalize public transport both in terms of planning and funding. It is important to note that by 2006 (i.e., a decade after the release of the White Paper on National Transport Policy) little progress had been made in corporatizing paratransit or in addressing the poor standard of public transport services in spite of prior national and local initiatives to improve public transport systems and integrate paratransit (Schalekamp and Behrens, 2009; Schalekamp et al, 2009; Wilkinson, 2009).

In addition to seeking to meet the city of Cape Town’s contractual obligation in terms of safe and reliable transport as a host city for the 2010 FIFA World Cup as well to regulate and “formalize” minibus-taxi operations, the introduction of the BRT-based IRT system was also aimed at improving public transport services for passengers in the city (CoCT, 2006; Schalekamp and Behrens, 2009; Schalekamp et al, 2009). In this context, the purpose of this study is to inquire on the changes which may be brought about by BRT in Cape Town from the point of view of public transport level of service improvement, particularly for the urban poor users of public transport. While it is
acknowledged that BRT system elements have different effects on diverse attributes of system performance, including reducing travel times, improving reliability, providing identity and a quality image, improving safety and security, increasing capacity and enhancing accessibility (Diaz et al., 2004; Diaz, 2009; NBRTI, undated), the study particularly focuses on the effect on walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement of the change to the BRT-based IRT system. This analysis was considered to be quantifiable and measurable as well as attainable within the available resources and time frame. However, it is important to stress that limiting the study to a few attributes of system performance has disadvantages in terms of the general applicability of results.

1.2 Problem statement

The current level of service provision of public transport in Cape Town, as in other cities in South Africa, is inadequate and ineffective in meeting user needs (Clark, 2000; CoCT, 2006; CoCT, 2010a; CoCT, 2010b; Wilkinson, 2008). The ‘current [very limited, modally fragmented] commuter based service’ (Wilkinson, 2008) characterized by poor performance in terms of reliability, capacity, safety and security and so on (CoCT, 2006) are evidence of the inadequacy and ineffectiveness. The foregoing severe shortcomings of the existing public transport service barely meet the definition of a system, and create daily hardship for thousands of residents, especially poorer communities living far from major centres of employment, higher order commercial and social facilities (Cape Argus, 2009; Creamer Media’s Engineering News, 2009; CoCT, 2008; Wilkinson, 2002 and 2008). This segment of the urban population – which, invariably, is ‘captive’ to public transport – not only has to put up with the poor standard of public transport services, but is also relatively overburdened by long journey times as well as high distance-related transport costs which have an adverse impact on meagre family incomes (Behrens and Wilkinson, 2001; Behrens et al., 2004; CoCT, 2006; Wilkinson, 2002). While it is clear that public transport provision in Cape Town is inadequate and ineffective, the BRT-based IRT system has recently been proposed as a ‘quick fix’ solution to these public transport problems (Cape Argus, 2009). In essence, the problem guiding this study is to assess the role that can be played by BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town.

1.3 Aim

This research seeks to assess the potential role of BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town.
1.4 Objectives

At a more general level the objectives of this study are to:

1. Investigate whether or not the change to the BRT-based IRT system can bring about improvements to public transport levels of service in terms of; walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement, particularly for the urban poor users of public transport in Cape Town.

2. Draw conclusions on the appropriateness (or otherwise) of the change to the BRT-based IRT system as an integral/key intervening public transport strategy targeted at improving public transport service levels particularly for the urban poor users.

3. Recommend appropriate measures that can be adopted to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport.

1.5 Research questions

This research aims to provide answers to the questions set out below:

1) What changes to public transport levels of service in terms of; walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement can be brought about through the change to the BRT-based IRT system, particularly for the urban poor users of public transport in Cape Town?

2) How appropriate is it to regard the change to the BRT-based IRT system as an integral/key intervening public transport strategy targeted at improving public transport service levels particularly for the urban poor users?

3) What appropriate measures can be adopted to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport?

1.6 Hypothesis

The basic assumption of this research project is that BRT has a critical role to play in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town.

1.7 Research methodology

The main actions carried out during the study are summarized in the Figure 1 below and shall be explained in more detail in Chapter 3. The different steps describe the process envisaged in a chronological order.
1.8 Organization of the Report

The report is organized in five chapters as follows:

**Chapter 1** introduces the research topic and outlines the background to the study, followed by concise statements of the research problem. Lastly, the formulated research proposition as well as the aim, objectives and questions of the research are provided. In addition, a summary of the main features of the research methodology is provided.

**Chapter 2** presents a theoretical underpinning of the study. This is meant to provide a critical review of previous studies relevant to the study problem. The chapter begins with an introduction of some pertinent information about the typical transport problems of poor populations in developing world cities and their consequences for the livelihood strategies of the urban poor. It also considers the crucial role of public transport in the lives of the urban poor. The chapter then presents a review of literature on the problems and characteristics of public transport system(s) in developing world cities in general, and in Cape Town in particular (issues of access and quality have been used to understand the prevailing conditions). This is then followed by a review on the appeal of BRT for developing world cities. BRT is then explored through a progression of three different perspectives (i.e., BRT elements, system performance and system benefits). A further review of international experience with
BRT system performance is also undertaken. In the end, a brief description of the planned BRT-based IRT system of Cape Town is provided.

Chapter 3 outlines the methodology applied in this study to address the research aim and objectives.

Chapter 4 presents the findings of the comparative analysis of current levels of public transport services versus predicted BRT-based IRT service levels.

Chapters 5 summarizes research findings, concludes the research and makes recommendations with regard to appropriate measures that can be adopted to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport.

1.9 Conclusion

This chapter has set the scene for the study. It has brought into clarity the research idea by briefly expressing the statement of the problem. The objectives and specific research questions raised here will help in the design of the research methodology; and in guiding the analysis and presentation of research findings (aspects dealt with in chapters 3 and 4 respectively).
2. LITERATURE REVIEW

2.1 Introduction

This chapter provides a critical review of literature and theory relevant to the study. The chapter begins with an introduction of some pertinent information about the typical transport problems of poor populations in developing world cities and their consequences for the livelihood strategies of the urban poor. It also considers the crucial role of public transport in the lives of the urban poor. The chapter then presents a review of literature on the problems and characteristics of public transport system(s) in developing world cities in general, and in Cape Town in particular (issues of access and quality have been used to understand the prevailing conditions). This is then followed by a review on the appeal of BRT for developing world cities. BRT is then explored through a progression of three different perspectives (i.e., BRT elements, system performance and system benefits). A further review of international experience with BRT system performance is also undertaken. In the end, a brief description of the planned BRT-based IRT system of Cape Town is provided.

2.2 Typical characteristics of the urban poor

The following box contains Turner's (1980) early description of the urban poor.

Box 1: A profile of the urban poor

Turner (1980) describes the urban poor as follows: they ‘tend to have very low family incomes, high unemployment and underemployment, with the majority of jobs in the informal sector. Standard of education and health care would be poor and there would be a high proportion of children and young people in the population. Environmental standards would be very poor, with unpaved roads, no drainage or sewerage networks and inadequate water supply, usually wells or common stand-pipes. As a result there would be a high incidence of gastro-enteric diseases, particularly amongst children. The houses themselves would be of traditional construction of mud, stone, brick or timber, etc. Quite probably there would be a government housing project build of modern materials which, equally probably, would be inappropriate to the climate and too expensive for the poorest people to afford. Land ownership or tenure would be difficult to resolve and the high incidence of squatting would compound the problem. Social and institutional facilities would be poor or non-existent and there would be little open space for recreation. Climatic conditions would be extreme, with serious water shortages during the dry season or danger from floods in the monsoons.’

The 1990 World Development Report on poverty also characterizes the urban poor as those who are unable to consume a basic quantity of clean water, and who are subject to unsanitary surroundings, lack the minimum energy requirements and have extremely limited mobility or communications beyond their immediate settlements (Poswa, 2008).

2.3 Typical characteristics of the urban poor’s transport situation

The transport situation of the urban poor can typically be characterized as follows:

2.3.1 Typical characteristics of the urban poor’s settlement patterns that influence their transport situation

In many cities of the developing world (Asia, Latin America and Sub-Saharan Africa), poorer segments of society often live further from centers of employment, social and economic opportunity and therefore are subject to long commuting distances and travel times as well as high transport costs (Behrens et al, 2004; Booth et al, 2000; Diaz et al, 2007; Eugenia, undated; Fouracre et al, 1999; Fox, 2000; Gannon and Liu, 1997; Howe and Bryceson, 2000; Mitric et al, 2005 cited in Nyarirangwe and Mbara, 2007; Palmer et al, 1997; SITRASS, 2004; Sohail, 2000; Sohail et al, 2003; Sohail et al, 2005; Urban Resource Centre, 2001; Wright, 2004). This situation means that poor populations incur the greatest monetary and time costs in terms of accessing employment, education, shopping and medical facilities; factors which are essential for sustainable economic and social development (Gannon and Liu, 1997; Palmer et al, 1997; Wright, 2004).

Moreover, the frequent lack of adequate, efficient and affordable public transport services in low-income areas negatively impacts on the quality of life of the poor residents as it reduces their ability to access employment opportunities and distant essential urban services, and further reduces the opportunities that might be available to them (Diaz et al, 2003; Eugenia, undated; Gannon and Liu, 1997; Mitric et al, 2005 cited in Nyarirangwe and Mbara, 2007; Palmer et al, 1997; Sohail, 2000; Sohail, 2005; Sohail et al, 2005; Urban Resource Centre, 2001). Under such circumstances, there is less chance for educational development, the strengthening of social networks or additional livelihood possibilities (Booth et al, 2000; Urban Resource Centre, 2001).

2.3.2 Restricted transport modal choice of the urban poor

Poor populations generally do not own or have access to private vehicles and therefore mainly rely on public transport for motorized travel (Barter, 1999; Behrens et al, 2004; Diaz et al, 2007; Fouracre et
Therefore, for the use of motorized vehicles, the poor’s modal choice is limited to public transport only (Eugenia, undated; Mitric et al, 2005 cited in Nyarirangwe and Mbara, 2007; Sohail, 2005; Sohail, undated). It is therefore the poor who are most affected by the lack of adequate and affordable public transport provision (Fouracre et al, 1999; Sohail et al, 2005). The very poorest of the urban poor may not even have access to public transport to meet their access and mobility needs (Fouracre et al, 1999). It is important to note that the White Paper on National Transport Policy of 1996 and the Moving South Africa (MSA) of 1999 present a policy and strategic framework for urban passenger transport provision in which one of the central concerns may be interpreted as: the prioritization of the provision of public transport (and Non-motorized transport) to address the access and mobility needs of the more disadvantaged sectors of the population including the poor (NDoT, 1996 and 1999 cited in Wilkinson, 2008).

2.3.3 **Heavy transport costs burden borne by the urban poor**

Poor populations cannot afford regular/daily use of public transport (Barter, 1999; Behrens et al, 2004; Diaz and Godard, 2000; Diaz et al, 2007), and some may be unable to afford public transport at all (Booth et al, 2000). Poor households also tend to spend a larger percentage of their income on travel than others (Kwakye, 1997; cited in Booth et al, 2000; Diaz et al, 2007; Fox, 2000; Kwakye et al, 1997; Mitric et al, 2005 cited in Nyarirangwe and Mbara, 2007). Diaz et al (2007) ascertain that transport is a major component of poor household expenditure. For example, the range of household travel expenditure in Sub-Saharan African cities is 8% to 20% of total household budget (Diaz et al, 2007). This clearly constitutes a substantial financial burden, a substantial drain on already scarce financial assets and has negative implications for socio-economic equality (Barter, 1999; Booth et al, 2000; Diaz et al, 2007; Howe and Bryceson, 2000).

In the face of high transport costs, poor households must prioritize their transport needs and expenditure (Booth et al, 2000; Diaz et al, 2007). They frequently limit the use of motorised vehicles, predominantly public transport, to the most essential trips depending on the activity to be carried out and on the financial resources available at the time, as has been shown to be the case amongst female petty traders in Accra (Diaz et al, 2003; Diaz et al, 2007; Grieco et al, 1996 cited in Behrens et al, 2004). Otherwise, they must walk; sometimes long distances, in order to carry out activities in other districts (Behrens et al, 2004; Diaz et al, 2007).
2.3.4 Vulnerability to traffic accidents, crime and overcrowding of the urban poor

The urban poor are particularly vulnerable to traffic accidents and a high percentage of victims come from the poorer sectors of society (Gannon and Liu, 1997; Jacobs et al, 1999 cited in Booth et al, 2000). This is partly explained by the poor’s limited modal choice and also their little awareness of safety issues. The poor are restricted to walking or using public transport to meet their travel needs, and it is these modes that are the most vulnerable to traffic accidents (Diaz et al, 2007; Jacobs et al, 1999 cited in Booth et al, 2000; Sohail et al, 2003). In addition, the poor also have little choice in the type of motorized transport service they can afford, usually being obliged to travel in old, ill-maintained, and overcrowded vehicles operated by small-scale operators, the condition of which often is the cause of accidents as in Dakar with the cars rapides (Diaz and Godard, 2000; Gannon and Liu, 1997).

Worse still, the poor are less likely to be able to find remedies to the problems of overcrowding (resulting from insufficient public transport capacity) (Fox, 2000) and crime on-board and while waiting for public transport (Barter, 1999; Transport Research Laboratory, 2002). Both these problems are a particular problem to the women (who find overcrowding especially unacceptable and are most vulnerable to criminal activities) and can result in their shunning public transport and denying themselves important economic, educational and social opportunities (Barter, 1999; Fox, 2000).

The foregoing literature makes clear that there is a continuing problem in respect of the access and mobility of the urban poor (i.e., unacceptable travel conditions, high transport expenditure, long travel times and so on) (Booth et al, 2000; Fouracre et al, 1999). The following section touches on how these transport problems impact on the livelihoods of the urban poor.

2.4 Impacts of the urban poor’s transport problems on their livelihoods

High public transport costs faced by the urban poor;

- As mentioned before, take a disproportionate share of their households’ meagre incomes (Booth et al, 2000; Diaz et al, 2007; Fox; 2000);
- Reduce their access to basic needs (i.e., the need for employment (as a proxy for income), and access to health, education, water and energy supplies) (Howe and Bryceson, 2000; Rwebangira, 2000 cited in Nyarirangwe and Mbara, 2007)
- Tend to add to their households’ travel and economic difficulties and transport-related difficulties can reduce livelihood opportunities and lower potential for social and economic
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users
Case of Cape Town, South Africa

development (Fox, 2000; Diaz et al, 2003; Diaz et al, 2007; Howe and Bryceson, 2000; Urban Resource Centre, 2001); and

- Reinforce the tendency of the urban poor to remain in their own districts, as a survival strategy to face economic crisis, and therefore increases the vulnerability of the poor by hindering their building up of labor, human and social capital assets (Diaz et al, 2003; Diaz et al, 2007). This condition leads to the reproduction and perpetuation of their poverty (Diaz and Godard, 2000).

Put in much simpler terms, the socio-economic exclusion of the urban poor, due to high transport costs, will contribute to their poverty and trap them in poverty vicious cycles (Chambers et al, 1992 and Ellis, 2000 cited in Nyarirangwe and Mbara, 2007; Gannon and Liu, 1997). Isolation results in “poverty of ideas, poverty of health, poverty of opportunities, poverty of income and even poverty of hope for a better future” (the International Forum for Rural Transport and Development (IFRTD), 1992 quoted in Nyarirangwe and Mbara, 2007).

Long commuting distances and travel times faced by the urban poor have a negative impact on their human capital and productivity, since they induce fatigue and boredom, and use up both time and energy that could be spent on productive activities (e.g., spending time with family, income generation activities and so on) (Akinlo, 1998 cited in Booth et al, 2000; Diaz et al, 2003; Sohail, 2000; Urban Resource Centre, 2001). This, in turn, can cause the poverty cycle to perpetuate itself. For example, in Lagos, it is estimated that long waiting times of over 30 minutes for half the commuters reduces the time available for productive activities, which by implication results in increasing poverty levels (Booth et al, 2000).

Vulnerability to traffic accidents of the urban poor
Traffic accidents hurt the poor the most (Sohail, 2000). According to the Transport Research Laboratory (2002), the poor are particularly vulnerable to the shocks in their livelihoods created by traffic accidents. For example, the injury or death of a breadwinner is most likely to be a considerable internal shock which would impact negatively on the livelihood of the poor household (Barter, 1999; Booth et al, 2000; Transport Research Laboratory, 2002). The household loses the income and has to bear the additional cost (Sohail, 2000). However, improved safety of public transport would improve the livelihoods of the poor by the reducing the likelihood of a severe internal shock (Gannon and Liu, 1997; Booth et al, 2000).

Vulnerability to crime and overcrowding of the urban poor
Booth et al (2000) assert that crime and the fear of it will impact negatively on the livelihoods of the urban poor in a number of ways. For example, fear of theft, attack or harassment on public transport
will deter use and curtail freedom of movement and will, in turn, affect the poor’s ability to travel to their places of employment or access services. This, together with the problem of overcrowding (causing physical discomfort), is particularly so for poor women (Barter, 1999; Booth et al, 2000; Fox, 2000; Sohail, 2000). There is therefore a need to make public transport more safe and less overcrowded so that women’s economic, educational and social opportunities are not adversely affected (Kaur, 2000: 16 cited in Booth et al, 2000).

2.5 The crucial role of public transport in the lives of the urban poor

Public transport is of particular importance to the urban poor (who do not have access to private transport), as this is the only mode available to them to travel longer distances (CoCT, 2006; Iles, 2005; Kwakye et al, 1997; Sohail, 2000; Sohail, undated). Clearly, public transport makes a significant contribution to the livelihoods of the urban poor as it provides them with the means to access employment and income-generation opportunities, education, health, and social networks such as extended families (Booth et al, 2000; CoCT, 2006; Gannon and Liu, 1997; Nyarirangwe and Mbara, 2007; Sohail, 2000; Sohail et al, 2003; Sohail, 2005; Sohail et al, 2005; Sohail, undated; Transport Research Laboratory, 2002; Urban Resource Centre, 2001), which can help in securing incomes and necessary goods and services (Sohail, 2000; Sohail, 2005; Sohail, undated). Therefore, any improvement(s) in public transport provision – resulting in improved quality and security of access to work, markets, and services – will also improve the livelihoods and quality of life of the poor; enable the poor to develop and broaden their asset base; reduce the poor’s vulnerability to household-level risks such as medical emergencies; and reduce their poverty (Gannon and Liu, 1997; Booth et al, 2000; Kwakye et al, 1997; Sohail, 2000; Sohail et al, 2005; Sohail, 2005; Sohail, undated).

The foregoing shows that public transport represents a particularly important physical common-property asset to the urban poor, yet it is not often organised in a way that benefits them (Booth et al, 2000). According to Fox (2000) and Sohail et al (2005), the value of public transport in enabling the urban poor to have access to economic and social opportunities depends on accessibility, affordability and quality of the public transport services. Thus, the poor are expected to benefit from improved accessibility, reliability, travel times, affordability, frequency, capacity, safety and security (and so on) of public transport services (Barter, 1999; Booth et al, 2000; Gannon and Liu, 1997; Fox, 2000; Palmer et al, 1997; Sohail et al, 2005; Wright, 2004). As such, the formulation of appropriate transport responses to the travel needs of the urban poor should include the provision of improved public transport in terms of these identified criteria (Howe and Bryceson, 2000). It is also important to stress that access to affordable public transport services is especially critical for the urban poor as it offers a way out of economic and financial deprivation and social and physical isolation (Sohail et al,
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor (Sohail, 2000).

2.6 Problems and characteristics of road-based public transport systems in developing countries

The provision of public transport services in a large number of cities in the developing world often does little to meet the travel needs of the population, particularly residents of low income areas (Palmer, 1997; Wright, 2004). The road-based public transport in developing world cities is characterized by a myriad of informal and formal vans, mini-buses, and full-sized buses (Wright, 2004), and the services provided are generally poor and often regarded as inadequate. Standards of safety, security, comfort, convenience, regularity, punctuality (where schedules apply), reliability, and speed are often low, and low incomes also lead to problems of affordability of fares (Behrens et al., 2004; Eugenia, undated; Fouracre et al., 1999; Iles, 2005; Palmer et al., 1997; Wright, 2004). According to Iles (2005), there is also general public dissatisfaction in many developing countries with the quality of public transport services. Wright (2004) identifies the following deficiencies in the current services that the public transport customers typically complain about:

1. Inconvenience in terms of location of stations and frequency of services;
2. Failure to service key origins and destinations;
3. Fear of crime at stations and within public transport vehicles;
4. Lack of safety in terms of driver ability and roadworthiness of public transport vehicles;
5. Service is much slower than private vehicles, especially when public transport vehicles make frequent stops;
6. Overloading of vehicles makes ride uncomfortable;
7. Public transport can be relatively expensive for some developing-nation households;
8. Poor-quality or non-existent infrastructure (e.g., lack of shelters, unclean vehicles, etc.);
9. Lack of organized system structure and accompanying maps and information make the systems difficult to use; and

As mentioned earlier, in most developing world cities, the urban poor rely/depend heavily on public transport for accessibility and mobility (Kwakye et al., 1997; Sohail, 2005), and where there is a lack of accessible, adequate, affordable, safe, reliable public transport;

- There is a negative impact on the poor’s livelihoods (i.e., a considerable limit on their livelihood strategies) and therefore on their household incomes (Booth et al., 2000; Palmer et al., 1997; Sohail, 2005; Gannon and Liu, 1997);
- The poor are unable to accumulate human, physical, financial, and social assets to break out of the poverty cycle (Gannon and Liu, 1997); and
The poor are kept physically, socially and economically isolated and trapped in poverty (Gannon and Liu, 1997; Sohail et al, 2003).

2.7 Appeal of BRT for developing world cities

The foregoing indicates that there is an urgent need in many developing world cities to make improvements in public transport for the benefit of the poor (Fox, 2000). Wright (2004) asserts that BRT attempts to address each of the above-identified deficiencies in current services by providing a rapid, high quality, safe and secure transit option. Actually, in this day in age, the BRT concept is becoming increasingly utilized by cities looking for cost-effective transit solutions (Wright, 2004). BRT is growing in popularity throughout the world, notably in Asia, Europe and South America, in contrast to other forms of mass transit (such as light and heavy rail) mainly due to its cost-effectiveness (Hensher, 2006; Levinson et al, 2002) as well as the following merits (many being advantages over rail-based modes);

- **Flexibility** – BRT systems can be designed with considerable flexibility, and this flexibility leads to a wide range of integrated BRT systems (Diaz et al, 2004; Fox, 2000). Furthermore, BRT has great operational flexibility (Fouracre et al, 1999; Hensher, 2006; Levinson et al, 2002; Stephen and Mott, undated) (e.g., as passenger demand changes, BRT capacity and operations can be readily augmented or modified) (Fox, 2000);

- **Affordability** – BRT systems cost less to implement and have lower operating costs than rail systems (Fouracre et al, 1999; Fox, 2000; Hensher, 2006; Levinson et al, 2002; Stephen and Mott, undated; Wright, 2004; Viva, 2007). Lower operating costs may result in quite affordable fare levels (CoCT, 2006 and 2008; Howe, undated), and in turn help reduce the transport costs burden of the urban poor (Kwakye et al, 1997);

- **Capability to be implemented rapidly and incrementally** – BRT is capable of rapid implementation and therefore can have an immediate impact on existing public transport problems (Grava, 2003; Fouracre et al, 1999; Fox, 2000; Levinson et al, 2002). In addition, BRT systems can be implemented incrementally and are thus able to accommodate city specific constraints more readily than fixed track systems that need to be developed more fully (Fouracre et al, 1999; Fox, 2000; Hensher, 2006; Levinson et al, 2002; Stephen and Mott, undated). Unlike rail systems, limited BRT systems can be operated effectively as funding allows, with high benefits (e.g., the Quito experience) (Fox, 2000);

- **High capacity** – BRT also provides sufficient capacity to meet demands in many corridors, even in the largest metropolitan regions (Levinson et al, 2002). BRT high-capacities can match or exceed the passenger volumes of some of the busiest light rail systems (Hensher, 2006; Levinson et al, 2002).
Therefore, for cities in developing countries, BRT (a high-performance and high-quality but low-cost mass transit option (Levinson et al, 2002; Polzin and Baltes, 2002; Wright, 2004)) has much to recommend it (Fox, 2000). BRT is an attractive option for cities of the developing world for the above mentioned reasons to include meeting the access needs of the poor (Graeff, 2009). Fox (2000) asserts that although there are no quantified data, BRT is used by bus passengers who are likely to include many or most of the urban poor. According to him, the urban poor may benefit substantially from the improved accessibility and high-quality service which BRT bring (i.e., in the right environment), and it is clear that BRT should be strongly pro-poor. Fox (2000) further argues that BRT creates major accessibility benefits for the urban poor, particularly when they live in the outer city areas, and particularly with ‘open’ systems, or ‘trunk-and-feeder’ systems incorporating through-ticketing.

The BRT concept is described in greater detail below.

2.8 Conceptual clarification of BRT

2.8.1 Rapid transit concept

“Rapid transit is not a transport mode as such, but, as its name implies, is a means of mass transportation offering a faster service than the alternatives which are available, typically with average operating speeds of 50 kph or more; this generally requires exclusive rights of way” (Iles, 2005: 26). Rapid transit services are commonly provided by light rail, but certain heavy rail systems also fall into this category, as do bus, guided bus or trolleybus services which operate on dedicated rights-of-way and which are therefore faster than those sharing road space with other traffic (Iles, 2005). Accordingly, BRT is a bona fide rapid transit concept (Diaz et al, 2004; Diaz, 2009).

2.8.2 Bus Rapid Transit (BRT) concept

According to Wright (2004: 1), BRT can best be defined as “a mass transit system using exclusive right of way lanes that mimic the rapidity and performance of metro systems but utilize bus technology rather than rail vehicle technology.”

A more detailed definition from the BRT Implementation Guidelines is: 

\textit{BRT is a flexible, high performance rapid transit mode that combines a variety of physical, operating and system elements into a permanently integrated system with a quality image and unique identity (Levinson et al, 2003 cited in Diaz et al, 2004 and Diaz, 2009).}
In simple terms, “BRT is a flexible, permanently-integrated package of rapid transit elements with a quality image and distinct identity” (Diaz, 2009: 26). This definition highlights BRT’s flexibility and the fact that it encompasses a wide variety of applications, each one tailored to a particular set of travel markets and physical environments (Diaz et al, 2004; Diaz, 2009).

2.9 BRT elements, system performance and system benefits

This section explores BRT through a progression of three different perspectives. Firstly, seven major elements of BRT are presented along with their respective features and attributes. Secondly, key BRT system performance attributes and important benefits of integrated BRT systems are identified. Thirdly, the BRT elements are related to attributes of system performance. The section then concludes by an assessment of experience with BRT system performance. BRT elements, system performance and system benefits are shown in Figure 1 below. It is important to note that BRT systems are built by choosing and integrating among BRT elements. The integration of elements, in turn, improves system performance and the experience for customers. Improvements to system performance (in combination with features of BRT elements) generate benefits to transit agencies as well as communities (Diaz et al, 2004; Diaz, 2009).

![Figure 2: BRT elements, system performance and system benefits](Source: Diaz (2009))

2.9.1 Major Elements of BRT

The seven major elements of BRT include the following;

**Running Ways** – Running ways significantly impact travel speeds, reliability, and identity. Options range from general traffic lanes to fully grade-separated BRT transitways;

**Stations** – Stations, as the entry point to the BRT system, are the single most important customer interface, affecting accessibility, reliability, comfort, safety, and security, as well as dwell times, and system image. BRT station options vary from simple stops with basic shelters to complex stations and intermodal terminals with many amenities;
**Vehicles** – BRT systems can utilize a wide range of vehicles, from standard buses to specialized vehicles. Options vary in terms of size, propulsion system, design, internal configuration, and horizontal/longitudinal control, all of which impact system performance, capacity and service quality. Aesthetics, both internal and external are also important for establishing and reinforcing the brand identity of the system;

**Fare Collection** – Fare collection affects customer convenience and accessibility, as well as dwell times, service reliability and passenger security. Payment options range from traditional pay-on-board methods to pre-payment with electronic fare media (e.g., smart cards);

**Intelligent Transportation Systems (ITS)** – A wide variety of ITS technologies can be integrated into BRT systems to improve BRT system performance in terms of travel times, reliability, convenience, operational efficiency, safety and security. ITS options include vehicle priority, operations and maintenance management, operator communications, real-time passenger information, and safety and security systems; and

**Service and Operations Plan** – To design a service plan that meets the needs of the population and employment centres in the service area and matches the demand for service is a key step in defining a BRT system. How it is designed can impact system capacity, service reliability, and travel times, including wait and transfer times. Please note that BRT services are generally planned to provide frequent, all–day and direct services. In addition, the flexibility and low-cost of BRT allow it to provide greater network coverage; and

**Branding Elements** – Branding elements tie all of the various physical and service elements of BRT systems together. The approach to branding BRT systems packages all of the elements into a cohesive system and communicates the value of BRT elements to the travelling public (Diaz et al, 2004; Diaz, 2009; Jarzab et al, 2002; Levinson et al, 2002; NBRTI, undated; VMC, 2006).

### 2.9.2 BRT System Performance attributes

The following are the six key BRT system performance attributes. It is important to note that these six ways that BRT systems perform better also represent ways that transit passengers benefit from the implementation of BRT (Diaz, 2009).

**Travel Time** – represents the amount of time spent by passengers (and vehicles) from the beginning to the end of their trips. The impact of BRT systems on travel time savings depends on how each BRT element is implemented in a specific application and how they relate to each other and the other elements of the BRT system (Diaz et al, 2004; Diaz, 2009). The following are the several different travel time components that BRT systems impact;
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users

Case of Cape Town, South Africa

Running time – the time BRT vehicles and passengers actually spend moving. Running times are dependent on traffic congestion, delays at intersections, and the need to decelerate into and accelerate from stations;

Station dwell time – the time vehicles and passengers spend at stations while the vehicle is stopped to board and alight passengers; and

Waiting and transfer time – the amount of time passengers spend initially waiting to board a transit service and the amount of time they spend transferring from one BRT service to another or to other public transport services (e.g., local bus routes and rail) (Diaz et al, 2004; Diaz, 2009).

Reliability – represents the variability of travel times and is affected by many BRT features. The three main aspects of reliability include;

Running time reliability – is the ability of a BRT service to maintain a consistently high speed to provide customers with consistent travel times;

Station dwell time reliability – the ability for passengers to board and alight within a set timeframe, with varying loads of passengers at stations, especially as measured across varying levels of congestion at different periods of a service day and on vehicles, thereby minimizing delay at stations; and

Service reliability – The availability of consistent service (i.e., availability of service to patrons, the ability to recover from disruptions, availability of resources to consistently provide the scheduled level of service) (Diaz et al, 2004; Diaz, 2009).

Identity and image – capture how a BRT system is perceived by both passengers and non-passengers. These attributes reflect the effectiveness of a BRT system’s design in positioning it in the transportation market place and in fitting within the context of the urban environment. It is important both as a promotional and marketing tool for public transport patrons and for providing information to non-frequent users as to the location of BRT system access points (i.e., stops and stations) and routing (Diaz et al, 2004; Diaz, 2009). The following are the two major elements of BRT system image and identity that capture its identity as a product and as an element of the urban form;

Brand identity – reflects how the BRT system is positioned relative to the rest of the public transport system and other travel options. Effective design and integration of BRT elements reinforce a positive and attractive brand identity that motivates potential customers and makes it easier for them to use the system; and

Contextual design – measures how effectively the design of the BRT system is integrated with the surrounding urban environment (Diaz et al, 2004; Diaz, 2009).

Safety and security for public transport customers and the general public can be improved with the implementation of BRT systems, where these are defined as:
● Safety – freedom from hazards, as demonstrated by reduced accident rates, injuries, and improved public perception of safety; and

● Security – the actual and perceived freedom from criminal activities and potential threats against customers and property (Diaz et al., 2004; Diaz, 2009).

Capacity – is defined as “the maximum number of passengers that can be carried past a point in a given direction, during a given period along the critical section of a given BRT under specific operating conditions.” Virtually all BRT elements affect capacity (Diaz et al., 2004: 125).

Accessibility – describes the general availability of service to all public transport users or proximity to points of access (stations and stops) of the public transport system. In a more specific sense, accessibility describes the ability and ease with which individuals with disabilities can use the public transport system (Diaz, 2009).

2.9.3 BRT System Benefits

In addition to affecting how the BRT system itself performs, BRT system elements also have positive benefits to the user, on the public transport system as a whole, and the communities in which BRT systems operate. As indicated in Figure 1 before, the five key benefits of implementing BRT include: additional ridership, cost effectiveness¹ and operating efficiencies² as well as increases in transit-supportive land development, and environmental quality (Diaz et al., 2004; Diaz, 2009; NBRTI, undated; VMC, 2006). However, these shall not be explored in detail since they fall out of the scope of this study.

2.9.4 Effects of BRT Elements on System Performance

As illustrated above, each of the BRT system elements has different effects on system performance. A summary of which elements directly affects each attribute of system performance is presented below.

¹ Refers to the effectiveness of a given project in achieving stated goals and objectives per unit investment; and

² Suggests how well BRT system elements support effective deployment of resources in serving transit passengers (Diaz et al., 2004; Diaz, 2009).
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users
Case of Cape Town, South Africa

Table 1: Summary of which elements directly affects each attribute of system performance

<table>
<thead>
<tr>
<th>System Performance</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RUNNING WAY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Way Location</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Level of Transit Priority</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Running Way Marking</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Way Guidance</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station Location and Type</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Amenities</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curb Design</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platform Layout</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Passing Capability</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Station Access</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>VEHICLES</strong></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Vehicle Configuration</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Aesthetic Enhancement</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Circulation Enhancement</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Propulsion Systems</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>FARE COLLECTION</strong></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fare Collection Process</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fare Media / Payment Options</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fare Structure</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>INTELLIGENT TRANSPORTATION SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Prioritization</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Intelligent Vehicle Systems</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Operations Management Systems</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Passenger Information Systems</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Safety and Security Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SERVICE AND OPERATING PLANS</strong></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route Length</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Route Structure</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Span of Service</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Frequency of Service</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Station Spacing</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>BRANDING ELEMENTS</strong></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing Classification of BRT Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branding Devices</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)

The following tables discuss in summary how each BRT element contributes to transit objectives/transit system performance, including reducing travel times, improving reliability, providing identity and a quality image, improving safety and security, increasing capacity and enhancing accessibility (Diaz et al, 2004; Diaz, 2009; NBRTI, undated).
Table 2: Summary of Effects of Running Way Elements on System Performance

<table>
<thead>
<tr>
<th>Running Way Location</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-Street</td>
<td>Off-street running ways normally reduce running time more than on-street but may increase access time.</td>
<td>Off-street running ways should provide greater reliability except on congested freeways.</td>
<td>Exclusive busways can become part of the image of a BRT and the subject of a marketing a campaign. An off-street transitway can be used as the primary branding element of a BRT. An on-street running way can be part of an overall streetscape renovation or upgrade.</td>
<td>Segregation from other traffic and pedestrians may decrease BRT vehicle collisions compared to on-street operations.</td>
<td>Off-street running ways may have higher capacity due increased number and frequency of transit vehicles that the bus lanes can accommodate. Off-street running ways may allow multiple lanes, which accommodates more vehicles and express or limited stop service as well as all-stop service.</td>
<td>On-street running ways are generally closer to land uses, require less walking and access time, and have fewer physical barriers.</td>
</tr>
<tr>
<td>Off-Street</td>
<td>Priority measures, if effectively implemented and enforced, should reduce running time, particularly in congested situations.</td>
<td>Priority measures should improve reliability.</td>
<td>Clear, enforced priority for running ways operating on regular streets improves the visibility and image of transit.</td>
<td>Separation of BRT vehicles from other traffic can reduce collisions.</td>
<td>Priority measures that reduce congestion delay also increase throughput.</td>
<td></td>
</tr>
<tr>
<td>Level of Transit Priority</td>
<td>Priority measures, if effectively implemented and enforced, should reduce running time, particularly in congested situations.</td>
<td>Priority measures should improve reliability.</td>
<td>Clear, enforced priority for running ways operating on regular streets improves the visibility and image of transit.</td>
<td>Separation of BRT vehicles from other traffic can reduce collisions.</td>
<td>Priority measures that reduce congestion delay also increase throughput.</td>
<td></td>
</tr>
<tr>
<td>Off-Street</td>
<td>Both at-grade and grade-separated running ways demonstrate good travel time reliability.</td>
<td>Both grade-separated and at-grade transitways can be used as the system’s central branding element.</td>
<td>Potential conflict points such as cross-street intersections and other at-grade vehicle and pedestrian crossings must be addressed.</td>
<td>Busways that bypass street-level intersections can accommodate higher vehicle numbers and frequency.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Way Marking</td>
<td>Clear designation of exclusive running ways can reduce unauthorized use.</td>
<td>Clear designation of exclusive running ways can reduce unauthorized use.</td>
<td>Markings highlight that BRT running ways are a special reserved treatment. Attractive markings or pavement coloring can enhance the system’s visual image.</td>
<td>Clear designation of exclusive running ways may reduce unauthorized use and thus increase throughput.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Way Guidance Type</td>
<td>Curb guidance reduces running time, especially in narrow rights-of-way. May allow bus lanes or transitways to fit where otherwise infeasible.</td>
<td>Precision docking allows level boarding and thus reduces boarding and alighting delay.</td>
<td>Guidance provides a smoother ride, enhancing image.</td>
<td>Curb guidance permits safer operation at higher speeds in narrow corridors.</td>
<td>Guidance may increase throughput through reduced running time and boarding delay.</td>
<td>Guidance systems can reduce the horizontal gap between vehicles and stations, facilitating boarding for all passengers, but especially for passengers who use wheelchairs or other mobility aids.</td>
</tr>
</tbody>
</table>

Source: Diaz (2009)
Table 3: Summary of Effects of Station Elements on System Performance

<table>
<thead>
<tr>
<th>Station Location and Type</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• On-Street, No Shelter</td>
<td>Stops adjacent to the running way minimize delay from circuitious routing. Transit centers can reduce wait and transfer times between transit services. Off-street or off-line stations may increase transfer times to other transit services.</td>
<td>More distinct stations enhance the system’s brand identity and present a “high quality” image. Stations can be architecturally noteworthy spaces, especially station buildings. On-street stations should complement and enhance public street-scapes. Off-street stations may mitigate noise and vibration impacts. They also provide opportunities for landscaping and sound walls.</td>
<td>Off-street stations may raise safety concerns if they are isolated from pedestrian and motor traffic. Transit centers and larger stops concentrate activity and thus make bus stops feel safer. On-street stations need to protect passengers from motorists. Station designs can enhance security by using transparent materials and ensuring good sightlines.</td>
<td>Larger stations increase loading capacity.</td>
<td>On-street station locations, especially those where station platforms are adjacent to street curbs, tend to have easier access. More complex station types – station enclosures, station buildings, and intermodal terminals or transit centers – tend to require additional design attention to ensure barrier-free access and ease of entry and transfers.</td>
<td></td>
</tr>
</tbody>
</table>

| Passenger Amenities | Complete, accurate, and up-to-date information reduces real and perceived waiting time. | Real-time info may provide perception of reliability. | Amenities make customers feel comfortable and well-served. They can reinforce a high quality image. | Lighting, video surveillance, and positive image contribute to safety. | Information amenities such as maps and real-time information can incorporate accommodations for people with vision and people with hearing impairments (real-time variable message signs). |

| Curb Design | Reduced vertical and horizontal gaps facilitate boarding and reduce dwell time. | Reduced vertical and horizontal gaps facilitate boarding and reduce dwell time variability, particularly if wheelchair ramps are not required. | Level platforms present an image of advanced technology, similar to rail. | Minimizing vertical and horizontal clearance may reduce tripping during boarding and alighting and may facilitate faster unloading during an emergency. | Reduced dwell times resulting from faster level boarding increase station throughput. | Curb designs that minimize the vertical gap between station platform and vehicle floors facilitate boarding for all groups. Level boarding treatments allow for people using wheelchairs to board without ramps. Use of detectable warning strips at boarding and alighting demarcations is an effective limit setting measure and provides delineators of the station areas. |

| Platform Layout | Allowing multiple vehicles to load and unload facilitates lower station clearance time. | Allowing multiple vehicles to load and unload reduces potential delays. | Long platforms with unassigned berths create confusion for passengers. | Longer platforms limit queuing delays for vehicles waiting to load and permit a variety of service options. | Platform layouts with assigned and well-signed berths create a system that it is easy to understand and navigate. |

| Passing Capability | Passing at stations allows for express routes and minimizes delays at stations. Bus pullouts in | | | | |

Case of Cape Town, South Africa
mixed traffic situations lead to delays.

recovery.

variety of service options.

<table>
<thead>
<tr>
<th>Station Access</th>
<th>Reduced vertical and horizontal gaps facilitate boarding and reduce dwell time.</th>
<th>Treatments to high-light station access make transit seem open, welcoming, and easy to use.</th>
<th>Better pedestrian linkages facilitate integration with communities.</th>
<th>Good integration to surrounding infrastructure, especially pedestrian linkages, allows barrier-free access to/from the station and between transit elements and modes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pedestrian Linkages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Park-and-Ride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)
### Table 4: Summary of Effects of Vehicle Elements on System Performance

<table>
<thead>
<tr>
<th>Vehicle Configurations</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low floors reduce dwell time delays.</td>
<td>Low floors may reduce variation in dwell time between peak and non-peak hours.</td>
<td>Advanced vehicles present a high-quality image and can appear rail-like. Stylized and articulated vehicles can be easily distinguished from other fleets.</td>
<td>Low floors may diminish tripping hazards.</td>
<td>Larger vehicles increase system capacity.</td>
<td>Partial low-floor vehicles comply with minimum access standards for passengers with disabilities. Specialized BRT vehicles, with low floors throughout the interior allow easier access for all.</td>
</tr>
</tbody>
</table>

**Aesthetic Enhancement**
- Specialized Logos and Livery
- Larger Windows and Enhanced Lighting
- Enhanced Interior Amenity

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved passenger circulation and disabled access, as well as multi-door boarding, reduce dwell time delays. Bike securement strategies can increase dwell times.</td>
<td>Improved passenger circulation may reduce variation between peak and non-peak hours.</td>
<td>Improved access to mobility impaired groups enhances image of service. Left side doors simulate rail systems. Alternative seat layouts can also simulate rail cars.</td>
<td>Improved passenger circulation and multi-door boarding increases vehicle throughput of BRT facilities. Interior bike securement can reduce interior capacity.</td>
<td>Improved passenger circulation treatments facilitate boarding for people with disabilities. Enhanced wheelchair securement systems provide a safer, more accessible environment, while limiting delay for persons using wheelchairs and scooters.</td>
</tr>
</tbody>
</table>

**Passenger Circulation Enhancement**
- Alternative Seat Layout
- Additional Door Channels
- Left Side Doors
- Enhanced Wheelchair Securement
- Interior Bicycle Securement

**Propulsion Systems**
- Internal Combustion Engines
- Fuel Choice (USLD, CNG)
- Trolley, Dual Mode and Thermal-Electric Drives
- Hybrid-Electric Drive Fuel Cells

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles powered by electricity (trolley, dual-mode, and hybrid-electric drives) have faster acceleration rates from stops.</td>
<td>Diesel buses are the most reliable technology. Early hybrids had lower reliability than diesels, but recent hybrids have good reliability.</td>
<td>Low emissions systems enhance the environmental image of BRT. Some propulsion systems may create noise or vibration impacts. Hybrids reduce noise.</td>
<td>Propulsion systems that provide a gentler ride, such as those with electric drive, increase on-board safety and comfort.</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Diaz (2009)*

The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users  
*Case of Cape Town, South Africa*  
Page 23
### Table 5: Summary of Effects of Fare Collection Elements on System Performance

<table>
<thead>
<tr>
<th>Fare Collection Process</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibilit y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-board payment enables all-door boarding, reducing vehicle dwell time and, thus, overall travel time. On-board conductor-validated fare payment allows faster boarding than driver-based onboard payment.</td>
<td>Off-board payment enables all-door boarding, reducing delays due to irregular dwell time and thus improving reliability.</td>
<td>Off-board payment, especially barrier-enforced fare collection, may convey image of a higher quality service and appear more rail-like.</td>
<td>Bus operators provide presence on all vehicles. Fare inspectors provide additional presence on vehicles and at stops/stations. POP may create additional security needs.</td>
<td>Travel time savings and improved reliability from all-door boarding improve system throughput.</td>
<td>Off-vehicle payment increases onboard space to manoeuvre with mobility aids.</td>
<td></td>
</tr>
<tr>
<td>Fare Media/Payment Options</td>
<td>Contactless smart cards (or flash passes) permit faster processing times than cash and magnetic stripe cards and thus the potential to reduce boarding times. Smart cards and farecards that can be used for other modes can reduce ease the transfer process.</td>
<td>Contactless smart cards (or flash passes) permit faster processing times than cash and magnetic stripe cards and thus increase potential for reducing dwell time delays especially during peak hours.</td>
<td>Electronic fare collection (magnetic strip and smart cards) and emerging options (credit/debit cards and mobile phones) enhance convenience, can take advantage of multiple applications, and may convey image of a higher quality service. Electronic fare collection that can also be used for rail modes reinforces a sense of an integrated rapid transit network.</td>
<td>Travel time savings and improved reliability from use of contactless smart cards improves system throughput.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare Structure</td>
<td>Differentiated fares are more complicated and may slow down boarding, increasing dwell time and overall travel time.</td>
<td>Differentiated fares are more complicated and may slow down boarding, increasing dwell time and reducing reliability.</td>
<td>Premium fares may convey image of a higher level of service.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)


Table 6: Summary of Effects of Intelligent Transportation System Elements on System Performance

<table>
<thead>
<tr>
<th>Element</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Vehicle Prioritization</td>
<td>Transit vehicle prioritization minimizes congestion and signal delays, improving travel times over local service and reducing wait times.</td>
<td>Transit signal priority, and to a lesser degree optimization of signal timing/phasing, facilitate schedule adherence and recovery.</td>
<td>Faster speeds enabled by signal priority enhancement image.</td>
<td>Bus operators provide presence on all vehicles. Fare inspectors provide additional presence on vehicles and at stops/stations.</td>
<td>Vehicle prioritization increases speed and throughput of running ways.</td>
<td></td>
</tr>
<tr>
<td>Optimization of Signal Timing/Phasing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station and Lane Access Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Signal Priority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligent Vehicle Systems</td>
<td>Precision docking allows for faster approaches to stations and reduced dwell times. Guidance may increase travel speed.</td>
<td>Precision docking facilitates boarding and reduces dwell time variability.</td>
<td>Precision docking and guidance promote an image of BRT as advanced or cutting-edge.</td>
<td>Affects service quality only.</td>
<td>Precision docking limits delays at stations, increasing throughput. Guidance systems increase travel speed, also increasing throughput.</td>
<td>Guidance systems reduce lane crosswidth, providing more space for sidewalk access facilities. Precision docking may enhance boarding and alighting by eliminating the gap between vehicle and station.</td>
</tr>
<tr>
<td>Collision Warning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precision Docking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane-Keeping Assistance Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Aided Dispatch (CAD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Vehicle Location (AVL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated Scheduling and Dispatch Software</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automated Passenger Counters (APC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Component Monitoring System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Information Systems</td>
<td>Effective pre-trip information coupled with reliable service minimizes wait time. Wayside/in-terminal information minimizes wait time perceptions.</td>
<td>Passenger Information allows for notices of service interruption, increasing service reliability and perceptions of reliability.</td>
<td>Passenger information systems enhance brand identity and provide a channel to communicate with customers.</td>
<td>Passenger information systems allow for communication of security threats.</td>
<td></td>
<td>Real-time passenger information tools must be designed to be used and understood by all passengers.</td>
</tr>
<tr>
<td>Pre-Trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>En-Route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Station/Terminal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Vehicle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety and Security</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Board Silent Alarms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Board Voice Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Board Video Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)
### Table 7: Summary of Effects of Service and Operations Plan Elements on System Performance

<table>
<thead>
<tr>
<th>System Performance</th>
<th>Route Length</th>
<th>Route Structure and Type</th>
<th>Span of Service</th>
<th>Frequency of Service</th>
<th>Station Spacing Narrow/Wide</th>
<th>Method of Schedule Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Longer routes may decrease the need for transfers.</td>
<td>Integrated route structures reduce the need for transfers. Express and Skip-Stop routes have shorter travel times than local service and can reduce systemwide travel times by spreading passenger loads and reducing station dwell times on local routes.</td>
<td>Wide spans of service suggest the service is dependable.</td>
<td>More frequent services reduce waiting time.</td>
<td>Less frequent station spacing has a major impact on travel time by increasing overall system speeds.</td>
<td>Headway-based control for high frequency operations maximizes speeds.</td>
</tr>
<tr>
<td>Travel Time Savings</td>
<td>Shorter route lengths may promote greater control of reliability.</td>
<td>Express and Skip-Stop routes can prevent bus bunching and reduce variability between peak and non-peak hour operations. They can cause congestion at stations if stations are not designed to accommodate multiple vehicles.</td>
<td>Peak-hour only service may require strong education efforts to make riders aware of service availability and schedule.</td>
<td>High frequencies limit the impact of service interruptions. Frequent service may experience bus bunching problems.</td>
<td>Less frequent station spacing limits variation in dwell time.</td>
<td>Headway-based control may result in variability between peak and non-peak hours, while schedule-based control can make service seem unreliable if schedules cannot be maintained during peak hours.</td>
</tr>
<tr>
<td>Reliability</td>
<td>Distinctions between BRT and other service may better define brand identity. Creating a strong image is important to avoid confusion for riders in differentiating these services. Integrated route structures may widen exposure to the brand.</td>
<td>Frequent service can make BRT appear more like some rail systems. It also makes BRT easier to use, which enhances its image as a premium service.</td>
<td>Increased frequency is a key determinant of operating capacity. Service frequency is limited by system capacity (vehicle, station and running way capacities).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identity and Image</td>
<td>Safety and Security</td>
<td>Capacity</td>
<td>Capacity Accessibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)
Table 8: Summary of Effects of Branding Elements on System Performance

<table>
<thead>
<tr>
<th>Marketing Classification</th>
<th>Travel Time Savings</th>
<th>Reliability</th>
<th>Identity and Image</th>
<th>Safety and Security</th>
<th>Capacity</th>
<th>Capacity Accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branding Devices</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
<td>Classifying BRT as a separate Tier of Service or as a Rapid Transit Route builds and reinforces Brand Identity</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
</tr>
<tr>
<td>• Brand Name</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
<td>Use of branding devices such as brand names, logos, color schemes accentuates brand identity and contributes to comprehensive contextual design of BRT systems</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
<td>Minimal impact</td>
</tr>
<tr>
<td>• Logo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Designated Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Other Branding Devices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Diaz (2009)
The above tables clearly spell out that BRT programs and actions are intended to achieve the following:

- **Reduced travel times**, by saving time at stops and while under way;
- **Improved reliability**, by minimizing all factors that can interfere with vehicle flow and providing responsive management controls;
- **Upgraded human amenities**, by providing attractive facilities and spaces inside and outside the vehicle and offering useful information to riders; and
- **Improved safety and security**, by providing monitoring systems, removing potentially dangerous features, and bringing many riders on the system;
- **Providing identity and a quality image**, by, again, providing attractive facilities and spaces as well as incorporating distinctive features;
- **Improved accessibility**, by incorporating design options that greatly improve the accessibility of a BRT system to mobility impaired and other riders; and
- **Increasing capacity**, by implementing various strategies that improve the throughput of the systems (Diaz et al., 2004; Diaz, 2009; Grava, 2003; NBRTI, undated).

### 2.9.5 Experience with BRT System Performance

BRT system performance can be assessed based on the experience of at least 40 systems across the United States and the world. The experience suggests that there are concrete improvements to travel time, reliability, and capacity as well as perceptions of improvements in safety and security and image and identity (Diaz et al., 2004; Diaz, 2009).

**Travel time and speed.** With regard to total BRT travel times, BRT projects with more exclusive running ways generally experienced the greatest travel time savings compared to the local bus route. Exclusive transitway projects operated at speeds (including stops) between 32 and 48 kilometres per hour (i.e., a travel time rate between 1 to 2 minutes per kilometre), with even higher speeds demonstrated along the portions of the routes in exclusive sections. Arterial BRT projects in mixed-flow traffic or designated lanes operated at between 19 and 29 kilometres per hour (i.e., between 2 and 3.5 minutes per kilometre). Demonstration of low dwell times per passenger is most evident where there are high passenger loads, pre-paid fare collection systems, and all-door level boarding (such as in many of the Latin American systems) (Diaz et al., 2004; Diaz, 2009).

**Reliability.** Performance in reliability also demonstrated a similar pattern as travel times. As expected, systems with more exclusive transitways demonstrated the most reliability and the least schedule variability and bunching. The ability to track reliability changes has been limited by the fact that most
transit agencies do not regularly measure this performance attribute. New automated vehicle location systems may, however, allow for the objective and conclusive measurement of reliability (Diaz et al., 2004; Diaz, 2009).

**Image and Identity.** Most BRT systems in the United States and internationally are successfully marketed as distinct brands of service through a combination of high quality service attributes and explicit use of branding devices. Performance in achieving a distinct brand identity for BRT has been measured by in-depth passenger surveys. The more successful BRT systems have been able to achieve a distinct identity and position in the respective region’s family of transit services. BRT passengers generally had higher customer satisfaction and rated service quality higher for BRT systems than for their parallel local transit services (Diaz et al., 2004; Diaz, 2009).

**Safety and Security.** Data measuring the difference in safety and security of BRT systems as compared with the rest of the respective region’s transit system are rarely collected. Therefore drawing conclusions about the ability of BRT elements in promoting safety and security is premature. Data from Pittsburgh, however, suggest that BRT operations on exclusive transitways have significantly fewer accidents per unit (vehicle mile or vehicle hour) of service than conventional local transit operations in mixed traffic. Customer perceptions of “personal safety” or security reveal that customers perceive BRT systems to be safer than the rest of the transit system (Diaz et al., 2004; Diaz, 2009).

**Capacity.** For virtually all BRT systems implemented in the United States, capacity has not been an issue. To date, none of them have been operated at their maximum capacity. On all systems, there is significant room to expand operated capacity by operating larger vehicles, higher frequencies, or both. International cases, especially in Latin America and Asia, demonstrate abilities to host significant loads of passengers with faster travel times and reliability (Diaz et al., 2004; Diaz, 2009).

2.10 What BRT is and what it is not

2.10.1 What BRT is

There is uncertainty among elected officials and even some transit professionals about what BRT is and how it differs from conventional bus services and systems. While this question is difficult to answer, in part because the options available for each BRT element are so extensive that there are an infinite variety of integrated BRT systems (Diaz et al., 2004; Diaz, 2009), it can be said with much confidence that BRT is far more than just a bus (Hensher, 2006; Wright, 2004). Wright (2004) ascertains that while BRT utilizes rubber-tyred vehicles, it has little else in common with standard bus
services and systems. Under its current definition, BRT is “a systematically coordinated service, fully integrated with other modes in a community” (Grava, 2003: 384). Unlike conventional bus services and systems which rely on fairly standard equipment and operating procedures, BRT involves the following:

- Rolling stock of improved design;
- Expanded physical facilities, including possibly preferential or exclusive lanes;
- Upgraded operational procedures, ranging from fare collection to traffic signals; and
- Advanced information and control methods, relying mostly on intelligent transportation systems (ITS) (Grava, 2003).

These BRT programs and actions are all different and are tailor-made for each situation. As mentioned before, they are aimed at providing faster, more reliable and convenient bus services than those provided by conventional bus operations. The services provided by conventional buses are too often unattractive, unreliable, time consuming, inaccessible, inconvenient, crowded, dirty, and unsafe (Grava, 2003; TCRP Report 63 cited in Diaz, 2009; Wright, 2004; VMC, 2006). In this light, BRT should not be seen as a separate transportation mode nor as just an additional bus service, but rather as an advanced variant of the conventional bus mode (Grava, 2003; Iles, 2005; Levinson et al, 2002).

Possibly, the most fundamental difference between BRT and conventional bus services (and other transit modes) is BRT’s central focus on the customer. BRT systems are designed around the customer-based needs of speed, comfort, convenience, cost, and safety rather than around a specific technology. The quality of customer service is directly related to customer satisfaction. Accordingly, BRT is generally defined as a high-quality, customer-oriented transit that delivers fast, comfortable and cost-effective urban mobility. All in all, BRT is really just a collection of best practice traits from a range of mass transit options (Wright, 2004; VMC, 2006). For instance, BRT combines the quality of rail transit and the flexibility of buses (Diaz, 2003; Thomas, 2001 cited in Levinson et al, 2002).

2.10.2 What BRT is not

BRT is not so much a concern with the vehicle itself as it is a matter of how it is operated and to what extent it receives full or partial priority on public rights-of-way (Grava, 2003). It is also not just about the exclusive lanes, excluding the other key system elements, which would result in a bad quality system that does not function efficiently with the desired impacts. A BRT system is about a total quality approach and involves more than the bus lanes (Diaz, 2003; Fox, 2000; Levinson et al, 2002). The afore-mentioned key system elements and their integration are equally, if not more important to form a fully integrated BRT system which will ensure fast, reliable, safe and secure, accessible, high
capacity service, which also has a distinct identity (Diaz et al, 2004; Diaz, 2009; Levinson et al, 2002).

2.11 Common BRT System Features

According to Wright (2004), there is no precise definition of what constitutes a BRT system and what represents simply an improved transit system. However, the following is a list of features found on some of the most successful BRT systems implemented to date:

- Exclusive right of way lanes;
- Rapid boarding and alighting;
- Free transfers between lines;
- Efficient pre-board fare collection and fare verification;
- Enclosed stations that are clean, secure and comfortable;
- Clear and prominent route maps, signage, and real-time information displays;
- Transit priorities at intersections;
- Modal integration at stations and terminals;
- Clean bus technologies; and
- Excellence in marketing and customer service (Wright, 2004; VMC, 2006)

It should be noted that local circumstances dictate the extent to which the above characteristics are actually utilized within a system (Wright, 2004). It is also important to note that the acronym BRT may be new, but the concepts of rapid bus operation are old and well tested (Grava, 2003; Levinson et al, 2002). Virtually, many of the concepts at the heart of BRT have been in use for decades. In particular, dedicated transitways/busways and exclusive bus lanes, limited-stop and express services have become part of the transit planning vocabulary because they have enhanced speed and reliability and thus encouraged public transport usage (Diaz et al, 2004; Diaz, 2009).

BRT was successfully implemented in Latin American cities, such as Curitiba, Bogotá and Sao Paulo, as well as elsewhere including Brisbane, Los Angeles, Ottawa, Rouen, Beijing, Delhi, Jakarta, Nagoya, and Taipei. It has become a global phenomenon synonymous with quality public transport (CoCT, 2006 and 2008).

2.12 Problems and characteristics of Cape Town’s public transport system

Public transport services in the city of Cape Town are provided by three main modes – over ground rail, formal bus services and paratransit in the form of minibus taxis (Behrens et al, 2004; Clark,
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users  
Case of Cape Town, South Africa

Despite high government expenditure on public transport subsidies, the existing public transport system is inadequate and ineffective in meeting user needs. (Clark, 2000; CoCT, 2006; CoCT, 2010). Public Consultation as an informant to Transport Needs Assessment of the Integrated Transport Plan (ITP) identified the following specific issues and/or concerns raised by I&APs;

“The majority of the public transport users interviewed were dissatisfied with the current public transport system and that they felt it was inadequate. It was believed that the government was not actively improving the quality and frequency of services that also included safety and security issues, which were considered to be of huge concern by those interviewed. Other issues raised included the unreliability of services (insufficient and infrequent), overcrowding, uncomfortable and unsafe minibuses, safety and security at train stations during off-peak times, badly maintained taxis that drove recklessly. Infrastructure (more bus shelters, lane dedicated for public transport users) also required attention. Other issues that were raised included no facilities for physically disabled users, as well as no bus/ taxi routes in many areas” (CoCT, 2006: 219).

The Integrated Rapid Transit (IRT) system currently being implemented in Cape Town is intended to address these issues (i.e., the poor standard of public transport services), and transform public transport by dramatically improving the customer experience (CoCT, 2006; CoCT, 2008; Wilkinson, 2009). In particular, it is aimed at ensuring that all segments of society receive an equal, high-quality public transport experience, especially through consideration of the special needs of the transport disadvantaged to include low-income earners (CoCT, 2010). The decision to implement such a system was prompted by the recognition that the current fragmented and non-integrated public transport services are unsustainable – creating daily hardship for thousands of residents, especially poorer
communities living far from the centre of economic activity, and hampering economic growth and development (Cape Argus, 2009-08-05; Creamer Media’s Engineering News, 2009; CoCT, 2008).

2.13 Cape Town’s Integrated Rapid Transit (IRT) System

2.13.1 What an Integrated Rapid Transit (IRT) system is

The IRT system is part of a national public transport oriented initiative that is being implemented in Cape Town amongst other major South African cities (CoCT, 2006 and 2008; Wilkinson, 2009; Schalekamp and Behrens, 2009). It offers a way of ensuring that all modes of public transport work together and have priority over private transport. A major component of this is a BRT system to provide commuters a modern, regular, fast, frequent, reliable, comfortable, safe and affordable public transport service (Creamer Media’s Engineering News, 2009; CoCT, 2006; CoCT, 2008; CoCT, undated; CoCT, 2010b). Cape Town’s IRT system, based on the concept and principles of a BRT, draws on successful examples from countries in South America, Asia, North America and Europe, where excellent and affordable BRT systems have been established (CoCT, 2006; CoCT, 2008; CoCT, 2010b).

2.13.2 How different the IRT is from existing services

Unlike existing public transport services in Cape Town, IRT services will be;

Faster. On trunk routes vehicles will have their own lane and there will be a regular, frequent, scheduled service on feeder routes;

Safer. There will be security personnel at the main stations with CCTV cameras in the stations and vehicles. Security will be a priority. Drivers will be monitored and vehicle tracking will ensure that there is no speeding or reckless driving and that vehicles will be at the stations on time;

Comfortable and accessible. The vehicles will be modern and clean, with space for seated and standing passengers. The vehicles are also adapted to be accessible to the elderly, children and people with disabilities and to provide space for wheelchairs;

Sustainable. Low-emission vehicles and more people using public transport rather than private cars will offer environmental benefits;

Affordable. While establishing the system will cost billions of Rands (see Section 2.13.6), the aim is to have fares that are comparable with those currently charged; and

Easy to use. A smart card system will be used that will allow passengers to transfer from one trunk route to another on a single fare. These cards will be widely available at stations and through other retailers (CoCT, 2010a; CoCT, 2010b).
In short, the IRT system will offer a considerably higher level and quality of service than is provided by the current road-based public transport operators at fare levels that are comparable (CoCT, 2010a; CoCT, 2010c). Amended tariffs for IRT services are shown in the fare level list attached in the annex section (Annex B). It should be noted that the City of Cape Town is investigating the following mechanisms to ensure that the proposed IRT fares are comparable with current road based public transport fares:

- **Transport fare products.** These products generally provide discounts for regular usage (such as weekly and monthly concessions). The city is investigating its fare system design and management capabilities to minimise unacceptable gaming; and

- **Off-peak travel incentives.** The city is investigating further and more significant reduction in off-peak fares. This generally complements and supports customers that travel further distances (i.e., the poor) and are forced to leave early (before the peak hour) to reach their workplace accordingly. The challenge (which the city is currently investigating) is the return trip home which normally coincides with the evening peak hour (CoCT, 2010a; CoCT, 2010c).

### 2.13.3 What the IRT comprises of

The IRT will operate along a network of routes and corridors (CoCT, 2006), and there will be two parts to the service – trunk routes and feeder routes. The trunk routes will largely feature median busways, 18m articulated vehicles, median and weatherproof stations, platform level boarding, and pre-board fare verification. The complementary set of feeder services will connect communities with trunk routes using smaller 8m and 12m vehicles running on normal streets (CoCT, undated; CoCT, 2010a; CoCT, 2010b; Viva, 2007). The service will run for far longer (19 hours a day) and will be regular, frequent and reliable. The frequencies will range between a few minutes in peak hours and at least three times an hour when there is less demand. Fares will be affordable and comparable with those charged by buses and minibuses at the moment (CoCT, 2010a; CoCT, 2010b).

### 2.13.4 Implications of implementing the IRT for passengers

The implementation of the IRT system will therefore bring the following key benefits to public transport users; lower public transport fare costs; reduced travel times; extended hours of operation; high frequencies along trunk corridors; full access for passenger with special needs; and an integrated fare structure through a common fare system on all modes on the network (Arrive Alive, undated; CoCT, 2010).
2.13.5 The IRT Network

The City of Cape Town intends to establish an IRT network across the city within 10 to 12 years. There are four phases for rolling out the IRT. The first phase will be completed from 2010 to 2012 (CoCT, 2008; CoCT, undated; CoCT, 2010b). The following transit map shows the system that will roll out over the next 12 years. The focus at present is on the grey route from the airport to the Green Point Stadium and surrounds (i.e., Phase 1A).
Figure 3: Integrated Rapid Transit Map
Source: CoCT (2010b)
2.13.6 Salient IRT project information

Full IRT system

In November 2009, the Council adopted an IRT implementation budget of R4.309 billion. In addition, according to the report entitled “Project Status and Financial Strategic Assessment” adopted by Council in October 2009, the initial modelling results for the complete IRT system, including all four proposed phases, would result in an annual deficit of R 440 million, as shown below (CoCT, 2010c).

Estimates of full system cost

<table>
<thead>
<tr>
<th>System appraisal of full IRT system (modelling scenario 57)</th>
<th>Modeled annual operating costs of full IRT system (2010 Rands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated income</td>
<td>R 5 700 million</td>
</tr>
<tr>
<td>Estimated total expenses</td>
<td>R 6 140 million</td>
</tr>
<tr>
<td>Deficit</td>
<td>- R 440 million</td>
</tr>
</tbody>
</table>

Notes: *Means figures include the financing costs of the vehicles
Source: CoCT (2010c)

It should be noted that as the existing scheduled bus services are phased out and replaced by the new IRT system, the subsidies paid for these services, which presently exceed R 600 million, are anticipated to be shifted across to the new system. Therefore, the initial modelled figures indicate that, once fully implemented, the IRT system operations would not require additional revenue sources over and above existing bus subsidies (CoCT, 2010c).

Phase 1A

The estimated total project system cost of implementing Phase 1A are shown in Annex C. It is important to note that Phase 1A, on its own, has a relatively high operational deficit of R 116 million per annum. However, according to city, as the system is rolled out, the operational deficit relative to turnover will fall. As mentioned before, the preliminary modelling of the entire system indicates that it will be possible to fund operations, including the purchase of vehicles, from a combination of fare revenues and a level of subsidy similar to that currently being provided to the subsidised conventional bus services in the Cape Town area (CoCT, 2010c).
The exceptional nature of Phase 1A

It should also be noted that in the standard BRT model, the system generates sufficient revenue from fares such that vehicle operators can be paid a fee per kilometre which covers the vehicle operating costs and the capital charges on the vehicle while also offering a profit assuming normal efficiency levels. Under this system the vehicle operators purchase the vehicles from the vehicle manufacturers and pay for them on terms they negotiate. But in Phase 1A the system does not generate sufficient revenue to do this. Modelling shows that fare revenues can cover the operating costs of the vehicles as well as a normal level of profit. But subsidies will be required from sources other than ticket sales to cover the remaining costs (CoCT, 2010c).

The Phase 1A roll-out sequence

The amended roll-out of Phase 1A is shown in Annex D. Current Phase 1A operations include the already existing MyCiTi Airport service and the following recently launched services:

- The full trunk service that runs (with stops at all stations) between the Civic Centre Station and Table View Station which started operating on 14 May 2011. The interim inner-city feeder route that runs between the Civic Centre and Green Point, the V&A Waterfront, the Loop and Long Street areas and Gardens which also started operating at the same date as the full trunk service; and
- The three Table View feeder services at Big Bay, Table View, Parklands and Blaauwberg which began operating on 21 and 22 May 2011 (Cape Times, 2011a).

2.14 Conclusion

This chapter has presented the literature review which underpins the research. It began with a review of typical transport problems of poor populations in developing world cities and their consequences for the livelihood strategies of the urban poor. A presentation of literature review on the problems and characteristics of public transport system(s) in developing world cities in general, and in Cape Town in particular then followed. The chapter then further explored literature on; the appeal of BRT for developing world cities; BRT elements, system performance and system benefits; as well as international experience with BRT system performance. Lastly, a brief description of the planned BRT-based IRT system of Cape Town was provided.
3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes in detail the research methodology employed in the study. An essential consideration in determining the research methodology to adopt was the need to systematically prove the research hypothesis and answer the key research questions. The research includes three steps namely, literature review, data generation and data analysis.

3.2 Literature review

A careful and systematic review of both local and international literature was undertaken to identify;

i. Typical transport problems of poor populations in developing world cities and their consequences for the livelihood strategies of the urban poor (existing data on transport and the urban poor was analyzed to understand the situation);

ii. The crucial role of public transport in the lives of the urban poor;

iii. Problems and characteristics of public transport system(s) in developing world cities in general, and in Cape Town in particular (issues of access and quality have been used to understand the prevailing conditions);

iv. The appeal of BRT for developing world cities;

v. BRT elements, system performance and system benefits as well as international experience with BRT system performance; and

vi. The planned BRT-based IRT system of Cape Town (mainly local literature was used here).

3.3 Data Analysis

A comparative analysis of current levels of public transport services versus predicted BRT-based IRT service levels was carried out to establish the changes that can be brought about to public transport level of service through changing to the BRT-based IRT system. The comparative analysis basically applied a “with” and “without” BRT test as the basic criterion for measuring the changes to service levels. That is; what are the levels of service with the use of the BRT-based IRT system and what are they without such use (i.e., with the use of the current public transport system). The parameters that were tested include; walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement. The outcome of this broad comparative analysis indicated the changes that can be brought about to public transport service levels, particularly for the low income users, through changing to the BRT-based IRT system. The data source, and
sampling, market segmentation, sample data generation and comparative analyses methods are briefly explained below.

3.3.1 **Data source and sampling method**

The main data source for the comparative analysis is the survey on travel patterns of households conducted for African Centre of Excellence for Studies in Public and Non-motorised Transport (ACET) in Cape Town during 2010. The database contains personal and household data on socio-economic characteristics (e.g. dwelling types, household monthly income, household size, household structure, formal and informal employment and socio-economic activity) and travel characteristics (e.g. trip origins and destinations, travel modes travel times and travel costs). In this research, a data subset was extracted from the original dataset that conformed to the following criteria;

- Only trips by public transport (i.e., train, bus, and minibus taxi) were considered;
- Only commuter trips were considered.

The data contained in the original dataset was firstly sorted by trip type and then by transport mode used so as to identify and retain work-related public transport trips only. It is important to note that the original dataset comprised of 5473 trips of different types made by different transport modes and the resulting data subset comprised of 866 public transport-based commuter trips. From the resulting data subset, a sample of 100 public transport-based commuter trips was randomly selected for inquiry. The random number selection function on Microsoft Excel was used in their selection to ensure that each trip had an equal probability of being chosen. The sample size was considered to be large enough for the inquiry.

3.3.2 **Market segmentation method**

The sample of 100 public transport-based work trips was then segmented based on current main mode of public transport used as well as income, race, gender and age of the individuals who made the selected trips. The market segmentation of the 100 commuter trips is shown in Table 9 below.

**Table 9: Market Segmentation of the 100 Commuter Trips**

<table>
<thead>
<tr>
<th>GROUP TYPE</th>
<th>CATEGORY</th>
<th>No.</th>
<th>CATEGORY</th>
<th>No.</th>
<th>CATEGORY</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current main mode</td>
<td>Bus</td>
<td>20</td>
<td>Minibus taxi</td>
<td>41</td>
<td>Train</td>
<td>39</td>
</tr>
<tr>
<td>Income</td>
<td>&lt; R5499</td>
<td>29</td>
<td>R5500 to R12499</td>
<td>37</td>
<td>&gt; R12500</td>
<td>14</td>
</tr>
<tr>
<td>Race</td>
<td>Black</td>
<td>29</td>
<td>Coloured</td>
<td>63</td>
<td>White</td>
<td>8</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>70</td>
<td>Male</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>18 to 35 years</td>
<td>51</td>
<td>36 to 55 years</td>
<td>42</td>
<td>&gt; 55 years</td>
<td>7</td>
</tr>
</tbody>
</table>
3.3.3 Sample data generation method

The data relevant for the inquiry retained on the sample dataset were walking times, waiting times, in-vehicle times, trip times, and actual number of transfer(s) and costs of the selected commuter trips made by the current public transport modes (i.e., train, bus and minibus taxi). However, it should be noted that the walking, waiting, in-vehicle and trip times are reported times, which may be different from actual times. It should also be noted that, while it is acknowledged that the current public transport fare cost data are representative of the year 2010 and, therefore, had to be escalated up to 2011 to make them comparable to 2011 IRT fares, it was considered that the current inflation rate of 3.75% per annum would not make much of a difference. Thus the reported 2010 fares were not inflated. Demographic data such as income, age, gender, race as well as the main public transport mode used to make the trip were also retained. Additional requisite sample data was generated through conducting a desktop survey. The following is a detailed description of the assumptions, tools and methods employed in the desktop survey to generate additional sample data.

With the use of the current public transport system

1. Approximate walking, in-vehicle and trip distances of the selected commuter trips made by the current public transport modes: Google Earth Origin and Destination (O-D) search and route length measuring tools were employed to facilitate the generation of this data;

2. Approximate walking, waiting, in-vehicle and trip times of the selected commuter trips made by the current public transport modes: As implied above, the quality of some of the data with regards to times is questionable as the reported times might not be an accurate depiction of the service currently provided. It was therefore decided to employ the following data cleaning method to make the data more reliable in determining current public transport service levels.

   a) Data with regards to in-vehicle times. The sample data was first sorted by current main mode used. The approximated in-vehicle distances of each mode were then summed using the SUMIF function on Excel (the condition or criteria was to only add the cells with numbers greater than zero). The same was done for the reported in-vehicle times of each mode. The total in-vehicle distances and times were then used to calculate the average in-vehicle speeds of the different modes as follows;

<table>
<thead>
<tr>
<th>MODE</th>
<th>Total In-vehicle distance (km)</th>
<th>Total In-vehicle time (hr)</th>
<th>Average In-Vehicle speed (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>328.38</td>
<td>12.17</td>
<td>26.98</td>
</tr>
<tr>
<td>Minibus taxi</td>
<td>319.11</td>
<td>13.72</td>
<td>23.26</td>
</tr>
<tr>
<td>Train</td>
<td>609.45</td>
<td>22.72</td>
<td>26.82</td>
</tr>
</tbody>
</table>

Notes: Speed = distance / time

The calculated average in-vehicle speeds of the different modes were then used to calculate the average in-vehicle time for each of the 100 commuter trips based on the
estimated average in-vehicle speed of the mode used and the approximated in-vehicle distance of each trip. The calculated average in-vehicle times were then used as yardsticks to identify unreliable reported in-vehicle times. Reported in-vehicle times which deviated from the calculated average in-vehicle times by more or less than 10 minutes were deleted from the sample dataset and replaced with the estimated average in-vehicle times. Also where in-vehicles times were not given, the calculated average in-vehicle times were used.

b) Data with regards to walking times. The approximated walking distances of each mode were also summed using the SUMIF function on Excel (the condition or criteria was to only add the cells with numbers greater than zero). The same was done for the reported walking times of each mode. The total walking distances and times were then used to calculate the average walking speeds of the different modes as follows;

<table>
<thead>
<tr>
<th>MODE</th>
<th>Total Walking distance (km)</th>
<th>Total Walking time (hr)</th>
<th>Average Walking speed (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>11.8</td>
<td>5.95</td>
<td>1.98</td>
</tr>
<tr>
<td>Minibus taxi</td>
<td>16.9</td>
<td>11.15</td>
<td>1.52</td>
</tr>
<tr>
<td>Train</td>
<td>51.63</td>
<td>18.83</td>
<td>2.74</td>
</tr>
</tbody>
</table>

Notes: Speed = distance / time

An average walking speed of 2km/hr was then used to calculate the average walking time for each of the 100 commuter trips based the approximated walking distance of each trip. The calculated average walking times were then used as yardsticks to identify unreliable reported walking times. Reported walk times which deviated from the calculated average walking times by more or less than 5 minutes were deleted from the sample dataset and replaced with the estimated average walking times. Also where walking times were not given, the calculated average walking times were used.

c) Data with regards to wait and transfer times. Also, some of the data with regards to wait and/or transfer times was not given. In such cases, the total trip time for each of the 100 trips (calculated by summing the total walking and in-vehicle times of each trip) was subtracted from an alternatively calculated total trip time (i.e., reported trip end minus reported trip start time of each trip). The difference was assumed to be the waiting and/or transfer time;

3. More reliable total trip times of the selected commuter trips made by the current public transport modes were, in turn, calculated by summing the retained reported and/or the estimated walking, waiting, transfer (where applicable) and in-vehicle times; and

4. Equivalent in-vehicle and trip speeds of the selected commuter trips made by the current public transport modes were calculated based on the approximate in-vehicle and trip distances and the retained reported and/or the estimated in-vehicle and trip times (i.e., speed = distance / time).
**With the use of the BRT-based IRT system**

The time, distance, speed, transfer(s) requirement and fare if the trip was made using the BRT-based IRT system were calculated as follows:

1. Estimated walking distances to (from an origin) or from (to a destination) a BRT service (either trunk or feeder), BRT trunk or feeder in-vehicle distances as well as the number of transfers required to complete a journey of the same selected 100 commuter trips: Content analysis of the full BRT-based IRT route network map (which includes all phases) as well as Google Earth Origin and Destination (O-D) search and route length measuring tools were employed to facilitate the generation of this data. A copy of the full BRT-based IRT route network map has been attached in the annex section (Annex A). BRT total trip distances were, in turn, estimated by adding the estimated walking distances to and from a BRT service to estimated BRT trunk and/or feeder in-vehicle distances.
   
   It should be noted that there were instances where estimated walking distances for IRT services (i.e., both BRT trunk and feeder services) were in excess of 1,500km as a result of the IRT routes being mostly too spaced out. It was, therefore, assumed that some other easily accessible services (which will not be part of the IRT system) will be made available in areas where there is no provision of feeder services within an access distance of 1,500km. This assumption was made so as to limit the estimated walking distances for IRT services to 1,500km;

2. Walking times to (from an origin) or from (to a destination) BRT services (either trunk, feeder or some other-easily-accessible-services) were estimated by dividing expected walking distances to or from a BRT service by the average walking speed (i.e., the average walking speed calculated for the walk trips to current public transport modes) of 2 km/hr;

3. Estimated BRT trunk in-vehicle time: As mentioned before in Chapter 2, exclusive transitway BRT projects, generally, operate at speeds (including stops) between 32 and 48 kilometres per hour (i.e., a travel time rate between 1 to 2 minutes per kilometre), with even higher speeds demonstrated along the portions of the routes in exclusive sections (Diaz et al., 2004; Diaz, 2009). Therefore, since the IRT trunk services will operate more or less like exclusive transitway BRT projects, the expected trunk in-vehicle times were obtained by dividing the estimated trip distance to be covered by the trunk mode by the median speed for exclusive busways of 40 km/hr;

4. BRT feeder in-vehicle times: Since BRT feeders, like minibus taxis, will operate in regular streets with shared traffic, the BRT feeder in-vehicle times were estimated by dividing the estimated trip distance to be covered by the feeder mode by the average in-vehicle speed (derived from the survey data) of minibus taxis of 23 km/hr.
Please note that the same average in-vehicle speed (derived from the survey data) of minibus taxis of 23 km/hr was used to calculate in-vehicle times of the other-easily-accessible-services that were assumed will be made available to cover the excess walking distances;

5. Expected wait and/or transfer times for BRT services: About two-thirds of BRT systems in the world, with the exception of U.S. systems, typically feature peak service headways less than 6 minutes, while most of the remaining systems have 6- to 10-minute headways (Diaz et al, 2004; Diaz, 2009). Therefore, the average wait or transfer time for a BRT service was estimated to be 5 minutes;

6. BRT total trip times were, in turn, obtained by adding the estimated walking times to and from a BRT service, estimated BRT trunk and/or feeder and other-easily-accessible-service (where applicable) in-vehicle times and estimated waiting and transfer (where applicable) times for a BRT service;

7. BRT trip speeds were calculated by dividing estimated BRT trip distances by BRT trip times;

8. BRT trunk and feeder service fares, for comparison purposes, were calculated using both the experimental flat IRT fare system and the initially proposed distance-based IRT fare system, i.e., the IRT Full Fare System for 2011/12 until 31 Dec 2011 (A copy of the IRT fare level list has been attached in the annex section (Annex B)) as follows:

Distance-based IRT fare system:

i. Trunk (Basic) Route fare, according to the fare level list, is supposed to be calculated based on the Peak Periods Distance-based fare per person comprising of a Boarding Fare of R 5.00 and a Rate per Kilometre of R 0.40 (NB. up to a maximum of R 17.00). Thus peak period trunk service fare per trip should be equal to: R 5.00 plus R 0.40 per km;

ii. Feeder extensions routes fares, according to the fare level list, are supposed to be calculated based on the Peak Periods Distance-based fare per person comprising of a Boarding Fare of R 5.00 and a Rate per Kilometre of R 0.40 after the first 10 km (NB. up to a maximum of R 17.00). Thus peak period feeder service fare per trip should be equal to: R 5.00 plus R 0.40 per km after first 10 km; and the

iii. Total IRT service cost per one way trip should, therefore, be equal to peak period trunk service fare plus peak period feeder service fare, that is (R 5.00 + R 0.40/km) + (R 5.00 + R 0.40/km after first 10 km) respectively.

It should be noted that the charging of the above two fares (wherein a R5 boarding fee will be collected in each segment) contradicts an integrated fare system. Therefore, it was decided to create a discount on the boarding fee (i.e., it was assumed that the R5 boarding fee will be collected only once per one way trip). Therefore, the total IRT fare cost per one way trip was assumed to be equal to R 5.00 + R 0.40/km (NB. up to a maximum of R 17.00);
Flat IRT fare system:
The special/experimental flat fare rates, for the week (i.e., from Monday 09-05-2011 to Friday 13-05-2011) of the launch of the first phase of the MyCiTi bus network (running between Civic Centre Station and Table View Station) which is part of the IRT system, are as follows:

i. A trip on the trunk service costs R10, but passengers can travel on any one of the feeder services connected to it – for example, starting on the feeder service, transferring to the trunk service, then to a different feeder service – at no extra charge; and

ii. Travelling only on one of the feeder routes costs R5 (Cape Times, 2011).

As such, the flat fare costs were also calculated based on the above-mentioned flat fare rates. Please note that it is not clear whether the City of Cape Town intends to maintain the flat IRT fare system or to change to the distance-based IRT fare system later on (Cape Times, 2011a; Cape Times, 2011b).

9. The other-easily-accessible-service fare: It was also assumed that the other-easily-accessible-services (which will not be part of the IRT system) will take commuters to or from trunk or feeder services at an extra cost of R5.

The following subsection describes the steps taken to get the survey data to the analysis stage and the analyses conducted.

3.3.4 Comparative analyses method

For each of the 100 commuter trips, the differences between the estimated values for the BRT-based IRT system and the values for the current public transport system were calculated. The differences were calculated for the walking, in-vehicle and trip distance; walking, waiting, in-vehicle and trip time; in-vehicle and trip speed; fare cost; and transfer requirement values.

Calculation of summary values
The averages and standard deviations of the travel parameter values for the BRT-based IRT system and for the current public transport system were also calculated. The differences of the calculated average travel parameter values were then calculated and tabulated (together with the standard deviations) for the demographic variables and the current main modes. Furthermore, the data was graphed to show the changes that would likely occur to the values of the travel parameters due to changing to the BRT-based IRT system.
Discussion and conclusions

The tabulated and graphed data were then discussed with respect to the overall, the poor and other groupings of commuters resulting in conclusions being drawn and recommendations made.

3.4 Conclusion

The chapter has presented details of the research process. It explained the data source and clarified the manner in which the 100 commuter trips were selected for analysis. It also explained the way in which particular techniques and instruments for sample data generation were employed. The data presented in Chapter 4 is based on the methodology highlighted in this chapter.
4. DATA ANALYSIS AND PRESENTATION

4.1 Introduction

The study seeks to assess the potential role of BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town. This chapter presents the results of the research findings relevant to the problem. The key research questions raised in Chapter 1 shall be guiding the analysis and presentation of data. The chapter firstly examines the general effect of changing to IRT as well as the effect of the current condition on changes in service levels for poor commuters versus other commuters. This is then followed by a sole examination of the effect of changing to IRT on poor/low-income commuters. A comparative analysis of the effect of changing to IRT on the different income groups then follows. This comparative analysis seeks to illustrate how the poor/low-income commuters’ predicted service level changes compare to those for middle-income and high-income commuters. The chapter lastly provides a comparative analysis of the effect of changing to IRT on different gender, age and race groups as well as current main mode users. This comparative analysis is done for interest sake or completeness of the study.

4.2 All commuters

4.2.1 Effect of changing to IRT: in general

Table 10 below summarizes the estimated IRT service levels, the current public transport service levels and the corresponding service level changes due to changing to IRT.
### Table 10: Effect of changing to IRT: in general

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Current PT System</th>
<th>IRT System</th>
<th>Ave. LOS Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DISTANCE (km)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking distance</td>
<td>0.955</td>
<td>0.908</td>
<td>-0.047 -5</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>15.709</td>
<td>16.605</td>
<td>0.896 6</td>
</tr>
<tr>
<td>Trip distance</td>
<td>16.663</td>
<td>17.512</td>
<td>0.849 5</td>
</tr>
<tr>
<td><strong>TIME (min)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>29</td>
<td>27</td>
<td>16.860 -1 -5</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>11</td>
<td>10</td>
<td>2.673 -1 -12</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>37</td>
<td>29</td>
<td>18.393 -8 -21</td>
</tr>
<tr>
<td>Trip time</td>
<td>77</td>
<td>67</td>
<td>28.730 -11 -14</td>
</tr>
<tr>
<td><strong>SPEED (km/hr)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>25.032</td>
<td>34.305</td>
<td>9.273 37</td>
</tr>
<tr>
<td>Trip speed</td>
<td>12.654</td>
<td>15.270</td>
<td>2.617 21</td>
</tr>
<tr>
<td><strong>FARE COST (R)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>6.80</td>
<td>11.00db</td>
<td>4.20 62</td>
</tr>
<tr>
<td>Fare per trip</td>
<td>6.80</td>
<td>10.00f</td>
<td>2.349 320 47</td>
</tr>
<tr>
<td><strong>TRANSFERS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer requirement*</td>
<td>28</td>
<td>84</td>
<td>56 200</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.28</td>
<td>0.451</td>
<td>0.7 257</td>
</tr>
</tbody>
</table>

**Notes:** All distances, times and fare costs are calculated totals for one way commuter trips

**Refers to total waiting time including transfer time
**Refers to percentage of commuters requiring one or more transfer(s)
**Refers to distance-based IRT fare per trip
**Refers to flat IRT fare per trip

Below follows a detailed account of the predicted service level changes (due to changing to IRT) indicated in Table 10.

*Walking distance and time* – Initially, the average total walking distance for IRT services (i.e., both BRT trunk and feeder services) was estimated to be in excess of 1,000km (1,433 km) as the IRT routes are mostly too spaced out. This, in turn, would increase the average total walking distance by approximately 39%. However, as mentioned before in Chapter 3, it was assumed that some other easily accessible services will be made available in areas where there is no provision of feeder services within an access distance of 1,500km. Due to this assumption, the average total walking distance and time is likely to slightly decrease, indicating a slight improvement in service level.

*In-vehicle and trip distance* – The average total in-vehicle distance and, in turn, average total trip distance is likely to slightly increase mainly as a result of limiting the maximum total walking distance to 3 km and due to the IRT route network structure (see Annex A). It is important to stress that most of the routes on the network are not direct thereby increasing the ratio of the actual physical travel distance between two points along a specific route and the straight line distance between the
two points. The indirectness of most of the IRT routes also entail that a high number of commuters first have to go to other parts of the city in order to connect to routes that will take them to their final destinations, thus further increasing their travel distances.

**In-vehicle speed and time** – BRT is generally understood to include bus services that are, at a minimum, faster than those sharing road space with other traffic (Diaz, 2009; Grava, 2003; Levinson et al, 2003, Iles, 2005; Wright, 2004). In line with this, the average IRT in-vehicle speed is expected to be significantly higher than the current average in-vehicle speed. It is important to stress that, despite the predicted slight increase in average total in-vehicle distance, there is likely to be a substantial increase in the average in-vehicle speed experienced by commuters (indicating a significant improvement in service level). This would be as a result of possible bus operating speed enhancements (due to operating buses in segregated lanes rather than mixed traffic) (Wright, 2004). Consequently, the predicted higher average IRT in-vehicle speed will be able to achieve significant in-vehicle travel time savings as indicated by the shorter average IRT total in-vehicle time and the resultant decrease in average total in-vehicle time. This, again, is in line with the general understanding that operating buses in segregated lanes rather than mixed traffic increases operating speed and, in turn, reduces in-vehicle travel time or achieves lower in-vehicle travel times (Wright, 2004).

**Trip speed and time** – As expected, due to the predicted higher average IRT in-vehicle speed, the average trip speed is likely to increase. Due to the increase in average trip speed, together with the slight decrease in average total walking, waiting and in-vehicle time, the average total trip time is also likely to decrease, indicating an improvement in service level. This is in line with the assertion that bus priority treatments should reduce both the mean (and variability) of average journey times (Levinson et al, 2003).

**Fare cost** – The average total fare cost is likely to increase substantially by approximately 62% with the distance-based IRT fare, and increase significantly by approximately 47% with the flat IRT fare. This is in line with the general acceptance that improvements in service levels will result in an increase in operating costs and, in turn, fare costs where there is an absence of operating subsidy provision. Another contributing factor to the significantly higher average IRT total fare cost (than the current average total fare cost) is the fact that, unlike the current zone-based fare type, the IRT distance-based fare type increases with an increase in distance travelled.

**Transfer requirement** – As mentioned before, most IRT routes are not direct, requiring commuters to do one or more transfer(s) to complete a journey. The percentage of commuters requiring a transfer is likely to increase significantly from 28% to about 84%. While, on average, 1 in 4 trips includes a
transfer with the use of the current public transport system, on average, every trip is likely to include a transfer with the use of the BRT-based IRT system (which may be time-consuming and inconvenient for commuters).

The following sub-sections examine the effect of the current condition on changes in service levels for poor commuters versus other commuters. Please note that, as indicated in the literature reviewed, the ways that IRT is likely to perform better (than the current public transport system) also represent the ways that commuters are likely to benefit from the change to IRT, and the reverse is also true (Diaz, 2009).

4.2.2 Effect of current condition on change: total walking distance

Figure 4 below illustrates the predicted effect of current condition on change in total walking distance.

![Figure 4: Effect of current condition on change: total walking distance](image)

The figure above generally shows that the majority of commuters (61%) are likely to; walk longer; and, in turn, spend more time walking; as well as travel extra kilometres after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; public transport services become slightly difficult and more time-consuming for them to access; and, in turn, as their total commuting distances become longer than before. On the other hand, 34% of the commuters are likely to; walk shorter; and, in turn, spend less time walking; travel fewer kilometres; spend much less time commuting; as well as enjoy much faster public
transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; public transport services become easy and less time-consuming for them to access; and, in turn, as their total commuting distances and times become much shorter; as well as their journey speeds become much higher than before. These changes are somehow indicative of an anticipated swapping of experiences between the two mentioned categories of commuters due to the change to IRT.

It is important to note that a proportionate percentage (11%) out of the 34% commuters that are likely to benefit or to be better-off with the change to IRT (as public transport services become easy and less time-consuming to access; and, in turn, as total commuting distances and times become shorter; as well as journey speeds become higher than before) are the poor commuters. On the other hand, 16% out of the 60% commuters that are likely to suffer or to be worse-off with the change to IRT (as public transport services become slightly difficult and more time-consuming for to access; and, in turn, as total commuting distances become longer than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

4.2.3 Effect of current condition on change: total in-vehicle distance

Figure 5 below illustrates the predicted effect of current condition on change in total in-vehicle distance.

![Graph](image_url)
The figure above generally shows that the majority of commuters (60%) are likely to; travel (in-vehicle) extra kilometres; and, in turn, spend more money on public transport (with the distance-based IRT fare) after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; their in-vehicle commuting distances become longer than before; and, in turn, as their total fare costs increase with an increase in in-vehicle travel distance (with the distance-based IRT fare). On the other hand, the other 39% of the commuters are likely to; travel (in-vehicle) fewer kilometres; and, in turn, spend much less time in public transport vehicles; spend much less time commuting; experience much faster public transport rides; enjoy much faster public transport services; as well as spend less money on public transport (with the distance-based IRT fare) after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; their in-vehicle commuting distances and times become much shorter than before; and, in turn, as their total commuting distances and times become much shorter than before; as their in-vehicle and journey speeds become much higher than before; as well as their total fare costs decrease with a decrease in in-vehicle travel distance (with the distance-based IRT fare).

It is important to note that a disproportionately large percentage (21%) out of the 60% commuters that are likely to suffer or to be worse-off with the change to IRT (as in-vehicle commuting distances become longer than before; and, in turn, as total fare costs increase with an increase in in-vehicle travel distance (with the distance-based IRT fare)) are the poor commuters. On the other hand, a disproportionately small percentage (8%) out of the 39% commuters that are likely to benefit or to be better-off with the change to IRT (as in-vehicle commuting distances and times become much shorter than before; and, in turn, as total commuting distances and times become much shorter than before; as in-vehicle and journey speeds become much higher than before; as well as total fare costs decrease with a decrease in in-vehicle travel distance (with the distance-based IRT fare)) are the poor commuters. Therefore, in this case, it is primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters. The foregoing findings are contrary to what is stated in the literature reviewed that BRT systems should be strongly pro-poor (Fox, 2000).

4.2.4 Effect of current condition on change: total trip distance

Figure 6 below illustrates the predicted effect of current condition on change in total trip distance.
Figure 6: Effect of current condition on change: total trip distance

As expected the figure above displays more or less the same general trend as the one for total in-vehicle distances (i.e., Figure 5). Figure 6 generally shows that the majority of commuters (60%) are likely to; travel extra kilometres (due to walking longer and/or travelling extra in-vehicle kilometres); and may, in turn, spend more money on public transport (with the distance-based IRT fare) after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; their total commuting distances become longer than before; and, in turn, as their total fare costs increase with an increase in in-vehicle travel distance. On the other hand, the other 39% of the commuters are likely to; travel fewer kilometres (due to walking shorter and/or travelling less in-vehicle kilometres); and, in turn, spend much less time commuting (due to spending much less time walking and/or in public transport vehicles and/or due to much higher in-vehicle and trip speeds); and may spend less money on public transport (with the distance-based IRT fare) after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; their total commuting distances and times become much shorter than before; and, in turn, as their in-vehicle and trip speeds become much higher than before as well as their total fare costs decrease with a decrease in in-vehicle travel distance.

It is important to note that a disproportionately large percentage (21%) out of the 60% commuters that are likely to suffer or to be worse-off with the change to IRT (as total commuting distances become longer than before; and, in turn, as total fare costs increase with an increase in in-vehicle travel distance) are the poor commuters. On the other hand, a disproportionately small percentage (8%) out
of the 39% commuters that are likely to benefit or to be better-off with the change to IRT (as total commuting distances and times become much shorter than before; and, in turn, in-vehicle and trip speeds become much higher than before as well as total fare costs decrease with a decrease in in-vehicle travel distance) are the poor commuters. Therefore, in this case, it is, again, primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters. The foregoing findings are, again, contrary to what is stated in the literature reviewed that BRT systems should be strongly pro-poor (Fox, 2000).

4.2.5 Effect of current condition on change: total walking time

Figure 7 below illustrates the predicted effect of current condition on change in total walking time.

![Figure 7: Effect of current condition on change: total walking time](image)

In line with general expectations, the figure above displays the same general trend as the one for total walking distances (i.e., Figure 4). Figure 7 generally shows that majority of the commuters (61%) are likely to spend more time walking (to and from public transport services) after the change to IRT (due to walking longer). In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as public transport services become more time-consuming for them to access. On the other hand, the 34% of the commuters are likely to; spend less time walking (to and from public transport services); and, in turn, spend much less time commuting (due to
travelling fewer kilometres); as well as enjoy much faster public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; public transport services become less time-consuming for them to access; and, in turn, as their total commuting times become much shorter; as well as their journey speeds become much higher than before.

It is important to note that a 16% out of the 61% commuters that are likely to suffer or to be worse-off with the change to IRT (as public transport services become more time-consuming to access) are the poor commuters. On the other hand, a proportionate percentage (11%) out of the 34% commuters that are likely to benefit or to be better-off with the change to IRT (as public transport services become less time-consuming to access; and, in turn, as total commuting times become much shorter; as well as journey speeds become much higher than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

4.2.6 Effect of current condition on change: total waiting time

Figure 8 below illustrates the predicted effect of current condition on change in total waiting time.

![Graph showing effect of current condition on total waiting time](image)

**Figure 8: Effect of current condition on change: total waiting time**

The figure above generally shows that 44% of the commuters are likely to spend more time waiting for public transport services after the change to IRT (due to time-consuming transfer(s)). In this case,
these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as public transport services become more time-consuming for them to wait for. On the other hand, the 44% of the commuters are likely to; spend less time waiting for public transport services; and, in turn, spend much less time commuting; as well as enjoy much faster public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; public transport services become less time-consuming for them to wait for; and, in turn, as their total commuting times become much shorter; as well as their journey speeds become much higher than before.

It is important to note that a proportionate percentage (14%) out of the 44% commuters that are likely to suffer or to be worse-off with the change to IRT (as public transport services become more time-consuming for them to wait for) are the poor commuters. On the other hand, 13% out of the 44% commuters that are likely to benefit or to be better-off with the change to IRT (public transport services become less time-consuming to wait for; and, in turn, as total commuting times become much shorter; as well as journey speeds become much higher than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

Please note that Figure 8 also shows that there is strong correlation between the actual changes in waiting times and the current total waiting times; as the r-value is almost 1.

**4.2.7 Effect of current condition on change: total in-vehicle time**

Figure 9 below illustrates the predicted effect of current condition on change in total in-vehicle time.
Figure 9: Effect of current condition on change: total in-vehicle time

As expected, the figure above does not display the same general trend as Figure 5 since total in-vehicle distances are, as mentioned earlier, not the main determinants of the total in-vehicle times but the possible bus operating speed enhancements. Figure 9 generally shows only 20% of the commuters are likely to; spend more time in public transport vehicles (due to slower feeders (than their current main mode) covering much of total in-vehicle distances); and, in turn, spend more time commuting; experience slower public transport rides; as well as put up with slower public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; their in-vehicle commuting times become longer than before; and, in turn, as their total commuting times become longer than before; as well as their in-vehicle and journey speeds become lower than before.

On the other hand, the majority of the commuters (75%) are likely to; spend less time in public transport vehicles (due to much faster trunk services (than their current main mode) covering much of total in-vehicle distances); and, in turn, spend less time commuting; experience faster public transport rides; as well as enjoy faster public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; their in-vehicle commuting times become shorter than before; and, in turn, as their total commuting times become shorter than before; as well as their in-vehicle and journey speeds become higher than before. Please note that the foregoing findings are in line with what is proclaimed in the literature reviewed that the BRT-based IRT system will provide customers with dramatically reduced travel times (CoCT, 2006; CoCT, 2008).
It is important to note that a proportionate percentage (7%) out of the 20% commuters that are likely to suffer or to be worse-off with the change to IRT (as in-vehicle commuting times become longer than before; and, in turn, as total commuting times become longer than before; as well as in-vehicle and journey speeds become lower than before) are the poor commuters. On the other hand, 21% out of the 75% commuters that are likely to benefit or to be better-off with the change to IRT (as in-vehicle commuting times become shorter than before; and, in turn, as total commuting times become shorter than before; as well as in-vehicle and journey speeds become higher than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

4.2.8 Effect of current condition on change: total trip time

Figure 10 below illustrates the predicted effect of current condition on change in total trip time.

![Figure 10: Effect of current condition on change: total trip time](image)

The figure above generally shows that 44% of the commuters are likely to; spend more time commuting (due to spending more time walking, travelling in-vehicle and/or waiting for public transport); and, in turn, put up with slower public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; their total commuting times become longer than before; and, in turn, as their journey speeds become lower than before. On the other hand, the majority of the commuters (52%)
are likely to; spend less time commuting; and, in turn, enjoy faster public transport services after the change to IRT after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as their total commuting times become shorter than before and, in turn, as their journey speeds become higher than before. Please note that the foregoing findings are contrary to the claim that the change to the BRT-based IRT system will result in improved journey times for all public transport users (Arrive Alive, undated).

It is important to note that a disproportionately large percentage (16%) out of the 44% commuters that are likely to suffer or to be worse-off with the change to IRT (as total commuting times become longer than before; and, in turn, as journey speeds become lower than before) are the poor commuters. On the other hand, a disproportionately small percentage (14%) out of the 52% commuters that are likely to benefit or to be better-off with the change to IRT (as total commuting times become shorter than before and, in turn, as journey speeds become higher than before) are the poor commuters. Therefore, in this case, it is, again, primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters. The foregoing findings are, again, contrary to what is stated in the literature reviewed that BRT systems should be strongly pro-poor (Fox, 2000).

4.2.9 Effect of current condition on change: in-vehicle speed

Figure 11 below illustrates the predicted effect of current condition on change in in-vehicle speed.

---

Figure 11: Effect of current condition on change: in-vehicle speed
The figure above generally shows that only 7% of the commuters are likely to; experience slower public transport rides; and, in turn, spend more time in public transport vehicles; spend more time commuting; as well as put up with slower public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as; their in-vehicle speeds become lower than before; and in turn as their in-vehicle and total commuting times become longer than before; as well as their journey speeds become lower than before. On the other hand, the majority of the commuters (81%) are likely to; experience faster public transport rides; and, in turn, spend less time in public transport vehicles; spend less time commuting; as well as enjoy faster public transport services after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as; their in-vehicle speeds become higher than before; and in turn as their in-vehicle and total commuting times become shorter than before; as well as their journey speeds become faster than before.

It is important to note that a disproportionately large percentage (4%) out of the 7% commuters that are likely to suffer or to be worse-off with the change to IRT (in-vehicle speeds become lower than before; and in turn as in-vehicle and total commuting times become longer than before; as well as journey speeds become lower than before) are the poor commuters. On the other hand, a disproportionately small percentage (22%) out of the 81% commuters that are likely to benefit or to be better-off with the change to IRT (as in-vehicle speeds become higher than before; and in turn as in-vehicle and total commuting times become shorter than before; as well as journey speeds become faster than before) are the poor commuters. Therefore, in this case, it is, again, primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters. The foregoing findings are, again, contrary to what is stated in the literature reviewed that BRT systems should be strongly pro-poor (Fox, 2000).

4.2.10 Effect of current condition on change: trip speed

Figure 12 below illustrates the predicted effect of current condition on change in trip speed.
Figure 12: Effect of current condition on change: trip speed

The figure above generally shows that 24% of the commuters are likely to incur lower trip speeds and, in turn, spend more time commuting after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as their journey speeds become lower than before and, in turn, as their total commuting times become longer than before. On the other hand, the majority of the commuters (64%) are likely to experience higher trip speeds and, in turn, spend less time commuting after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as their journey speeds become higher than before and, in turn, as their total commuting times become shorter than before.

It is important to note that a proportionate percentage (8%) out of the 24% commuters that are likely to suffer or to be worse-off with the change to IRT (as journey speeds become lower than before and, in turn, as total commuting times become longer than before) are the poor commuters. On the other hand, 19% out of the 64% commuters that are likely to benefit or to be better-off with the change to IRT (as journey speeds become higher than before and, in turn, as total commuting times become shorter than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.
4.2.11 Effect of current condition on change: total fare cost (with distance-based IRT fare)

Figure 13 below illustrates the predicted effect of current condition on change in total fare cost (with distance-based IRT fare).

![Figure 13: Effect of current condition on change: total fare cost (with distance-based IRT fare)](image)

The figure above generally shows that, with the distance-based fare, the majority of the commuters (82%) are likely to spend more money on public transport (due to a combination of a fare level increase and an increase in fare costs with an increase in total in-vehicle distance) after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as their total fare costs become higher than before. On the other hand, with the distance-based fare, only 16% of the commuters are likely to spend less money on public transport after the change to IRT. In this case, these commuters are therefore the ones who are likely to benefit or to be better-off with the change to IRT as their total fare costs become lower than before. Please note that the foregoing findings are in contrary to what is proclaimed in the literature reviewed that the BRT-based IRT system will provide all customers with lower fare costs (CoCT, 2006; CoCT, 2008).

It is important to note that 24% out of the 82% commuters that are likely to suffer or to be worse-off with the change to IRT and to the distance-based fare type (as total fare costs become higher than before) are the poor commuters. On the other hand, a proportionate percentage (5%) out of the 16% commuters that are likely to benefit or to be better-off with the change to IRT and to the distance-
based fare type (as total fare costs become lower than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

It should be noted that one of the commuters is a minibus taxi rank worker who currently takes a minibus taxi to work free of charge. So it has been assumed that this commuter will be absorbed into the BRT-based IRT system as an employee and will still need not to pay a fare.

4.2.1 Effect of current condition on change: total fare cost (with flat IRT fare)

Figure 14 below illustrates the predicted effect of current condition on change in total fare cost (with flat IRT fare).

![Graph](image)

**Figure 14: Effect of current condition on change: total fare cost (with flat IRT fare)**

As expected the figure above does not display the same trend as the one for the distance-based IRT fare (Figure 13). Figure 13 generally shows that, with the flat fare, the majority of the commuters (77%) are likely to spend more money on public transport (due to a fare level increase) after the change to IRT. In this case, these commuters are therefore the ones who are likely to suffer or to be worse-off with the change to IRT as their total fare costs become higher than before. On the other hand, with the flat IRT fare, only 17% of the commuters are likely to spend less money on public transport after the change to IRT. In this case, these commuters are therefore the ones who are likely
to benefit or to be better-off with the change to IRT as their total fare costs become lower than before. Please note that the foregoing findings are in contrary to what is proclaimed in the literature reviewed that the BRT-based IRT system will provide all customers with lower fare costs (CoCT, 2006; CoCT, 2008).

It is important to note that a disproportionately small percentage (24%) out of the 77% commuters that are likely to suffer or to be worse-off with the change to IRT and to the flat fare type (as total fare costs become higher than before) are the poor commuters. On the other hand, a disproportionately small percentage (4%) out of the 17% commuters that are likely to benefit or to be better-off with the change to IRT and to the flat fare type (as total fare costs become lower than before) are the poor commuters. The foregoing findings indicate that the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

It should be noted that one of the commuters is a minibus taxi rank worker who currently takes a minibus taxi to work free of charge. So it has been assumed that this commuter will be absorbed into the BRT-based IRT system as an employee and will still need not to pay a fare.

### 4.2.2 Summary

The findings presented in this section can be summarized in the points listed below.

In terms the general effect of changing to IRT, findings have indicated that:

- The average total walking distance and time is likely to slightly decrease, indicating a slight improvement in service level;
- The average total in-vehicle distance and, in turn, average total trip distance is likely to slightly increase mainly as a result of limiting the maximum total walking distance to 3km and due to the IRT route network structure, indicating a decline in service level;
- Despite of the predicted slight increase in average total in-vehicle distance, there is likely to be a substantial increase in the average in-vehicle speed experienced by commuters (due to possible bus operating speed enhancements) and, in turn, a decrease in average total in-vehicle time, indicating a significant improvement in service level;
- Due to the predicted higher average IRT in-vehicle speed, the average trip speed is likely to increase. Due to the increase in average trip speed, together with the slight decrease in average total walking and waiting time, the average total trip time is also likely to decrease, indicating an improvement in service level;
The average total fare cost is likely to increase substantially by approximately 62% with the distance-based IRT fare, and increase significantly by approximately 47% with the flat IRT fare; and

The percentage of commuters requiring a transfer is likely to increase significantly from 28% to about 84%. While, on average, 1 in 4 trips includes a transfer with the use of the current public transport system, on average, every trip is likely to include a transfer with the use of the BRT-based IRT system (which may be time-consuming and inconvenient for commuters).

Findings have also indicated that in terms of the effect of the current condition on change in;

- Total walking distances and times – the poor commuters compare well with the other commuters as they both exhibit more or less the same change;
- Total in-vehicle and trip distances – it is primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters;
- Total waiting times – the poor commuters compare well with the other commuters as they both exhibit more or less the same change;
- Total in-vehicle times – the poor commuters compare well with the other commuters as they both exhibit more or less the same change;
- Total trip times – it is, again, primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters;
- In-vehicle speeds – it is, again, primarily the poor commuters that are likely to suffer (or to be worse-off) in comparison to the other commuters. The reverse is also true that it is secondarily the poor commuters that are likely to benefit (or to be better-off) in comparison to the other commuters;
- Trip speeds – the poor commuters compare well with the other commuters as they both exhibit more or less the same change; and
- Total fare costs (with either the distance-based or flat IRT fare) – the poor commuters compare well with the other commuters as they both exhibit more or less the same change.

The following section solely examines the effect of changing to IRT on poor/low-income commuters.
4.3 Poor/low-income commuters

4.3.1 Effect of changing to IRT on poor/low-income commuters

Table 11 below illustrates the predicted effect of changing to IRT on poor/low-income commuters.

**Table 11: Effect of changing to IRT on poor/low-income commuters**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Current System</th>
<th>IRT System</th>
<th>Ave. LOS Change</th>
<th>Actual</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DISTANCE (km)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking distance</td>
<td>1.048</td>
<td>0.8</td>
<td>0.964</td>
<td>0.6</td>
<td>-0.084</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>15.908</td>
<td>11.1</td>
<td>17.271</td>
<td>10.2</td>
<td>1.363</td>
</tr>
<tr>
<td>Trip distance</td>
<td>16.956</td>
<td>11.5</td>
<td>18.235</td>
<td>10.4</td>
<td>1.279</td>
</tr>
<tr>
<td><strong>TIME (min)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>31</td>
<td>25.1</td>
<td>29</td>
<td>17.1</td>
<td>-3</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>12</td>
<td>8.0</td>
<td>11</td>
<td>2.5</td>
<td>-1</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>38</td>
<td>25.6</td>
<td>33</td>
<td>21.0</td>
<td>-5</td>
</tr>
<tr>
<td>Trip time</td>
<td>82</td>
<td>44.6</td>
<td>73</td>
<td>33.5</td>
<td>-9</td>
</tr>
<tr>
<td><strong>SPEED (km/hr)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>24.831</td>
<td>1.8</td>
<td>32.755</td>
<td>6.5</td>
<td>7.924</td>
</tr>
<tr>
<td>Trip speed</td>
<td>12.082</td>
<td>4.0</td>
<td>14.544</td>
<td>5.2</td>
<td>2.462</td>
</tr>
<tr>
<td><strong>FARE COST (R)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>7.00</td>
<td>4.1</td>
<td>11.50d</td>
<td>0.5</td>
<td>4.50</td>
</tr>
<tr>
<td></td>
<td>7.00</td>
<td>4.1</td>
<td>11.00f</td>
<td>2.5</td>
<td>4.00</td>
</tr>
<tr>
<td><strong>TRANSFERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer requirement*</td>
<td>38</td>
<td>93</td>
<td>55</td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.4</td>
<td>1.2</td>
<td>0.5</td>
<td>0.8</td>
<td>218</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips

**Refers to total waiting time including transfer time

*Refers to percentage of commuters requiring one or more transfer(s)

dRefers to distance-based IRT fare per trip

fRefers to flat IRT fare per trip

Before drawing into details, the reader is reminded that the literature reviewed indicated that the value of public transport in enabling the urban poor to have access to economic (and social opportunities) depends on accessibility, affordability and quality of the public transport services. Thus, for BRT to be successful for the poor they should benefit from improved accessibility, travel times, affordability, frequency, reliability, capacity, safety and security (and so on) of public transport services (Barter, 1999; Booth et al, 2000; Gannon and Liu, 1997; Fox, 2000; Palmer et al, 1997;
Sohail et al., 2005; Wright, 2004). The following is a detailed account of the predicted effect of changing to IRT on poor/low-income commuters indicated in Table 11.

While the poor’s average total walking distance is likely to decrease by approximately 8%, this will not, in turn, result in a reduction in their average total trip distance. This is mainly because the poor’s actual/absolute increase in average total in-vehicle distance is likely to be much greater (about 16 times greater) than their actual/absolute decrease in average total walking distance, resulting in an increase in their average total trip distance. However, the poor’s predicted decrease in average total walking, waiting and in-vehicle time as well as the predicted increase in their average in-vehicle and trip speed is likely to result in a reduction in their average total trip time.

In summary, the above findings indicate an average decline in service level in terms of the poor’s total journey distances due to changing to IRT. However, this is off-set by the average improvement in service level in terms of their total journey times. Though small, the decrease in the average total trip time will benefit the poor significantly. As implied in the literature reviewed, improved travel times for the urban poor have a positive impact on their human capital and productivity, since they deter fatigue and boredom, and save up both time and energy that can be spent on productive activities (e.g., spending time with family, income generation activities and so on) (Akinlo, 1998 cited in Booth et al., 2000; Diaz et al., 2003; Sohail, 2000; Urban Resource Centre, 2001).

Unfortunately, the poor’s average total fare cost is likely to increase substantially by approximately 64% (with the distance-based IRT fare) and by approximately 57% (with flat IRT fare). Clearly, both the predicted higher average distance-based and flat IRT fare costs (than the current average total fare cost) will constitute a substantial financial burden to poor. In simple terms, the improvement of public transport service level in terms of increased service frequency and accessibility as well as reduced travel times will be less affordable or unaffordable to the poor commuters due to the predicted tremendous increase in the average total fare cost. This finding is contrary to what was identified in literature that BRT systems have lower operating costs (than rail systems) which may result in fares that are quite affordable (Arrive Alive, undated; CoCT, 2006 and 2008; Howe, undated).

All in all, the foregoing findings indicate that IRT might not be of value to the poor commuters. While the poor commuters may benefit from more accessible, frequent and fast IRT services, ironically, these will be more expensive and in some cases unaffordable to them and therefore of no benefit to them. This is in line with the argument by Fox (2000) that where fares are set above the market level the urban poor will be less able to afford them and so the better service will be of no benefit to them. Fox (2000) further argues that fares above their market levels will harm the poor as high fares will
take a disproportionate share of their households’ meagre incomes and, in some circumstances, limit their opportunities to those that can be reached on foot or by bicycle.

4.3.2 Summary

The findings presented in this section can be summarized in the points listed below.

Findings have indicated that:

- IRT might not be of value to the poor commuters. While the poor commuters may benefit from more accessible, frequent and fast IRT services as well as reduced travel times, ironically, these will be more expensive and in some cases unaffordable to them and therefore of no benefit to them; and

- Both the predicted higher average distance-based and flat IRT fare costs (than the current average total fare cost) will not benefit but harm the poor commuters.

The foregoing findings indicate that BRT is not as clearly beneficial to the poor as proclaimed in the literature reviewed (Fox 2000). Research findings fit well with the assertion by Fox (2000) that BRT may create accessibility benefits for the poor but may be at the expense of higher tariffs. Therefore the poor may not benefit substantially (if not at all) from the improved accessibility which BRT may bring.

The following is a comparative analysis of the effect of changing to IRT on the different income groups. The comparative analysis seeks to illustrate how the poor/low-income commuters’ predicted service levels changes compare to those for middle-income and high-income commuters.

4.4 All commuters by income

4.4.1 Effect of changing to IRT: by income

Table 12 below illustrates the predicted effect of changing to IRT on the different income groups.
Table 12: Effect of changing to IRT: by income

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>LOW-INCOME COMMUTERS (29)</th>
<th>MIDDLE-INCOME COMMUTERS (37)</th>
<th>HIGH-INCOME COMMUTERS (14)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td>Change</td>
</tr>
<tr>
<td>DISTANCE (km)</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Ave. LOS</td>
</tr>
<tr>
<td>Walking distance</td>
<td>1.048</td>
<td>0.8</td>
<td>0.964</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>15.908</td>
<td>11.1</td>
<td>17.271</td>
</tr>
<tr>
<td>Trip distance</td>
<td>16.956</td>
<td>11.5</td>
<td>18.235</td>
</tr>
<tr>
<td>TIME (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>31</td>
<td>25.1</td>
<td>29</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>12</td>
<td>8.0</td>
<td>11</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>38</td>
<td>25.6</td>
<td>33</td>
</tr>
<tr>
<td>Trip time</td>
<td>82</td>
<td>44.6</td>
<td>73</td>
</tr>
<tr>
<td>SPEED (km/hr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>24.831</td>
<td>1.8</td>
<td>32.755</td>
</tr>
<tr>
<td>Trip speed</td>
<td>12.082</td>
<td>4.0</td>
<td>14.544</td>
</tr>
<tr>
<td>FARE COST (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>7.00</td>
<td>4.1</td>
<td>11.50</td>
</tr>
<tr>
<td>Transfer rqmt *</td>
<td>38</td>
<td>93</td>
<td>55</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.4</td>
<td>0.5</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips
**Refers to total waiting time including transfer time
*Refers to percentage of commuters requiring one or more transfer(s)
Refers to distance-based IRT fare per trip
†Refers to flat IRT fare per trip
Below follows a detailed account of how the poor/low-income commuters’ predicted service level changes compare to those for middle-income and high-income commuters as indicated in Table 12.

In terms of:

- **Walking distance and time** – Changing to IRT is likely to bring public transport services closer to (or to make public transport services more accessible to) middle-income commuters than to poor/low-income commuters, and take public transport services further away from (or to make public transport services less accessible to) high-income commuters. This is indicated by the predicted higher decrease in both the middle-income commuters’ average total walking distance and time than that of poor/low-income commuters. In this case, with the change to IRT, the poor/low-income and middle-income commuters are likely to be better-off while the high-income commuters (predicted to experience an increase in both average total walking distance and time) are worse-off;

- **In-vehicle and trip distance** – Changing to IRT is likely to make the commuting distance much longer for poor/low-income commuters than for the other income groups. This is indicated by the predicted highest increase in both the poor’s average total in-vehicle and trip distances. In this case, with the change to IRT, the poor/low-income commuters are likely to be worse-off than the other income groups;

- **In-vehicle and trip time** – Changing to IRT is likely to make the commuting time less short for poor/low-income commuters than for the other income groups. This is indicated by the predicted lowest decrease in the poor’s average total in-vehicle and trip time. In this case, with the change to IRT, the poor/low-income commuters are likely to be worse-off than the other income groups;

- **Waiting time** – Changing to IRT is likely to make public transport services much more frequent for middle-income commuters than for poor/low-income commuters and less frequent for high-income commuters. This is indicated by the predicted higher decrease in the middle-income commuters’ average total waiting time than that of poor/low-income commuters. In this case, with the change to IRT, the poor/low-income and middle-income commuters are likely to be better-off while the high-income commuters (predicted to experience an increase in average total waiting time) are worse-off;

- **Fare cost** – Changing to IRT, with either the distance-based or flat IRT fare, is likely to make public transport services much less affordable to poor/low-income commuters than to the other income groups. This is indicated by both the poor’s predicted highest average total distance-based and flat IRT fare costs. In this case, with the change to IRT, the poor/low-income commuters are likely to be worse-off than the other income groups, mostly likely as a result of their much longer commuting distances. This is in line with what was identified in
the literature reviewed that the typical marginal location of the urban poor subjects them to the longest commuting distances (and times) and in turn highest distance-related transport costs; and

- **Transfer requirement** – Changing to IRT is likely to make the requirement to transfer much more inconvenient for poor/low-income commuters than for the other income groups. This is indicated by the predicted highest percentage of poor commuters likely to require one or more transfer(s) and highest average number of transfers required with the use of IRT. In this case, with the change to IRT, the poor/low-income commuters are likely to be worse-off than the other income groups.

### 4.4.2 Summary

Figure 15 below summarizes and provides a diagrammatic presentation of the predicted effect of changing to IRT on the different income groups.

![Figure 15: Effect of changing to IRT: by income](image)

The findings presented in this section and illustrated in Figure 15 above can be summarized in the points listed below.

As findings indicated and as shown in Figure 15 above, the poor/low-income commuters reveal substantial differences compared to the middle-income and high-income commuters. With the change to IRT, the poor are likely to be worse-off than the other income groups in terms of all the service
levels under investigation, i.e., in terms of; improved accessibility and frequency of public transport services; increased average total commuting distance; faster public transport rides and services; reduced average total commuting time; increased average total fare costs (with either the distance-based or flat IRT fare); and transfer requirements.

In light of the foregoing findings, the change to IRT is likely not going to contribute much in terms of addressing social equity issues as the urban poor will largely remain marginalized. This is in contrary to what is proclaimed in literature that BRT promotes social inclusion instead of isolation (Arrive Alive, undated) and can underpin a city’s progress towards social equality (Wright, 2004).

For interest sake or completeness of the study, the following remaining sections provide a comparative analysis of the effect of changing to IRT on different gender, age and race groups as well as current main mode users. The comparative analysis seeks to illustrate how commuters falling into a particular category (e.g., black commuters) would compare to those falling into different categories (e.g., coloured and white commuters) but within the same group type (e.g., race group).

4.5 All commuters by race

4.5.1 Effect of changing to IRT: by race

Table 13 below illustrates the predicted effect of changing to IRT on the different race groups.
Table 13: Effect of changing to IRT: by race

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>BLACK COMMUTERS (29%)</th>
<th>COLOURED COMMUTERS (63%)</th>
<th>WHITE COMMUTERS (8%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td>Change</td>
</tr>
<tr>
<td>DISTANCE (km)</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Ave. LOS</td>
</tr>
<tr>
<td>Walking distance</td>
<td>0.903</td>
<td>0.8</td>
<td>1.014</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>19.138</td>
<td>10.5</td>
<td>19.287</td>
</tr>
<tr>
<td>Trip distance</td>
<td>20.041</td>
<td>11.0</td>
<td>20.301</td>
</tr>
<tr>
<td>TIME (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>27</td>
<td>24.9</td>
<td>30</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>12</td>
<td>8.0</td>
<td>10</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>46</td>
<td>24.4</td>
<td>35</td>
</tr>
<tr>
<td>Trip time</td>
<td>85</td>
<td>45.2</td>
<td>75</td>
</tr>
<tr>
<td>SPEED (km/hr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>24.727</td>
<td>1.8</td>
<td>34.524</td>
</tr>
<tr>
<td>FARE COST (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>6.60</td>
<td>3.7</td>
<td>12.30*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.60</td>
<td>3.7</td>
<td>10.20†</td>
</tr>
<tr>
<td>TRANSFERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer rqtnt*</td>
<td>34</td>
<td>83</td>
<td>48</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.3</td>
<td>0.5</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips
**Refers to total waiting time including transfer time
*Refers to percentage of commuters requiring one or more transfer(s)
†Refers to distance-based IRT fare per trip
‡Refers to flat IRT fare per trip
Below follows a detailed account of the predicted effect of changing to IRT on the different race groups indicated in Table 13. It is important to note that the sample size of white commuters is too small to draw appropriate conclusions. Consequently, the detailed comparative analysis shall focus on how the black commuters’ predicted service level changes compare to those for coloured commuters.

In terms of:

- **Walking distance and time** – Changing to IRT is likely to bring public transport services closer to (or to make public transport services more accessible to) coloured commuters and take public transport services far away from (or to make public transport services less accessible to) black commuters. As shown in the table above, the coloured commuters are likely to experience a decrease in both their average total walking distance and time while black commuters experience an increase in both their average total walking distance and time. In this case, with the change to IRT, the coloured commuters are likely to be better-off while the black commuters are worse-off;

- **In-vehicle and trip distance** – Changing to IRT is likely to make the commuting distance much longer for coloured commuters than for black commuters. As shown in the table above, the coloured commuters are likely to experience a higher increase in both their average total in-vehicle and trip distance than black commuters. In this case, with the change to IRT, the coloured commuters are likely to be worse-off while the black commuters are better-off;

- **Trip time** – Changing to IRT is likely to make the total commuting time much shorter for coloured commuters than for black commuters. As shown in the table above, the coloured commuters are likely to experience a higher decrease in their average total trip time than black commuters. In this case, with the change to IRT, the black commuters are likely to be worse-off while the coloured commuters are better-off;

- **Trip speed** – Changing to IRT is likely to make public transport services much faster for coloured commuters than for black commuters. As shown in the table above, the coloured commuters are likely to experience a higher increase in their average trip speed than black commuters. In this case, with the change to IRT, the black commuters are likely to be worse-off while the coloured commuters are better-off; and

- **Fare cost** – Changing to IRT, with either the distance-based or flat IRT fare, is likely to make public transport services more costly for black commuters than for coloured commuters. This is indicated by the predicted higher increase in black commuters’ average total fare cost than that of coloured commuters. In this case, with the change to IRT, the black commuters are likely to be worse-off than coloured commuters.
4.5.2 Summary

Figure 16 below summarises and provides a diagrammatic presentation of the predicted effect of changing to IRT on the different race groups.

![Figure 16: Effect of changing to IRT: by race](image)

The findings presented in this section and illustrated in Figure 16 above can be summarized in the points listed below.

As findings indicated and as shown in Figure 16:
- With the change to IRT, the coloured commuters are likely to be better-off in terms of improved accessibility of public transport services, reduced average total commuting time and faster public transport services while the black commuters are worse-off;
- With the change to IRT, the coloured commuters are likely to be worse-off in terms of increased average total commuting distance while the black commuters are better-off; and
- With the change to IRT, the black commuters are likely to be worse-off in terms of costly public transport services than coloured commuters.

The foregoing findings indicate quite significant differences between black and coloured commuters in terms of their predicted service level changes due to changing to IRT.
4.6 All commuters by current main public transport mode

4.6.1 Effect of changing to IRT: by current main public transport mode

Table 14 below illustrates the predicted effect of changing to IRT on the different current main mode users.
### Table 14: Effect of changing to IRT: by current main public transport mode

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>BUS USERS (20%)</th>
<th>MINIBUS TAXI USERS (41%)</th>
<th>TRAIN USERS (39%)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td>Current System</td>
<td>IRT System</td>
</tr>
<tr>
<td></td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Ave. LOS</td>
<td>SD</td>
</tr>
<tr>
<td><strong>DISTANCE (km)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking distance</td>
<td>0.548</td>
<td>0.3</td>
<td>0.739</td>
<td>0.4</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>17.700</td>
<td>13.0</td>
<td>17.716</td>
<td>13.3</td>
</tr>
<tr>
<td>Trip distance</td>
<td>18.249</td>
<td>13.1</td>
<td>18.455</td>
<td>13.4</td>
</tr>
<tr>
<td><strong>TIME (min)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>16</td>
<td>10.2</td>
<td>22</td>
<td>10.5</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>11</td>
<td>5.4</td>
<td>10</td>
<td>2.8</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>40</td>
<td>29.4</td>
<td>29</td>
<td>20.4</td>
</tr>
<tr>
<td>Trip time</td>
<td>67</td>
<td>32.9</td>
<td>61</td>
<td>25.2</td>
</tr>
<tr>
<td><strong>SPEED (km/hr)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>26.793</td>
<td>0.7</td>
<td>36.871</td>
<td>5.1</td>
</tr>
<tr>
<td>Trip speed</td>
<td>15.102</td>
<td>4.5</td>
<td>16.988</td>
<td>5.7</td>
</tr>
<tr>
<td><strong>FARE COST (R)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>7.50</td>
<td>3.1</td>
<td>11.50**</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>7.50</td>
<td>3.1</td>
<td>10.50†</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>TRANSFERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer reqnt*</td>
<td>15</td>
<td>80</td>
<td>65</td>
<td>433</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.2</td>
<td>0.4</td>
<td>0.9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips  
**Refers to total waiting time including transfer time  
*Refers to percentage of commuters requiring one or more transfer(s)  
†Refers to distance-based IRT fare per trip  
dbRefs to flat IRT fare per trip  
"Refers to flat IRT fare per trip  
Page 77
Below follows a detailed account of the predicted effect of changing to IRT on the different current main mode users indicated in Table 14.

In terms of:

- **Walking distance and time** – Changing to IRT is likely to take public transport services further away from (or to make public transport services less accessible to) current minibus taxi users than from current bus users, and bring public transport services closer to (or to make public transport services more accessible to) current train users. This is indicated by the predicted higher increase in both the current minibus taxi users’ average total walking distance and time than that of current bus users. In this case, with the change to IRT, the current minibus taxi users are likely to be worse-off while the current train users (predicted to experience a substantial decrease in both average total walking distance and time) are better-off.

**Commentary**

It is important to note that the current minibus taxi users (currently walking, on average, the shortest distance) are at present enjoying almost a door-to-door service as existing minibus taxi drivers often operate much like taxi services and stop frequently and over short distances (Wright, 2004). However, the change to IRT, comprising of BRT dedicated stations and/or stops, means that all buses will have formal stops (Wright, 2004) and this will, in turn, force the current minibus taxi users to walk longer than before. On the other hand, the current train users who are currently walking, on average, the longest distance are probably commuters residing a considerable distance from train stations. Therefore, these commuters will greatly benefit (as they will start walking shorter than before) when public transport services are brought closer to them by the IRT system;

- **Trip distance and time** – Changing to IRT is also likely to make the in-vehicle and total commuting distance much longer for current minibus taxi users than for the other current mode users. This is indicated by the predicted highest increase in both the current minibus taxi users’ average total in-vehicle and trip distance. As expected, a combination of the highest increase in average total walking, in-vehicle and trip distance and, in turn, the smallest increase in average trip speed as well as the lowest average IRT trip speed for current minibus taxi users means that their average total commuting time is likely to increase while that for the other current mode users decreases. In this case, with the change to IRT, the current minibus taxi users are likely to be worse-off while the other current mode users (predicted to experience a decrease in average total trip time) are better-off;

- **Waiting time** – Changing to IRT is likely to take public transport services more frequent for current train users than for current bus users, and make public transport services less frequent
for current minibus taxi users. This is indicated by the predicted higher decrease in the current train user’s average total waiting time than that of current bus users. In this case, with the change to IRT, the current train users are likely to be better-off while the current minibus taxi users (predicted to experience a slight increase in average total waiting time) are worse-off;

- **Transfer requirement** – Changing to IRT is likely to make the requirement to transfer much more inconvenient for current minibus taxi and bus users (who at present rarely interchange) than for current train users (who at present commonly interchange). This is indicated by the predicted smallest increase in the percentage of current train users likely to require one or more transfer(s) with the use of IRT. In this case, with the change to IRT, minibus taxi and bus users are likely to be worse-off than the current train users; and

- **Fare cost** – Changing to IRT, with either the distance-based or flat IRT fare, is likely to make public transport services much more costly for current train users than for the other current main mode users. This is indicated by the current train users’ predicted highest average total IRT fare cost and their predicted highest increase in average total fare cost. In this case, with the change to IRT, the current train users are likely to be worse-off than the other current main mode users.

**Commentary**

It is important to note that the findings with respect to fare costs are in contrary to what was identified in literature. While literature revealed that the IRT system will offer a considerably higher level and quality of service than is provided by the current road-based public transport operators *at fare levels that are comparable* (Arrive Alive, undated; CoCT, 2010a; CoCT, 2010b; CoCT, 2010c), findings indicate that both the distance-based and flat IRT fares will be much higher.

### 4.6.2 Summary

Figure 17 below summarizes and provides a diagrammatic presentation of the predicted effect of changing to IRT on the different current main mode users.
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users

Case of Cape Town, South Africa

Page 80

Figure 17: Effect of changing to IRT: by current main mode

The findings presented in this section and illustrated in Figure 17 above can be summarized in the points listed below.

As findings indicated and as shown in Figure 17:

- With the change to IRT, current train users are likely to be better-off in terms of improved accessibility of public transport services while current bus users and especially current minibus taxi users are worse-off;
- With the change to IRT, both current bus and train users are likely to be better-off in terms of improved frequency of public transport services, reduced average total commuting distance and time and faster public transport rides and services, while current minibus taxi users are worse-off; and
- With the change to IRT, minibus taxi and bus users are likely to be worse-off in terms of transfer requirements than the current train users; and
- With the change to IRT, current train users are likely to be worse-off in terms of costly public transport services (with either the distance-based or flat IRT fare) than current minibus taxi and train users.
In light of the foregoing findings, the change to IRT, by one means or another, is likely going to dramatically improve the customer experience as proclaimed in the literature reviewed (CoCT, 2006 and 2008; Wilkinson, 2009).

4.7 All commuters by age

4.7.1 Effect of changing to IRT: by age

Table 15 below illustrates the predicted effect of changing to IRT on the different age groups.
Table 15: Effect of changing to IRT: by age

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>18 to 35 years (51%)</th>
<th></th>
<th>36 to 55 years (42%)</th>
<th></th>
<th>&gt; 55 years (7%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td>Change</td>
<td>Current System</td>
<td>IRT System</td>
<td>Change</td>
</tr>
<tr>
<td>DISTANCE (km)</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Actual</td>
<td>%</td>
</tr>
<tr>
<td>Walking distance</td>
<td>0.872</td>
<td>0.8</td>
<td>0.894</td>
<td>0.5</td>
<td>0.022</td>
<td>3</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>14.777</td>
<td>9.8</td>
<td>15.626</td>
<td>8.5</td>
<td>0.849</td>
<td>6</td>
</tr>
<tr>
<td>Trip distance</td>
<td>15.649</td>
<td>10.1</td>
<td>16.520</td>
<td>8.5</td>
<td>0.871</td>
<td>6</td>
</tr>
<tr>
<td>TIME (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>26</td>
<td>23.5</td>
<td>27</td>
<td>16.2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>12</td>
<td>6.7</td>
<td>10</td>
<td>2.7</td>
<td>-2</td>
<td>-17</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>35</td>
<td>22.6</td>
<td>27</td>
<td>15.0</td>
<td>-8</td>
<td>-23</td>
</tr>
<tr>
<td>Trip time</td>
<td>74</td>
<td>37.8</td>
<td>64</td>
<td>21.9</td>
<td>-10</td>
<td>-14</td>
</tr>
<tr>
<td>SPEED (km/hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>24.831</td>
<td>2.0</td>
<td>35.031</td>
<td>6.2</td>
<td>10.201</td>
<td>41</td>
</tr>
<tr>
<td>Trip speed</td>
<td>12.378</td>
<td>4.2</td>
<td>15.365</td>
<td>5.6</td>
<td>2.987</td>
<td>24</td>
</tr>
<tr>
<td>FARE COST (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>6.40</td>
<td>3.8</td>
<td>10.90^a</td>
<td>3.5</td>
<td>4.50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>6.40</td>
<td>2.4</td>
<td>10.10^f</td>
<td>2.4</td>
<td>3.70</td>
<td>57</td>
</tr>
<tr>
<td>TRANSFERS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer reqmt*</td>
<td>22</td>
<td>82</td>
<td>60</td>
<td>280</td>
<td>33</td>
<td>88</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.2</td>
<td>0.4</td>
<td>1.0</td>
<td>0.5</td>
<td>0.7</td>
<td>345</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips.
**Refers to total waiting time including transfer time
^a Refers to percentage of commuters requiring one or more transfer(s)
^db Refers to distance-based IRT fare per trip
^f Refers to flat IRT fare per trip
Below follows a detailed account and a diagrammatic presentation of the predicted effect of changing to IRT on the different age groups indicated in Table 15. It is, again, important to note that the sample size of commuters within the age category of more than 55 years is too small to draw appropriate conclusions. Consequently, the detailed comparative analysis shall focus on how commuters within the age category of 18 to 35 years compare to those within the age category of 36 to 55 years.

Figure 18 below provides a diagrammatic presentation of the predicted effect of changing to IRT on the different age groups.

![Figure 18: Effect of changing to IRT: by age](image)

Figure 18: Effect of changing to IRT: by age

In terms of the predicted service level changes between the 18 to 35 aged and 36 to 55 aged commuters due to changing to IRT, the following points, as shown in Table 15 and Figure 18 above, can be inferred:

- With the change to IRT, the 36 to 55 aged commuters are likely to be better-off in terms of improved accessibility of public transport services (as indicated by the predicted decrease in their average total walking distance and time) while the 18 to 35 aged commuters are worse-off (as indicated by the predicted increase in their average total walking distance and time);
- With the change to IRT, the 18 to 35 aged commuters are likely to be better-off in terms of improved frequency of public transport services (as indicated by the predicted decrease in their average total waiting time) while the 36 to 55 aged commuters are worse-off (as indicated by the predicted non-change in their average total waiting time);
With the change to IRT, the 18 to 35 aged and 36 to 55 aged commuters are both likely to be better-off in terms of faster public transport rides and services (as indicated by the predicted increases in both their average in-vehicle and trip speeds) and, in turn, in terms of reduced average total commuting times (as indicated by the predicted decreases in both their average total in-vehicle and trip times;

With the change to IRT, the 18 to 35 aged and 36 to 55 aged commuters are both likely to be worse-off in terms of increased transfer requirements (as indicated by the predicted more or less the same increases in their average number of transfers required and in the percentage of commuters requiring one or more transfer(s);

With the change to IRT, the 18 to 35 aged commuters are likely to be worse-off in terms of costly public transport services (with either the distance-based or flat IRT fare) than the 36 to 55 aged commuters (as indicated by the predicted higher increase in their average total fare cost).

4.8 All commuters by gender

4.8.1 Effect of changing to IRT: by gender

Table 16 below illustrates the predicted effect of changing to IRT on the two different gender groups.
Table 16: Effect of changing to IRT: by gender

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>FEMALE COMMUTERS (70%)</th>
<th>MALE COMMUTERS (30%)</th>
<th>Change</th>
<th>FEMALE COMMUTERS (70%)</th>
<th>MALE COMMUTERS (30%)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td></td>
<td>Current System</td>
<td>IRT System</td>
<td></td>
</tr>
<tr>
<td>DISTANCE (km)</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Ave. LOS</td>
<td>SD</td>
<td>Actual</td>
<td>%</td>
</tr>
<tr>
<td>Walking distance</td>
<td>0.873</td>
<td>0.8</td>
<td>0.924</td>
<td>0.6</td>
<td>0.052</td>
<td>6</td>
</tr>
<tr>
<td>In-vehicle distance</td>
<td>15.035</td>
<td>10.6</td>
<td>16.079</td>
<td>10.0</td>
<td>1.044</td>
<td>7</td>
</tr>
<tr>
<td>Trip distance</td>
<td>15.908</td>
<td>10.8</td>
<td>17.004</td>
<td>10.1</td>
<td>1.096</td>
<td>7</td>
</tr>
<tr>
<td>TIME (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking time</td>
<td>26</td>
<td>23.9</td>
<td>28</td>
<td>18.1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Waiting time**</td>
<td>12</td>
<td>7.2</td>
<td>10</td>
<td>3.1</td>
<td>-2</td>
<td>-18</td>
</tr>
<tr>
<td>In-vehicle time</td>
<td>36</td>
<td>24.5</td>
<td>29</td>
<td>18.1</td>
<td>-7</td>
<td>-20</td>
</tr>
<tr>
<td>Trip time</td>
<td>74</td>
<td>41.4</td>
<td>66</td>
<td>29.8</td>
<td>-8</td>
<td>-10</td>
</tr>
<tr>
<td>SPEED (km/hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-vehicle speed</td>
<td>24.967</td>
<td>2.0</td>
<td>33.950</td>
<td>6.7</td>
<td>8.982</td>
<td>36</td>
</tr>
<tr>
<td>Trip speed</td>
<td>12.529</td>
<td>4.1</td>
<td>14.996</td>
<td>5.5</td>
<td>2.467</td>
<td>20</td>
</tr>
<tr>
<td>FARE COST (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fare per trip</td>
<td>6.60</td>
<td>3.7</td>
<td>10.90*</td>
<td>3.6</td>
<td>4.40</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>6.60</td>
<td>3.7</td>
<td>10.30†</td>
<td>2.7</td>
<td>3.70</td>
<td>57</td>
</tr>
<tr>
<td>TRANSFERS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer requirement*</td>
<td>26</td>
<td></td>
<td>79</td>
<td>1.0</td>
<td>0.6</td>
<td>206</td>
</tr>
<tr>
<td>No. of Transfer(s)/trip</td>
<td>0.3</td>
<td>0.4</td>
<td>1.0</td>
<td>0.6</td>
<td>0.7</td>
<td>278</td>
</tr>
</tbody>
</table>

Notes: All distances, times and fare costs are calculated totals for one way commuter trips

**Refers to total waiting time including transfer time
*Refers to percentage of commuters requiring one or more transfer(s)
†Refers to flat IRT fare per trip
Below follows a detailed account and a diagrammatic presentation of the predicted effect of changing to IRT on the two different gender groups indicated in Table 16.

Figure 19 below provides a diagrammatic presentation of the predicted effect of changing to IRT on the two different gender groups.

**Figure 19: Effect of changing to IRT: by gender**

In terms of the predicted service level changes between female and male commuters due to changing to IRT, the following points, as shown in Table 16 and Figure 19 above, can be inferred:

- With the change to IRT, male commuters are likely to be better-off in terms of improved accessibility of public transport services (as indicated by the predicted decrease in their average total walking distance and time) while the female commuters are worse-off (as indicated by the predicted increase in their average total walking distance and time);
- With the change to IRT, female commuters are likely to be better-off in terms of improved frequency of public transport services (as indicated by the predicted decrease in their average total waiting time) while the male commuters are worse-off (as indicated by the predicted non-change in their average total waiting time);
- With the change to IRT, female and male commuters are both likely to be better-off in terms of faster public transport rides and services (as indicated by the predicted increases in both their average in-vehicle and trip speeds) and, in turn, in terms of reduced average total commuting times (as indicated by the predicted decreases in both their average total in-vehicle and trip times);
• With the change to IRT, female and male commuters are both likely to be worse-off in terms of increased transfer requirements (as indicated by the predicted more or less the same increases in their percentage of commuters requiring one or more transfer(s);

• With the change to IRT, female commuters are likely to be worse-off in terms of costly public transport services (with either the distance-based or flat IRT fare) than male commuters (as indicated by the predicted higher increase in their average total fare cost).

4.9 Conclusion

The chapter has analyzed and presented the data obtained from the database of the ACET Household Survey (conducted in Cape Town during 2010) and the data generated through the desktop survey. It firstly examined the general effect of changing to IRT as well as the effect of the current condition on changes in service levels for poor commuters versus other commuters. This then led to a sole examination of the effect of changing to IRT on poor/low-income commuters. A comparative analysis of the effect of changing to IRT on the different income groups then followed. This comparative analysis sought to illustrate how the poor/low-income commuters’ predicted service level changes compare to those for middle-income and high-income commuters. The chapter then ended by providing a comparative analysis of the effect of changing to IRT on different gender, age and race groups as well as current main mode users. This comparative analysis was done for interest sake or completeness of the study.
5. CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The problem guiding this study was to assess the role played by BRT in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town. To address this problem, the current condition and the effect of changing to IRT were examined together. This chapter therefore synthesizes findings in the context of theory and debates outlined in Chapter 2. Based on the empirical study of the key questions some recommendations are proposed.

5.2 Summary of findings and conclusion

The picture painted by the research regarding the role of the BRT-based IRT system in improving public transport levels of service, particularly for the urban poor users of public transport in Cape Town, reflects rather a confusing situation. In summary, the findings revealed that;

- In terms of the overall effect, the change to IRT is likely to bring about, on average, improvements to all the public transport levels of service under investigation, with the exception of in-vehicle and trip distance;

- In terms of the effect on poor/low-income commuters, the same trend is predicted for the poor commuters as the general trend. For poor/low-income commuters, the change to IRT is likely to bring about, on average, improvements to all the public transport levels of service under investigation, with the exception of in-vehicle and trip distance; and

- In terms of the effect of the change to IRT on the different income groups, the poor/low-income commuters reveal substantial differences compared to the middle-income and high-income commuters. The difference in predicted average service levels changes for the three income groups is significant. Where all income groups are likely to experience declines in average service levels in terms of in-vehicle and trip distances, the negative changes are likely to have a larger impact on poor commuters than on the other income groups. On the other hand where improvements are predicted in terms of the other service levels under investigation, it is mostly the middle-income commuters, and in some cases (i.e., in terms of in-vehicle speed and time) the high-income commuters, that are likely to benefit more than the poor/low-income commuters.

The rest of the discussion brings into clarity the implication of these findings.

Literature revealed that the value of public transport in enabling the urban poor to have access to economic (and social opportunities) depends on accessibility, affordability and quality of the public
transport services. Thus, for BRT to be successful for the poor they should benefit from improved accessibility, travel times, affordability, frequency, reliability, capacity, safety and security (and so on) of public transport services (Barter, 1999; Booth et al, 2000; Gannon and Liu, 1997; Fox, 2000; Palmer et al, 1997; Sohail et al, 2005; Wright, 2004). On the contrary, in terms of the predicted effect of changing to IRT on poor/low-income commuters, this study has observed that:

- IRT might not be of value to the poor commuters. While the poor commuters may benefit from more accessible, frequent and fast IRT services as well as reduced travel times, ironically, these will be more expensive and in some cases unaffordable to them and therefore of no benefit to them; and

- Both the predicted higher average distance-based and flat IRT fare costs (than the current average total fare cost) will not benefit but harm the poor commuters.

The foregoing findings indicate that BRT is not as clearly beneficial to the poor as proclaimed in the literature reviewed (Fox 2000). Research findings fit well with the assertion by Fox (2000) that BRT may create accessibility benefits for the poor but may be at the expense of higher tariffs. Therefore the poor may not benefit substantially (if not at all) from the improved accessibility which BRT may bring.

Moreover, findings revealed that, with the change to IRT;

The poor are likely to be worse-off than the other income groups in terms of all the service levels under investigation, i.e., in terms of; improved accessibility and frequency of public transport services; increased average total commuting distance; faster public transport rides and services; reduced average total commuting time; increased average total fare costs (with either the distance-based or flat IRT fare); and transfer requirements.

The paradox is that it is proclaimed in literature that BRT promotes social inclusion instead of isolation (Arrive Alive, undated), can underpin a city’s progress towards social equality (Wright, 2004) and should be strongly pro-poor (Fox, 2000). Particular to Cape Town, the literature reviewed indicated that the implementation of the BRT-based IRT system is aimed at ensuring that all segments of society receive an equal, high-quality public transport experience, especially through consideration of the special needs of the transport disadvantaged to include low-income earners (CoCT, 2010). It is further stated that the implementation of the BRT-based IRT system will bring the following key benefits to all public transport users; lower public transport costs or affordable fares, reduced travel times, high frequencies along trunk corridors; and so on (Arrive Alive, undated; Creamer Media’s Engineering News, 2009; CoCT, 2006; CoCT, 2008; CoCT, 2010b; CoCT, undated). However, on the contrary, the above-mentioned findings indicate that the change to IRT is likely not going to contribute much in terms of addressing social equity issues as the urban poor will largely remain
The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users

Case of Cape Town, South Africa

marginalized. It is also important to note that literature revealed that the socio-economic exclusion of the urban poor, due to high transport costs, will contribute to their poverty and trap them in poverty vicious cycles (Chambers et al, 1992 and Ellis, 2000 cited in Nyarirangwe and Mbara, 2007; Gannon and Liu, 1997).

The foregoing findings show that the research hypothesis, which related the introduction of the BRT-based IRT system to public transport service levels improvement, particularly for the urban poor users of public transport, tested negative. Further, the findings are also indicative of the inappropriateness of regarding the change to the BRT-based IRT system, alone, as an integral/key intervening public transport strategy targeted at improving public transport service levels particularly for the urban poor users; or as a key to achieving the overarching goal of bringing about a fundamental transformation of the ineffective and inequitable transport system (inherited from the apartheid era) captured in the ‘vision for South Africa transport’ articulated in the White Paper on National Transport Policy of 1996 (NDoT, 1996: 3 quoted in Wilkinson, 2008). Thus addressing the following key issues is the starting points for a viable transformation of the current, ineffective public transport system and any possible future improvements (Wilkinson, 2008).

5.3 Recommendations

5.3.1 Key issues to be firstly addressed

Rather than being engaged with a predisposition toward the inspirational BRT technology, that has been shown by this study as likely not to do much to address the mobility needs of the urban poor, the South African public authorities firstly need to address the following key issues identified by Wilkinson (2008) as underlying the lack of progress towards achieving the above-mentioned overarching goal:

- The highly fragmented and incoherently configured institutional framework within which the increasingly ineffective provision of public transport occurs; For example, service regulation, planning and infrastructure provision responsibilities remain fragmented across national, provincial and local governments, and subsequently the planning for, and provision of, modal integration to improve passenger choice and service levels will also remain difficult to achieve (Wilkinson, 2008). Please note that, institutional fragmentation of responsibilities, if not addressed can also inhibit the development of BRT (Levinson et al, 2003);
- The essential preconditions for establishing effective transport authorities – devolution to the local level of powers to plan, regulate and manage all public transport modes within an
integrated system of provision, and the establishment of an appropriate framework to fund the execution of these functions – have not yet been put in place (Wilkinson, 2008); and

- The lack of robustness in at least some of the strategic planning frameworks currently in place – entailing a lack of a platform for effective and appropriate decision making – resulting in interventions widely regarded as strategically inappropriate and unviable. For example, urban passenger transport proposals associated with hosting once-off mega events (i.e., in preparation of the Olympic bid in 2000 and proposals for the 2010 World Cup) or to address prestige or inspirational ‘world-class’ projects rather than the ‘routine’ transport needs of the ‘ordinary city’ (Wilkinson, 2008).

Wilkinson (2008) ascertains that these complex issues to be firstly addressed are contextually specific and would prevent any simplistic or unproblematic adoption of ‘international best practice’ in either the technological or the institutional arenas. He argues that there is no ‘quick fix’ to be important from outside and that, in many ways, it is likely that the formulation of locally derived and contextually appropriate responses to critically important passenger transport issues that confront both the metropolitan cities in particular, and the nation more generally represents the better – and perhaps the only – way forward. However, since the implementation of the BRT-based IRT system is already under way, and may be too late to reverse now, the following are recommended, appropriate measures that the South African public authorities can adopt to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport.

5.3.2 Measures to make the change to the BRT-based IRT system mostly beneficial to the urban poor users of public transport

The following are recommended, appropriate measures that the South African public authorities can adopt to rationalize the BRT-based IRT system. The resultant revised and rationalized BRT-based IRT system should allow primarily the urban poor users of public transport to reap the full potential benefits of BRT (particularly in the area of service levels improvements).

1) Making IRT affordable to the poor

As mentioned before in the literature reviewed, the importance of affordability is particularly relevant for the provision of public transport services to the urban poor (Fox, 2000; Sohail, 2000). While there is a claim that IRT fares will be affordable and comparable with those currently being charged by buses and minibuses (CoCT, 2010a; CoCT, 2010b; CoCT, 2010c), there is no explicit mention of the provision of operating subsidies. Since the urban poor live far from major centres of employment, higher order commercial and social facilities and would therefore face the highest distance-related
IRT fare costs, it is recommended that the experimental flat fare system be maintained instead of changing to the initially proposed distance-based fare system later on. Wright (2004) ascertains that a flat fare system can be a mechanism to ensure greater social equity within public transport services as it generates a cross-subsidy designed to assist lower-income groups (i.e., wherein poor commuters are subsidized by high-income commuters that make shorter trips (Diaz, 2003)). Moreover, as findings have indicated that the flat R10 tariff (which is about 50% more the poor commuters’ current average total fare cost) is still likely to be unaffordable to the poor, it is further recommended that IRT services be subsidised to make IRT affordable and therefore beneficial to poor commuters. The employment of the mechanisms under investigation by the city (mentioned in Chapter 2) such as discounts for regular usage (e.g., weekly and monthly concessions) and reduction in off-peak fares could also help in making fares less costly for all users. Of particular importance, in this case, is that policies aimed at making public transport affordable do not undermine public transport service levels by causing a reduction in investment (Barter, 1999). The city should ensure an optimum balance between affordability and quality of service (CoCT, 2010a; CoCT, 2010b).

2) Making IRT route network efficient and effective
Wright (2004) emphasizes the importance of routing efficiency. According to him, it is only a more rationalized routing structure that can mean shorter travel distances and much less in-vehicle travel time. Therefore, in order to ascertain the best means of improving the IRT route network to the benefit of the poor commuters it is recommended that the routing structure be revised and rationalized to make IRT in-vehicle and trip distances and, in turn, in-vehicle travel times further shorter, particularly for the poor commuters who face the longest commuting distances and times. The route rationalisation procedure should also be aimed at maximizing on;

- Route directness to reduce time-consuming transfer requirements; and
- Service coverage and, in turn, on access. The IRT route network should comprehensively cover all residential areas within the city, with feeder routes further penetrating communities, so that all commuters are within, at most, a radius of 1,500km from an IRT stop/station. This, in turn, would reduce the walking distance and the need for commuters (residing in areas where there is no provision of feeder services within an access distance of 1,500km) to take another service (which will not be part of the IRT system) and pay an additional fare in order to reach IRT services.

It is important to note that the flexibility and low-cost of BRT allow it to provide greater network coverage (Diaz et al, 2004; Diaz, 2009) which therefore makes the foregoing proposals feasible.
3) **Making BRT solutions work under South African conditions**

As indicated in the literature reviewed, the BRT-based IRT system of Cape Town draws on successful examples from countries in South America, Asia, North America and Europe, where excellent and affordable BRT systems have been established (CoCT, 2006; CoCT, 2008; CoCT, 2010b). However, contextual differences need to be recognized and taken into account. What may be appropriate in one case may not be workable or acceptable in another. Therefore, as local public transport problems and needs as well as local realities may differ drastically from those in other case cities, BRT solutions need to be tailored so that they can work within the South African environment or under South African conditions (i.e., under existing demographic, economic, environmental, physical (or urban form), social, and political conditions) (Iles, 2005). For example, one of the critical success factors of the Lagos BRT-Lite System (i.e., Africa’s first Bus Rapid Transit Scheme) is considered to be the effort to define a form of BRT that meets local user needs, is appropriate to the context in which it is placed, and is affordable and deliverable in the broadest sense (Mobereola, 2009).

5.4 **Areas for further research**

- A large-scale research is needed on the role of BRT in improving public transport service levels. This would require the use of a bigger sample size in assessing the role of BRT in improving the public transport service levels investigated in this study, particularly for the urban poor users of public transport.
- The study has demonstrated that BRT has relevance in improving the public transport service levels investigated in this study. However, these findings alone are not sufficient to do justice to the significance of BRT in public transport service levels improvement. Further research can be done to assess the role of BRT in improving reliability, capacity, safety and security, particularly for the urban poor users of public transport.
- A more sophisticated research is needed on the role of BRT in improving public transport service levels. This would require the development of a model aimed at assessing the role of BRT in improving the public transport service levels investigated in this study as well as reliability, capacity, safety and security, particularly for the urban poor users of public transport.
- Further research is also needed on the role of BRT in promoting additional ridership, cost effectiveness and operating efficiencies as well as increases in transit-supportive land development, and environmental quality (i.e., BRT system benefits).

All these areas may be useful follow-ups to the study.
5.5 Conclusion

This was a study on “The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users of public transport: A case of Cape Town, South Africa”. This chapter has therefore summarized the major findings of the study. The chapter has concluded that the BRT-based IRT system is not clearly beneficial to the urban poor in the area of service levels improvements. However, the success of IRT in delivering benefits primarily to the urban poor is contingent upon adopting appropriate measures to rationalize the BRT-based IRT system, as shown in the preceding recommendations.
REFERENCES


City of Cape Town (2006). *Integrated Transport Plan (ITP) for the City of Cape Town (2006 To 2011)*, City of Cape Town, Cape Town, South Africa.

City of Cape Town (2008). *Putting Policy into Practice*, Enviroworks, Biannual Environmental Newsletter of the City of Cape Town, Volume 2/08, City of Cape Town, Cape Town, South Africa.


City of Cape Town (2010c). *Business Plan: Phase 1A of Cape Town’s MyCiTi Integrated Rapid Transit System* – October 2010, City of Cape Town, Cape Town, South Africa.

City of Cape Town (undated). *Managing Growth and Leading Change in the Cape Town Central City: Central City Development Strategy (CCDS)*, Cape Town, South Africa.


The role of Bus Rapid Transit in improving public transport levels of service, particularly for the urban poor users
Case of Cape Town, South Africa


Poswa, N. (2008). Characteristics of Households Living in Poverty, Strategic Development Information and GIS Department, City of Cape Town, Cape Town, South Africa.


Cape Argus, 2009-08-05
Cape Times, 2011-05-09
Cape Times, 2011-05-17
Creamer Media’s Engineering News, 2009-05-22
Annex A: The full IRT route network maps
Annex B: The IRT fare level list

Source: CoCT (2010c)
Annex C: The estimated total project system cost of implementing Phase 1A
Source: CoCT (2010a)
Annex D: The amended roll-out of Phase 1A
Source: CoCT (2010a)