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Masters Dissertation

A Comparative study of Public Transport systems in Developing Countries

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ACET

VREF African FUT CoE for Studies in Public and Non-motorised Transport

ABSTRACT

The large and mostly impoverished populations of African cities are dependent on public transport to provide them with accessibility and mobility. In most African cities, private vehicle ownership and traffic is increasing rapidly, scheduled or formal public transport systems are declining or have disappeared altogether and the unscheduled or informal Para-transit systems that have replaced them are unsafe and offer a low quality service.

The problem with public transport planning in most African cities is that public transport is either poorly planned or not planned at all. This is due to the fact that there is a lack of adequate information and planning framework to guide decision makers and that they either select inappropriate systems based on those used in developed countries or allow private operators to decide.

It is the responsibility of government to ensure that public transport systems meet the needs of the communities they serve and political decision-makers urgently need to make the right decisions for the development of public transport. Precise and relevant performance indicators and statistics will give a clear overview of the public transport systems of cities and will help to monitor the benefits of implementing efficient public transport systems. There is therefore a need to develop a methodology to assess public transport systems in African cities.

The main aim of this study is to describe, discuss, and compare the public transport systems in developing countries. The methodology will be based on a set of performance indicators and related benchmarks that can be used to evaluate the public transport system of a city against certain goals. This study also describes the current existing public transport systems and their characteristics, as well as findings on the application of the methodology in Cape Town, Dar es Salaam and Nairobi.

The literature review aims to identify the characteristics of public transport systems and to develop a methodology that can be used to describe, discuss and compare public systems. It is based on studies that have been done on the characteristics of public transport systems. The first part of the literature review examines various studies and papers on public transport to determine which components of the public transport system are important and is followed by a more detailed discussion on the characteristics of these components.

The following components were found to be the most important components of a public transport system:

- Institutional and Regulatory Frameworks.
- Networks and City Structures.

- Public Transport Modes.
- Financial Issues.

Each of these components is described and discussed in the literature review.

Previous studies done on evaluating and comparing public transport systems of different cities were analysed to create a methodology to evaluate and compare public transport systems with each other. The focus was on the elements of the public transport system that the authors evaluated and compared, the amount of detail that they gave and the ways they compared the various elements with each other. Literature on the various performance indicators, transport performance measures and criteria to choose performance indicators were also reviewed.

The methodology used in this study consists of five phases: Literature review to determine the characteristics and performance measures of the public transport systems, a methodology to describe and discuss the public transport systems, the collection of the data from the three case cities, the methodology to evaluate and compare the public transport systems and the application of the methodologies to the three case cities; Cape Town, Nairobi and Dar es Salaam. The use of the different phases of the methodology worked well together in order to undertake a comprehensive study of the public transport systems of the case cities.

The applications of the methodology to the case cities were successful, although the chosen components and characteristics provided too much information for inclusion in a short summary on the public transport system of each city. The process of selecting the goals and objectives of a city in order to identify the Key Performance Indicators (KPIs) worked very well, especially to ensure that the most important KPIs for a city are selected. Although it can be difficult to select objectives that will apply to all three cities and thus this can reduce the number of KPIs selected. The results from the KPIs were contextualised to make it easy to compare across cities; income per capita, area, population and car ownership were used to contextualise the data for each city. It was difficult to collect all the data needed to evaluate the selected KPIs and careful consideration needs to be given to the time and resources needed to collect the data versus the importance of the specific KPI.

This thesis quantified and analyzed the performance of the public transport systems of three case cities through the use of different methodologies in order to describe, discuss and evaluate the public transport systems. The characteristics of the public transport systems in Nairobi and Dar es Salaam are very similar, with both markets dominated by paratransit services whereas Cape Town's market is dominated by commuter rail services. Some of the characteristics of the public transport system in Cape Town are different from the other two cities, but all three cities have congested networks, poor

quality of public transport services, struggle with the regulation of the paratransit services and have a large proportion of low income population that cannot afford public transport. Cape Town has a higher private vehicle ownership level and also a much higher GDP per capita than the other two cities. All three cities need to improve the quality of service and performance of their public transport systems in order to reach the standards and compare well against "World-class" public transport systems.

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DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the information presented. The contents do not necessarily reflect the official views or policies of the University of Cape Town.

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously submitted it at any other university for a degree.

Signature:.....

Date:.....

ABBREVIATIONS

ACET – African Centre of Excellence for Studies in Public and Non-motorised Transport

ACSA –Airport Company of South Africa

BRT – Bus Rapid Transit

CATA – Cape Amalgated Taxi Association

CBD – Central Business District

CBRTA – Cross-Border Road Transport Agency

CMA - Cape Metropolitan Area

COCT – City of Cape Town

CODETA – Congress for Democratic Taxi Association

COSATU – The Congress of South African Trade Unions

CPTR – Current Public Transport Record

DART - Dar es Salaam Rapid Transit Agency

DARCOBOA - Dar es Salaam Bus Owners Association

DCC - Dar es Salaam City Council

DOT – Department of Transport

DORA – Division of Revenue Act

DRTLA - Dar es Salaam Regional Transport Licensing Authority

DUTA - Dar es Salaam Urban Transport Authority

ECPTS – Evaluation and Comparison of Public Transport Systems

GABS – Golden Arrow Bus Services

HCI – Hosken Consolidated Investments Limited

HIS – Household Interview Survey

HOA – Heads of Agreement

IC/ICs - Interim Contract/s

IDP – Integrated Development Plan

IRPTN – Integrated Rapid Public Transport Network

ITP – Integrated Transport Plan

JICA - Japan International Coperation Agency

KIPPRA - Kenya Institute for Public Policy Research and Analysis

KPI - Key Performance Indicator

KRB - Kenya Roads Board

KRC – Kenya Railway Corporation

LOS - Level of Service

LRT – Light Rail Transit

MOA - Matatu Owners Association

MOLG - Ministry of Local Government

MOTC - Ministry of Transport and Communications

MSA – The Moving South Africa Strategy

MVOA - Matatu Vehicle Owner Association

MWA - Matatu Welfare Association

NATDO – National Taxi Drivers Organisation

NC – Negotiated Contracts

NLTA – National Land Transport Act

NLTF - National Land Transport Framework

NLTTA – National Land Transport Transitional Act

NMA - Nairobi Metropolitan Area

NMT – Non-motorised Transport

NTPC – The National Transport Policy Committee

OLS – Operating License Strategy

OLB – Operating Licensing Board

PGWC – Provincial Government of the Western Cape

PLTF – Provincial Land Transport Framework

POLB - Provincial Operating Licensing Board

PRASA – Passenger Rail Agency of South Africa

PSV - Passenger Service Vehicles

PT - Public Transport

PTA – Peninsula Taxi Association

PTP – Public Transport Plan

ROW – Right of Way

SABOA – South African Bus Operators Association

SABTA – South African Black Taxi Association

SACAA – South African Civil Aviation Authority

SACCOS - Savings and Credit Cooperation Organisations

SALDTA – South African Long Distance Taxi Association

SAMSA – South African Maritime Safety Authority

SANRAL – South African National Road Agency

SANTACO – South African National Taxi Council

SARCC – South African Rail Commuter Corporation

SATAWA – South African Transport and Allied Workers Union

SNPs – Special Needs Passengers

SUMATRA - Surface and Marine Transport Regulatory Authority

TC – Tendered Contracts

TDM - Travel Demand Management

TLB - Transport Licensing Board

TPMs - Transport Performance Measures

TRB - Transport Research Board

UDA - Usafiri Dar es Salaam

VREF – Volvo Research and Education Foundation

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1. INTRODUCTION

1.1. Introduction to the problem and research motivation

The large and mostly impoverished populations of African cities are dependent on public transport to provide them with accessibility and mobility. Public transport is not just a social good or an alternative to private car travel, but it is the only motorised mode available to the vast majority of the urban population in most African cities (Koster, 1999).

"*The income-poor make less trips and more of their trips are undertaken on foot. For most purposes they are restricted to whatever services can be accessed within walking distances, making them accessibility-poor. The journey to work may be relatively long. Even if it is not, they will use slow modes and it may be very time consuming, so they are also time-poor. For poor people, and particularly women, children and the elderly, trip making is often discouraged by their vulnerability as pedestrians both to traffic accidents and to personal violence, making them safety-poor. Finally there is evidence that long walking distances and times also create a tiredness and boredom adding an energy-poverty dimension to their deprivation."* (The World Bank, 2002). Thus, public transport is very important to offer an affordable and reliable alternative to people who cannot afford private transport.

From the above statement it can be deduced that the four criteria of a good public transport system are accessibility, reliability, affordability and efficiency. Public Transport systems that meet these four criteria will help to improve the social and economic development of a city and offer a way out of economic, social and physical isolation for the poor.

The problem with public transport planning in most African cities is that public transport is either poorly planned or not planned at all (Mfinanga, 2009). There is a lack of adequate information and planning framework to guide decision makers, resulting in many cities either selecting inappropriate systems based on those used in developed countries or letting private operators decide. Developing countries have different economic and social conditions from those in developed countries and solutions, specific to their own needs as opposed to simply copying approaches used by developed countries, should be developed and applied in each country.

It is the responsibility of government to ensure that public transport systems meet the needs of the communities they serve. Political decision-makers urgently need to make the right decisions for the development of public transport. Precise and relevant performance indicators and statistics will give a clear overview of the public transport systems of cities and will help to monitor the benefits of

implementing efficient public transport systems (UITP, 2010). There is therefore a need to develop a methodology to assess public transport systems in African cities.

1.2. Background to the study

During the past few decades, African Cities have experienced large population increases. It is estimated that by the year 2020 about 55% of the African population will live in urban areas. This creates an enormous challenge for cities to cope with the increase in the demand for transport especially when the transportation infrastructure provided in most of the African cities is not efficient and appropriate for the actual transport demand. There is also an increase in the demand for public transport and most of the public transport systems are overwhelmed by these increases which create overcrowded public transport services, especially during the peak periods. (UITP, 2010)

In African cities private car ownership is increasing rapidly, which even though it starts from a low car ownership base, leads to traffic congestion and an increase in air pollution. Traffic congestion also results in the situation where the road-based public transport vehicles cannot make as many daily trips as before and this results in less income generation for public transport operators. The increase in the use of private vehicles also creates a decrease in the demand for public transport which leads to a loss of income to the public transport operators. Most of the current public transport users in African cities are captive user. In order to compensate for the loss of income, public transport operators provide a lower quality of service. (Razat *et al*., 1998; Gwilliam, 2002)

Scheduled and formal public transport systems are in decline, or have disappeared altogether, while unscheduled, informal paratransit systems have replaced formal public transport in most of the African cities. These informal paratransit systems are unsafe, unreliable and offer a low quality service (Addo, 2002). Although pedestrian and other NMT is poorly served in most of these cities, a large portion of the transport markets in African cities consist out of Non-Motorised (NMT) trips.

Most of the governments in these African countries have a lack of financial and human resources which limits them to cope with the problems mentioned above (Armstrong-Wright, 1993; UITP, 2010). The financial resources supplied by government to formal public transport operators in the form of subsidies have declined over the years and operators could not sustain their vehicle fleet and quality of service, which led to a shortage in the supply of public transport services. Public transport supplied by private public operators' needs to adhere to a time schedule and set fares which are lower than the fares that the paratransit operators ask. This leads to unfair competition in the public transport market. Gwilliam (2000) notes that the traditional bus companies of most African cities were nationalised in the process of de-colonialism, which involved direct political control of the fares that

they had to ask. These bus companies were operating without subsidies and increasingly fell into deficit, which was met by government on an open-ended basis. Government started to struggle to meet the deficits and the companies became unable to maintain the vehicles. This has led to a decline in the quality and quantity of the service. Most of the companies have failed, although the traditional operators remained in the private sector, (e.g. in Kenya and Malawi), but the competition from the informal sector in a fare controlled situation made it difficult for them to survive.

Para-transit operators have filled the gap between the demand for public transport and the decreasing supply and level of service of the formal public transport operators. Currently, informal public transport dominates most of the public transport markets in African countries.

Gwilliam (2000) notes that in South Africa the situation was different, high levels of subsidy were granted to selected private sector operators to support the high transport requirements and costs of the apartheid era. This helped the strong conventional bus companies to survive. From the 1950's to the 1990's the provision of public transport in Cape Town has responded to apartheid strategies that located townships on the peripheries of cities. The government provided rail and bus infrastructure to link the distant residential areas with the employment facilities in the city centre of Cape Town. These public transport modes were heavily subsidised to enable the workers to be transported over long distances at low fares (Clark, 2000).

In this study, the public transport systems of three case cities, Cape Town, Nairobi and Dar es Salaam, will be assessed and compared across cities.

1.3. Problem Statement

Public transport in most African cities is poorly planned by governments. Many cities select inappropriate public transport systems that are either based on developed country models or they let private operators decide. Developing countries should learn from the mistakes already made in developed countries, where unbalanced transportation systems are exacting economic costs (Razat *et al.,* 1998). The economic and social environments in developed countries differ from those in Africa. Razat *et al.* (1998) states that urban areas in developing countries require new approaches to addressing their transportation problems. Countries must make their approaches city specific, even for cities within the same country. They must also realise that solutions designed for cities of developed countries cannot be applied directly to cities of developing countries.

Political decision-makers urgently need to make the right decisions for the development of public transport and also ensure that public transport systems meet the needs of the communities they serve.

Performance indicators will give a clear overview of the current status quo, quality and performance of public transport systems of cities. Through the assessment and comparison of the public transport systems of the cities, decision makers will obtain an understanding of the problem areas and where they need to invest to improve their public transport systems. There is therefore a need to assess and compare the public transport systems in the three case cities through the development of a methodology to describe, discuss and compare the public transport systems of the case cities.

1.4. Statement of purpose

In the light of the above, the dissertation will focus on the assessment of the public transport systems of the case cities and will describe, evaluate and compare them. The evaluation and comparison of the performance indicators of public transport systems will make it possible to find realistic values for public transport objectives, and also creates the opportunity to build a database on the performance results. These results can be compared across different years to evaluate whether there has been any improvement in performance and if the strategies implemented are achieving the expected results. Benchmarks give values that the city and operator should try to achieve. The results from the assessment of public transport systems will help to identify the areas where the government and authorities must invest their resources in order to improve the quality of public transport services. This is very valuable, especially with most governments that want to promote the usage of public transport and shift the modal split towards a greater use of public transport.

1.5. Aims and objectives of study

The Volvo Research and Education Foundation (VREF) has funded the African Centre of Excellence for Studies in Public and Non-motorised Transport (ACET) research programme, which is being done jointly by the Universities of Cape Town, Dar es Salaam and Nairobi. The ACET research programme focuses on two main areas. The first research area is on Public Transport and Paratransit and the second research area is on Non-Motorized Transport.

Project 6 of the ACET Programme Project is focussed on Public Transport. Its main aims are to investigate the conditions under which investments into particular public transport modes and systems are appropriate, to analyse which public transport systems have the greatest potential for improvement in different African city contexts, to assess the performance and impact of large public transport projects in the case cities currently being planned or implemented and to identify implications for policy and practice.

This dissertation forms Sub Project 1 of Project 6 and has the objective “To undertake a comparative study of public transport systems in developing countries.”

This methodology will be used to provide the following:

- A comprehensive discussion on the characteristics of the public transport systems within the case cities.
- An assessment of the public transport systems of the case cities.
- A comparison of the public transport systems of the case cities.

1.6. Research Question

The key questions of this research are:

- What are the key characteristics, determinants and performance indicators to describe and assess the public transport systems of the case cities?
- How can the public transport systems of the case cities be assessed and compared with each other?

1.7. Research method

The research has 6 main steps:

- The literature review to inform the methodology.
- Development of methodologies to describe, discuss, assess and compare the public transport systems of the three case cities.
- Development of a questionnaire which will be used to collect data from the case cities, Cape Town, Nairobi and Dar es Salaam.
- Collection of secondary information to describe, discuss, assess and compare the public transport system of the three case cities.
- Analysis of the secondary data in accordance with the methodologies developed.
- Write up of the dissertation.

Figure 1.1 shows the conceptual framework for the research methodology.

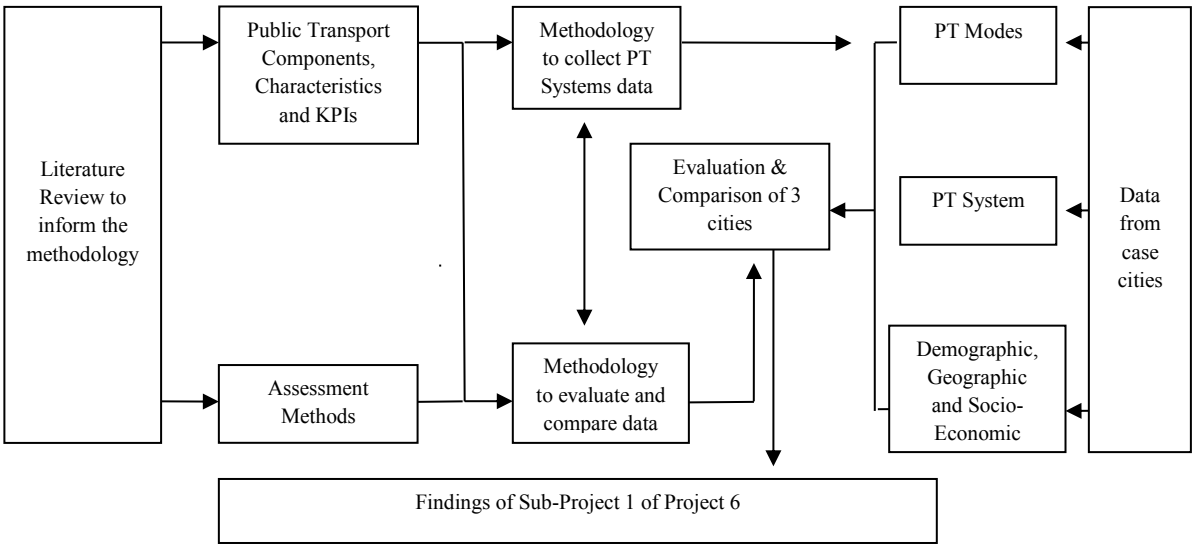

Figure 1.1: The Conceptual Framework for the Research Methodology

1.8. Dissertation Outline

The dissertation is comprised of eight chapters.

The first chapter discusses the area of interest and gives an introduction to the study. The problem that is being investigated is also outlined in this chapter as are the aims and the objectives of the study.

The second chapter reviews literature on the components and characteristics of public transport systems and also methodologies to describe and evaluate the performance of public transport systems.

The third chapter discusses the study's methodological approach to collect the data from the case cities used and to assess and compare the public transport systems.

The fourth, fifth and sixth chapters describe the public transport systems of each city and then apply the methodology to assess and discuss the public transport system. The public transport data collected from the case cities are used to describe their public transport systems.

Chapter 7 discusses the results from the application of the methodology to compare the public transport systems of the three case cities. The first section focuses on the comparison of the characteristics of the public transport systems of the case cities, while the rest of the chapter compares the performance of the public transport systems of the case cities.

Chapter 8 is the concluding chapter and provides a summary of the conclusions made in the body of the report.

1.9. Conclusion

This dissertation will focus on the key components, characteristics and performance indicators that are necessary to describe, discuss, evaluate and compare the public transport systems of cities. The next chapter will present the literature reviewed for this study.

2. LITERATURE REVIEW

2.1. Introduction

This chapter reviews the literature on the characteristics and components of public transport systems that are necessary to describe and discuss the public transport systems of the case cities. Literature on each characteristic is reviewed in terms of a description and nature of each characteristic.

Literature on assessment methods to evaluate and compare public transport systems is also reviewed to identify performance indicators that can be used to evaluate the public transport systems of the case cities with each other. Methods to contextualize data in order to make them comparable with each other are identified through the literature review. This is very important to ensure that the data and results can be compared across cities. Literature on how to select and reduce performance indicators that are specific to a city was also reviewed.

2.1.1. The role of transport

The main purpose of transport is to overcome the distance to where a person needs to be. Motorised transport modes are used when distances are too far for walking. Transport not only serves to overcome the distance to an activity, but it also influences where the activities locate. A city cannot function without a good transport system as explained through the following quotation; "*Transport is the lifeblood of a city and various organs within a city cannot function without a transport system that works for all*." (COCT, 2006b)

The transport system consists of infrastructure and service components, and transport planning has to be dealt with in a holistic approach (Mbara, 2002). Public transport is a component of the transport system of a city. Duff-Riddel (2009) describes the role of public transport as follows: "*The role of public transport is to provide access to economic opportunities, reduce the cost of doing business, to provide environmental sustainability to support other broader strategies, to provide access to social opportunities and to achieve shared growth and integrated development. Public transport goes wider than the provision of a public transport service and it means the determination of policy, the making of legislation, the regulation and control, the provision of public transport services and the provision of infrastructure for public transport."*

Public transport provides an alternative to private transport for passengers that do not have access to or cannot afford a private vehicle, which in developing countries is a large segment of the population. The greater capacity of public transport makes it an obvious choice of mode to convey passengers that need to be aggregated in large numbers. This saves the need for land and infrastructure along the route

and for parking of vehicles when they are not being used. Public transport is also more energy efficient and less polluting than private vehicles where large numbers of passengers are to be conveyed. The concern about climate change makes the increased use of public transport an obvious Travel Demand Management (TDM) strategy. For an urban public transport system to contribute to economic and social development it has to be reliable, efficient, affordable and demand-responsive.

2.1.2. The components of a public transport system

This section reviews the literature on the components of the public transport system. Table 2.1 shows all the components of public transport systems that are mentioned in the literature. This table was developed using phase two of the methodology as described in section 3.2.

Table 2.1: List of the public transport system components that can be used to describe the public transport systems of cities

	Theme		**Components**
1	Institutional and regulatory framework	1.1	Stakeholders
		1.2	Regulatory framework
		1.3	Industry structures
2	City and Public Transport Network structure	2.1	City characteristics
		2.2.	Transport network
		2.3	Transportation demand and usage
		2.4	Infrastructure
3	Public transport modes	3.1	General
		3.2	Infrastructure
		3.3	Vehicle fleet
		3.4	Main routes
4	Financial issues	4.1	Economic background of the city
		4.2	Fares
		4.3	Affordability of PT service

The four themes used to describe public transport systems are: i.e. Institutional and Regulatory framework, City and Public Transport Network Structure, Public Transport Modes and Financial issues.

2.2. Institutional and Regulatory Framework

This section includes a discussion on what is necessary and important to regulate a public transport system. The roles and places in the hierarchy of the different stakeholders that are involved in the public transport industry are also discussed.

According to Van de Velde *et al.* (2008) public transport regulatory arrangements vary considerably from city to city. In their study they indicate that various aspects influence how public transport is organised: how regulatory powers on public transport are divided between the national and local authorities, how public transport financing is organised, the ownership and structure of the operators, and the nature of the relationship between authorities and transport operators.

The extent of public transport regulation varies between cities. Regulation can range from the basics of issuing operating licences for the public transport vehicles up to a point where it covers almost every aspect of the transport operation (Iles, 2005).

2.2.1. Regulatory Stakeholders

Regulatory institutions should have enough capability and independence to undertake basic network planning, administer the regulations and guide the development of the public transport sector. Efficient political and administrative institutions are fundamental to the effective planning, development and management of urban transport.

Armstrong-Wright (1993) mentions that public transport systems are shaped by the various governmental institutions that play a role in the sector. The strength of these institutions can improve the effectiveness of public transport. He indicates in his study that institutions in developing countries tend to be overstaffed, but they are lacking in skills and experienced staff and that institutional weakness is the primary reason for poor project implementation or performance.

The stakeholders include the government (national, provincial and municipal levels), international funders and agencies and overseeing organisations (Golub, 2009); the owners, operators and their associations, and the passengers and their associations. These regulatory bodies have to work together in a co-ordinated and co-operative manner to ensure that the optimal outcome is possible. Armstrong-Wright (1993) identified that there is a wide variety of institutional structures in developing countries and especially African countries and that these differences usually exist because of the differences in the cultures, politics, economies and geographic features of a country.

2.2.2. Regulatory Framework

Meakin (2004) described the regulatory framework as the broader concept of the full range of incentives, freedoms and regulatory measures where government or the public authority plays a central role. He indicates that the regulatory framework should provide a legal basis to impose the right mix of obligations and incentives by which the policy objectives may be achieved.

Meakin (2004, III-35) indicates that a regulatory framework consists of the following legal instruments:

- *Legislation which may have international, national, provincial, metropolitan or municipal effects.*
- *Regulations made under legislation which formalise technical regulations and operating standards.*
- *Administrative procedures which become subject to legal standards of fairness and objectivity.*
- *Licences and franchises.*
- *By-laws.*

The success of a regulatory framework strongly depends on the relationship between authorities and operators. Anreiter (2000, 5) writes that *"The regulatory framework determines the way in which transport services are designed, planned and produced. The definition of transparent rules for the allocation of responsibilities and the sharing of risks between the different agents of the system is thus an indispensable tool for the management of public transport. Operators from different modes and authorities from different legal entities have to coexist both in time and space."*

Different regulatory frameworks can exist in the same location for different modes (e.g. long-term franchise or public monopoly for rail-based mode, with more competitive, open market for bus / para-transit). There is no optimum regulatory framework and the most appropriate strategy should be selected and adjusted to local conditions. According to the study done by Meakin (2004) the following factors affects the choice of a regulatory framework;

- Geographic, demographic and socio-economic characteristics.
- Public transport policy and pricing objectives.
- Institutional capacity.
- Industry structure.
- The types of transport modes.

Regulation is described by UNESCAP (2001) in the following way: *"sustained and focused control, normally exercised by a public agency, over activities that are valued by a community... [which] can either prevent undesirable behaviour, actions and activities or enable and facilitate desirable ones."*

Iles (2005) lists the three main areas of public transport regulation as:

- Quality of service regulation which is primarily intended to ensure the safety of the public transport users and to protect the road system and other infrastructure from damage.
- Quantity of service regulation which controls the number of public transport vehicles operating on a route and the frequency of the vehicle trips on the route (amount of passenger capacity provided).
- Fare regulation which specifies the fares to be charged. The regulations may specify the actual fares to be charged, a maximum fare that an operator is allowed to charge as well as different fare levels for different standards of service.

The disadvantage in a fully regulated system is that an operator may exploit the users of the service', and, without competition, the operator might become inefficient. Thus, it is good to implement controlled competition when you know that you have economies of scale and contestable markets. Controlled competition can be achieved through contracting out the supply of transport services to multiple operators.

Public transport services are usually provided under some form of contract which gives the operator the right to provide services in specified areas or on specified routes. The different types of contracts are described as follow;

- Gross cost contract – The operator is assured of an income which is based on vehicle-km provided regardless of passengers carried. All the revenue goes to the authority and the risk is carried by the authority.
- Net cost contract – The operator takes some of the risk and the onus is on the operator to maximise passengers to increase revenue from fares. The authority pays a predetermined subsidy to the operator.
- Quality contract – This is an incentive contract which aims to obtain the best possible service for the users at a given subsidy level.
- Route or Area contracting – The operator is contracted to provide a specified service to an area or on a route; for which the contractor has the exclusive rights but also the responsibility for planning and designing the services to be provided.

(Iles, 2005; Meakin, 2004)

The national government usually enacts legislation that applies to the delivery of public transport services, although some countries allow their provincial and local governments to make their own statutes and regulations (Meakin, 2004). These need to comply with national policies which Meakin (2004) describes as *"Policies are the basic, universal principles that should guide and govern choices, decisions and actions. Policies address the questions 'what?' and 'why?'"*

Transport policies are necessary goals and objectives for which performance measures need to be developed so that plans, strategies and operations can be assessed. Transport policies should be formulated in such a way that they will improve the quality of the transport system for commuters. Countries usually have different transport policies that are based on the socio-economic, demographic and geographic conditions and context of a city, although many cities have similar goals and objectives.

2.2.3. Industry Structures

The public transport industry can have various forms of ownership and structure, each of which has its own characteristics, advantages and disadvantages. The regulatory regime has a strong influence on the nature of the industry and the way in which it operates.

Meakin (2004) describes the different industry structures as follow;

- Monopoly – The operation of public transport is undertaken by one company or authority with no competition for contracts or services. While this could result in a well-coordinated service where the profit obtained on profitable routes are used to fund services on unprofitable routes; it can also result in an inefficient service because there is no competition.
- Mix of small and large scale public and private operators – This is typically public sector operators supplemented by small private operators. This could introduce some competition with some improvement in service, but could also produce unfair competition between government-supported public operators and the unfunded private operators.
- Multiple private operators – Consist of many private operators, which is the case in many African cities. When a fragmented industry experiences some consolidation through associations or cooperatives, the opportunity emerges to begin regulating the industry. While this structure results in competition between operators, this competition can be robust and unprofitable routes could be ignored and left without service.

The regulatory framework and operating environment in developed cities favours a formal, corporate industry structure, while developing countries usually have an industry structure that is composed out of many private operators.

2.3. City and Public Transport Network Structures

In this section the transportation network of a city is discussed. The important components of the transportation network include characteristics of the city, the transport network, transportation demand and usage, and transport infrastructure.

2.3.1. City characteristics

A city's form greatly influences and is influenced by travel patterns (the classical land use-transportation interaction). The development of urban form and urban sprawl has been one of the root causes of many transportation problems throughout the world. The rapid, unplanned, and uncoordinated growth of cities has spread their populations, with more people moving from the city centres to the urban periphery. This distribution of the population reduces access to public transportation and makes the cost of building and maintaining new public transportation systems very high and sometimes impossible. Urban sprawl has also caused motorised trips to be longer. (Razat *et al.*, 1998; Armstrong-Wright, 1993)

2.3.1.1. Density

Density refers to the intensity of land use and is generally measured in dwellings per hectare or square metre. Density has major influences on the use of public transport. Without sufficient density, land use design and land-mix will not be sufficient to ensure an environment where public transport will have significant public transport users. Density increases accessibility by shortening the average trip lengths for all travel modes. The closer the public transport routes are to each other, the denser the network and the better the accessibility will be, but the capital and operating costs will be greater.

A study in Portland, Oregon concluded that the two most significant variables for determining public transport demand are overall housing and overall employment densities (Nelson and Nygaard, 1995). Pushkarev and Zupan (1977, 1982) also stated that residential densities in public transport corridors, along with the size of the CBD and the distance of the stations from the CBD explain the demand for a variety of public transport modes. Several studies have also shown that when employment is concentrated in a large employment centre (CBD), people are more likely to use public transport (Halifax Regional Municipality, 2002).

Corridor densities can be used to establish the most viable public transport mode for specific densities alongside a corridor. Densities can also be used to decide on an optimal service frequency for public transport services.

Table 2.2 and figure 2.1 summarize the residential densities that are required for the various types of public transport services to be viable. The residential densities mentioned in Table 2.2 are very similar to other estimates by transport experts: e.g. Brisbane Transportation Study (1965), Thompson (1977) and Mees (2000), in Public Transport Users Association (2007).

Table 2.2: Recommended residential densities for public transport service (Source: Pushkarev and Zupan, 1982; TRB, 2002)

Service Levels	Residential Density Thresholds
Bus: Minimum service (20 buses/day)	10 dwelling units/hectare
Bus: Intermediate service (40 buses/day)	17 dwelling units/hectare
Bus: Frequent service (120 buses/day)	37 dwelling units/hectare
Light Rail: 5 minute peak headways	22 dwelling units/hectare (40-160sq. km corridor)
Rapid Rail: 5 minute peak headways	30 dwelling units/hectare (160-240sq. km corridor)
Commuter Rail: 20 trains/day	3-5 dwelling units/ hectare (existing track)

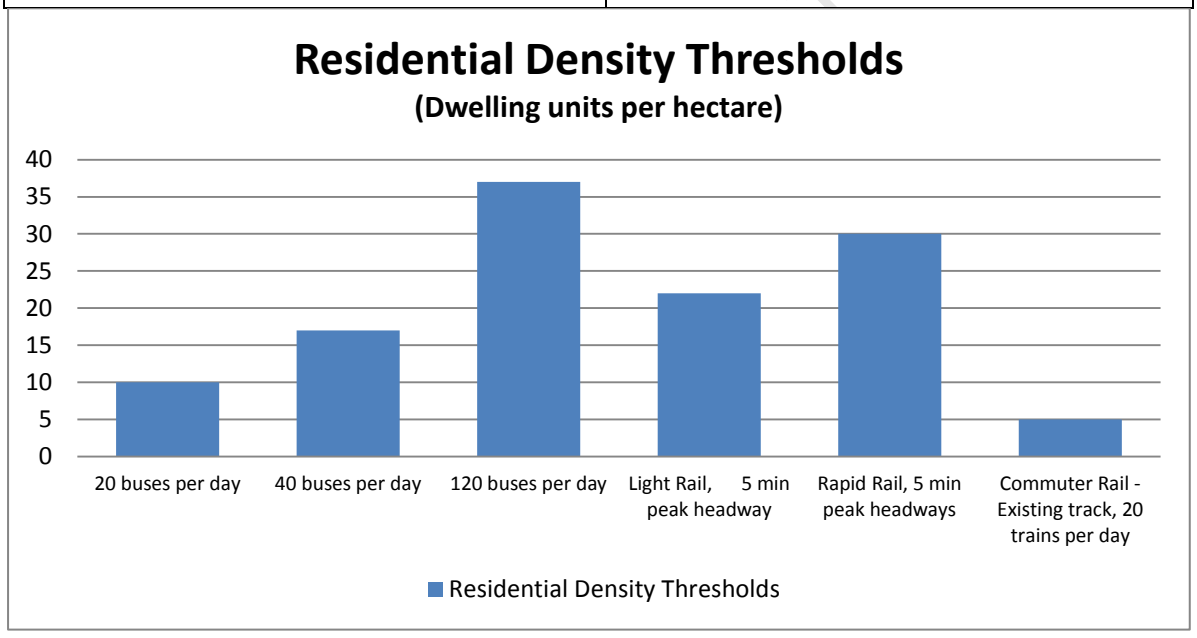

Figure 2.1: Residential Density Thresholds

2.3.1.2. City Structure

Pickrell (1999) describes that the historical evolution of transportation from the horse-drawn carriage to the trolley system to car and bus, together with investment and pricing practices for supporting infrastructure have been three of the most influential forces that shaped the development of metropolitan areas. When transport was only human and animal powered, cities were dense with mixed land use since the range was short and resources could not be imported from far which limited the size. The trolley system allowed public transport to extend along corridors further out from the CBD. Although the corridors were limited in width and also dense since pedestrians needed to walk to

public transport stops and stations. The motor car allowed activities to be dispersed and not limited to the centre or to narrow corridors, together with "cheap" oil it promoted development which led to urban sprawl.

The starting point of any public transport network must be the pattern of land use which strongly influences the potential transport and public transport usage. The public transport network itself may also influence the land-use pattern. There is a direct relationship between land use form and public transport.

Urban sprawl causes some cities to develop in a low density manner. Urban sprawl is caused particularly by the location of low-income housing projects on low value land that is on the urban edge of a city and this leads to long travel distances and high transportation costs. In some cities high-income development also takes place on the urban edge. By discouraging low density "urban sprawl" development and encouraging concentrated development, the number of private vehicle trips and the distance travelled by commuters can be significantly reduced.

The number of trips required to reach common activities can be reduced by locating different types of activities close together such as shops and schools within or next to residential neighbourhoods. Mixed land uses can create a number of transportation benefits (TRB, 2002):

- The more that complementary land uses are mixed, (i.e. offices, shops, restaurants, banks etc.) the more likely people are to walk and less likely to drive.
- Trips are potentially more spread out throughout the day and week, instead of all the trips concentrated during the morning and evening peak periods.
- Mixed-use development generates opportunities for resource sharing, such as parking.
- Multi-use and multi-nodal corridors improve public transport ridership and efficiency by generating trips during peak periods in the non-peak directions and increasing off-peak usage.

2.3.2. Transport Network

Iles (2005) describes a route network as the aggregation of transport routes serving a particular area and the individual routes are complementary to one another so that travellers can use different routes during their journey. A public transport network can consist of routes operated by a single transport operator or different operators within the same mode and services that are provided by different modes. A problem in many route networks is that there are no direct links between major public transport stops and gathering points and a large proportion of commuters must change public transport vehicles during their journeys.

The majority of commuter movements in cities are radial (see figure 2.2); most people travel from places outside the city centre to the city centre and back again, mostly for work purposes. Since the CBD was the centre for many non-residential activities, public transport routes radiated from the CBD, which produced a public transport network referred to as radial or hub and spoke. This network form is usually found in large cities with the radial services usually being the line haul services. (Iles, 2005; Duff-Riddel, 2009) The disadvantage of this network is that as it extends outwards, passengers need to always travel to the hub to transfer to destinations on another radial route. Non-radial passenger movements can be catered for by operating a number of routes that link suburbs with each other, circumferential routes (see figure 2.2) linking outer points or inter-suburban movements by extending services from the main radial routes (Iles, 2005).

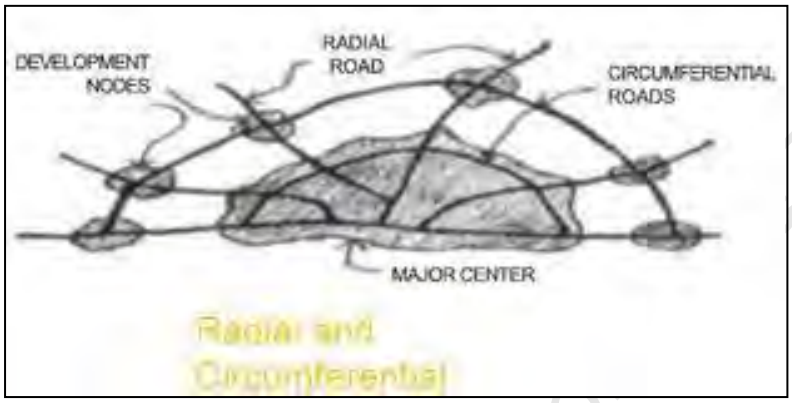

Figure 2.2: Radial and circumferential services

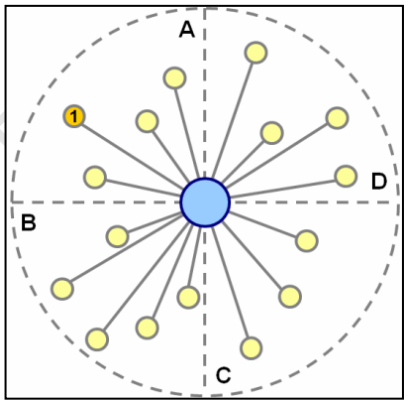

Figure 2.3: Hub and Spoke Transport Network

Hub and spoke systems (figure 2.3) (they are very similar to radial networks), may be appropriate particularly in smaller towns where all routes meet at a central focal point and the passengers are able to travel between any two points in the city by transferring from one route to another (Iles, 2005).

As urban areas expanded and passenger volumes along routes grew, it was possible to change to large vehicles and more dedicated routes to increase capacity and speed. This requires passengers to be aggregated at stops, collected to feed the trunk and then distributed at the destinations. A collector-distributor service is a core service (trunk line/line haul service) which is fed by a number of feeder services (see figure 2.4). (Duff-Riddel, 2009)

Figure 2.4: Collector-distributor service

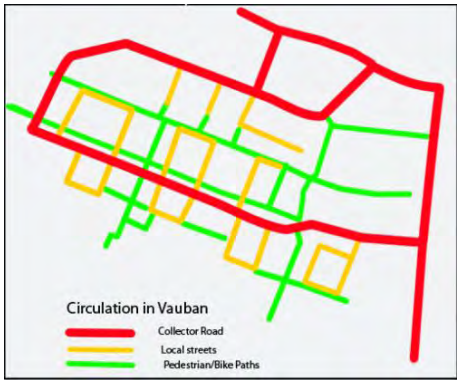

Figure 2.5: Grid services

Grid networks can be found in residential or CBD areas. The core of a radial-circumferential network is often in this form (see figure 2.5) (Duff-Riddel, 2009).

A public transport network rarely has only one particular pattern and the network type of a city will largely determine the traffic flow of a city. This is largely because specific public transport modes are best suited to the demands of each segment of the public transport network and the modes needs to be integrated.

Network capacity

Cities in developing countries have experienced rapid urbanisation and transport infrastructure and services in many cities have become severely overloaded. The authorities have not been able to meet the demand for formal housing and formal public services (including transport). This has resulted in a spatial layout which does not have the space required to accommodate high capacity public transport. The authorities also do not have the financial resources to provide additional formal public transport services. Substantial capacity of road networks continues to be lost due to a lack of proper traffic management and inefficient usage of the road (Armstrong-Wright, 1986).

Wright (2007) suggests that mass rapid public transit systems have the ability to move large numbers of passengers on corridors with large passenger volumes. This ability is very valuable, especially in developing countries where mode shares for public transport are sometimes higher than 70 percent.

Most cities in Africa are faced with a sizable population living in informal housing, poorly served by an informal public transport service that is unsafe, uncomfortable and unreliable.

2.3.2.1. Network Performance

Traffic congestion is caused by the increase in the volume of vehicles on a road, and usually occurs when the volumes exceed the design capacity of the roads. Traffic congestion can have a negative

impact on the economy because it slows down the movement of goods and it also causes commuters to spend more time travelling in the peak hour which leads to loss of valuable and productive time (City of Cape Town, 2006b).

Expanding the roadway by building more lanes and increasing vehicle capacity will only be a short term resolution because the more road space there is the more private vehicle users will start using that road until it is congested again (Iles, 2005). Efficient travel demand measures (TDM) can be used to get people to stop using their private vehicle and start using public transport. Before TDM measures can be efficiently used, the quality of public transport services will have to be improved in order to provide an alternative to private vehicle users and to get them to shift to public transport.

2.3.3. Transportation demand and usage of public transport modes

Circumstances differ considerably from city to city, but certain basic trends determine transport demand. The growth in urban population leads to a proportional increase in transport trips, while the spread of urban areas gives rise to the expansion of road networks, longer journeys, and more fuel consumption. Greater availability of motorized transport results in more motorized trips and more fuel consumption while increases in household income create a greater propensity for travel and an increase in car ownership which leads to the demand for more road capacity (Armstrong-Wright, 1986).

These factors cause a huge increase in transport demand which has implications for the efficiency of the city. These implications are traffic congestion, loss of productivity in commerce and industry, air pollution, increased costs and specifically fuel consumption. In many cities demand has outstripped the available road capacity which has led to greater congestion and this causes delays to commuters (Armstrong-Wright, 1986).

2.3.3.1. Modal split

Modal split is the share of different modes of transport within overall transport demand. It can also be defined as the varying proportions of different modes which may be used at any time as it describes the number of trips or percentage of travellers using a particular type of transportation. Usually choices of transport modes are determined by the costs, destinations, capacities and frequencies of modes. Transport modes can be seen as competing services, especially in the competition between private car and public transport services.

Bruun (2005) warns that it is very important to include Non-Motorised Transport (NMT) trips in a modal split. Misunderstanding as well as intentional disingenuous representation can occur when

analysts do not include NMT modes in modal-split. Indicators such as modal-split percentage must be carefully designed so that they can detect differences that may arise from investment projects and operational changes.

2.3.3.2. Daily passenger demand

Daily passenger demand can be expected to grow in proportion to population increase (Armstrong-Wright, 1986). The ability of a system to attract ridership is very important. The greater the passenger demand, the greater the capacity needed for public transport service and the more viable the system will be if enough capacity is available and the most suitable modes are operating on the transport corridors.

There is an increase in the use of private vehicles in developing countries (Gwilliam, 2002).The perception is usually that only captive users will make use of public transport services, this is mainly because of the poor quality of service that public transport provides. In most developing countries the captive public transport users are more than fifty percent of the total transport market.

As income grows, private car ownership also increases (UITP, 2010). Developing countries are not implementing enough and effective Travel Demand Management (TDM) strategies to keep the growth in the use of private vehicles down.

2.3.4. Infrastructure

Public transport infrastructure consists of road and rail networks, public transport stops, terminals, depots, railway stations, workshops and NMT facilities. Most African cities do not have adequate public transport facilities and infrastructure, mostly due to a lack of financial resources (Iles, 2005).

The roads in most African cities tend to also be in a poor condition with potholes and rough surfaces. The poor condition of the roads is due to unexpectedly large traffic volumes, roads that are under designed, overloaded trucks and lack of proper maintenance. By keeping roads in good condition the authorities of a city can benefit from large savings in their budgets (in the long run), extended lifecycles of roads, reduced vehicle operating cost and the reduced risk of traffic accidents. (Armstrong-Wright, 1986; Iles, 2005)

2.4. Public transport modes

There are several public transport modes which are unique in terms of their operational characteristics and it is important to understand the roles of each mode and the way in which they complement and compete with each other (Iles, 2005). Public transport services can be provided on road or rail. Rail services are limited or non-existent in most African cities.

2.4.1. Various modes

The wide variety of public transport services can be categorized on the basis of the mode, the vehicle fleet and the type of service provided. Road-based public transport modes consist of conventional buses, informal paratransit vehicles, taxis and human and animal powered vehicles. Rail passenger transport systems consist of tramways, high speed rail, light rail transit, metros and heavy rail systems. (Iles, 2005)

Vuchic (1981) defines a public transport mode using the following three characteristics: Right-of-way (ROW) category, technology and type of service. In this study commuter rail, commuter bus and paratransit systems will be discussed.

2.4.1.1. Rail transport

Railway services can be provided in the form of trams, light rail transit, high speed rail, metros and suburban rail. Some African cities make use of suburban rail services, but trams, light rail transit and metros are very scarce in most African cities.

Tramways (see figure 2.6) operate in mixed-traffic and they are slow and have limited capacities. The rapid growth in public transport in developing countries occurred after the successful periods of tramway transport, and thus only a few tramways were ever established in these countries.

Figure 2.6: Tram in Bendigo, Victoria

Figure 2.7: Two-car light rail train in San Diego, California

Light rail transit (LRT) is a form of urban rail transport that generally has a lower capacity and speed than heavy rail and metro systems but higher than the tramway systems (see figure 2.7). Vuchic (1981) describes that LRT is a mode that mostly uses grade separated right of way (ROW), but they can also operate in mixed partially segregated ROW's. LRT provides a wide range of Level of Service (LOS) and performance characteristics and provides reliable, convenient, accessible and comfortable public transport services. They have higher capacity and speed than bus systems and dedicated ROW results in reliable and predictable service. Their capacity range between 100-375 passengers/coach i.e. up to 20,000 pass/hour/lane (http://en.wikipedia.org/wiki/Light_rail).

Commuter (suburban) rail systems usually operate on tracks shared with regional and national passenger trains and freight trains. This limits capacity and can create some operational problems. Cities in developing countries make use of heavy railways to provide commuter rail services to their suburbs or close-by urban areas. Some of these systems have large patronage, 0.5 – 1 million passengers per day, but several systems are poorly patronized because they are not close enough to high density areas or do not terminate conveniently near city centres. If the suburban railway system is very well located it will account for significant patronage. (Armstrong-Wright, 1993)

Rail infrastructure can be expensive and it is important to have very dense corridors and passenger demands along railway lines in order for the service to be viable. The rolling stock of suburban railways generally comprises electric or diesel multiple units with sets of 8, 10, 12 or 14 coaches. The route capacity of the train sets varies considerably and depends on the train size, frequency and delays that may happen during operation. A typical suburban railway set which consists of 8 coaches will carry 1995 passengers per train. Metro services or rail rapid transit operate on dedicated track and can carry more than 50,000 passengers per hour operating at 3 min headway. (Armstrong-Wright, 1993)

2.4.1.2. Commuter bus services

Commuter bus services usually provide a regular, scheduled service on fixed routes with predetermined stops and fares (Iles, 2005; Vuchic, 1981). Bus services were the dominant mode of motorised transport in developing countries for many years, and in some African cities still are (Armstrong-Wright, 1993). Traditionally urban bus services have been run mostly by the public sector; urban local authorities, public utility corporations or parastatals, but now many private operators also provide bus services.

Vuchic (1981) mentions that because buses have a wide capacity range and they have the ability to operate on almost all streets, arterials, and freeways, they provide services covering a wide range of LOS, performance, cost and impacts. Buses have capacities that range between 50-100 passengers

(single and double deck) and articulated vehicles (between 110-270 passengers). These vehicles can carry up to 6,000 passengers per hour.

Bus Rapid Transit (BRT) is a high-quality road-based public transport system that delivers fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations and excellent customer service. There are numerous BRT systems in operation throughout the world, many of which are in South America, and also BRT systems that are in the planning or construction phase (http://www.balancia.com/home/nieuws-archief/nieuws-item/article/bus-rapid-transit-rukt-op-in-afrika). South Africa recently started operating BRT systems in Johannesburg and Cape Town. It is reported that BRT can carry over 40,000 passengers per hour on a lane.

2.4.1.3. Paratransit

Paratransit is the term that is given to small passenger transport vehicles which operates informally. There are no scheduled services and usually the fares are not fixed. Paratransit services have become very popular since they have filled the gap where the formal public transport services did not keep up with the growing passenger demand. (SARB Chair of Transportation Engineering, n.d.)

Paratransit generally consists of minibus-taxis and shared taxis, these include 10-19 seater minibuses and 25-35 seater midi-buses. They account for a considerable portion of public transport journeys, especially in African cities (Joewono & Kubota, 2007). This service is operated on a less formal basis than conventional bus service, with smaller vehicles and often by owner-drivers or small fleet owners (Iles, 2005). The smaller vehicles allow them to provide a more frequent service and a service closer to the homes of the passengers. They operate on either fixed or variable routes and usually have different fare systems. Iles (2005) has identified many local names for paratransit vehicles: such as Daladalas (Tanzania), Jeepneys (Philippines), Matatus (Kenya) and Minibus-taxis (South Africa). Iles (2005) mentions that minibus-taxis are particularly suited to the operation of low-volume routes, off-peak and feeder services, and serving areas of unplanned or upgraded squatter towns, where the roads are too narrow, winding or uneven for conventional buses. Although minibuses have a much smaller capacity than standard buses, with their speed and manoeuvrability they can still carry a large number of passengers per hour per direction.

2.4.2. Public transport modes capacity

Iles (2005) mentions that an important consideration is the most appropriate vehicle size to meet the demand of passenger transport along a corridor. Large buses and small vehicles are appropriate in different circumstances and planning needs to be carried out to determine whether several small

vehicles or a large vehicle would meet the requirements of the passengers and operators more efficiently. The appropriate vehicle size is influenced by the traffic volumes, the ROW and the quality of services which passengers require and are prepared to pay for (Iles, 2005).

The study by UITP (2010) on Public Transport in Sub-Saharan Africa shows that as the density of low capacity transport increases, the average speed of the vehicles on the road decreases. If there are too many low capacity public transport vehicles on the road, instead of a smaller number of larger public transport vehicles, it can create dysfunctions in the transport system.

The passenger demand on a corridor will largely determine the public transport mode that should operate on that corridor. Figure 2.8 compares the optimum capacity ranges of alternative transport modes. (There is some disagreement with the capacity given for BRT, e.g. Vuchic 1981). The capacity of a transport mode and especially the maximum passenger flow per hour per direction plays an important role in deciding which transport mode will be the best option for a specific transport corridor. The maximum capacity of different public transport modes is shown in table 2.3.

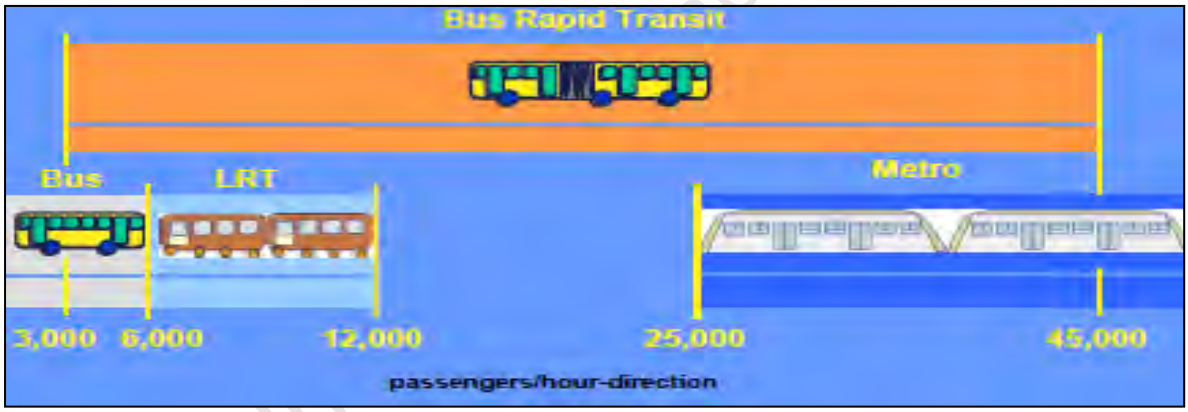

Figure 2.8: Public transport capacity (Wright, 2007)

Table 2.3: Mode Capacities			
Mode	**Location**	**Max pass flow (pphpd)**	**References**
Paratransit (Minibuses)	* Not applicable to a specific location	2,000	Golub, 2009
Buses in mixed traffic	* Not applicable to a specific location	2,500 - 4,000 3,000 - 6,000	Transport for London, n.d. Wright, 2007
Busway (BRT)	Porto Alegre Sao Paulo Abidjan Curitiba Bogota * Not applicable to a specific location	25,000 20,000 20,000 18,000 35,000 (3,000 - 45,000)	Armstrong-Wright, 1993 Armstrong-Wright, 1993 Armstrong-Wright, 1993 Armstrong-Wright, 1993 Wright, 2007 Wright, 2007
Suburban Rail	Bombay Western Bombay Central Buenos Aires Lagos	22,000 20,000 20,000 8,000	Armstrong-Wright, 1993 Armstrong-Wright, 1993 Armstrong-Wright, 1993 Armstrong-Wright, 1993
Tramways (LRT)	* Not applicable to a specific location	6,000 12,000	Armstrong-Wright, 1993 Transport for London, n.d.
LRT	Manila Hong Kong * Not applicable to a specific location	19,000 28,000 18,000 (6,000 - 12,000)	Armstrong-Wright, 1993 Armstrong-Wright, 1993 Transport for London, n.d. Wright, 2007
Metro	Hong Kong Mexico City Rio de Janeiro * Not applicable to a specific location	80,000 60,000 21,000 30,000 (12,000 - 60,000)	Armstrong-Wright, 1993 Armstrong-Wright, 1993 Armstrong-Wright, 1993 Transport for London, n.d. Wright, 2007

According to Wright (2007) the passenger capacity of transport modes depends on the passenger capacity of the vehicle, the number of vehicles that can be grouped together, minimum headway between vehicles and the availability of limited stop, boarding and alighting techniques and express services. The passenger demand on a particular corridor is mainly determined by the population density along the corridor, the total catchment area for passengers and the origin and destination profile of the residents.

2.4.3. Infrastructure

The capital costs of rail systems are very high, especially in the case of metros. Heavy capital subsidies are necessary to provide this service. Rail systems very often also need an operating subsidy to be able to provide the service. The construction period of building a railway system is very long compared to other modes. The capital cost of building tramways is not as high as other railway systems, this is because trams are able to make sharp bends and operate on steep inclines. This has made it possible to build tramways in existing streets with mixed traffic, which leads to a reduction in the capital infrastructure costs. The cost of light rail construction varies widely, largely depending on the amount of tunnelling and elevated structures required. The infrastructure cost to build light rail is cheaper than the cost of full metro systems. Metros are usually referred to as rail rapid transit and can also be called the subway or underground. They operate on completely segregated right-of-ways at high speeds and high capacity. This involves very high infrastructure cost. Flyvberg *et al.* (2008) concluded that capital costs per route-kilometre of urban rail vary greatly between projects. It has been established that the main reasons for the high variation in the route-kilometre costs are differences between projects as regards to the ratio of underground to above-ground construction, ground conditions, station spacing, type of rolling stock, environmental and safety constraints and labour costs. The capital cost of metros and almost always the operating cost are heavily subsidized, usually by central governments. In developing cities the full cost of building and running a metro is never fully recovered from the users.

The infrastructure that a bus needs to operate on is the road it moves on, terminals and stops where passengers can board and alight from the bus and depots where the buses can be stored at night and during off-peak periods. The infrastructure that is necessary for buses to operate in mixed traffic is not expensive compared to the infrastructure that is necessary for more enhanced operating environments. A greater degree of separation of the operating environment can lead to a higher level of service and efficiency, but with increased infrastructure cost. It is a trade-off between higher capital cost and faster and more reliable services, because the interference by other road users is reduced or eliminated. The infrastructure usually consists of the bus way infrastructure, the stations, transfer stations, terminals, depots, control centre and traffic control signals. The capital cost of bus ways is still much less than the capital cost for building a rail system. (Ceneviva, 1999; Montezuma, 2001; Wright, 2007)

The infrastructure cost for paratransit operations is usually the least of all the modes. The only infrastructure that they need is the road they operate on, taxi-ranks and sometimes stops along the routes, which are usually provided by government.

2.5. Financial issues

Mengesha *et al* (2002) mention that the funding of public transport systems is a problem in African cities and it is made even worse by the fact that transportation usually takes a low priority in the budget allocation of a country.

Public sector public transport operators generally provide their services at a substantial loss and they rely heavily on subsidies from the government. The demand for public transport keeps on rising as well as the cost of providing the service and this increases the operating subsidy that operators need, but the government can usually not afford to pay the larger subsidy amount. Shortages of public revenues have made it difficult to finance modernisation and expansion of public transport infrastructure and this has resulted in decreasing service quality and growing congestion (Heggie, n.d.).

2.5.1. Funding

The sources of funding and money available for public transport generally are obtained from direct income (fare box revenue), government grants in the form of operating and capital subsidies, development income from buildings at stations, commercial loans, supplier's credit, international and bilateral grants and loans and private investment including "build, operate and transfer" and joint ventures (Armstrong-Wright, 1993).

The road based public transport industry in many developing countries is not very viable, because of competition by operators who do not make provision for major repairs and replacement. This results in poor quality of service, insufficient capacity to meet demand and the operation of old, unsafe, unreliable and uneconomic vehicles.

The lack of funding for urban transport in developing cities results mainly because of the following factors (Armstrong-Wright, 1993):

- The low income of users.
- The stagnation of national economies.
- Severe cutbacks of public spending.
- Stiff competition between sectors.
- Steep growth in outstanding debts.
- Decline in official and private lending.

2.5.2. Costs

The cost of public transport is composed of capital and operating costs.

Capital cost

Capital costs are fixed costs and are independent of the distance travelled by the vehicle. Capital costs are incurred when building new infrastructure, or buying vehicles, or for major overhauls. These costs are usually large amounts and do not occur often, usually only when new infrastructure for the public transport system is built and when new vehicles are bought to replace the old and worn-out vehicles (Fuller, 2009; Iles, 2005). It is expected that these expenditures will happen infrequently, although for a public transport system they are actually on-going since some vehicles in the fleet will need to be overhauled or replaced at any point in time, and similarly infrastructure will be incurring capital expenditure.

Operating costs

Operating costs are the recurring expenses which are related to the operation of the public transport service. The operating cost consists of the following cost elements (Duff-Riddell, 2009; Iles, 2005):

- Variable costs

  The variable costs of a vehicle are associated with the use of the vehicle. These costs are directly proportional to the distance travelled and are charged on a per-kilometre basis. These include

  - Fuel cost (Energy cost).
  - Maintenance.
  - Tyre costs.

- Fixed costs

  The fixed costs of a vehicle are those costs independent of the distance travelled by the vehicle (Iles, 2005). Fixed cost can be split into two components, standing cost and the overhead costs.

  The standing costs are associated with the vehicle and include (Duff-Riddell, 2009):

  - Depreciation of vehicles.
  - Salary of the driver.
  - Vehicle insurance.
  - Licences.

- Overhead costs

  The overhead costs are not specific to any vehicle and include (Duff-Riddell, 2009):

  - Depot rent.
  - Security cost.
  - Administration.

Because of widely differing circumstances and differences in the nature of the operations, different accounting practices and major fluctuations in currency values, it is difficult to make accurate comparisons between operating costs in different countries (Iles, 2005). Iles (2005) mentions that the comparison of component costs is reasonably useful, but that the user should keep in mind that if one cost item is much higher in real terms in one country than another, then the other cost items will appear lower in percentage terms.

2.5.3. Fares

Fare income is usually the main source of income for public transport service. It is usually expected that the fare income should cover operating cost of a public transport system when no subsidy is paid to to the operator.

Fares can also affect passenger demand. If the fares are too high, fewer passengers will make use of the service. It is very important to look at the income of the population, to decide what proportion of their household income they can afford to use for public transport. The maximum percentage of household income spent on public transport should be 10% (Armstrong-Wright, 1993).

Government usually controls public transport fares in most developing countries although the fares of paratransit services are not regulated. The way in which fares are regulated is usually based on political rather than financial or economic considerations and authorities are under pressure to keep fares down despite rising costs (Armstrong-Wright, 1993).

The intention to keep fares down may be to protect the interest of the public, but this does not keep pace with increasing costs. This often leads to the long term decline in the quality of services provided because operators often reduce their costs by lowering the standards of service, saving on maintenance and repairs and not making any specific provision for replacements, which leads to a loss in passengers. (Iles, 2005; Armstrong-Wright, 1993)

2.5.3.1. Fare Structures

Countries usually have different fare structures, South African cities predominantly use distance based fares with some exceptions. South America largely uses flat fares and Western Europe seems to cover a wide range from flat, zonal and distance based fares. Three common structures for fares are;

- Distance based fares – Fares are based on increments of distance, which can be considered to be equitable except possibly in circumstances where government spatial policy has located the poor in the furthest locations. It can be difficult to manage the integration between modes with different cost structures.

- Zonal based fares – There is a flat fare for travel within the same zone and the fares are set for travel between zones. This is fairly easy to understand and encourages shorter journeys and supports land use policies to reduce urban sprawl. This fare structure can be unfair to passengers who travel short distance but cross zonal boundaries.
- Flat fare – The same fare is charged irrespective of distance travelled. This is easy to adthminister and can meet the social objectives in aiding those that have to travel the furthest. This fare structure can encourage urban sprawl as there is no incentive to minimise travel.

2.5.3.2. Fare Pricing

The affordability of public transport fares is a major issue and there is usually an argument amongst politicians that fares must be universally affordable. By making the service affordable to everyone often means that the fare revenue will not be enough to sustain the public transport service at existing standards. Many users of public transport in developing countries are poor and some households spend more than 30% their household income on fares. (Iles, 2005)

The following objectives and requirements are important when deciding on the fare levels (Mass Transit Systems, n.d.):

- To attract the maximum number of passengers.
- To attract the maximum amount of revenue for the public transport undertaking.
- To achieve specific social goals.
- To be convenient to the passenger as well as the operator.

A compromise between these objectives is necessary to establish the best fare system.

Some public transport operators are also required to ask special fares. Special fares include commuter fares, peak hour fares, scholar/student fares, fares for the underprivileged/senior citizens/disabled persons, shopper fares, owl fares, etc. Public transport operators usually receive contributions from local government for these reduced fares (Simpson, 1994). It is desirable that the fare level corresponds to the quality and quantity of the service provided and the cost of providing the service.

2.5.4. Subsidies

Since revenue is usually insufficient to cover the costs of public transport, different types of subsidies are provided to public transport operators to enable them to provide a reliable, safe, good and affordable transport service on all profitable and unprofitable routes. Many countries in Africa do not have subsidies for public transport and this can have a negative impact on the quality of service that is provided by the operators (Mengesha *et al*., 2002). Only a small proportion of public transport

operators in the developed world can deliver a public transport service without some form of subsidy. To do this, an operator needs to be able to cover all its capital and operating costs from fares and other sources of revenue, such as advertising (Simpson, 1994).

Subsidies can have various forms: operating, capital, revenue enhancement, cost reduction and the provision of services under contract (Armstrong-Wright, 1993; Iles, 2005).

The provision of subsidies is usually justified for the following reasons (Fuller, 2009; Iles, 2005):

- To provide affordable public transport for the poor.
- To promote a mode of transport that is subject to large economies of scales.
- To support travel demand management and bring a change in the mode choice of passengers.
- To promote more environmentally friendly transport modes.
- To provide public transport services on unprofitable routes.
- To provide public transport services to special groups (scholars, disabled, etc.)
- To help public transport to compete on equal terms with other private transport operators. Public operators who provide services under a contract have to provide services according to a certain schedule, with specified headways and on specific routes. This means that they sometimes have to operate on unprofitable routes where a private operator provides its service without a fixed schedule and can decide on which routes to operate and when.

These are valid reasons for subsidising public transport, but there are also strong arguments against it. Experience in developing countries is that subsidies often lead to inefficiency and increasing costs of operators. Services are inclined to deteriorate under these circumstances, particularly with the growing demand for public transport. Inevitably they require more and more subsidies, which cannot be met by the national or local government with limited financial resources. (Armstrong-Wright, 1993; Iles, 2005)

2.6. Assessment of the performance of Public Transport systems

Cities use performance measures to help improve public transport services with the intention to attract new passengers and keep the existing passengers. Public transport operators are also monitored to see whether their goals are being met. Government usually encourages public transport operators to develop performance evaluation plans for improving and evaluating the performance of their operations (Talley, 1986; Ryus 2003).

Kelley (1982) mentions that performance monitoring and evaluation is seen as an essential process in maintaining and improving public transport service within the acceptable limits of the public support. Decision-making bodies need to have access to accurate information to help them make decisions on public transport services (Ryus, 2003).

Ryus (2003) also notes that performance data provide public transport agency management with objective assessments of current circumstances, past trends, existing concerns and unmet needs. "*What gets measured gets attention.*" (Ryus, 2003) It is necessary to have performance indicators against which you can compare the quality of service that operators are delivering as well as the quality of service of the public transport system as a whole.

Talley (1986) mentions that there are two methodologies that can be used for selecting appropriate performance indicators. The first methodology requires the specification of public transport objectives for the purpose of selecting the performance indicators (Talley & Anderson, 1981), and the second methodology specifies the criteria that selected performance indicators must satisfy (Fielding & Glauthier, 1976). In this study the goals and objectives of each case city will be used to identify the possible performance indicators that can be used to evaluate the public transport systems. The criteria that the selected performance indicators must satisfy will be used at a later stage to assist the user to minimise the number of performance indicators that will be used.

Kelley (1982) mentions that each public transport system is unique and operates in its own environment and strict comparisons of performance of these systems should be avoided. He suggests that each system can be classified into "peer groups" which would be similar in size and scale of operations. Comparisons of public transport system performances can be made with its associated peer group's performance.

2.6.1. The evaluation process

Public transport performance evaluation can be viewed as a continuing process and Kelley (1982) uses the following steps to perform the evaluation process:

- The establishment of the goals and objectives of the public transport system.
- Development of measures that relate to the stated goals and objectives and reflect the criteria of effectiveness and efficiency.
- The development and application of standards that can serve as benchmarks against which the measures can be compared.
- Continuous monitoring and evaluation over time.

Ryus (2003) indicates that the TRCP Guidebook for Developing a Transit Performance-Measurement System uses the following eight-step process for establishing a performance-measurement programme:

- Define goals and objectives.
- Generate management support.
- Identify users, stakeholders and constraints.
- Select performance measures and develop consensus.
- Test and implement the programme.
- Monitor and report performance.
- Integrate results into agency decision-making.
- Review and upgrade the programme.

A combination of these two sets of steps will provide a valuable evaluation process that can be followed in order to successfully evaluate a PT system.

2.6.2. The role of goals and objectives in choosing performance indicators

KPIs to evaluate a city's public transport system need to be derived in relation to the goals and objectives of a city. Litman (2010) describes goals as *general desired outcomes* and objectives as *specific, measurable ways to achieve goals*. The process therefore requires the translation of each goal into one or more objectives and each objective into suitable KPIs that can be used to evaluate and measure the performance of a city's public transport system

Public transport goals and objectives provide the policy context for evaluating performance.

Kelley (1982) specifies goals as broad, general statements that describe a preferred alternative for the future. Goals are broad and qualitative statements of desired end-results from the standpoint of the community that is served by the public transport service (Talley, 1986; Litman, 2010).

Objectives are more specific and often specify a time period, for example: "to increase ridership by 100% from 1984 to 1988" or "to maintain fare box revenue at a minimum of 50% of operating cost for the foreseeable future" (Talley, 1986). Kelley (1982) also states that objectives will describe how individual goals will be achieved.

It is not easy to decide on appropriate public transport goals and objectives for a city. It is important to recognize the need for establishing priorities and also to know that some objective statements can be in conflict with others. Conflicting objectives require decision makers to carefully weigh the trade offs between each and establish priorities accordingly (Kelley, 1982).

2.6.3. The selection criteria for performance indicators

Many performance measures have been developed and used in various ways but processes to determine the most appropriate performance measures for a public transport organization are missing in the public transport industry (Ryus, 2003).

Ryus (2003) mentions that traditional service efficiency indicators and cost-effective indicators are sometimes not linked to customer-oriented and community issues. He identified the need to develop a process to prepare a performance-measurement programme that includes customer-oriented and community issues. A context or framework is needed in which the appropriate performance measures integral to public transport system decision making, are selected and applied. To do this a practical, user-friendly guidebook, "*TRCP Report 88: A Guidebook for Developing A Transit Performance-Measurement System*", was produced and it assists public transport system managers in developing a performance-measurement system that uses traditional and non-traditional performance measures to address customer and community issues. The TRCP Guidebook suggests that agencies should develop a set of measures that address the agency goals and objectives.

Gleave *et al*. (2005) warn that it is often relatively straight forward to determine how performance should be assessed, but in practice it may be much more difficult to obtain the necessary information from which the precise indicators of performance can be prepared. The authority responsible may have to consider carefully whether the cost of collecting the information, which is ideally required to monitor the performance of the transport system, can be justified. Table 2.4 shows the various selection criteria that can be used to select the correct performance indicators for public transport evaluation.

Table 2.4: Selection Criteria for Performance Indicators	
Selection Criteria	**References**
Acceptable to all parties involved	(Kelley, 1982); (Fielding, Glauthier & Lave, 1977); (Ryus, 2003)
Costs to collect data	(Kelley, 1982); (Talley, 1986); (VTPI, 2010)
Consistency with goals and objectives of government	(Kelley, 1982); (Talley, 1986); (Gilbert & Dajani, 1975); (Ryus, 2003)
Data availability	(Kelley, 1982); (Talley, 1986); (Fielding, Glauthier & Lave, 1977); (VTPI, 2010)
Data quality	(VTPI, 2010);
Easy to understand	(Kelley, 1982); (VTPI, 2010)
Measurability	(Drosdat & Herbert, 1977); (VTPI, 2010)
Reliability	(Ryus, 2003)
Time needed to collect data	(Talley, 1986); (VTPI, 2010)
Uniqueness of measure	(Kelley, 1982)
Utility	(Kelley, 1982); (Drosdat & Herbert, 1977)
Variety of measures	(Ryus, 2003)

2.6.4. Public Transport Performance Measures (TPMs)

2.6.4.1. Introduction

TRB (2003) gives the following description for a transit performance measure: "a quantitative or qualitative factor used to evaluate a particular aspect of transit service." These measures are usually quantifiable and can be expressed as a whole number, a percentage or as a ratio (Kelley, 1982).

Gleave *et al*. (2005) uses the following seven criteria to assess the performance of the transport systems in their study: affordability, safety, journey times, quality of service, impact on the environment, the working conditions of those employed in the transport industry and sustainability over a number of years. Ryus (2003) used the following eight categories to assign performance measures for developing a Transit Performance-Measurement System: availability, service delivery, safety and security, maintenance and construction, economic, community, capacity and travel time.

Vuchic (1981) classifies public transport system performance evaluation into the following four categories:

- System performance – The entire set of performance elements.
    - Service frequency – The number of transit units' departures per hour.
    - Operating speed – The travel speed on a line or route.

    - Reliability – Expressed as a percentage of transit units arrivals with less than a fixed time deviation from schedule.
    - Safety – Measured by the number of fatalities, injuries, and property damage per 100 million passenger-km.
    - Line or route capacity – The maximum number of spaces or persons public transport vehicles can carry past a point along the line during 1 hour.
    - Productive capacity – Operating speed multiplied with line or route capacity, this is a very convenient performance indicator for mode comparisons because one element is affecting the passengers and the other one is affecting the operator.
    - Productivity – The quantity of output per unit of resource eg. Vehicle-km, space-km, person-km, operating cost, fuel, etc.).
    - Utilization, ratio of output to input (person-km / space-km etc.).
- Level of service (LOS) – The overall measure of all service characteristics that affect users. Major factors that compromise LOS can be divided into three groups:
    - Performance elements that affect users (operating speed, reliability, safety).
    - Service quality that consist of qualitative elements of service such as convenience and simplicity of using the system, riding comfort, aesthetics, cleanliness and behaviour of passengers.
    - Price that the user must pay for the service.
- Impacts – The effects that public transport service has on its surroundings and the entire area it serves.
- Costs – Divided into two major categories, investment costs and operating costs.

2.6.4.2. Efficiency and effectiveness

Performance evaluation plans of public transport firms usually consist of two concepts; effectiveness and efficiency (Kelley, 1982; Talley, 1986).

The effectiveness of public transport measures how well public transport is meeting the goals and objectives set by government policy. It measures the consumption and quality of public transport service and the impact on society. (Kelley, 1982; Talley, 1986)

Public transport system effectiveness measures (Kelley, 1982):

- Total ridership.
- Ridership per vehicle kilometre or hour.
- Ridership per capita.

- Safety indicators (per 100,000 population or 10,000 vehicles).
- Schedule reliability (Percent of on time arrivals).
- Percent employment served.
- Revenue generation (Passenger revenue per kilometre/hour).
- Cost effectiveness (Operating ratio).

Categories of interest relative to effectiveness criteria (Kelley, 1982):

- Service utilization.
- Accessibility of service.
- Quality of service.
- Cost effectiveness.
- Revenue generation.

The efficiency of public transport systems measures how well the resources are used. Efficiency is usually expressed as a ratio of output (kilometres and hours of service) per unit of input (labour, capital and fuel). Efficiency is very important to measure because limited public funds must be allocated among various important public services. (Kelley, 1982; Talley, 1986)

Efficiency measures (Kelley, 1982):

- Vehicle kilometre or hours per employee.
- Vehicle kilometre or hours per vehicle.
- Vehicle kilometre per breakdown of public transport vehicle.
- Vehicle kilometre or hours per operational cost

Categories of interest relative to efficiency (Kelley, 1982):

- Vehicle utilization.
- Labour productivity.
- Energy utilization.
- Cost efficiency.

Single criteria cannot evaluate performance appropriately and there is a need to seek the optimal balance between efficiency and effectiveness criteria.

2.6.4.3. Description of various performance measures

Accessibility

Accessibility measures the walking distance to public transport facilities. Kumar & Barret (2008) acknowledge that this indicator considers the extent to which any particular user in the city is within easy geographic reach of a public transport stop. TRB (2003) indicates that the maximum walking distance should not be more than 1000m; while Armstrong-Wright (1993) mentions that for a dense urban area the maximum walking distance should be between 300 and 500m and in low density areas the distance can be between 500 and 1000m.

Accessibility can be measured by the average distance to public transport vehicle stop or the proportion of the population who can reach a public transport stop within the appropriate distance (Essakali, 2005). Accessibility also describes the ease with which all categories of passenger can use public transport (Carruthers *et al.*, 2005).

Affordability

Carruthers *et al.* (2005), describes affordability as the extent to which the financial cost of a journey puts an individual or household in the position of having to make sacrifices to travel and the extent to which they can travel when and where they want to. Affordability can be considered as the ability to make necessary journeys (to work, school, health and other social services).

Affordability is a vital indicator of transport performance in African cities. If a high quality transport system is too expensive for people to use it, it fails to achieve the prime objective of an urban transport system. (Gleave *et al*., 2005) Affordability varies widely with income and distance travelled. Rising transport fares can isolate people from employment opportunities (Kumar & Barret, 2008).

The affordability of public transport can be measured by comparing the financial price which has to be paid for transport with the financial resources of potential commuters (Gleave *et al*., 2005). If the ratio is too high for a particular mode of transport, the commuters will not use that mode. Kumar & Barret (2008) also recommends that affordability of fares needs to be dependent on household income. There is a norm that a passenger should not spend more than 10% of his disposable income on public transport (Armstrong-Wright, 1993; TRB, 2003).

Gleave *et al*. (2005) specifies the following potential indicators to measure affordability:

- Public transport fares by mode and distance:
  Information must be collected on the average fares charged for journeys of different lengths by different types of public transport.
- Public transport fares by mode and distance / average daily wage for different types of activity:
  Information on the average daily wage for different types of activity is usually already available from the Government, if not it can be accessed from anecdotal knowledge or from limited but not very expensive sampling. A disadvantage of this indicator is that it does not allow for the extent to which a desired journey will require one or more changes of mode with a consequent need to pay two fares.

The World Bank, (Carruthers *et al.*, 2005), uses the following Index to measure affordability:

$$Affordability\ Index = \frac{Number\ of\ trips * Average\ cost\ per\ trip}{Per\ capita\ income}\ expressed\ as\ a\ percent$$

Carruthers *et al.* (2005) mentions that the high cost of urban transport has a negative impact on the lives of the urban poor, by restricting their access to jobs that are within feasible walking or cycling distance, by consuming an unsustainable portion of their income, or by reducing the number of journeys that they make.

Availability

Availability measures how easily passengers can use public transport for various kinds of trips (TRB, 2003). Carruthers *et al.* (2005), describes availability of transport as the route possibilities, service hours, travel time and frequency. An individual's journey is constrained by the route and the time taken to travel. Public transport will be an option for a trip when service is available at or near the locations and times that someone wants to travel. It is important that the passengers can get to the public transport stops, within reasonable time and without too much effort and that there is sufficient capacity available on the public transport vehicles (Ryus, 2003; TRB, 2003).

TRB (2003) indicates that there are four different categories under availability: spatial availability (where is the service provided and can a passenger get to it), temporal availability (when is the service provided), information availability and capacity availability (is there passenger space available for the desired trip).

The maximum walking distance that people are willing to walk to public transport stops and services depends on the context and population of a country or city. Several studies in North American cities show that 75 – 80% of the passengers walk 400 metres or less to a bus stop, this is equivalent to a maximum walking time of 5 minutes. For rail transport these times and distances can be doubled. The perception will be that passengers in African cities will be more willing to walk a further distance to a PT stop than users in developed countries. (TRB, 2003)

Information availability is important because passengers need to know how to use public transport service, where to access it, where to get off, whether any transfers are required and when the public transport services are scheduled to depart and arrive (TRB, 2003a).

Capacity

Capacity measures the ability of public transport facilities to move people and public transport vehicles. Insufficient capacity can have an impact on public transport service availability, for example if a vehicle is full when it arrives at a stop, the public transport service is not available at that time to the passengers waiting. (TRB, 2003)

Data on the fleet sizes of public transport modes and the vehicle capacities can be converted into an indicator of seat availability per 1000 population. The seating capacities of the different public transport modes of cities can be compared against each other. (Kumar & Barret, 2008) Capacity can also be measured in terms of the number of spaces per hour per direction on a certain road or line, or the trunk capacity (pax/hour/direction) (Dauby, 2009).

Comfort and Convenience

Potential passengers often weigh the comfort and convenience of public transport against competing modes. Comfort and convenience are compared in terms of how long the walk is to the public transport stop, whether the service is reliable, how long you have to wait for the vehicle, are there security concerns, how comfortable is the trip, how much will the trip cost, how many transfers are required and how long will the trip take in total. (TRB, 2003)

Passenger loads:

TRB (2003) mentions that public transport service is less attractive when passengers must stand for long periods of time, especially when the public transport vehicles are very crowded. Crowded vehicles also tend to slow down public transport operations because it takes more time for passengers to get on and off the vehicles. Many public transport agencies assess the degree of passenger

crowding based on the occupancy of the vehicle relative to the number of seats, this is expressed as a load factor.

Reliability:

Reliability is measured in terms of the amount of time passengers must wait at a public transport stop for a public transport vehicle to arrive and also the consistency of a passenger's arrival time at a destination from day to day. Reliability can be measured in terms of on-time performance and also the regularity of headways between successive public transport vehicles. (TRB, 2003)

Appearance and comfort:

Clean, attractive public transport stops, stations and vehicles can improve the image of public transport. Passengers are also interested in personal comfort while they are using public transport. This will include; appropriate climate control, seat comfort and ride comfort. (TRB, 2003)

Frequency of service

This is measured in terms of the amount of public transport vehicles per hour or the headway of the vehicles on a specific route. The more frequent the service, the shorter the waiting time (depending on how full the vehicle is) and the greater the flexibility that customers will have in selecting travel times. (TRB, 2003)

Journey times

Journey times measure how long it takes to make a trip by public transport. TRB (2003) mentions that total trip time includes the travel time from the passenger's place of origin to a public transport stop, the waiting time for a public transport vehicle, travel time on-board a vehicle, travel time from a public transport stop to the passenger's destination, including the time required for transfers between routes during the trip.

Commuters should not spend more than 3 hours per day to travel to and from work. The benchmark for journey speed is usually 10km/h in dense urban area with mixed traffic and 25km/h in medium-low density areas (Armstrong-Wright, 1993).

Passenger volumes

Passenger volumes are an indicator of productivity and indicate the number of passengers carried in relation to the capacity of the system. It can be measured in terms of the average number of

passengers per operating vehicle per day or the number of passengers per vehicle km. (Armstrong-Wright, 1993; TRB, 2003)

Transfers

This measures the number of times that a passenger has to change vehicles or modes on a journey. The need to interchange between routes or between modes adds to the time spent waiting and the inconvenience experienced by the passengers. No more than 1 out of 5 passengers should be expected to transfer modes more than once. (TRB, 2003) Armstrong-Wright (1993) states that the benchmark is that less than 10% of the public transport passengers should transfer two or more times per journey.

Quality of service

Quality of service reflects the passenger's perception of the public transport performance. Quality of service measures how successful an agency is in providing service to its customers and it focuses on those aspects of public transport service that directly influence how passengers perceive the quality of a particular public transport trip. (TRB, 2003) Individuals base their decision of the quality of service of a mode on economic criteria, trip time, convenience, reliability, comfort and safety (Mohan & Tiwari, 1999; Gleave *et al*., 2005).

Kumar & Barret (2008) use the following indicators to describe the quality of service of a public transport system: quality of roads, crowding on public transport vehicles, regularity of service, terminal facilities, accessibility, waiting times, trip times and reliability.

Gleave *et al*. (2005) specifies the following potential indicators:

- Comfort, the percentage of the journey time spent standing in public transport vehicle.
- The length of time that the average passenger has to wait before being able to board a vehicle. This will vary from route to route and the frequency of the service offered.

Financial performance

Financial performance measures the performance of a public transport system from a business perspective, including the use, efficiency, effectiveness and also the administrative measures (Ryus, 2003).

The following economic measures can be used: ridership, cost-efficiency, cost-effectiveness and productivity (Ryus, 2003). The capital and operating cost of systems can be measured in terms of cost per vehicle-kilometre or cost per passenger-kilometre (Dauby, 2009; Henry & Litman, 2006).

Fleet utilisation

Fleet utilisation indicates the effectiveness of vehicle procurement and the maintenance staff. It measures the proportion of bus fleet that can be put into service each day. Public transport systems can have an 80-85% fleet utilization if they are well-run (Armstrong-Wright, 1993).

Fuel consumption

The fuel consumption of vehicles depends on the size of vehicles, load, fuel, engine, gradients and the traffic conditions. Usually it will be between 20-25 litres/100km for minibuses and 29-45 litres/100km for buses (single deck large buses) (Armstrong-Wright, 1993). The energy consumption for commuter trains is estimated at 1,964 MJ per passenger-km (en.wikipedia.org/wiki/Fuel_efficiency_in_transportation).

Operating Ratio

The operating ratio depends on the vehicle type and their capacity and it is measured by dividing the total revenue by the operating costs of the service (TRB, 2003). Operating cost can also be indicated as operating cost per passenger kilometre.

Vehicle-kilometres

This indicates the productivity of the vehicle fleet and it shows the total distance travelled by vehicles in service. It is usually indicated as average kilometres per operating vehicle per day and if a service is well-run it can achieve between 210-260 km's per bus per day (Armstrong-Wright, 1993).

Safety and security

This measures the likelihood that someone will be involved in an accident or become a victim of crime while they are using public transport (TRB, 2003). Safety measures the potential for being involved in an accident, while security measures the chance of being a victim of a crime related incident. Accidents are also an indication of standard of driving and the maintenance of vehicles. It is influenced by traffic conditions and it is important to compare it with vehicles operating in the same environment. If a service is safe and well-run it will have 1,5-3,0 accidents per 100,000 vehicle km's (Armstrong-Wright, 1993).

Gleave *et al*. (2005) specifies the following potential indicators to measure safety:

- Death and injury by mode of travel / person
- Death and injury by mode of travel / vehicle-km travelled

Sustainability

Transport has some of the following impacts on a city: air quality, noise and vibration, accidents, global climate change, natural habitats, waste disposal, congestion, depletion of non-renewable resources, economic efficiency, separation, vision intrusion and the loss of living space (COCT, 2006b).

To make the transport system of a city more sustainable it is necessary to reduce these negative impacts of transport. City of Cape Town (2006b) describes sustainable transportation as the ability to move people and goods effectively, efficiently, safely and affordably without jeopardising the economy, social matters and the environment, today and in the future.

"*A sustainable transportation system is one in which fuel consumption, vehicle emissions, safety, congestion and social and economic access are of such levels that they can be sustained into the indefinite future without causing great or irreparable harm to future generations of people throughout the world.*" (Richardson, 1999)

Figure 2.9, shows the sustainable transport goals. Each of these goals has various transport planning objectives to support them.

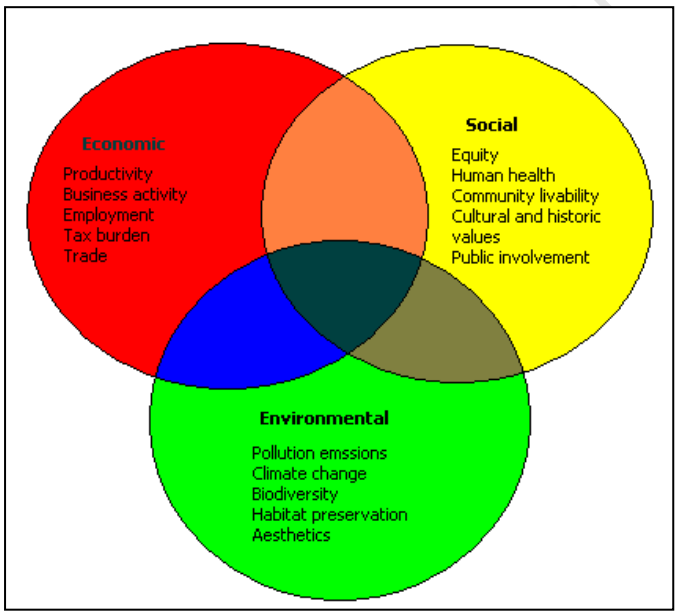

Figure 2.9: Sustainable Transport Goals (Source: Litman, 2010)

Table 2.5 shows a summary of the most important performance indicators that emerged from the literature review.

Table 2.5: Summary of performance indicators	
Performance Indicator	**Reference**
Quality of service	
Accessibility, Affordability, Availability	(TRB, 2003a), (Armstrong-Wright, 1993) (Eboli & Mozzulla, 2007)
Reliability	(TRB, 2003a), (Luke, n.d.), (Eboli & Mozzulla, 2007)
Service frequency	(TRB, 2003a), (Eboli & Mozzulla, 2007)
Journey speed	(TRB, 2003a), (Luke, n.d.), (Armstrong, Wright, 1993)
Waiting time	(TRB, 2003a), (Armstrong-Wright, 1993)
Journey time	(TRB, 2003a), (Armstrong-Wright, 1993), (Ryus, 2003)
Number of transfers	(TRB, 2003a) (Armstrong-Wright, 1993)
Comfort, convenience, customer service	(TRB, 2003a), (Ryus, 2003), (Dauby, 2009), (Eboli & Mozzulla, 2007)
Safety and security	(TRB, 2003a), (Mohan & Tiwari, 1999), (Ryus, 2003)
Operator efficiency	
Passenger Volumes	(TRB, 2003a), (Armstrong-Wright, 1993), (Henry & Litman, 2006)
Fleet utilisation	(TRB, 2003a), (Armstrong-Wright, 1993)
Vehicle-kilometres	(TRB, 2003a), (Armstrong-Wright, 1993)
Vehicle breakdowns	(TRB, 2003a)
Fuel consumption	(TRB, 2003a)
Accidents	(TRB, 2003a)
Dead-km's	(TRB, 2003a)
Costs (Operating ratio)	(TRB, 2003a), (Luke, n.d.), (Ryus, 2003), (Dauby, 2009), (Henry & Litman, 2006), (Eboli & Mozzulla, 2007)
Flexibility of operator to adapt to changes	(TRB, 2003a)
Service capacity	(Luke, n.d.), (Ryus, 2003), (Dauby, 2009)
Load factor	(Armstrong-Wright, 1993)
Profitability (revenue: cost)	(Armstrong-Wright, 1993)
Community	(Ryus, 2003), (Dauby, 2009)
Environmental impacts	(Dauby, 2009)

2.7. Conclusion

Each public transport system consists of various elements to make it a successful and efficient system (see figure 2.10). These elements should be planned thoroughly, successfully implemented and monitored continuously. If one of these elements is a weak link, it can make the whole public transport system unsuccessful. The arrows going inward in figure 2.10 indicate the components of the public transport system and this will then form the performance indicators. To understand and evaluate the way in which a public transport system operates, each component of the public transport system needs to be studied, analysed and compared with other systems and against certain benchmarks.

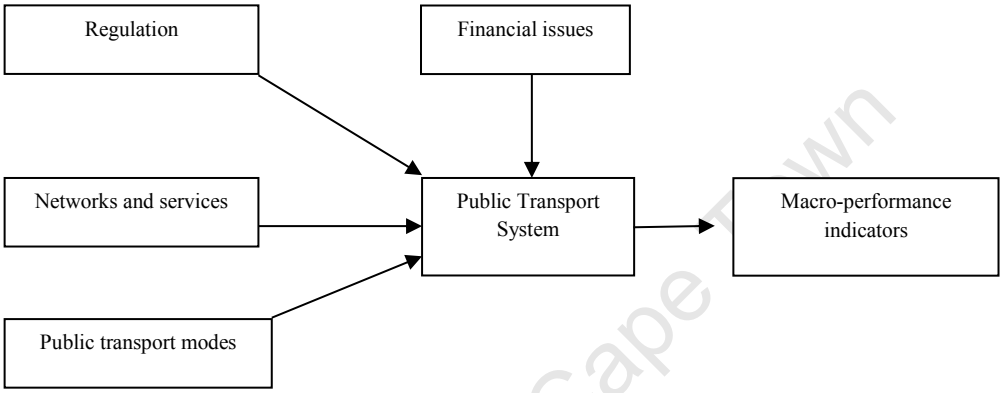

Figure 2.10: The components of a public transport system

3. DEVELOPMENT OF AN EVALUATION MODEL

3.1. Introduction

This chapter describes the research methodology which includes the following phases:

1. Extraction of characteristics and performance measures from the literature (chapter 2).
2. Development of a methodology to describe and discuss urban public transport systems.
3. Collection of data from three case cities to develop and interrogate the practical lists of characteristics, goals, objectives and performance measures and to test the applicability of these.
4. Development of the methodologies to evaluate and compare urban public transport systems.
5. Application of the methodologies to three case cities; namely Cape Town, Dar es Salaam and Nairobi.

Phase 1 forms part of chapter 2 and thus the next section will start with Phase 2.

3.2. Describing and discussing the public transport systems of the case cities (Phase 2)

In order to describe a public transport system, a set of components and characteristics needs to be established. Public transport systems consist of many components and characteristics and these components and characteristics will have to be reduced to make the list more practical. The components/characteristics that will be selected will serve as headings for the description and discussion of urban public transport systems and were developed through a review of the relevant literature.

3.2.1. Research instrument

A spread sheet was developed (an extract of which is shown as figure 3.1) to help reduce the number of characteristics and components of public transport systems. This spread sheet shows:

- Whether a characteristic was referred to in the literature reviewed. This is shown as a "1" for each characteristic for each text.
- The number of references that mentioned each characteristic. This was calculated as the sum of "1"s and shown in the third last column.
- The percentage of references that mentioned each characteristic. This is shown in the second last column.
- The most relevant characteristics. The characteristics that were mentioned in more than 40% of the references are highlighted in the last column as "y". In this way the original list of 148 characteristics reduced to 21 characteristics.
- Additional characteristics were identified as important and are highlighted as "i" in the last column. These additional characteristics were identified in studies where the main focus of the study was on these specific characteristics.

	Methodology to choose the characteristics to describe public transport systems																														
	Literature (References)	1	2	3	4	5	6	7	8	9	10	11	12	13	41	43	44	46	47	48	49	50	51	52	53	54	55	56	57		40%
	Public transport characteristics																													Usage Sum	Usage %	use yes/ no
	1. Institutional and regulatory framework	0	1	1	1	1	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	1	1	0	1	0	1	1	1	24	43	y
1	Stakeholders		1	1	1							1		1		1						1					1|		15	63	y
a	Authority responsible for maintenance of roads, infrastructures		1	1												1														5	21	
b	Authorities responsible for development of the network			1																										2	8	
2	Regulatory framework		1	1	1	1	1					1		1											1		1	1	1	17	67	y
a	PT Regulation			1	1	1						1															1	1	1	12	46	y
b	Markets											1													1		1			6	25	
c	Contract types																								1					2	8	
d	Vehicle & driver licensing			1	1																						1	1		6	25	
e	Route allocation			1								1															1	1		6	25	
f	Monitoring of service quality			1																										4	17	
g	Vehicle inspections			1	1							1																1		5	21	
h	Operating rules			1																								1		3	13	
i	Market Entry			1								1															1	1		7	29	i
j	Enforcement						1																				1			5	21	
3	PT Policies		1	1		1	1					1		1			1					1			1		1	1	1	19	75	y
a	Fare Policy		1	1								1										1					1	1		8	33	i
b	Subsidy policy																											1		3	13	i
c	Funding policies		1			1																								6	25	
d	TDM policies			1	1		1										1					1			1				1	11	42	y
e	Other policies													1													1			3	13	
f	Goals & objectives of PT																													1	4	i
4	Industry Structures			1										1																3	13	i

Figure 3.1: Extract from the spread sheet used to select public transport characteristics

3.2.2. Practical list of components / characteristics

Tables 3.1, 3.2, 3.3 and 3.4 show the components and characteristics that were chosen for the four themes, their inclusion in the "practical" list and the percentage of relevant reference that referred to them.

Table 3.1: Institutional and regulatory framework

	1. Institutional and regulatory framework (Referred to in 41% of the references)	y = yes i = included	usage %
1	Regulatory Stakeholders	y	65
2	Regulatory Framework	y	70
a	PT Regulation	y	48
3	Industry Structures	i	13

Table 3.2: Network Structure

	2. Network Structure (Referred to in 71% of the references)	y = yes i = included	usage %
1	City characteristics		73
a	Area & Population	i	35
b	Densities	i	38
c	City structure	i	35
2	Transport Network	y	60
a	Commuting Patterns	i	38
b	Public transport routes	i	33
c	Network Performance	y	42
3	Transportation demand and usage	y	70
a	Modal Split	y	55
b	Daily passenger demand	y	50
c	Non-motorised transport	i	18
4	Infrastructure	y	48

Table 3.3: Public Transport Modes

	3.PT Modes (Referred to in 80% of the references)	y = yes i = included	usage %
1	General	y	87
a	History	i	18
2	Passenger volumes	y	40
3	Infrastructure & Vehicle fleet	y	67
a	Network & operating environment	i	33
b	Facilities	i	44
c	Fleet description	y	44
4	Main routes	y	69

Table 3.4: Financial Issues

	Theme 4. Financial Issues (Referred to in 66% of the references)	y = yes i = included	Usage %
1	Economic background of the city	i	35
2	Fares	y	52
3	Affordability of pubic transport services	y	54
4	Subsidies	i	38

The review of additional literature could lead to some changes in the list of characteristics. However, the quality of the texts reviewed provides confidence that none of the most important characteristics has been omitted. KPIs are necessary to evaluate the public transport systems of cities.

3.2.3. Application of the list of practical components/characteristics

The components/characteristics listed in Tables 3.1 to 3.4 serve as headings for the description and discussion of urban public transport systems in chapters 4, 5 and 6. Quantitative values can be used to benchmark urban public transport systems against others, however these are not considered sufficient to compare public transport systems.

The characteristics selected above are adequate to describe and discuss public transport systems, but they cannot be used to evaluate and compare public transport systems of cities. A comparison needs to take local factors into account since public transport systems operate in different socio-economic conditions and have to achieve different development and transport objectives. The methodology devised to account for this is described in Section 3.4.

3.3. Data collection from the case cities (Phase 3)

This phase focuses on the data collection tool that was used to collect public transport data from the case cities. The findings from the literature review on the components of the public transport system were used to develop the questionnaire that was used for the interviews held in each of the case cities.

3.3.1. Questionnaire to collect data

In each of the case cities, Cape Town, Dar es Salaam and Nairobi, interviews were held with the public transport stakeholders.

A questionnaire was developed for the interviews. The questionnaire was structured according to the four public transport components that were identified during the literature review (See section 2.1) as well as the macro performance indicators (See section 2.6) namely:

1. Institutional and Regulatory Framework
2. City Structure and Public Transport Networks
3. Passenger Rail Transport (Public transport mode)
4. Bus Transport (Public transport mode)
5. Paratransit (Public transport mode)
6. Financial Issues
7. Macro Performance Indicators

The questionnaire and interviews served to collect information on the existing public transport services in each of the case cities and to prompt questions and requests for printed and/or electronic information. The questionnaire was structured in such a way that only relevant sections would be answered by each of the public transport stakeholders. An example of the questionnaire is provided in Annexure 1.

3.3.2. Interviews to collect data

Meetings were held in each city with:

1. Urban transport planners, city planners and/or City Council representative for the Public Transport Regulatory authority.
2. Representatives of Commuter Rail (where applicable), Bus and/or Paratransit Operators.

The following interviews were arranged in the case cities:

Cape Town

03/03/2010 - Interview with Mr D. Cupido from the City of Cape Town - Transport Planner.

03/03/2010 - Interview with Mr I Scott from Metrorail – Rail Operator.

09/06/2009 - Interview with Mr F. Meyer and A. Ally from Golden Arrow Bus Services – Bus Operator.

Nairobi

23/11/09 - Interviews with Dr Obiero and Dr Opiyo from the University of Nairobi – Transport Planners.

24/11/09 - Interview with Mr Mukabanah who is the Director of Kenya Bus Services – Bus Operator.

25/11/09 - Interview with Dr Gairy – Transport Planner.

Dar es Salaam

26/11/09 - Interview with Dr Mfinanga from the University of Dar es Salaam – Transport Planner.

26/11/09 - Interview with Mr D Shelling from the World Bank – Transport Planner.

26/11/09 - Interview with Mr Mabruk, Representative of Dar es Salaam Commuter Bus Ownership Association (DARCOBOA) – Bus and Paratransit Operator.

27/11/09 - Interview with Ms Mkupasi - Town Planner.

28/11/09 - Interview with Ms Mlambo from Dar es Salaam Rapid Transit (DART) – Town Planner.

Three days were allocated for data collection in each city. The time allocated for each interview was between one and two hours. The number of interviews held in each city was dependent on the willingness and availability of stakeholders to be interviewed.

3.3.3. Limitations

The sample size of respondents was never intended to be statistically significant. Nevertheless the calibre of respondents gives confidence to the data collected. In Dar es Salaam there are no commuter rail services and thus there were no interviews arranged with a rail operator. In Nairobi, no interviews could be arranged with a rail or a paratransit operator. In Cape Town, no interviews could be arranged with a paratransit operator.

The data collected from the interviews held in each city were not enough to describe, discuss and compare the public transport systems of the case cities and additional data has also been collected through secondary data collection and desktop studies.

The data collected from the interviews held in each city will need to be augmented with secondary data from transportation and other studies and reports for the three cities.

3.4. Assessment of the performance of public transport systems (Phase 4)

The first three phases of the research methodology focused on the themes, components and characteristics of public transport system that are used to describe and discuss public transport systems; while phases four and five focused on the development of Key Performance Indicators (KPIs) and comparison of the calculated KPIs across the cities.

From the literature review, the interviews with the relevant stakeholders and the reports of the public transport systems of cities, it emerged that the methodology to evaluate and compare public transport systems required the following components:

a) A method to select measures of performance that can be used to evaluate a public transport system in terms of the goals and objectives of the urban area.
b) A method to input the necessary information required to calculate the performance measures.
c) A method to calculate and display the performance measures.

3.4.1. Toward a methodology to evaluate and compare urban public transport systems

The following steps were followed during the evaluation and comparison process of the public transport systems of the case cities:

a) Deriving KPIs from goals and objectives.
b) Determining which data are required to estimate the KPIs.
c) Collection of data to determine KPIs.
d) Calculation of KPIs.
e) Comparison of PT systems.

a) Key Performance Indicators (KPIs) form goals and objectives

Table 3.5 shows a list of possible public transport goals and their related objectives and KPIs from which the user can choose the most appropriate KPIs. In order to compare the results from the KPIs for public transport systems of different cities the KPIs can be contextualized in terms of the area of a city, the income per capita, size of population or passenger volumes.

Table 3.5: Goals, Objectives and KPIs

No.	Goals	Objectives	KPI
1	Improve accessibility and mobility provided by the public transport system	To provide appropriate public transport choices.	% Population that has access to all three PT modes.
		To improve the accessibility of public transport services to all.	% Population within walking distance from PT facility (1000m).
			# PT stops per 100sq km.
			# PT seats per 1000 population.
			% of Public transport vehicles that is universally accessible.
			% of PT facilities that are universally accessible.
		To increase the mobility of public transport systems.	% of Population that can reach employment opportunities within 1 hour journey time.
2	Affordable public transport	To provide a public transport system that is affordable to everyone.	Average % of Household income spent on PT per month.
			% of PT users that spend more than 10% of their income per month on PT.
			Average PT fare per trip.
3	The promotion of public transport over private transport	To promote public transport over private transport.	The percentage of dedicated PT network out of the total road network of a city.
			The % of motorised transport users using public transport vs % of motorised transport users using private transport.
			# Daily PT Passengers per 1000 population.
			% of Population within 15 minutes' walk from a PT facility.
			Cost of Private vehicle parking vs Public transport fare.
4	Change the modal split in favour of public transport	To move towards a city-wide modal split in favour of public transport.	Modal Split: Public Transport vs. Private Transport
5	Environmental sustainability	To provide a sustainable public transport system.	Emissions per PT vehicle km per year.
			Average vehicle-km's per litre of fuel consumed.

Table 3.5: Goals, Objectives and KPIs (Continued)			
No.	**Goals**	**Objectives**	**KPI**
6	Service Quality & Convenience	To provide a public transport system that is convenient to the customers.	% Population within walking distance from PT facility (1000m).
			# PT stops per 100sq km.
			Average load factor in the peak period (Passengers per seat)
			Average # transfers per passenger per trip
		To improve the service quality of the public transport system.	% of Population that are satisfied with the quality of PT service provided
			Average travel time to work during the morning peak period.
			Average travel speed of public transport vs average travel speed of private transport in peak hour.
			Total road-based PT seat capacity per 1000 people.
			Total PT seat capacity per 1000 people.
			Passengers transported per train, bus and minibus-taxi per day.
		To improve the reliability of the public transport system.	% of Scheduled public transport vehicles that depart on-time at a PT stop
		To provide frequent public transport services.	Frequency in the peak hour (minutes)
7	Safety & Security	To improve the safety and security of public transport services.	# Road Accidents per 10,000 vehicles.
			# Road Accidents per 100,000 population.
			# Fatalities per 10,000 vehicles.
			# Fatalities per 100,000 population.
			Accident cost as a % of the GDP of a city
			# PT Crime related incidents per year per 100,000 population.
		To improve pedestrian safety.	# Pedestrian accidents per 100,000 population.
			Percentage of pedestrian casualties.
8	System efficiency	To provide a public transport system that operates to improve the overall efficiency & competitiveness of the city.	# Road-km on which PT service is provided per $100km^2$.
			# Private vehicles per 1,000 population.
			% of the Population that uses Public Transport.
			Average age of the vehicle fleet.
		To provide a public transport system that operates to improve the overall system costs of the city at optimum levels.	Total cost per PT vehicle-km.
			Operating cost per PT vehicle-km.
		To provide cost-effective public transport services.	Operating cost per passenger-km
Sources (Bruun, 2005; COCT, 2006a; COCT, 2006b; City of Johannesburg, 2004; City of Tswane, 2006; Kelley, 1982; Litman, 2010; Ministry of Transport and Communications, 2003; Talley, 1986; Vuchic, 1981)			

b) Data required to estimate the KPIs

Data are needed to calculate the KPIs. Gleave *et al*. (2005) warns that it is often relatively straight forward to determine how performance should be assessed, but in practice it may be more difficult to obtain the necessary information from which the KPIs can be measured. The authority or government responsible for the evaluation of the public transport system may have to consider carefully whether the cost of collecting the information which is required to calculate specific KPIs can be justified.

This step of the methodology will indicate and show the public transport data that is required to calculate a KPI. The selection criteria mentioned in section 2.6.3 are used to determine the final set of KPIs that will be used. Table 3.6 indicates the data that are required to calculate the KPIs. It is grouped according to various objectives. This will give an idea as to which KPIs you can use if you have a certain set of data, or which data you need to collect in order to evaluate a specific KPI.

Table 3.6: Data required to evaluate KPI

KPI	Population Volume	Population that has access to all 3 PT modes	Average PT fare per trip	Average monthly income per capita	Average # of PT trips per month	Population within walking distance from PT facility	# PT stops in city	Area of city	Average seat capacity per PT vehicle	# PT vehicles	Population that can reach employment opportunities within 1 hour journey times	# PT vehicles that are universally accessible	Average household income	Average household income spent on public transport per month	# Population that spend more than 10% of their household income on PT	Average PT trip length	Public transport subsidy per year	# PT passengers per year	Km's of dedicated public transport lanes	Total km's of road network	Daily PT passengers	# Daily Private vehicle users	Emissions per year	PT vehicle-km per year	Litres of fuel consumed per PT vehicle per year	# Population that has jobs in the PT sector	Population that walks less than 1000m to PT stop	# PT service hours per day	Average seat capacity per PT vehicle	# PT Passengers in peak period	# Transfers per passenger trip
Improve accessibility and mobility provided by the public transport system.																															
% Population that has access to all 3 PT modes	*	*																													
% Population within walking distance from PT facility (1000m)	*					*																									
# PT stops per 100sq km's							*	*																							
# PT seats per 1000 population	*								*	*																					
% of Population that can reach employment opportunities within 1 hour journey time	*										*																				
% of Public transport vehicles that are universally accessible										*		*																			
Affordable public transport.																															
Average % of Household income spent on PT per month													*	*																	
% of PT users that spend more than 10% of their income per month on PT	*														*																
Average PT fare per 10km trip			*													*															
The subsidies for public transport must be beneficial to the poor.																															
Average public transport subsidy per passenger per year																	*	*													
Higher priority to public transport than private transport.																															
The percentage of dedicated PT network of the road network of a city																			*	*											
# Daily PT Passengers per 1000 population	*																				*										
Change the modal split in favour of public transport.																															
Modal Split, Public Transport : Private Transport																					*	*									
Environmental sustainability																															
Emissions per PT vehicle km per year																							*	*							
Average vehicle-km's per litre of fuel consumed																								*	*						
Service quality and convenience																															
% Population within walking distance from PT facility (1000m)	*																										*				
PT Service hours per day as a % of the total daily hours																												*			
Average load factor in the peak period (Passengers per seat)																													*	*	
Average # transfers per passenger per trip																															*

Table 3.6 (Continued): Data required to evaluate KPI

KPI	Population that are satisfied with the quality of PT	Population Volume	Average journey time in the peak period from home to work	# Daily scheduled PT vehicle trips that arrive on-time	# Scheduled PT vehicle trips per day	Peak hour frequency	Operating cost per year	# PT Passenger-km's per year	# PT accidents per year	# Vehicles	# PT Fatalities per year	Accident cost per year	Annual GDP of city	# PT Crime related incidents per year	Daily PT passengers	# Pedestrian accidents	Population within 1000m from a PT stop	# PT users that spend less than 10% of their income on PT per month	Km's of road on which PT service is provided	Area of city	# Private vehicles	Average age of the PT vehicle fleet	Total Cost per year (Operating and Capital cost)
Service Quality and Convenience																							
% of Population that are satisfied with the quality of PT service provided	*	*																					
Average journey time in the peak period from home to work			*																				
% of Scheduled public transport vehicles that arrive on-time at a PT stop				*	*																		
Frequency in the peak hour (minutes)						*																	
Operating cost per passenger-km							*	*															
Safety & Security																							
# PT Accidents per 10,000 vehicles									*	*													
# PT Accidents per 100,000 population		*							*														
# Fatalities per 10,000 vehicles										*	*												
# Fatalities per 100,000 population		*									*												
Accident cost as a % of the GDP of a city												*	*										
# PT Crime related incidents per year per 100,000 PT users														*	*								
# Pedestrian accidents per 100,000 population		*														*							
# Km of road on which PT service is provided per $100km^2$																			*	*			
# Private vehicles per 1000 population		*																			*		
Average age of the PT vehicle fleet																						*	
Total cost per PT passenger-km								*															*

Sources (Bruun, 2005; COCT, 2006a; COCT, 2006b; City of Johannesburg, 2004; City of Tswane, 2006; Kelley, 1982; Litman, 2010; Ministry of Transport and Communications, 2003; Talley, 1986; Vuchic, 1981)

c) Collection of data to determine KPIs

The data needed to calculate the KPIs can be obtained from three main sources namely; secondary data (literature, studies, reports and data already collected), personal interviews in a city and primary data. Since resources are scarce in African cities it is preferable to use KPIs that require the least amount of additional data. Therefore the first step in setting up an evaluation system is to record the data that is available and then to decide whether the missing data should be collected through a more extensive data collection process or whether the specific KPI for which additional data were required should be excluded from the evaluation process. If too many of the most important KPIs have had to be excluded because data were unavailable, it will adversely affect the evaluation of the performance of public transport systems.

d) Calculation of KPIs

The KPIs are easy to calculate once all the necessary data is available. KPIs usually present values that represent efficiency, effectiveness, production, consumption and quality. The KPIs can be expressed as whole numbers or ratios or percentages.

e) Comparison of Public Transport System

The values calculated for the KPIs serve to measure the performance of a city's public transport system. Because they have been contextualised, they can also be used to compare the performance of a public transport system:

- With other different public transport systems within or across cities.
- Against benchmarks.
- Across preceding years for a specific city, to determine whether the public transport system of a city has improved.

3.4.2. The spread sheet model structure

Figure 3.2 shows a schematic layout of the spread sheet model structure.

The model has four steps namely:

a) Step 1 involves the process of choosing the goals and objectives from the list of possible goals, objectives and related KPIs. (See figure 3.3, 3.4)
b) Step 2 involves the process of choosing the KPIs; this will be done with the help of selection criteria. After the KPIs are chosen the data required for each KPI will be presented. (See figure 3.5, 3.6,3.7)

c) The user can go to step 3 to enter the data required, the user can change the KPIs selected or could even go back to step 1 to unselect some of the goals and objectives selected. During step 3 the data required to calculate the KPIs will be entered by the user. There is an iterative process between steps 2 and 3 to input the required data. (See figure 3.8)

d) Step 4 calculates the KPIs and produces the output. (See figure 3.9)

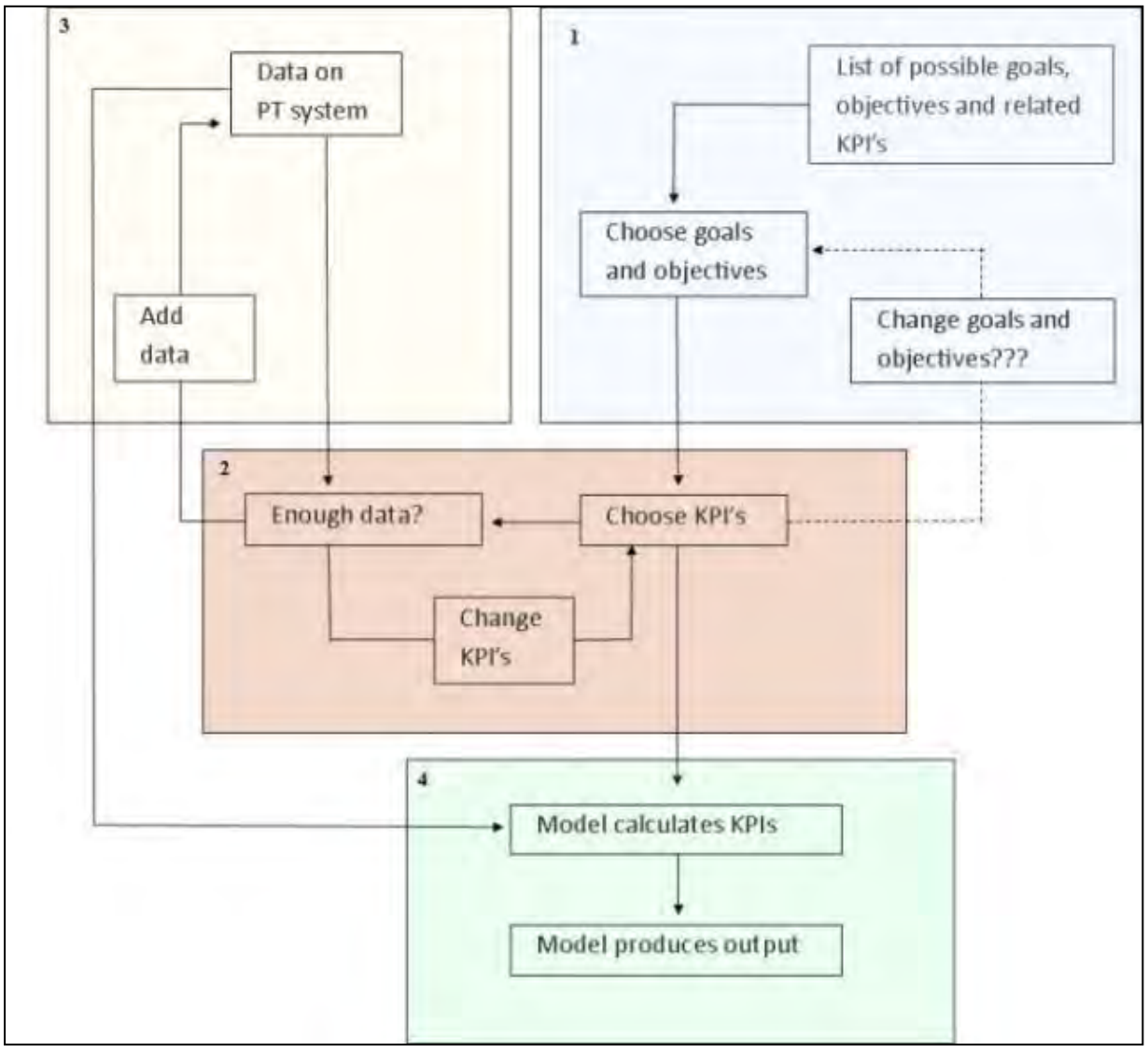

Figure 3.2: Methodology to evaluate public transport systems

a) Goals, objectives and KPIs

The first step for the user in the "*Evaluation and Comparison of public transport systems (ECPTS)*" spread sheet model is to select the objectives that are relevant to each city for which the public transport system is evaluated. This will be carried out on the "*Choosing goals & objectives*" sheet. A table will be presented to the user that will list the goals, then the objectives linked to each goal and the KPIs linked to each objective. The public transport goals and objectives of a city that are selected

will determine the list of KPI's that will be used to measure the public transport system. After the user has selected the public transport objectives, the user will select a macro that will write down the KPI's that are linked to the selected goals and objectives, in the "*Results Step 1*" worksheet.

b) Data and KPIs (Full list of KPIs, selection of KPIs on the basis of desired and availability of the data required to estimate the KPIs)

A list of possible performance indicators compiled in the "*Results Step 1*" worksheet during the previous step, will be compiled. This will be purely based on the KPIs that the user has chosen. Each KPI will indicate the data required to calculate that KPI in the "*Choosing KPIs*" worksheet (step 2).

The selection of the KPIs that will be used to evaluate the public transport system of a city will be based on the following criteria: Data availability, cost to collect data, data quality and neccesity. The user will be asked to give a value between one and five for each of these criteria for each KPI in the "*KPI Criteria*" worksheet. A score for each KPI will be indicated, this will help the user to select the KPIs that will be used to evaluate the public transport system of a city and compare across cities. The selection of the chosen KPIs will happen during step 2 on the "*Choosing KPIs*" worksheet. The next step, "*Data Input*" worksheet (step 3), is for the user to provide the data that is required to calculate each KPI. If there is still data missing to calculate a specific KPI, it will be indicated and the user will have to go back to the "*Data Input*" sheet in step 3 and provide the information required.

c) The calculation and output

After the user has successfully selected the KPIs and provided the necessary data required, a macro will be selected to run and list the goals and objectives linked to the chosen KPIs and to the values for each KPI in a worksheet called "*Data Output*". A calculation sheet, "*Calc*", automatically calculates the values for each KPI from the data provided in the Data Input Sheet. If there is still some data missing in order to calculate a specific KPI, a message "*Data Incomplete*" will appear in the value Column of the KPI on the "*Data Output*" sheet. The user will have the option to go back to the "*Data Input*" sheet, and provide the required information or he / she can go to the "*KPI*" worksheet and unselect the specific KPI.

Another macro will run after the user is satisfied with the results of the KPIs. This macro will write down the results of the KPIs with their relevant goals and objectives in the "*Comparison*" worksheet. In this worksheet the results for various cities that are being evaluated, are listed. This allows the results of the selected KPIs to be compared across cities and also against benchmarks.

Step 1: Selection of goals and objectives that are relevant to the public transport goals and objectives of the city

	Goals	Objectives	KPI	Yes/No
1a	Improve accessibility and mobility provided by the public transport system	To provide appropriate public transport choices	% of Population that has access to all three PT modes	N
1.1b	Improve accessibility and mobility provided by the public transport system	To provide an universal accessible public transport system	% of PT vehicles that provide universal accessible PT	Y
1.2b			% of PT facilities that provide universal accessible PT facilities	Y
1c	Improve accessibility and mobility provided by the public transport system	To increase the mobility of public transport systems	% of Population that can reach employment opportunities within 1 hour journey time	N
1.1d	Improve accessibility and mobility provided by the public transport system	To improve accessibility of the public transport services to all	% of Population within 1000m walking distance from a PT facility	Y
1.2d			# PT stops per 100 km2	Y
1.1e	Improve accessibility and mobility provided by the public transport system	To promote the usage of NMT	Modal split of the transportation system (PT, Private vehicles & NMT)	Y
1.2e			% of Transport budget spent on investment in NMT and PT projects	Y
1.1f	Improve accessibility and mobility provided by the public transport system	To provide an integrated public transport system across all modes	% Population that has access to all three PT modes	Y
1.2f			% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities	Y
1.3f			# PT facilities where passengers can transfer from one mode to any two PT modes	Y
2.1a	Affordable public transport	To provide affordable public transport	Average % of household income spent on PT services per month	Y
2.2a			Average % of per capita income spent on PT services	Y
2.3a			% of PT users that spent more than 10% of their household income on PT services	Y
2.4a			Average fare per PT trip	Y
3a	The subsidies for public transport must be beneficial to the poor	To provide public transport subsidies that is beneficial to the poor	Average PT subsidy per passenger per year	N
4.1a	Higher priority to public transport than private transport	To promote public transport over private transport	% of motorised transport users using public transport	Y
4.2a			% of motorised transport users using private transport	Y
4.3a			% of dedicated PT road km's out of the total road network for the city	Y
4.4a			Number of daily PT passengers per 1000 population	Y
5a	Change the modal split in favour of public transport	To move towards a city-wide modal split in favour of public transport	Modal Split: Public transport vs Private transport	N
6.1a	Environment sustainability	To provide a sustainable public transport system	Emissions per PT vehicle km per year	N
6.2a			Average vehicle-km's per litre of fuel consumed	N
6.3a			Operating cost per vehicle-km	N
7a	Develop a transport system that drives economic growth	To create job opportunities through the development of the public transport system	% of Population that have PT related jobs	N
8.1a	Service Quality & Convenience	To provide a public transport system that is convenient to the customers	% Population within walking distance from PT facility (1000m)	N
8.2a			# PT stops per 100 km2	N
8.3a			PT service hours per day as a % of teh total daily hours	N
8.4a			Average load factor in the peak period (passengers per seat)	N
8.5a			Average # of transfers per passenger per trip	N
8.1b	Service Quality & Convenience	To improve the quality of public transport service provided to meet the needs of all users	Average load factor in the peak period (passengers per seat)	Y
8.2b			% of Population that are satisfied with the PT service quality	Y
8.3b			% of Sample surveys satisfied with PT services	Y
8.4b			Average travel time to work, for all public transport commuters during the morning peak period	Y
8.5b			Peak-hour frequency of the PT services	Y
8c	Service Quality & Convenience	To provide reliable public transport services	% of Scheduled PT services that arrive on-time	Y
8d	Service Quality & Convenience	To provide frequent public transport services	Frequency in the peak hour (minutes)	N
8e	Service Quality & Convenience	To provide cost-effective public transport services	Operating cost per passenger-km	N
9.1a	Safety & Security	To improve the safety and security of public transport services	# Road accidents per 100,000 population	Y
9.2a			# Road fatalities per 100,000 population	Y
9.3a			# PT crime-related incidents per year per 1000 population	Y
9.1b	Safety & Security	To improve pedestrian safety	# Pedestrian accidents per 100,000 population	N
9.2b			% of pedestrian casualties	N
10.1a	Equity	To provide a public transport system with equitable basic access and affordability of public transport for all	% of Population within walking distance to a PT stop (1000m)	N
10.2b			% PT users that spent less than 10% of their income per month on PT	N
11.1a	System efficiency	To provide a public transport system that operates to improve the overall efficiency & competitiveness of the City	# Road-km on which PT servic is provided per 100km2	N
11.2a			# Private vehicles per 1000 population	N
11.3a			% Population that uses PT	N
11.4a			Average age of the vehicle fleet	N
11.1b	System efficiency	To provide a public transport system that operates to improve the overall system costs of the city at optimum levels.	Total cost per PT vehicle-km	N
11.2 b			Operating cost per PT vehicle-km	N
11c	System efficiency	To promote high density residential development along public transport corridors	# PT stops within 1000m from a high household density area	N
12a	Rehabilitation of road network	To rehabilitate key roads that are currently in a poor condition	% of roads that are in a bad condition in the transport road network of the city	N

Proceed to Result 1

Figure 3.3: Evaluation and Comparison of public transport systems (ECPTS) -Step 1(Choosing goals & objectives)

Proceed to Step 2

Results 1 : Selected Goals & Objectives with their KPIs

	Goals	Objectives	KPI
1.1b	Improve accessibility and mobility provided by the public transport system	To provide an universal accessible public transport system	% of PT vehicles that provide universal accessible PT
1.2b			% of PT facilities that provide universal accessible PT facilities
1.1d	Improve accessibility and mobility provided by the public transport system	To improve accessibility of the public transport services to all	% of Population within 1000m walking distance from a PT facility
1.2d			# PT stops per 100 km2
1.1e	Improve accessibility and mobility provided by the public transport system	To promote the usage of NMT	Modal split of the transportation system (PT, Private vehicles & NMT)
1.2e			% of Transport budget spent on investment in NMT and PT projects
1.1f	Improve accessibility and mobility provided by the public transport system	To provide an integrated public transport system across all modes	% Population that has access to all three PT modes
1.2f			% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities
1.3f			# PT facilities where passengers can transfer from one mode to any two PT modes
2.1a	Affordable public transport	To provide affordable public transport	Average % of household income spent on PT services per month
2.2a			Average % of per capita income spent on PT services
2.3a			% of PT users that spent more than 10% of their household income on PT services
2.4a			Average fare per PT trip
4.1a	Higher priority to public transport than private transport	To promote public transport over private transport	% of motorised transport users using public transport
4.2a			% of motorised transport users using private transport
4.3a			% of dedicated PT road km's out of the total road network for the city
4.4a			Number of daily PT passengers per 1000 population
8.1b	Service Quality & Convenience	To improve the quality of public transport service provided to meet the needs of all users	Average load factor in the peak period (passengers per seat)
8.2b			% of Population that are satisfied with the PT service quality
8.3b			% of Sample surveys satisfied with PT services
8.4b			Average travel time to work, for all public transport commuters during the morning peak period
8.5b			Peak-hour frequency of the PT services
8c	Service Quality & Convenience	To provide reliable public transport services	% of Scheduled PT services that arrive on-time
9.1a	Safety & Security	To improve the safety and security of public transport services	# Road accidents per 100,000 population
9.2a			# Road fatalities per 100,000 population
9.3a			# PT crime-related incidents per year per 1000 population

Figure 3.4: ECPTS – Step 1 (Results Step 1)

Data Required

Step 2 : Data Required to calculate each KPI				
	KPIs	**Data Required**		
1.1b	% of PT vehicles that provide universal accessible PT	# Universal accessible PT vehicles	Total PT vehicle fleet	
1.2b	% of PT facilities that provide universal accessible PT facilities	# PT facilities that are universally accessible	Total number of PT facilities	
1.1d	% of Population within 1000m walking distance from a PT facility	# Population within 1000m from PT facility	Population size	
1.2d	# PT stops per 100 km2	# PT stops in city	Area of the city	
1.1e	Modal split of the transportation system (PT, Private vehicles & NMT)	# PT users	# Private vehicle users	# NMT users
1.2e	% of Transport budget spent on investment in NMT and PT projects	Government capital investment in NMT projects	Government investment in transportation	
1.1f	% Population that has access to all three PT modes	# People that has access to all three PT modes	Population size	
1.2f	% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities	# PT modes that are integrated through ticketing	# PT modes that have coordinated schedules	
1.3f	# PT facilities where passengers can transfer from one mode to any two PT modes	# PT facilities that have modal interchange facilities	# Total PT modes and PT facilities	
2.1a	Average % of household income spent on PT services per month	Monthly household income spent on PT	Monthly household income	
2.2a	Average % of per capita income spent on PT services	Monthly per capita income spent on PT	Monthly per capita income	
2.3a	% of PT users that spent more than 10% of their household income on PT services	# PT users that spent more than 10% of HH income on PT services per month	Total PT users	Average monthly household income
2.4a	Average fare per PT trip	PT fares per trip	# PT trips	Total monthly expenditure on PT
4.1a	% of motorised transport users using public transport	# Motorised transport users	# PT users	
4.2a	% of motorised transport users using private transport	# Motorised transport users	# Private transport users	
4.3a	% of dedicated PT road km's out of the total road network for the city	Dedicated PT lane km's	Total road-km's of city	
4.4a	Number of daily PT passengers per 1000 population	Daily PT passengers volumes	Population size	
8.1b	Average load factor in the peak period (passengers per seat)	# PT passengers in the peak period	# PT seats available in the peak period	
8.2b	% of Population that are satisfied with the PT service quality	# Population that are satisfied with PT service quality	Population size	
8.3b	% of Sample surveys satisfied with PT services	Sample Size	# Sample commuters that are satisfied with PT service quality	
8.4b	Average travel time to work, for all public transport commuters during the morning peak period	# PT trips in the peak period	Travel times per PT trip in the peak period	
8.5b	Peak-hour frequency of the PT services	Peak-hour frequency (min)		
8c	% of Scheduled PT services that arrive on-time	# Scheduled PT trips (daily)	# Of PT trips that arrive on-time	
9.1a	# Road accidents per 100,000 population	Annual # of Road accidents	Population size	
9.2a	# Road fatalities per 100,000 population	Annual # of Road fatalities	Population size	
9.3a	# PT crime-related incidents per year per 1000 population	Annual crime-related PT incidents	Population size	

Figure 3.5: ECPTS - Step 2a

1) Write down KPIs

2) Go to Step 2b

	KPIs	Selection Criteria (Give a score between 1-5 for each KPI, 1 = Poor, 5 = Excellent)					
		Data Availability	Cost to collect data	Data Quality	Neccesity	Score	100%
1.1b	% of PT vehicles that provide universal accessible PT	3	4	3	3	13	65
1.1d	% of Population within 1000m walking distance from a PT facility	1	1	2	5	9	45
1.2d	# PT stops per 100 km2	3	3	3	3	12	60
1.1e	Modal split of the transportation system (PT, Private vehicles & NMT)	4	4	4	5	17	85
1.1f	% Population that has access to all three PT modes	1	1	2	3	7	35
1.2f	% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities	3	4	4	3	14	70
1.3f	# PT facilities where passengers can transfer from one mode to any two PT modes	3	4	4	3	14	70
2.1a	Average % of household income spent on PT services per month	2	1	2	5	10	50
2.2a	Average % of per capita income spent on PT services	2	1	2	5	10	50
2.3a	% of PT users that spent more than 10% of their household income on PT services	2	1	2	5	10	50
2.4a	Average fare per PT trip	4	4	4	4	16	80
4.1a	% of Motorised transport users using public transport	3	3	3	4	13	65
4.2a	% of Motorised transport users using private transport	3	3	3	4	13	65
4.3a	% of Dedicated PT road km's out of the total road network for the city	4	4	4	4	16	80
4.4a	Number of daily PT passengers per 1000 population	3	2	3	5	13	65
8.1b	Average load factor in the peak period (passengers per seat)	2	2	3	5	12	60
8.3b	% of Sample surveys satisfied with PT services	1	1	2	3	7	35
8.4b	Average travel time to work, for all public transport commuters during the morning peak period	2	1	2	4	9	45
8.5b	Peak-hour frequency of the PT services	3	4	2	4	13	65
8c	% of Scheduled PT services that arrive on-time	2	3	3	4	12	60
9.1a	# Road accidents per 100,000 population	3	2	3	5	13	65
9.3a	# PT crime-related incidents per year per 1000 population	2	2	2	4	10	50

Figure 3.6: ECPTS – Step 2b_KPI Selection Criteria

1) Write down KPIs

2) Proceed to Step 3

	KPIs	Yes / No
1.1d	% of Population within 1000m walking distance from a PT facility	Y
1.2d	# PT stops per 100 km2	Y
1.1e	Modal split of the transportation system (PT, Private vehicles & NMT)	Y
1.2e	% of Transport budget spent on investment in NMT and PT projects	Y
1.1f	% Population that has access to all three PT modes	Y
1.2f	% Public transport services and facilities that are integrated through ticketing, coordinated schedules and modal interchange facilities	Y
1.3f	# PT facilities where passengers can transfer from one mode to any two PT modes	Y
2.1a	Average % of household income spent on PT services per month	Y
2.2a	Average % of per capita income spent on PT services	Y
2.3a	% of PT users that spent more than 10% of their household income on PT services	Y
2.4a	Average fare per PT trip	Y
4.1a	% of Motorised transport users using public transport	Y
4.2a	% of Motorised transport users using private transport	Y
4.3a	% of Dedicated PT road km's out of the total road network for the city	Y
4.4a	Number of daily PT passengers per 1000 population	Y
8.1b	Average load factor in the peak period (passengers per seat)	Y
8.2b	% of Population that are satisfied with the PT service quality	Y
8.3b	% of Sample surveys satisfied with PT services	Y
8.4b	Average travel time to work, for all public transport commuters during the morning peak period	Y
8.5b	Peak-hour frequency of the PT services	Y
8c	% of Scheduled PT services that arrive on-time	Y
9.1a	# Road accidents per 100,000 population	Y
9.2a	# Road fatalities per 100,000 population	Y
9.3a	# PT crime-related incidents per year per 1000 population	Y
		Y

Figure 3.7: ECPTS - Step 2 (Choosing KPIs)

	Input Required Data		Calculate KPIs
	KPIs	**Data Required**	**Data Input**
1.1b	% of PT vehicles that provide universal accessible PT	# Universal accessible PT vehicles	
		Total PT fleet	
1.2d	# PT stops per 100 km2	# PT stops in city	
		Area of city	
1.1e	Modal split of the transportation system (PT, Private vehicles & NMT)	# PT users	
		# Private vehicle users	
		# NMT users	
1.1f	% Population that has access to all three PT modes	# People that has access to all three PT modes	
		Population size	
1.3f	# PT facilities where passengers can transfer from one mode to any two PT modes	# PT facilities that have modal interchange facilities	
		# Total PT facilities	
2.1a	Average % of household income spent on PT services per month	Monthly household income spent on PT	
		Monthly household income	
2.2a	Average % of per capita income spent on PT services	Monthly per capita income spent on PT	
		Monthly per capita income	
2.3a	% of PT users that spent more than 10% of their household income on PT services	# PT users that spent more than 10% of HH income on PT services per month	
		Total PT users	
		Average monthly household income	
		Average monthly PT expenditure	
2.4a	Average fare per PT trip	PT fare per trip	
		# PT trips	
		Total monthly expenditure on PT	
4.1a	% of Motorised transport users using public transport	# Motorised transport users	
		# PT users	
4.2a	% of Motorised transport users using private transport	# Motorised transport users	
		# Private transport users	
4.3a	% of Dedicated PT road km's out of the total road network for the city	Dedicated PT lane-km's	
		Total road-km's in city	
4.4a	Number of daily PT passengers per 1000 population	Daily PT passenger volumes	
		Population size	
8.1b	Average load factor in the peak period (passengers per seat)	# PT passengers in peak period	
		# PT seats available in the peak period	
8.3b	% of Sample surveys satisfied with PT services	Population size	
		Sample Size	
		# Sample commuters that are satisfied with PT service quality	
8.4b	Average travel time to work, for all public transport commuters during the morning peak period	# PT trips in teh peak period	
		Travel times per PT trip in teh peak period	
8c	% of Scheduled PT services that arrive on-time	# Scheduled PT trips (daily)	
		# of PT trips that arrive on-time	
9.1a	# Road accidents per 100,000 population	Annual road accidents	
		Population size	
9.3a	# PT crime-related incidents per year per 1000 population	Annual crime-related PT incidents	
		Population size	

Figure 3.8: ECPTS - Step 3 (Data Input)

KPI Results

Next City

	KPIs	City
1.1b	% of PT vehicles that provide universal accessible PT	
1.2d	# PT stops per 100 km2	
1.1e	Modal split of the transportation system (PT, Private vehicles & NMT)	
1.1f	% Population that has access to all three PT modes	
1.3f	# PT facilities where passengers can transfer from one mode to any two PT modes	
2.1a	Average % of household income spent on PT services per month	
2.2a	Average % of per capita income spent on PT services	
2.3a	% of PT users that spent more than 10% of their household income on PT services	
2.4a	Average fare per PT trip	
4.1a	% of Motorised transport users using public transport	
4.2a	% of Motorised transport users using private transport	
4.3a	% of Dedicated PT road km's out of the total road network for the city	
4.4a	Number of daily PT passengers per 1000 population	
8.1b	Average load factor in the peak period (passengers per seat)	
8.3b	% of Sample surveys satisfied with PT services	
8.4b	Average travel time to work, for all public transport commuters during the morning peak period	
8c	% of Scheduled PT services that arrive on-time	
9.1a	# Road accidents per 100,000 population	
9.3a	# PT crime-related incidents per year per 1000 population	

Figure 3.9: ECPTS - Step 4 (Data Output)

3.5. Method of application

The methodology explained in 3.2, 3.3 and 3.4 was used to do a comparative study of the public transport systems of the case cities; Cape Town, Nairobi and Dar es Salaam. Phase 2 was used to describe and discuss the public transport systems of the case cities. In Phase 3 data from the case cities were collected and during Phase 4 the data collected from the interviews and desktop study was used to evaluate and compare the public transport systems of the case cities by using KPIs.

One of the challenges faced in this research has been to decide which KPIs should be used to evaluate the public transport systems of the case cities. It was realized that in order to decide on a fair set of KPIs for each case city, the goals and objectives for a city needed to be taken into account. These objectives will determine the set of KPIs that are relevant for each city. African cities usually do not have up to date information that is required to evaluate the KPIs and resources to collect this information are usually scarce. In order to overcome this problem, selection criteria can be used to select the most appropriate KPIs that trade-off between the benefits of being able to use the set of KPIs and the resources (financial and human) required to determine these KPIs. Chapters 4, 5 and 6 will describe the public transport systems of Cape Town, Nairobi and Dar es Salaam respective.

4. CAPE TOWN

This chapter will describe and evaluate Cape Town's public transport system.

The City of Cape Town plays an important role locally, regionally, nationally and internationally and is the second largest city in South Africa. The City of Cape Town has a population of 3,5 million people and an area of 2,487 km^2. The metropolitan municipality for Cape Town is the City of Cape Town. It was established in December 2000 by merging the Cape Metropolitan Council and the six local councils namely: Tygerberg, Oostenberg, Blaauwberg, South Peninsula, Helderberg and Cape Town. (COCT, 2007a)

4.1. Institutional and Regulatory Framework

There are many transport policies in South Africa, but until recently only a few of them were fully implemented. South Africa is in the process of tackling most of these issues, focussing mainly on the National Land Transport Act (NLTA) of 2009. (COCT, 2007a; Walters, 2008)

4.1.1. Stakeholders

Table 4.1 indicates the stakeholders that play a role in public transport in Cape Town.

Table 4.1: Cape Town public transport stakeholders. (Source: COCT, 2005; COCT 2006a; COCT, 2006b; COCT 2007a; Cupido, 2010; PRASA 2010; Walters, 2010)	
Planning, Coordination and Strategy Stakeholders	
National Government: The Department of Transport (DOT)	• Responsible for PT on the national level. • Determines overall policies for PT (These policies are contained in the National White Paper on Transport 1996, NLTTA 2000 and the NLTA 2009).
Public Entities	The following public entities are at National level: • PRASA, they were established to manage the operations, personnel and assets of the South African Rail Commuter Corporation (SARCC), Metrorail, Intersite Property Management Services (Pty) Ltd, Shosholoza Meyl and Autopax. PRASA is a public passenger transport entity that is owned 100% by the South African Government from the consolidation of government-owned passenger rail entities, property asset management and road based passenger carrier entities. • SANRAL (Regulated in terms of The South African National Roads Agency Limited and National Roads Act, Act 7 of 1998) • ACSA (Regulated in terms of the Airports Company Act, 1993).
Planning, Coordination and Strategy Stakeholders	
Provincial Government: The Provincial Government of the Western Cape (PGWC)	• Responsible for the regulation of PT at a provincial level for Cape Town. • Responsible for a more detailed provincial policy and strategy formulation, more detailed transport planning and co-ordination in the provincial sphere. • Required to prepare a Provincial Land Transport Framework (PLTF) on a five year basis. • Ensure co-ordination between municipalities and transport authorities.

Table 4.1 (Continued): Cape Town public transport stakeholders.	
City or Metropolitan Government: The City of Cape Town	• Responsible for municipal transport functions, including municipal public transport in its areas of jurisdiction. • Responsible for commuter bus operations, minibus-taxi operations, traffic control and law enforcement of road-based public transport systems. • Provides, manages and maintains the roads, bus termini and taxi ranks and other public transport facilities in the CMA. • Provides information on PT planning, statistics, passenger information on services and the management of road-based public transport interchanges. • Required to prepare an Integrated Transport Plan which together with the Spatial Development Framework and plans for other municipal activities make up the Integrated Development Plan.
Operations	
Rail Operator: Main stakeholders; PRASA, Metrorail and National Government.	• PRASA owns and finances all passenger coaches, railway lines and stations. • Metrorail is a business unit of Transnet and it has a concession agreement with PRASA to operate the trains and rail stations. • The City of Cape Town intends to play a more significant role in the planning and service level decisions of the rail system and is hoping that in the long term this could lead to the assignment of the rail function to the City.
Bus Operator	• Only one bus operator who provides scheduled bus services in Cape Town, Golden Arrow Bus Services (GABS). • Sibanye Bus Services is a joint venture company comprising of GABS and Abahlobo-Sijakula Bus Companies, and provides the service on the CBD-Atlantis route.
Minibus-taxi Operators	• Minibus-taxi services are provided by multiple private operators. • Most of the owners belong to local taxi associations. • The taxi industry has two national trade unions for workers; the South Africa Transport and Allied Workers' Union (SATAWU, subsidiary of COSATU) and the National Taxi Drivers' Organisation (NATDO). • The South African National Taxi Council (SANTACO) acts as the association management organisation and enables taxi associations to have a direct link to the Government.

4.1.2. Regulatory Framework

A study done in 1991 in South Africa revealed that there was a fragmented institutional framework between and within the government. Central Government was responsible for bus and rail services, while the local authorities were responsible for traffic management and municipal transport services. Land-use and transport planning were the responsibility of regional government. This had a negative influence on comprehensive transport and land-use planning and management and it was believed that urban transport policy can only be successfully implemented when responsibilities for all public transport services, regulations and policies are vested in the same body. A follow-up study was done in 1993 on the institutional arrangements in South Africa. It was noted that there was a need for the devolution of planning powers and it was believed that transport planning would be more effective at local authority level. A third study undertaken in 1995 revealed that there was still a fragmentation of responsibilities within the government. It was noted that there was no coordination between commuter rail, commuter bus and minibus-taxi services. The institutional framework for the City of Cape Town is still fragmented and government is struggling to get this right. (Kane, 2002)

The provision of public transport in South Africa is governed by the NLTA (2009), which is the main piece of legislation on public transport (Cupido, 2010). Table 4.2 list the key legislation and policy documents that have an impact on public transport in South Africa and Cape Town.

Table 4.2: Key legislative and policy documents related to urban transport planning in the Cape Metropolitan Area. (Source: Wilkinson, 2008)	
National sphere of Government	
1996	White Paper on National Transport Policy
1999	Moving South Africa: The Action Agenda. A 20-year Strategic Framework for Transport in South Africa
2000	National Land Transport Transition Act (NLTTA) (No. 22 of 2000)
2006	Draft Strategy to Accelerate Public Transport Implementation
2007	Public Transport Strategy, Public Transport Action Plan Phase 1
2009	National Land Transport Act (NLTA) (2009)
	Provincial sphere of Government
1997	White Paper on Western Cape Provincial Transport Policy
2002	Provincial Vision for Public Transport and Five-Year Strategic Delivery Programme
2004	Provincial Land Transport Framework
2005	Transformation of Scheduled subsidised Services in the City of Cape Town: Phase One
	Local sphere of Government
1998	Moving Ahead: Cape Metropolitan Transport Plan. Part 1: Contextual Framework
1999	Moving Ahead: Cape Metropolitan Transport Plan. Part 2: Public Transport Strategic Component
2001	Moving Ahead: Cape Metropolitan Transport Plan. Part 2: Public Transport Operational Component
2003 2004	Mobility Strategy - Phase 1: Klipfontein Corridor Project Public Transport Feasibility Study Stage 1 for Klipfontein Corridor (Technical Transport Planning Team)
Table 4.2 (Continued): Key legislative and policy documents related to urban transport planning in the Cape Metropolitan Area. (Source: Wilkinson, 2008) (Continued)	
2004	Public Transport Planning, Design and Implementation Programme – Public Transport Corridor Strategy: Summary Report
2006	Public Transport Plan, Integrated Transport Plan for the City of Cape Town 2006 to 2011
2007	Public Transport Implementation Framework

4.1.3. Industry Structure

The commuter rail and commuter bus services in Cape Town operate under a monopoly while the minibus-taxi industry comprises of multiple private operators and operates in a deregulated market.

The National Department of Transport is responsible for the regulation of commuter rail services, while the City of Cape Town municipality and Provincial Government of Western Cape is responsible for the regulation of bus and minibus-taxi services (Wilkinson, 2008).

Commuter Rail

The Legal Succession Act (Act 38 of 2008), Railway Regulation Act (Act 16 of 2000) and the NLTA (2009) are the most important legislation and regulation for PRASA and Metrorail (Scott, 2010). Prior to 1990, Transnet, a state owned enterprise, and the national rail carrier, was responsible for general freight, bulk rail transport, long distance passenger rail services, and for commuter rail. In 1990, the responsibility and commuter rail assets were transferred to a government agency, South African Rail Commuter Corporation (SARCC), who reported to the DOT. The functions of SARCC included investment planning, subsidy management and the quasi-regulatory compliance of the operator (Metrorail). After the Cabinet decision to consolidate passenger rail in December 2004, the Legal Succession to the South African Transport Services Act of 1989 was amended by Parliament and signed into law on 27 November 2008. This enabled PRASA to oversee SARCC, Metrorail, Intersite, Shosholoza Meyl and Autopax. PRASA is regulated by the National DOT and the National Rail Safety Regulator. (Walters, 2008; Wilkinson, 2008)

A National Passenger Rail Plan was developed in 2004; the main objectives were to determine the role of passenger rail services in the public transport system and to plan strategies for short term stabilisation, medium term turnaround and long term expansion of the passenger rail system. A Consolidated Regional Rail Plan was approved by the South African Cabinet in 2006. This plan is supported by detailed business and operational plans for each of the regions. (Walters, 2008)

Commuter Bus

The ITP for the City of Cape Town for 2006-2011 specifies that the subsidised commuter bus services operates under the control of the Provincial Government and falls under the planning control of City of Cape Town (COCT, 2009). The Provincial Operating License Board (OLB) is responsible for the regulation of the subsidised and commercial service contracts for commuter bus services. These contracts are either tendered for or negotiated. (Wilkinson, 2008)

GABS cater for thousands of commuters across the greater CMA. Since 1997 GABS has been contracted by Provincial Government through an Interim Contract that was originally supposed to last for three years, but is still in place. This contract is currently renewed on a monthly basis and prevents GABS from planning for the future and also makes efficient capital resource management very difficult. (Thomas, 2008)

The policies applicable to the commuter bus industry in South Africa and Cape Town are found in the White Paper on National Transport Policy (1996), the Moving South Africa Strategy, NLTTA (2000), NLTA (2009), the Heads of Agreement between organised labour, the DOT and the Southern African Bus Operators Association (SABOA) and interim contracts with subsidized operators. (Walters, 2008)

Minibus-Taxi Industry

The City of Cape Town, Western Cape Provincial Government, Department of Transport, Provincial Operating Licensing Board (POLB) and Registrar are responsible for the regulation of minibus-taxi services. (COCT, 2005; COCT, 2007a)

In the late 1970's the minibus-taxi industry began small scale operations, but after 1986 when government legislation facilitated the entry of minibus-taxis, this mode grew rapidly to become the dominant transport mode in South Africa. A lack of proper regulatory regimes has led this industry to operate in a deregulated environment which has caused oversupply, capital replacement issues and a lack of long term economic sustainability. (Williams & Kingma, 2002; Kane, 2002)

In 2000, the Government attempted to formalise and regulate the minibus-taxi industry by introducing the four-year recapitalisation programme. The Taxi Recapitalisation Programme is consistent with the White Paper on National Transport Policy of 1996 and the Moving South Africa Strategy. The National Cabinet approved that the current ageing minibus-taxis must be replaced with purpose-built 18 or 35 seater vehicles. A once-off scrapping allowance of approximately R60 000 per scrapped vehicle is given to the owners of the vehicles. Unfortunately there have been a number of delays in this process. In 2004, the Minister of Transport released a revised recapitalisation timeline which was scheduled to start in 2005/6 and end 7 years later. Government is still having some problems with the implementation of the proposed Taxi Recapitalisation system. (Fourie, 2003; COCT, 2007a; Walters, 2008)

4.2. Network Structure

Cape Town has an extensive public transport network which has evolved over time in response to land-use patterns and travel characteristics. Commuter rail, bus and minibus-taxi services provide public transport services for more than half of the daily commuters in Cape Town. Many of these passengers do not have an alternative transport mode to use and are captive public transport users (TRC Africa, 2000). The City of Cape Town is committed to creating equal opportunities for all its citizens and thus needs to improve the public transport services and infrastructure in order to achieve this.

Cape Town's growing population has caused an increase in the demand for travel in Cape Town which has taken its toll on the transport infrastructure in Cape Town. This has resulted in an increase in congestion on the roads and overcrowding on the public transport services. The quality of the public transport system has also declined and the government is struggling to keep up with the subsidies needed to supply a good quality public transport system. (COCT, 2006a)

Cape Town's public transport system needed urgent restructuring and improvement because the public transport system is ineffective and inadequate in terms of the quantity and quality of public transport services. This has prompted the restructuring of public transport in Cape Town. The planning for the transformation of public transport began in 2002 as the *Cape Town's Moving Ahead* project. This approach entailed the total transformation and restructuring of public transport systems into an efficient, integrated, financially viable and sustainable system based on customer needs. (TRC Africa, 2000)

4.2.1. City Characteristics

Cape Town covers an area of 2,487km^2 and has a population of 3,5 million people with an annual population growth rate of 3,5%. Cape Town's population represents 64% of the Western Cape's population. (COCT, 2007a)

Cape Town consists of a fairly large area and has a relatively low population density of 1407 inhabitants per square kilometre. Population densities are the highest in the informal settlement areas. The densities can rise up to 46,000 people per square kilometre. The densities in the traditional white residential areas, especially those located on the urban periphery, are far lower. These range from 200-400 units per square kilometre in the wealthiest suburbs to 9,000-10,000 units per square kilometre in the inner city areas which have a high number of apartment buildings. Figure 4.1 indicates the 2001 population density for the Cape Metropolitan Area.

Wilkinson (2000) describes the development of the city structure for Cape Town as follow. The Group Areas legislation in the 1960's had led to the forced removal of an estimated 150,000 people to new "townships" built on the Cape Flats. These forced removals changed Cape Town's social geography during the 1960's and 1970's. Cape Town's African population continued to grow and they were accommodated in new townships constructed at Gugulethu and Nyanga in the early 1960's. In the early 1970's the government failed to provide enough public housing for the increasing demand and the failure of containing African urbanisation has led to the re-emergence of squatting around the city's periphery. After the 1980's, low density suburban expansion emerged in Cape Town which was reliant on high levels of car ownership. The levels of car ownership and urban sprawl were encouraged by the construction of an intra-urban freeway system. In 1986 the Western Cape Regional Service Council was established and it initiated major low-cost housing projects in the south-eastern sector of the metropolitan area with the establishment of Khayelitsha, Blue Downs and Delft. This created the situation where high density and poor communities are located on the outskirts of the metropolitan area and are faced with long journey times and usually have to spend a considerable portion of their income on transport. Cape Town has an inefficient and inequitable distribution regarding economic activity and population, which has a negative impact on the economic growth and

the social sustainability of the city. Cape Town has corridors of intense activity and mixed land use associated with major arterial roads and suburban rail lines that radiate from the geographic eccentric city centre south towards Muizenberg and east towards Bellville. About 70% of the Cape Metropolitan Area's formal employment and higher order facilities are located around these corridors. Since 2001, the decentralisation of office and retail activity as well as manufacturing services has been evident, which has given rise to the growth of important nodes at Claremont and Bellville.

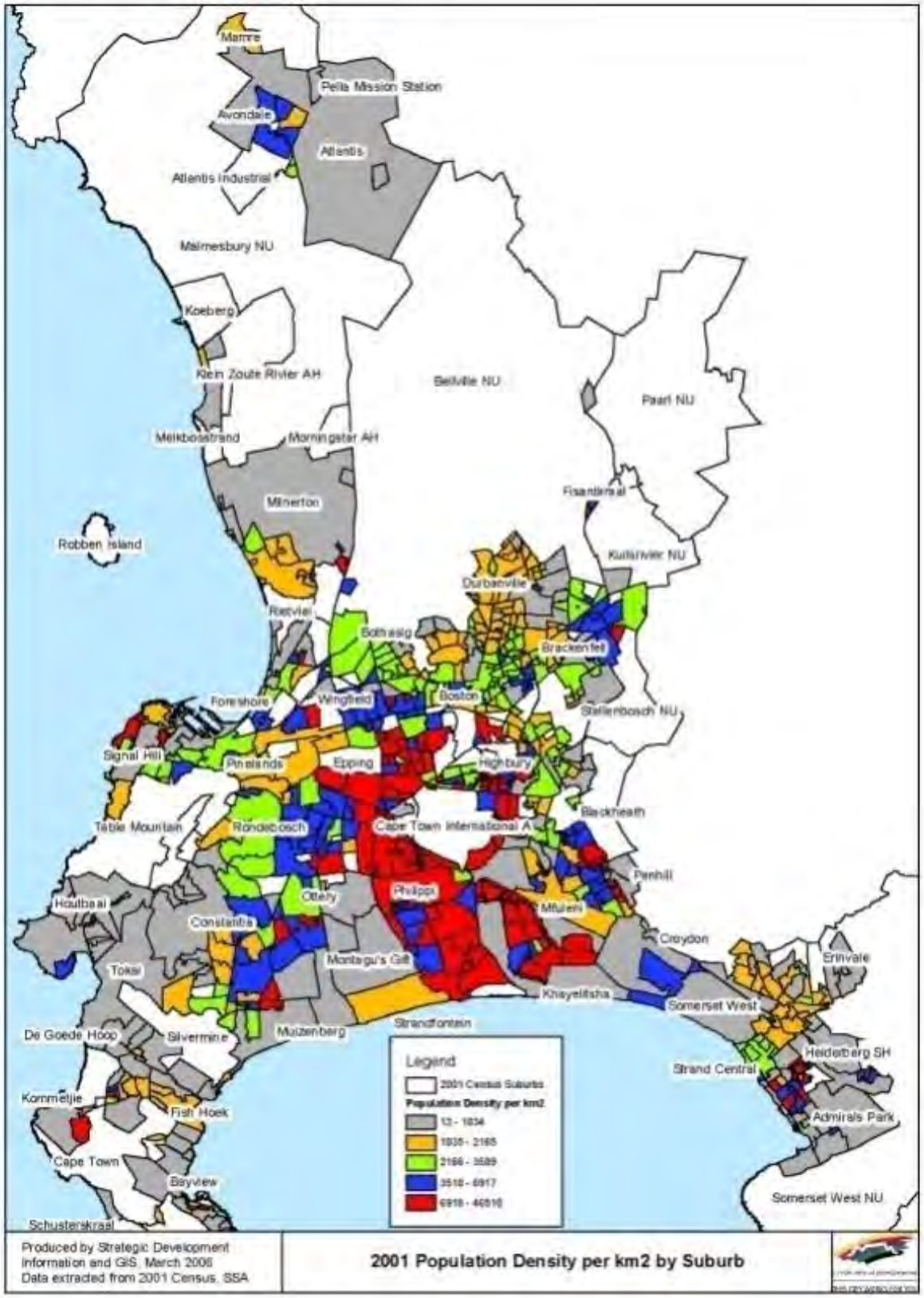

Figure 4.1: Population Density for Cape Metropolitan Area (Source: COCT, 2006d)

4.2.2. Transport Network

The transport network for Cape Town consists of an extensive road network of over 8,500 kms which carries around 90 million vehicle kilometres per year with traffic volumes that grow at approximately 3% per annum, and 260km of electrified track on 14 routes for rail services (COCT, 2006b).

Cape Town has a radially-oriented road system that is focussed on Cape Town's CBD. It consists of limited circumferential links that do not adequately accommodate the multi-directional movement patterns that emerged with dispersal of commercial, employment and residential activity. Currently, Cape Town has a low density residential development across the city which does not support an efficient city-wide public transport system and service. (COCT, 2006c; Wilkinson, 2010)

Cape Town's CBD is a very active business node with a large number of peak period vehicles, commuters and pedestrians entering it. There has been an increase in the total annual number of vehicles and passengers commuting to Cape Town CBD, even though Cape Town has experienced decentralisation from Cape Town CBD to other urban nodes and centres. The spatial and economic function of the historic Cape Town CBD extended eastwards in a broad band running parallel to the N1 and Voortrekker Road. This expansion was reinforced by the rapid industrial and commercial growth to the south, north and north eastern direction of the city. Figure 4.2 illustrates the spatial distribution of trip production and trip attraction in the CMA. This indicates that the most trips are produced in the Mitchell's Plain and Khayelitsha area, while most of the trip attractions are in Cape Town CBD (COCT, 2006c).

Cape Town's transport system can be divided into two zones, the one consisting of major formal employment and high order urban facilities and the other zone is occupied by lower income households living in townships and informal settlements in the more peripheral zones. The lower income households mostly use public transport systems or walking as their primary transport mode, while most of the middle and higher income households in more advantageously located suburbs use private motorized transport. (Wilkinson, 2000) Figure 4.3a indicates the percentage of employed population using private vehicle by suburbs, while figure 4.3b indicates the percentage of employed population using public transport by suburb. There are extensive distances between residential and workplaces, which indicates that there is an absence of appropriate land use arrangements to support and encourage bi-directional peak and off-peak travel. This influences the travel time and travel cost for commuters in Cape Town.

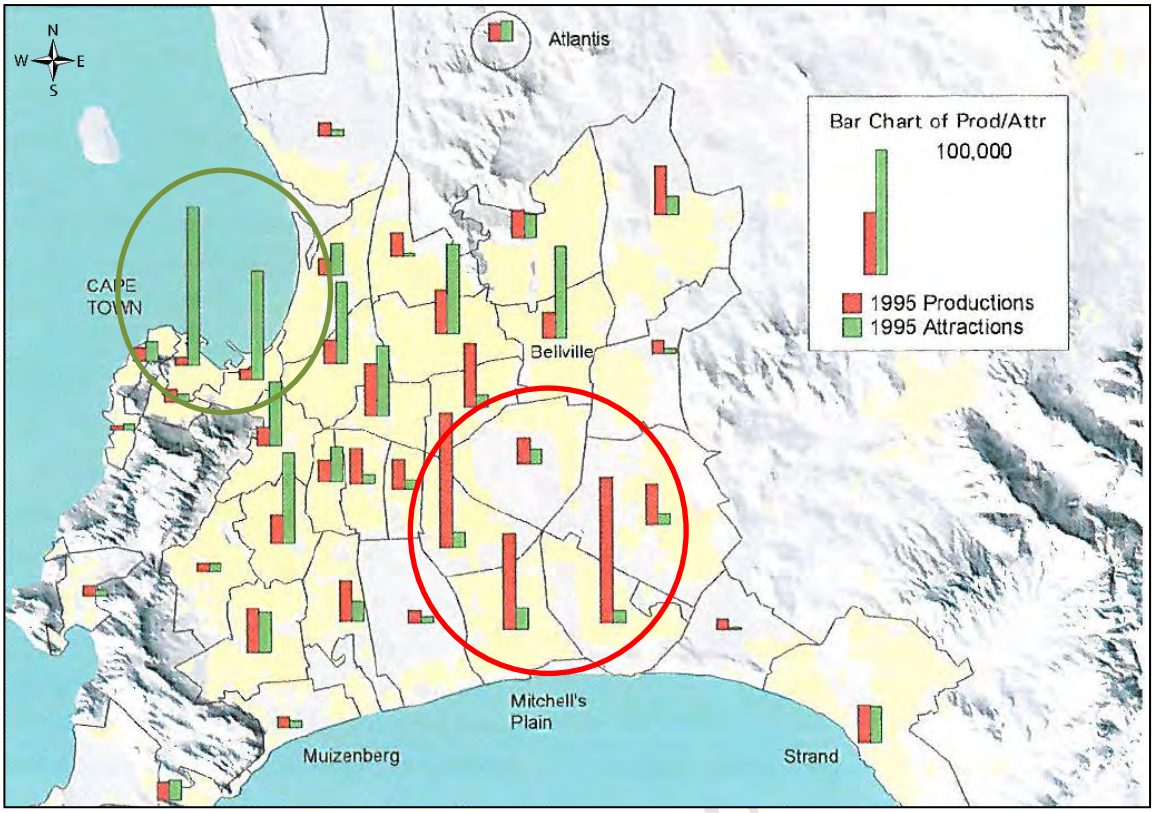

Figure 4.2: Spatial distribution of trip production and trip attraction in the CMA (Source: Cape Metropolitan Council, 2002)

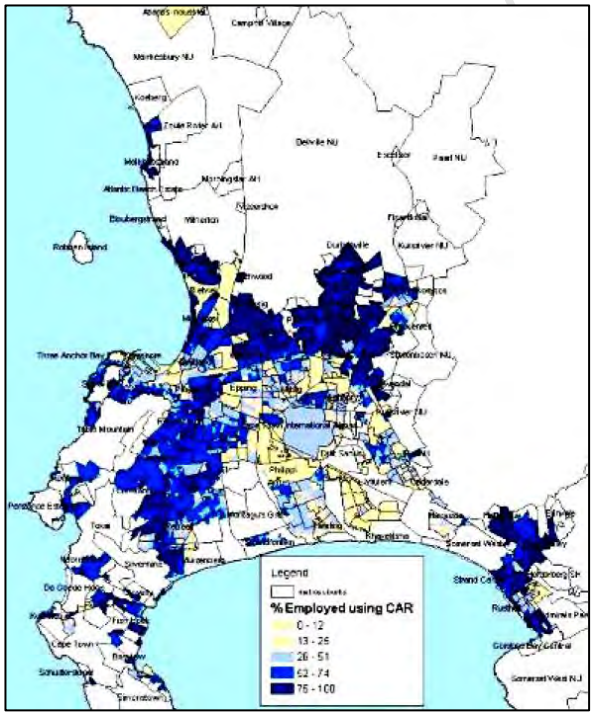

Figure 4.3a: Percentage employed population using private vehicle by suburb (Wilkinson, 2008)

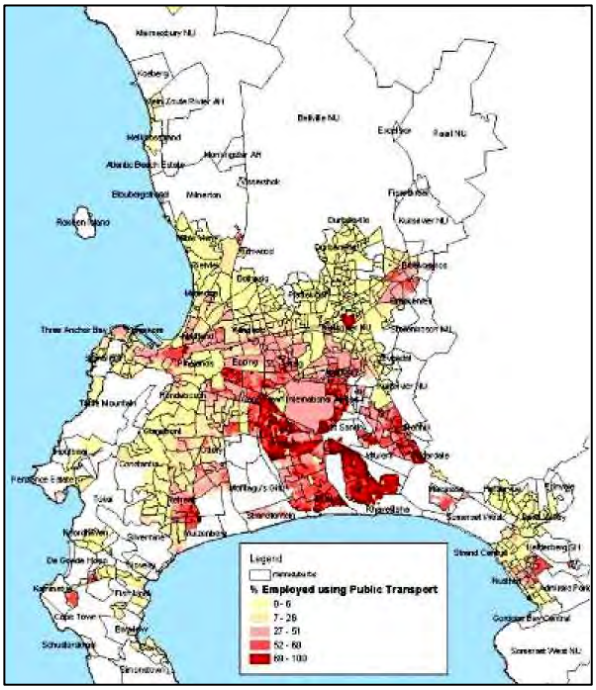

Figure 4.3b: Percentage employed population using public transport by suburb (Wilkinson, 2008)

The public transport commuter trends identified in the 1998 Cape Metropolitan Plan (Cape Metropolitan Council, 1998) indicated that there is a mismatch between population and employment across the Cape Metropolitan Area. Cape Town CBD, and the Northern and Southern Corridors house 37% of the population of the CMA, although more than 80% of all the jobs in Cape Town are located along these corridors (see figure 4.2). This separation causes large movements between the homes and workplaces of people and places a burden on the travelling time and cost of travelling. Commuters in the CMA have relatively long commuting distances. The distribution pattern of low income workers is more dispersed and unstable than that of higher income groups. In 1998 the average home to work trip length for commuters in Cape Town was between 14 and 17 km (Cape Metropolitan Council, 1998).

4.2.3. Transportation demand and usage

The Provincial Land Transport Framework 2011/12 – 2015/16 (PGWC, 2011) indicates that the modal split in the peak period for commuter trips (passenger trips) in the CMA is 48% public transport, 44% private vehicles and 8% for non-motorised vehicles.

The daily modal shares of private and public transport (including rail) passenger trips in Cape Town CBD area are 67% and 33% respectively (see figure 4.4). During the morning and evening peak periods there is an almost equal share between trips undertaken by private and public transport in the CBD area, but during the inter-peak period private vehicles have a higher mode share than public transport. Two of the main reasons for the sharp decline in the share of public transport trips during the inter-peak period are the reduced frequency of public transport services and the increase in business trips which are mostly made by private vehicle owners. The number of private vehicles registered in Cape Town in 2001 amounted to 825,000 vehicles. The car ownership in 2006 was established as 200 cars per 1000 people. The number of daily car commuters grew from 285,000 (1980) to 680,000 (2001) at a mean annual growth rate of around 4.6%. This growth rate exceeds the population growth rate for the City of Cape Town. (Behrens & Wilkinson 2009; COCT, 2005; COCT 2006b)

The Modal share for public transport in the Cape Metropolitan Area is shown in table 4.3 and figure 4.6. Figure 4.5 shows the public transport modal split for the CMA.

Table 4.3: Cape Metropolitan Area Public Transport Modal Split (Sources: COCT, 2005)

	Commuter Rail		Commuter Bus		Minibus-taxi	
	# Passengers	%	# Passengers	%	# Passengers	%
All day modal share	601940	54	197444	17	332407	29
Peak Period Passengers	246000	56	68037	16	121000	28

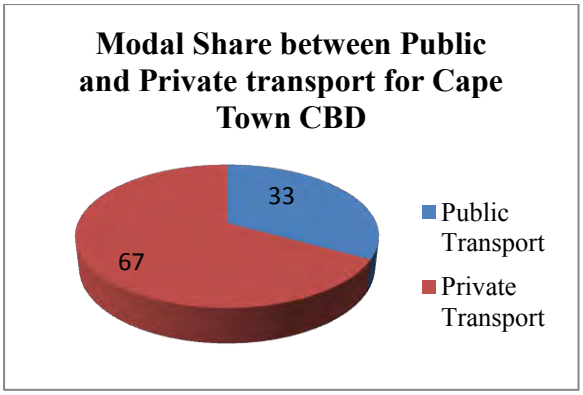

Figure 4.4: Daily Modal Spit between Public and Private Transport for Cape Town CBD (Source: COCT, 2005)

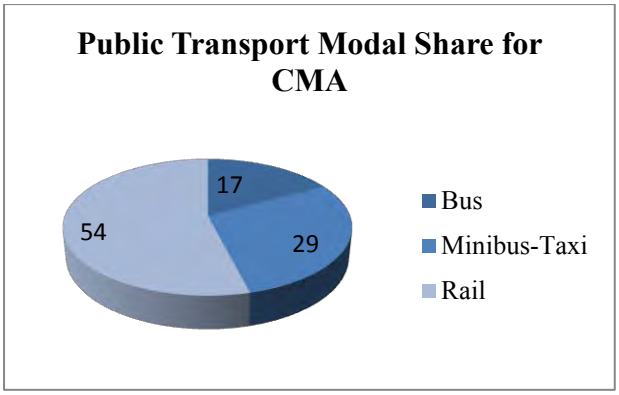

Figure 4.5: Daily Modal Split between the Public Transport Modes for CMA (Source: COCT, 2005)

Tables 4.4 and 4.5 show the total vehicle trips and passenger trips for Cape Town CBD traffic during the morning and evening peak periods that was observed in a study during 2004.

Table 4.4 : CBD traffic during the morning peak hour – 2004 (Source: COCT, 2005)

Mode	Peak hour start	Direction	Vehicle trips	Passenger trips
Car	07:15	Inbound	20 220	29 539
		Outbound	10 459	16 263
Rail	07:15	Inbound	46	20 482
		Outbound	25	2 238
Bus	06:45	Inbound	177	6 323
		Outbound	147	1 732
Minibus-taxi	07:00	Inbound	764	7 101
		Outbound	687	4 241
Metered taxi	08:00	Inbound	149	214
		Outbound	96	124
Bicycle	06:45	Inbound	33	33
		Outbound	8	8

Table 4.5: Cape Town CBD traffic during the evening peak hour - 2004 (Source: COCT, 2005)

Mode	Peak hour start	Direction	Vehicle trips	Passenger trips
Car	16:00	Inbound	12 768	20 575
		Outbound	18 352	29 534
Rail	16:30	Inbound	26	3 296
		Outbound	40	16 206
Bus	16:30	Inbound	124	692
		Outbound	162	5 298
Minibus-taxi	16:00	Inbound	474	3 883
		Outbound	541	5 151
Metered taxi	17:15	Inbound	144	160
		Outbound	158	279
Bicycle	17:15	Inbound	16	16
		Outbound	35	35

This indicates that private transport and commuter rail transport accounts for the largest commuter volumes for travel to and from the CBD.

NMT is an important transport mode in South Africa and Cape Town. For some households it is their only means of transport because they cannot afford public transport. NMT trips are usually for short distances and are also used as access to some motorised from of transport. Currently, there are not enough facilities and infrastructure provided for non-motorised transport in Cape Town. The City of Cape Town is systematically developing planning frameworks to create NMT friendly environments such as the Metropolitan Bicycle Route Master plan, various Local area NMT network plans, the development of a policy on NMT, renewed traffic calming approaches and the formulation of the proposed Pedestrian Safety Implementation Plan. The City of Cape Town has also developed the NMT Plan, which is an integrated plan that addresses access for all, the needs of people and communities, economic and social transformation and environmental sustainability. The vision of the NMT Plan is that Cape Town will be a city where all people feel safe and secure to walk and cycle and NMT will be integrated as part of the transport system. (COCT, 2006b)

Walking can be seen as one of the most important feeder modes for public transport. Most of the people from low-income groups use walking as the primary feeder mode to access public transport. They usually have to walk much longer distances than people from high-income groups. The use of bicycles as a transport mode is low and has decreased over the past years. A survey in 2004 indicated that 390 bicycles enter and leave Cape Town CBD during the morning peak period. Only 1% of all public transport trips use cycling as their primary feeder mode. Some of the factors that have an influence on the decrease in the use of bicycles are: road safety, personal safety, weather, affordability, land-use patterns and the topography of many areas in Cape Town. Most of the low-income groups cannot afford to buy a bicycle and have to use walking as their transport mode. Pedestrian casualties are a big contributor to the overall road traffic accidents in Cape Town. In 2001 pedestrian fatalities accounted for 59% of the total road accident fatalities. These fatalities occurred mainly among the 26 – 40 years age group. Illegal crossing of railway lines by pedestrians have accounted for 96% of all fatalities on railway lines in 2001. (Pretorius & Bester, 2004; COCT, 2005)

4.2.4. Infrastructure

The 2004 CPTR report indicates that there are 97 rail, 132 bus, 203 minibus-taxi and 47 metered-taxi facilities in Cape Town. The City of Cape Town is responsible for the management of the non-rail public transport facilities, while PRASA is responsible for the railway stations. Cape Town, Bellville and Mitchell's Plain commuter rail stations have the highest number of passengers transferring to different transport modes. Figure 4.6 shows the locations of all the major public transport facilities in Cape Town.

Most of the rail infrastructure, rolling stock, facilities and public transport vehicle fleet are in a poor condition due to under-investment and need to be upgraded. Out of the 132 bus facilities in the CMA, 50 are terminals, 80 are ranks and two are bus holding areas. Out of 203 minibus-taxi facilities in the CMA, 112 are termini, 62 ranks and 30 holding areas. According to the 2007 COCT public transport database there are a total of 3344 bus stop locations in the CMA. Out of these stops, 2090 have no shelter structure whatsoever, 474 have concrete shelters, 897 have the new bus shelter designs, 60 are steel shelters and 8 shelters are classified as "other shelters". (COCT, 2007b)

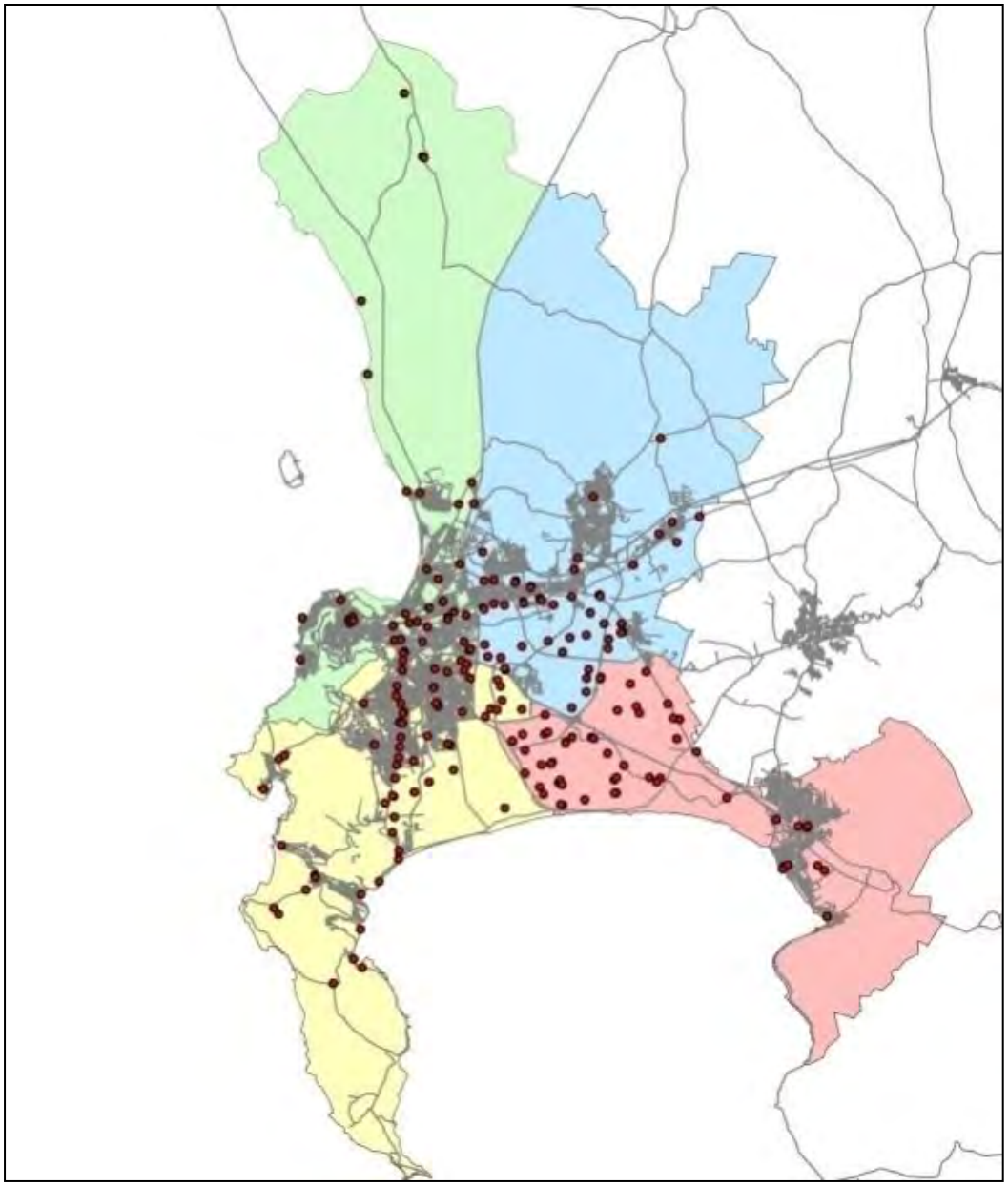

Figure 4.6 Public transport facilities in the Cape Metropolitan Area (Red dots indicates the public transport facilities)

* *Data from the COCT 2005 Current public transport record and COCT 2007 Database were obtained from the City of Cape Town and used to create shapefiles that plotted the locations of the major public transport facilities and bus stops onto Cape Town's network.*

4.3. Public Transport Modes

The public transport modes that will be discussed for Cape Town are commuter rail, commuter bus and minibus-taxi services. Commuter rail and bus provide scheduled services, while the minibus-taxi services are unscheduled. Commuter bus and minibus-taxi operate parallel to each other and also sometimes in parallel to commuter rail services. This creates competition between the various public transport modes.

Commuter rail services are provided by Metrorail in terms of a concession agreement with PRASA. Scheduled bus services in the Cape Metropolitan Area are provided by Golden Arrow Bus Services (GABS), while Minibus-taxis provide non-contracted, non-subsidised, unscheduled services throughout the CMA. Minibus-taxis are operated by owners of single vehicles or small vehicle fleets. The railway system is the backbone of Cape Town's public transport system.

4.3.1. General

The first trains started operating on 18 September 1861 between Cape Town and Stellenbosch. Over the years Cape Town has developed a good railway system and although passenger volumes have declined since the mid 1970's, the system continues to operate and was significantly extended after the 1980's to serve two major residential areas. A lack of investment in rail infrastructure and fleet has led to the situation where the rail services are failing to provide a good quality public transport service. The train sets are old and in poor condition, with the average age of the trains being about 46 years. Trains often have to be withdrawn from service due to unreliability and safety concerns. Cape Town's railway signalling system also requires upgrading and some of the railway stations lack proper facilities for the commuters and operators. During peak hours crowding occurs on some of the trains, especially on the busy lines. There is also a poor level of personal safety on the trains. (COCT, 2006a)

The history of the private commuter bus service can be traced back to 1861 when the original Cape Town and Green Point Tramway Company was established. It provided services without subsidy until the mid 1970's. A succession of companies formed links in an unbroken chain of mergers and acquisitions, which continues after more than 149 years (Meyer, 2008). Golden Arrow (in its current form) was established in 1992 when all the bus operations controlled by the Tollgate Holdings subsidiary, Tramway Holdings, were taken over by a consortium of investors. GABS has formed a joint venture with Siyakhula Bus Services and Abahlobo Transport Services in 2001 to form a new company, Sibanye Bus Services. Sibanye Bus Services operate 66 buses on the Atlantis route (Meyer, 2008). The modal share of bus services has declined over the last 30 years, however, during the last few years the passenger numbers and ticket sales have been increasing. The main reason for the

decline in the modal share is the competition from private transport and other public transport modes, especially minibus-taxis (COCT, 2007).

The minibus-taxi industry started operating in the late 1970s in response to heavy demand for cheap transport in the townships. A lack of proper regulatory regimes has led to the industry operating in a deregulated environment. The minibus-taxis served emerging residential areas (often informal) which were not served by train or bus, which resulted in the rapid growth in the use of minibus-taxis. Their service provision is split up into 30 % feeder services, 55% line haul services and 15% distribution services. (PGWC, 2011) The minibus-taxi industry operates more or less independently of all control. The only control available to the City of Cape Town is through the recommendations to the Provincial OLB in respect of granting operating licenses.

4.3.2. Passenger Volumes

This section will describe the public transport passenger demand for all three public transport modes in Cape Town. On a daily basis more than 1,1 million passenger trips are made in the CMA by three main public transport modes; train, bus and minibus-taxi.

Commuter rail provides transport to more than half of the daily public transport commuters in Cape Town. During 2004, 54% of the public transport market used commuter rail as their main transport mode. The 2004 morning peak period passenger demand was 246,431 passenger trips and the evening peak was 194,360 passenger trips. Figure 4.7 indicates that 41% of the 2004 daily passengers travelled during the morning peak period, 19% during the inter-peak period and 32% during the evening peak. Passenger volumes had declined by 11% in four years from 675607 daily passenger trips (year 2000) to approximately 601 940 daily passenger trips (in 2004) (see table 4.6). The largest decrease in volume was observed on the Khayelitsha/Kapteinsklip lines. The 2007 CPTR records a total of 634,837 daily trips (104,829 Metro Plus and 530,008 Metro class passengers), which indicates a slight increase from the 2004 volumes of 601,940. The 2007 CPTR report also reflects that there has been an increase in the number of scheduled services provided since 2004 to 2007. The highest daily passenger volumes are experienced on the Khayelitsha line with 150,000 passengers. (COCT, 2005; COCT, 2006a; COCT, 2007a; COCT, 2009) There are over-capacity conditions during the peak-period between Heathfield and Plumstead, between Mowbray and Salt River, between Philippi and Bonteheuwel and between Bellville and Woltemade (COCT, 2009).

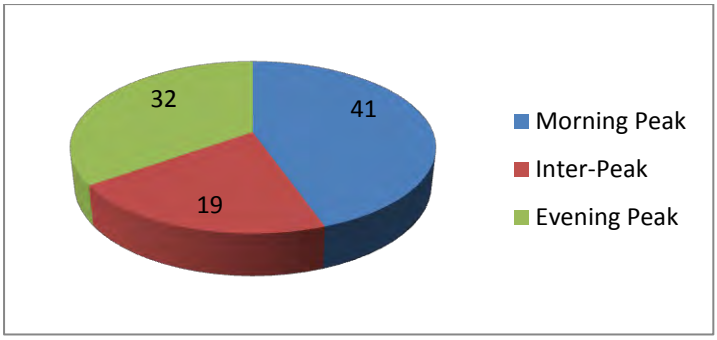

Figure 4.7: Commuter Rail: Distribution of passengers during the day

Table 4.6 : Passenger Volumes (Source: COCT, 2005; COCT 2007a)

Direction	1998				2000				2004			
	Morning Peak	Inter Peak	Evening Peak	All Day	Morning Peak	Inter Peak	Evening Peak	All Day	Morning Peak	Inter Peak	Evening Peak	All Day
To Cape Town	182 982	83 679	66 356	359 413	181 151	62 870	60 561	338 991	172 958	48 536	55 253	307 843
From Cape Town	84 961	109 246	178 490	388 594	73 677	87 200	161 791	336 616	73 473	66 668	139 107	294 097
Total	267 943	192 925	244 846	748 007	254 828	150 070	222 352	675 607	246 431	115 204	194 360	601 940

A total of 197,444 passenger trips were made daily using commuter bus services (COCT, 2005). The passenger volumes increased from 120,000 in 2002 to more than 197,000 in 2007 (COCT, 2009). During the morning peak period there are 68,037 boarding passengers (COCT, 2006). Meyer (2008) indicates that 260,000 passengers are transported by GABS during a normal working day, and the Integrated Transport Plan shows 270,000 (COCT, 2009). This indicates an increase in the number of passengers using commuter bus services. GABS conveys approximately 55,9 million passengers annually (COCT, 2009). Table 4.7 indicates the average number of passengers travelling per bus trip for different periods of the day. This indicates that the highest utilisations of the bus services are during the morning peak period.

Table 4.7: Average number of passengers per bus trip (Source: COCT, 2005)

Time Period	Forward routes	Return routes	All routes
06:00 – 09:00	52	15	42
09:00 – 16:00	19	34	28
16:00 – 19:00	11	44	35
All day	33	35	34

Minibus-taxi passenger trips have increased from 283,000 (2002) to 332,000 (2004) and to 379,000 daily passenger trips in 2005. This indicates an increase of 14% in the 2004 passenger volumes for minibus-taxi services. There are a total number of 121,000 passenger trips in the morning peak period. (COCT, 2006a; COCT 2007a)

The busiest boarding locations of the public transport system in Cape Town are shown in Table 4.8. It indicates that the highest number of boardings happens in Cape Town for rail and minibus-taxi and Khayelitsha for bus services.

Table 4.8: Busiest boarding locations of the public transport system (Source: COCT, 2005, 2006a)

Train boardings in 2004 (COCT, 2006a)		Bus boardings in 2004 (COCT, 2005)		Minibus-taxi boardings in 2004 (COCT, 2005)	
Station	Daily	Residential area	3 hour AM peak period	Minibus-taxi ranks	3 hour peak period
Cape Town	59316	Khayelitsha	14365	Cape Town	13460
Mutual*	28173	Mitchell's Plain	13561	Bellville	10820
Salt River*	23230	Nyanga	5760	Khayelitsha	8002
Bonteheuwel	20920				
Phillipi	16151				
Bellville	15744				

** Transfer stations*

4.3.3. Infrastructure and vehicle fleet

Commuter Rail

PRASA owns the railway stations in the CMA and Metrorail utilise these stations to provide commuter rail services within the city. The total length of the commuter rail network in the City of Cape Town area is 260 km's and consists of 97 stations. Daily services are provided on 14 service lines with 227 train trips in the peak period. The rail network consists of multiple branch lines that radiate from Cape Town Station to the south (Simon's Town and Cape Flats line), south-east (Kapteinsklip and Khayelitsha lines) and the east (Bellville, Monte Vista, Paarl, Wellington, Strand and Stellenbosch lines). The network forms a system where different lines interlink to form a complex network of routes, rather than lines serving single origins or destinations. Figure 4.8 shows the rail network layout for the City of Cape Town. (COCT, 2005; COCT, 2006; COCT, 2007)

The following branch lines radiate from Cape Town station:

- Simon's Town Line: Cape Town to Simon's Town.
- Kapteinsklip Line: Cape Town to Mitchell's Plain.
- Khayelitsha Line: Cape Town to Khayelitsha.
- Monte Vista Line: Cape Town to Bellville, and beyond to Wellington.
- Strand Line: Cape Town to Strand.
- Sarepta link: Mutual to Sarepta and Bellville.
- Cape Flats Line: Maitland to Heathfield.

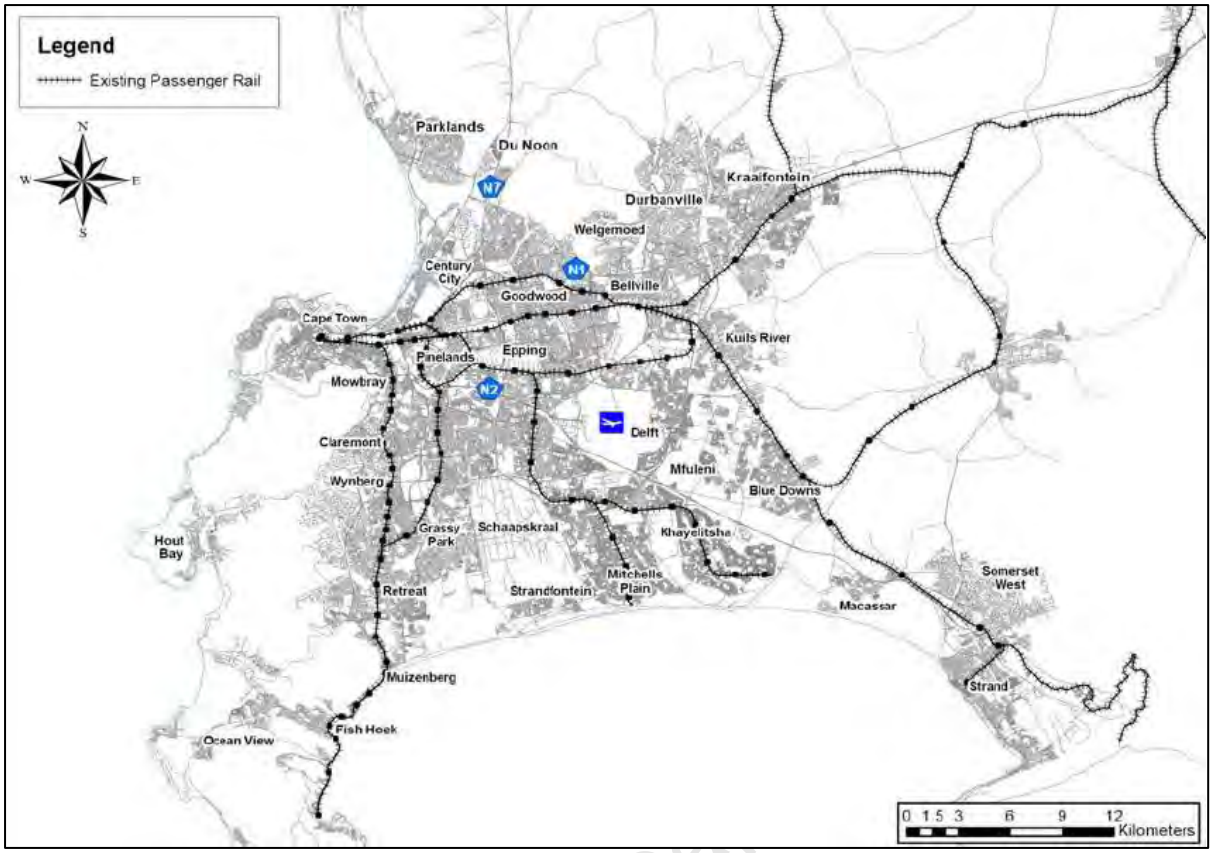

Figure 4.8: Commuter Rail Network (Source: Wilkinson, 2008)

A shortage of rolling stock has led to the situation where the commuter rail network is operating at below its technical capacity. The system lacks about 20 train sets and this causes inadequate passenger capacity on most lines during the peak periods. Insufficient funding over many years for the upgrading of rolling stock, stations and other system components of the Cape Town railway system has led to the deterioration of commuter rail service. Cable theft often compromises the integrity of signalling systems, which leads to delays and cancellation of services. Vandalism of rolling stock also remains a serious problem to rail operations. There is a perception that the rail system is not operating as well as it could, which gives rise to the reality of loss of choice users. The rail system needs to be recapitalised, modernised and integrated into a properly managed public transport system. Funding for the upgrading and modernizing of rolling stock and rail infrastructure is urgently required for commuter rail operations. The facilities for passengers with special needs, especially the mobility and visually impaired, are extremely limited at most of the railway stations in the CMA. PRASA supports universal design principles to accommodate SNP and some stations are accessible to passengers who use wheelchairs. There is still some way to go before all the rail facilities and rolling stock becomes fully accessible to all SNP's. (COCT, 2006a; Behrens & Wilkinson, 2009)

The 2007 Rail Census (Asakhe, 2008) indicated that there were 81 train sets operating on 14 service lines in the CMA. In 2004, Metrorail was operating 66 train sets in peak periods and the rolling stock

comprised of 231 motor coaches and 770 passenger coaches. The availability and condition of the rolling stock is one of the main problems for the operation of commuter rail services in Cape Town. The number of train sets declined from 95 to 85 in 2005 and to 81 in 2007. The withdrawal of train sets has been largely on the grounds of their condition and for safety considerations. This severely affects the ability to increase the service provision, frequency, reliability, the quality of the service, as well as the ability to attract modal choice passengers. PRASA is currently planning the upgrading and replacing of the old rolling stock. (COCT, 2007a)

Commuter Bus

GABS provide services on 1,530 routes per day, 771 on the forward direction and 759 on the return trip. The bus fleet travels approximately 65,9 million kilometres per year (PGWC, 2011). On a typical weekday approximately 5,300 bus trips are operated (COCT, 2009). GABS provide services in residential areas such as Mitchell's Plain, Blue Downs, Langa, Nyanga, Crossroads and Khayelitsha. Services to these areas are provided from six depots which are strategically located over the operational area. The majority of the bus services are operated as line-haul services with route distances of more than 15km, with some feeder and distribution services that are also provided. The average route length is 21,8km (Meyer, 2008). Buses operate from 05:30 in the morning till 19:30 in the evening on the major routes, with some services on the Khayelitsha-Bellville route running until 23:00 in the evening on a weekday. The bus network is comprehensive but unfortunately has limited off-peak services on most of the routes.

GABS own and operate six operating depots that are located at Montana, Woodstock, Atlantis, Phillipi, Simon's Town and Blackheath (Ally, 2009). Figure 4.9 shows the commuter bus network layout for the CMA (COCT, 2007a). The current GABS fleet consist out of 1160, in 2004 GABS was operating a fleet of 852 single deck buses (Behrens & Wilkinson, 2009). Most of the buses are single deck vehicles, with 24 buses being double deck buses (COCT, 2007a). The current bus fleet also has some articulated buses. The average seating capacity of the single deck bus is 65 seating passengers, with 25 standees. Based on 2002 data, approximately 220 buses are less than five years old, while the rest of the bus fleet is older. Studies in 2006 also indicate that most of the bus fleet is old and not up to modern standards, although some new buses have recently been purchased. GABS has been accelerating their fleet renewal programme since 2000 and they are focusing on enhancing the quality of service that they provide. Meyer (2008) indicated that GABS was able to reduce the percentage of vehicle breakdowns by 35% in recent years. Since 2000 they have purchased 450 new vehicles as well as refurbished 400 of their existing fleet, which enabled them to increase the amount of scheduled service trips that they provide by 34%. Most of the current bus fleet is inaccessible to SNP passengers. The GABS bus fleet in 2009 was totally inaccessible to passengers using wheelchairs and only a little

more accessible to other mobility-impaired users. The City of Cape Town provides a subsidized service to SNP, Dial-a-Ride services. Dial-a-Ride has 30 vehicles and they provide +/- 400 trips per day to more than 5000 registered people (COCT, 2009).

Minibus-taxi

Minibus-taxis operate daily on 565 routes with approximately 55,998 daily vehicle trips. During the morning peak period (06:00 – 09:00) there are approximately 22,893 vehicle trips and 120,922 passenger trips. Most of these routes originate in residential areas and end at railway stations or employment areas for the morning peak period. Line-haul services are operated from residential areas directly to and from employment or commercial areas. Data from 2004 indicates that line-haul services convey approximately 176,000 passenger trips daily using 26,000 vehicle trips. Feeder services are provided in residential areas, to and from railway stations or road-based public transport interchanges. The feeder services convey 92,000 passenger trips daily using 16,000 vehicle trips. Distributor minibus-taxi services operate to and from transport interchanges, in employment or commercial areas and convey 50,000 passenger trips a day using 7,000 vehicle trips. Figure 4.10 shows the minibus-taxi routes for Cape Town. (COCT, 2005)

The City of Cape Town Public Transport Plan 2006 -2011 indicates that 49% of the minibus-taxi operators operate 'illegally'. This spread of illegal operators has resulted from the lack of proper law enforcement in the CMA. Overtrading is possibly one of the main reasons for the instability of the minibus-taxi industry in the City Of Cape Town. About 70% of the minibus-taxi routes in Cape Town are overtraded and there are still a growing number of illegal operators. Overtrading leads to fierce competition for passengers, this often leads to violence and conflict. Despite the overtrading on many of the routes, more operating licences are being granted, causing a reduction in economic viability for the operators. (COCT, 2006a; COCT, 2007a)

The City of Cape Town owns and is responsible for the minibus-terminals, public transport interchanges, holding areas and taxi-ranks that are used by the minibus-taxis. There are 203 major minibus-taxi facilities in the City of Cape Town area, of these 112 are minibus-taxi terminals and 61 are ranks, while 30 are holding areas. The rank with the highest number of bays is Nyanga with 180 bays. In 2007 the size of the minibus-taxi fleet was estimated at 7,576 unlicensed and licensed vehicles, which are predominantly 15-seat minibus-taxis. Over the last few years the fleet size has remained relatively stable (COCT, 2005; COCT, 2007a).

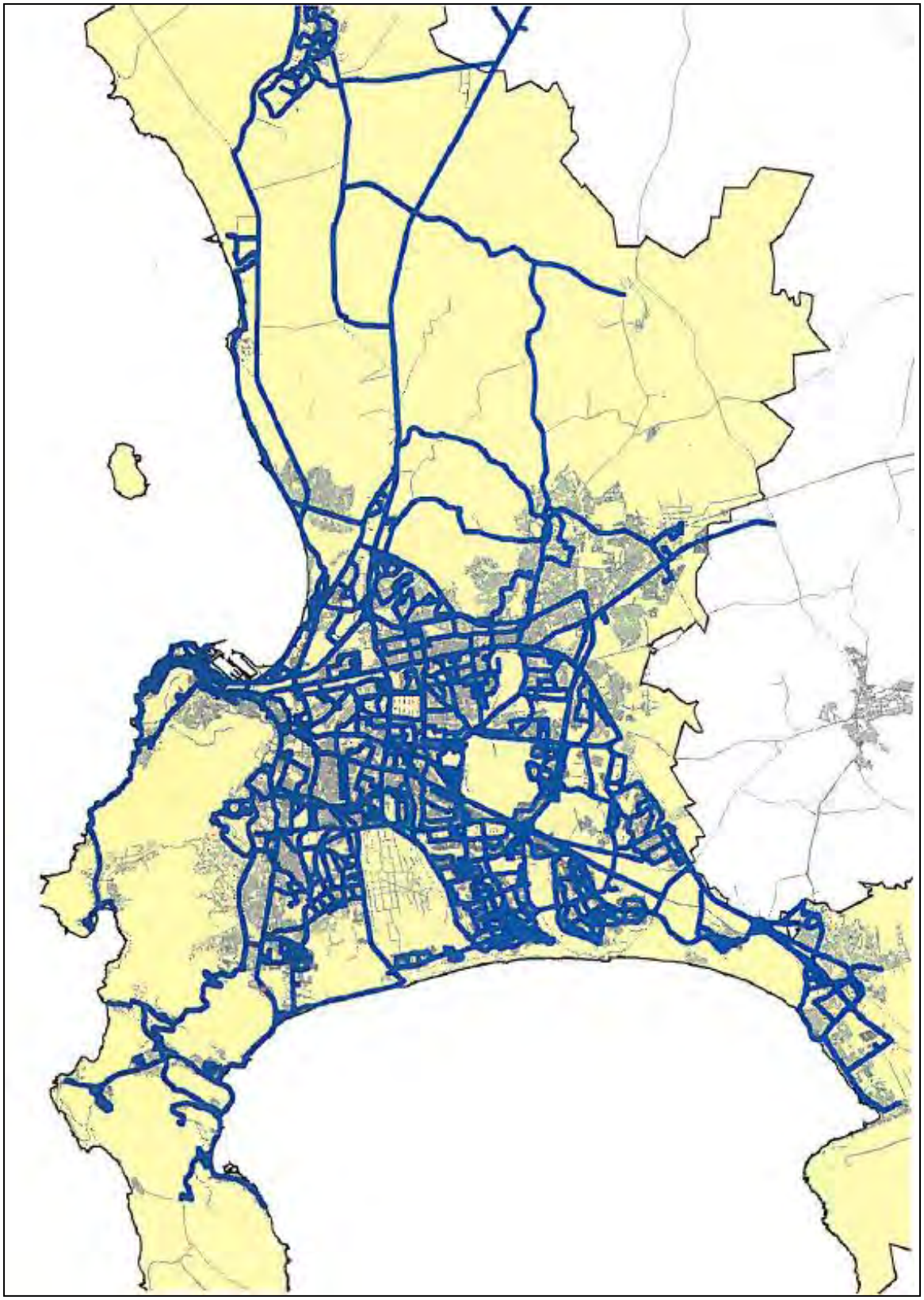

Figure 4.9: Bus Network for CMA (Source: COCT, 2005)

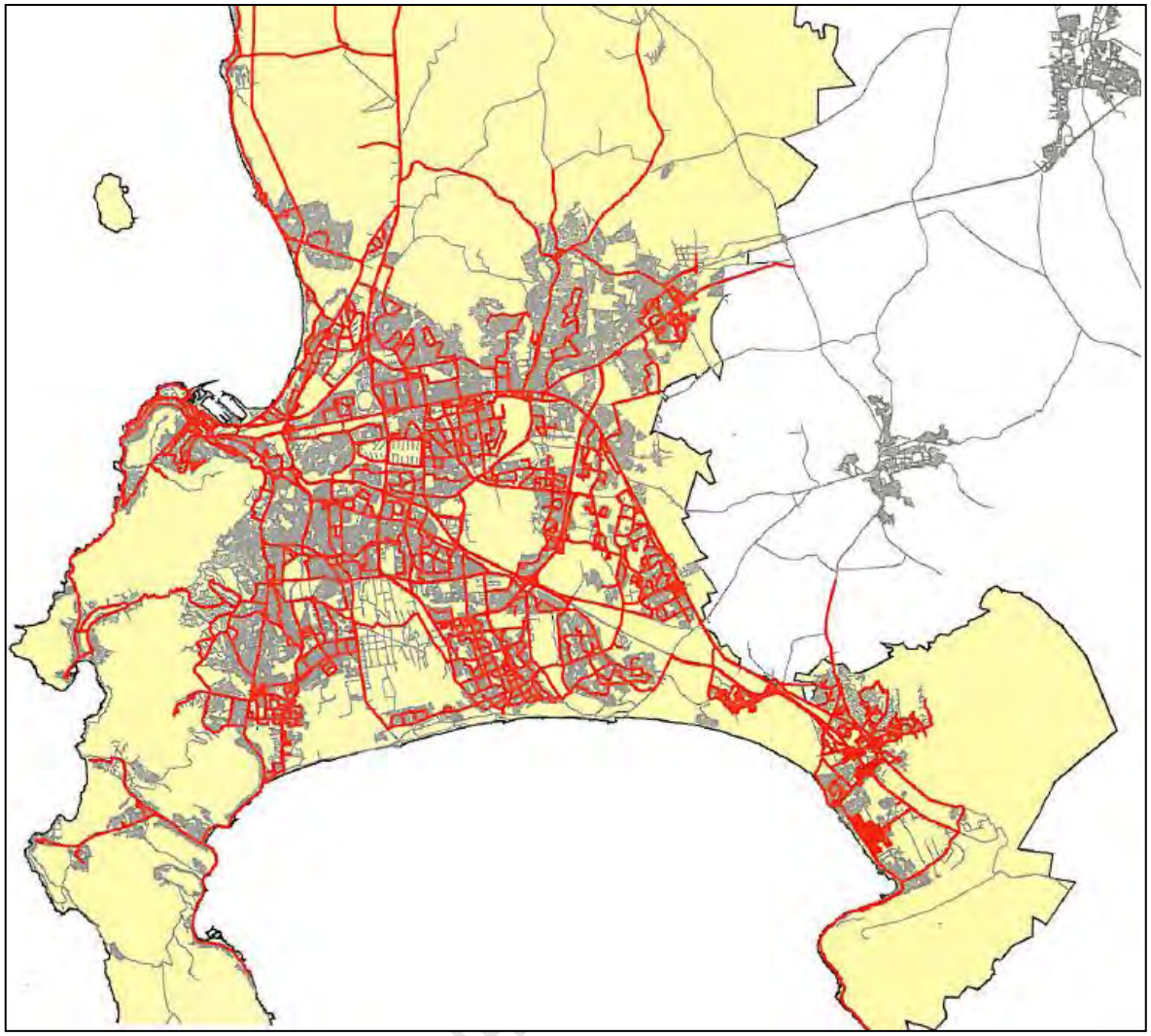

Figure 4.10: Minibus-Taxi Routes for CMA (Source: COCT, 2005)

4.3.4. Main routes

Public transport is a vital and essential element in the transport plans for Cape Town. Public Transport should provide opportunities for all citizens to access the full range of work opportunities, facilities and services that the City of Cape Town offers. Public transport services are provided over a much dispersed network and they offer good service coverage during the peak period, although in the off-peak period the services are provided at low frequency. The average number of daily trips per public transport mode per route is six trips per day in both directions (COCT, 2007a).

The major commuter rail corridors are the following (COCT, 2007a):

- Cape Town – Khayelitsha / Kapteinsklip
- Cape Town – Bellville
- Cape Town – Simon's Town

The major road-based public transport corridors are the following (COCT, 2007a):

- Klipfontein Road / N2 (Khayelitsha – Cape Town)
- Lansdowne Road (Khayelitsha - Claremont / Wynberg)
- Vanguard Drive
- Delft Main Road / R300

Table 4.9 indicates the busiest routes of the public transport segment.

Table 4.9: Busiest routes of the public transport system (Source: COCT, 2005, 2006a)

Train boardings (COCT, 2005)		Bus boardings (COCT, 2005)		Minibus-taxi boardings (COCT, 2005)	
Line	Daily	Route	3 hour AM peak period	Route	Daily
Khayelitsha	149542	Khayelitsha (Makhaza) to Claremont via Village 3 and Site C	1507	Cape Town-Waterfront	4898
Mitchells Plain	121640	Mitchells Plain to Cape Town via freeway	1348	Atlantis – Atlantis Industrial	4181
Strand	95571	Mitchells Plain to Claremont via Kennilworth Centre	1133	Bellville - Durbanville	3652
Simon's Town	92788	Nyanga to Cape Town	1021	Bonteheuwel – Cape Town	3546
Kraaifontein/Parow	60572	Khayelitsha (Makhaza) to Wynberg via Village 3 and Site C	893	Nyanga Central – Cape Town	3296

Table 4.10 shows the frequency and headways on the main railway lines for the morning peak period. The most frequent services in the morning peak period are provided on the Simon's Town line with a frequency of 25 train trips and a headway of 7.5 minutes. The average headway on the five main railway lines during the morning peak period is 11.16 minutes. Table 4.11 shows the busiest individual bus routes in the morning peak with their passenger volumes. The busiest bus route is the Khayelitsha to Claremont route which carries 1507 passengers in the morning peak period, with an average number of 74 bus passengers per trip. Table 4.12 indicates the busiest bus routes in the evening peak period as well as the number of boarding passengers per bus route. The ten busiest minibus-taxi routes on a weekday with their total passenger trips are shown in table 4.13.The busiest minibus-taxi route is Cape Town Adderley Street to Waterfront on a weekday. During the morning peak period 140 routes are operated at an average headway of less than five minutes, while 150 routes are operated at a headway of more than 30 minutes. Seven minibus-taxi routes have a frequency of more than 40 minibus-taxi trips per hour. The route with the highest frequency in the peak period is the Macassar to Somerset West route where 160 trips are operated in the three hours of the morning peak period. During the evening peak period (16h00 – 19h00) three routes have a frequency of more than 40 minibus-taxi trips per hour, with the Wynberg to Khayelitsha route having the highest frequency of 152 vehicle trips in the peak period. (COCT, 2005)

Table 4.10 : Frequency and headways on the five main railway lines during morning peak period (Source: COCT, 2005)		
Line	Frequency (# Train Sets)	Headway (Minutes)
Simon's Town	25	7.5
Mitchells Plain	20	9
Khayelitsha	18	10
Strand	14	12.9
Kraaifontein / Parow	11	16.4

Table 4.11: Busiest individual bus routes in the morning peak period (Source: COCT, 2005)			
Routes	Number of passengers	Number of bus trips	Average number of passengers per bus
Khayelitsha (Makhaza) to Claremont via Village 3 and Site C	1507	18	74
Mitchells Plain to Cape Town via freeway	1348	19	70
Mitchells Plain to Claremont via Kennilworth Centre	1133	15	76
Nyanga to Cape Town	1021	14	71
Khayelitsha (Makhaza) to Wynberg via Village 3 and Site C	893	14	61

Table 4.12: Busiest bus routes in the evening peak period (Source: COCT, 2005)							
Bus Route	Cape Town	Bellville	Wynberg	Claremont	Killarney	Subtotal of areas	Total number of boarding passengers in evening peak
Number of boarding passengers	19031	5344	4824	6069	3394	38662	60199
% of the boarding passengers	31.6	8.9	8	10	5.6	64.2	
Number of bus trips	368	109	106	112	63	758	
Average occupancy (passengers per bus)	52	49	46	54	54	51	

Table 4.13: Ten busiest minibus-taxi routes on a weekday (Source: COCT, 2005)					
Origin	Destination	Route Category	Number of unique vehicles	Vehicle trips	Total passenger trips
Cape Town Adderley Street	Waterfront	Distributor	30	330	4898
Atlantis	Atlantis Industrial Area	Feeder	166	1046	4181
Bellville	Durbanville	Distributor	123	319	3652
Bonteheuwel	Cape Town via Gatesville. Ahlone, Mowbray	Line-haul	123	584	3546
Nyanga Central	Cape Town via Sea Point	Line-haul	83	300	3296
Mitchells Plain Town Centre (East)	Cape Town Station Deck	Line-haul	83	397	2952
Macassar	Somerset-West via Somerset Mall	Line-haul	64	384	2824
Cape Town Station	Gugulethu	Line-haul	120	224	2791
V&A Waterfront	City	Distributor	33	336	2767
Wynberg Station (West)	Cape Town via Mowbray	Line-haul	128	625	2731

Figure 4.11 shows the high frequency bus routes for the morning peak period, 736 routes are operated in the morning peak period with 1,613 scheduled bus trips (COCT, 2005).

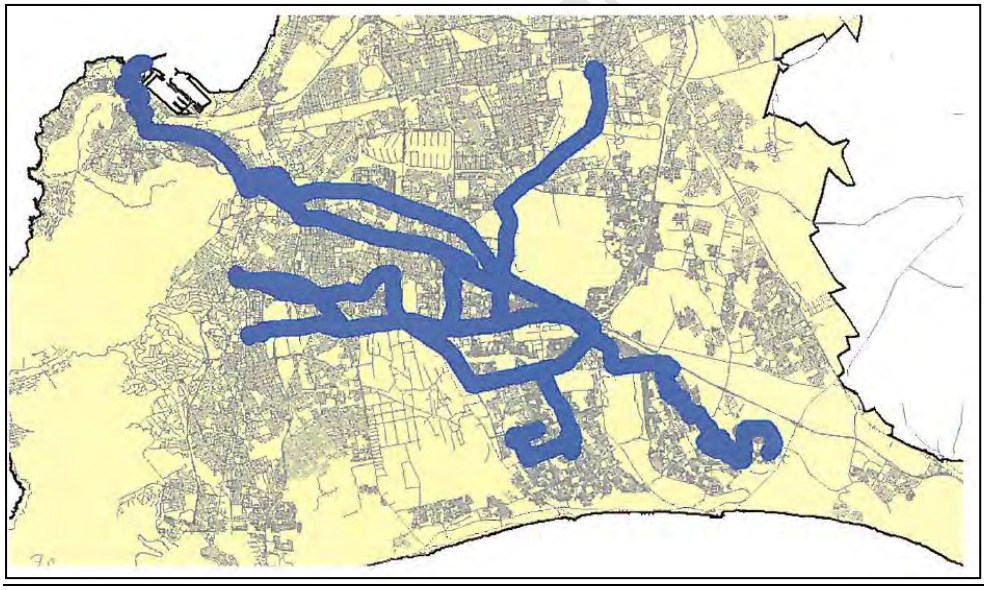

Figure 4.11: High frequency bus route for morning peak period (Source: COCT, 2005)

The 2004 CPTR study recorded passenger waiting times in queues before minibus-taxis arrived on 343 different routes. 67 of these routes had waiting times of more than eight minutes, 129 routes had times of three to eight minutes, while no passenger queues were observed at 170 routes. This study

indicated that 216 routes have a waiting time of less than one minute. Figure 4.12 shows the results from the study. (COCT, 2005)

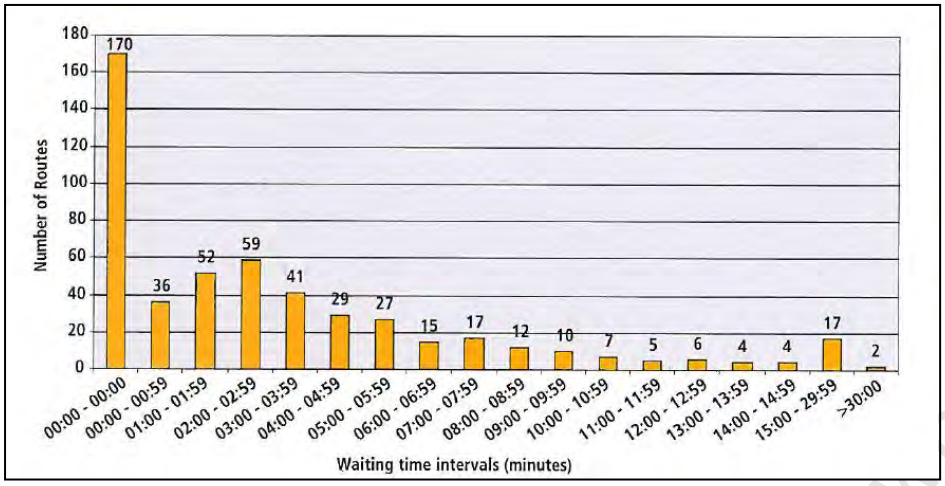

Figure 4.12: Waiting time intervals at minibus-taxi ranks (Source: COCT, 2005)

4.4. Financial Issues

4.4.1. Economic background of the city

Cape Town is the second largest city economy in South Africa (COCT, 2007a) and contributed 11.6% to national economy and 77.3% to the Western Cape economy in 2008 (COCT, 2009).

There are vast disparities between the wealthiest communities and the poorest. The poorer communities live mostly on the periphery of the urban area. Cape Town has an inefficient and inequitable distribution regarding economic activity and population distribution. Most of the poor communities have to travel long distances to their work place and also have to spend a considerable portion of their monthly income on transport, i.e. if they live in Khayelitsha and works in Cape Town CBD etc. Cape Town has high levels of unemployment and very low levels of wages in some of the market sectors, which suggest that a substantial proportion of the population are largely captive to public transport for access to employment, education, health and other essential opportunities (Clark, 2000). "*49% of the population earn less than R1 600 per month.*" (COCT, 2006e)

Table 4.14 indicates the key socio-economic characteristics for the CMA.

Table 4.14: Key socio-economic characteristics for the CMA(Source: Haskins & Smith, 2006; COCT, 2006c; COCT, 2009)	
Area	2,487km^2 (2006)
Population	3,500 000 (2007)
Population growth rate	3.5%
% Households earning less than R20 000 per annum	39% (2007)
Contribution to SA's GDP	R130 Billion 11% (2006), 11.6% (2007)
% Unemployment	16.9 (2007)

4.4.2. Fares

The structure of public transport fares in Cape Town is shown in Table 4.15. PRASA is responsible for setting the train fares, but they have to approach the City of Cape Town for comments and also the National Government as they are the main body that is responsible for the fares of rail services (Cupido, 2010). The commuter rail service gives the option of single, return, and discounted weekly and monthly tickets for Metro and Metro Plus passengers. Four distance categories are used for all types of rail tickets. Commuter Bus gives the option of single tickets, discount-priced ten-ride clip cards and monthly tickets. Passenger subsidies only apply to the discount priced tickets that are sold. From the interview with GABS and making use of their fares and distances tables, the fair per km is calculated at an average of R0,55 per km for 2009. Minibus-taxi fares are not subsidised and they do not provide special prices on multiple or return trips. The data from Fuller (2009) might be out-dated and it is expected that the fares are higher. The fares are paid in cash to the driver and no tickets are issued. Fares increase as the distance travelled increases. Minibus-taxis do not have any fare policy with the City of Cape Town and the fares that they ask are uncontrolled (Cupido, 2010).

Table 4.15: Public Transport fares for Cape Town			
Distance (km)	Tain	Bus	Minibus-Taxi
	2012 [1]	2012 [1]	2012 [1]
0-<5	$0.73	$0.77	$0.97
5-<10	$0.73	$1.02	$1.10
10-<15	$0.73	$2.44	$1.10
15-<20	$0.73	$1.83	$2.44
20-<25	$1.04	$2.74	$2.44
25-<35	$1.04	$2.92	$2.44
35-<50	$1.52	$4.87	$3.41

[1] Personal Observation (2012), Exchange rate R8.21 per US $ (www.rainbownation.com)

4.4.3. Affordability of public transport services

Table 4.16 indicates the percentage of household income spent on public transport for Cape Town. It shows that 11% of households spend more than 20% of their household income on public transport and 23% of households spend more than 10% of their household income on public transport.

Table 4.16: Percentage of household income spent on public transport (Source: DOT, 2007)					
Percentage of household income spent on PT	0%	1-5%	6-10%	11-20%	>20%
Percentage of Cape Town Households	40.9	19.9	16.3	12.0	11.0
Monthly household expenditure on public transport	Nothing	R1-R50	R51-R100	R101-R200	R201+
Percentage of Cape Town Households	37.8	9.1	8.9	15.7	28.7

One of the objectives of *The White Paper on National Transport Policy* is to ensure that passengers will not spend more than 10% of their household income on public transport (COCT, 2009). In order to achieve this objective the government will have to pay more subsidies or implement strategies in order to reduce the percentage of income spent on public transport.

Figure 4.13 indicates that 65% of the households earning less than R500 per month spend more than 20% of their household income on public transport. Only 1% of the households earning above R3000, spends more than 20% on public transport. This indicates that the lowest income group spends a large part of their household income on public transport. There are two reasons for this; firstly because their total household income is very low it makes the percentage spend on public transport high in comparison to their total income and secondly because they live on the periphery and travel the furthest to their work places which increases their travel costs. This creates the situation where the higher the income group, there are lesser households that spends money on public transport.

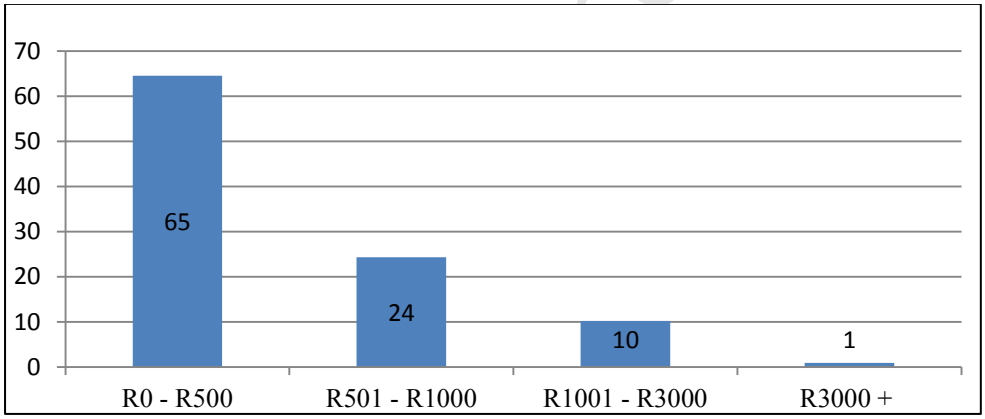

Figure 4.13: Percentage of Households that spends more than 20% of income on public transport (Source: DOT, 2007a)

4.4.4. Subsidies

Commuter rail and bus services in Cape Town have been subsidised for many years. The minibus-taxi industry has only recently been subsidised by the government to encourage the industry to recapitalise its vehicles with newer, larger and safer vehicles; which currently amounts to R65,000 per vehicle.

Public transport subsidies are regulated by the National Government through the National Policy Framework, while the National Treasury determines the subsidy framework. The funding comes from

National Government through the Provincial Government. Funding is dealt with under the National Policy and is part of the Public Transport action plan. There is also Grant Funding and other funding sources. The Division of Revenue Act (DORA) helps the National Government to allocate funds to the provinces and municipalities; one of the objectives of DORA is to "*provide for the equitable division of revenue raised nationally among the three spheres of government*" (Government Gazette, 2011) (Cupido, 2010).

Funding for the capital investment and operations for commuter rail services is provided through National Treasury to the National Department of Transport who then provides the funding to PRASA. The funding consists of a budget allocation (which includes operational subsidy) and farebox revenue. Funding for the capital investment for commuter bus services and minibus-taxi services are provided through the Provincial Department of Transport budget, the Municipal budget and the Public Transport Systems and Infrastructure Fund. The operators are responsible for the funding of the vehicles. Minibus-taxi operators can receive some funding from the government through the taxi recapitalisation programme, although this is a relatively small amount which they can receive only once. Minibus-taxi operators do not have to pay income fare to the government, which is another way in which they are subsidised. The funding for the operations of commuter bus services is provided by National Treasury through the Provincial Department of Transport in the form of an operational subsidy. The only funding for operations for the minibus-taxi operators is through their farebox revenue. (Wilkinson, 2008)

The annual operating subsidy for PRASA for the 2010/2011 financial year was R3,15 billion. Scheduled commuter bus services are also subsidised by National Government. GABS is subsidised for the number of multi-journey tickets sold. This amounted to R660 million for 2010/2011 (PGWC, 2011). The subsidy paid to commuter bus services has increased from R130 million in 1997/8 to R360 million in 2003/4, which indicates an increase of 175% over seven years (COCT, 2007a).

4.5. Summary of Cape Town's Public Transport System

This section will summarise Cape Town's Public Transport System into the four categories; Institutional and Regulatory Framework, Network Structure, Public Transport Modes and Financial Issues (See table 4.17).

Table 4.17: Summary of Cape Town's Public Transport System	
	1. Institutional and Regualtory Framework
Stakeholders	• PT Regulation is fragmented across different institutions & stakeholders. • Planning, Coordination & Strategy Stakeholders: NDOT, PRASA, SANRAL, ACSA, PGWC, The City of Cape Town. Operations: PRASA, Metrorail, GABS, Private Minibus-Taxi operators, SATAWU, NATDO, SANTACO.
Regulatory Framework	• Fragmented institutional framework. • No coordination between commuter rail, commuter bus and minibus-taxi services. • Provision of PT governed by NLTA (2009). • NDOT – Responsible for the regulation of commuter rail services. • OLB & DOT – Responsible for the regulation of bus & minibus-taxi services.
Industry Structure	• Commuter rail and commuter bus services operate under a monopoly. • Minibus-taxi industry operates in a deregulated environment.
	2. Network Structure
City Characteristics	• Area of 2,487km^2. • Population of 3,5 million people. • Annual population growth rate of 3,5%. • Average Population Density – 1,407 inhabitants per square km, low density development across city. The population density range between 12 – 46,510 people per square km. • Cape Town has an inefficient and inadequate economic activity and population distribution.
Transport Network	• Road Network of over 8,500kms. • Traffic volumes growth at approximately 8% per year. • Radially-oriented road system that is focused on Cape Town's CBD. • Consist out of limited radial linkages that do not adequately accommodate the multi-directional movement patterns. • Major road network – promoted low density urban sprawl and inefficient PT operations. • Experienced decentralisation from Cape Town CBD to other nodes & centres. • Commuters in CMA have relatively long commuting times. • PT services are provided over a much dispersed network, Commuter rail services – 14 lines Commuter bus services > 900 routes Minibus-taxi services > 600 routes • Limited off-peak period services.
Transportation demand and usage of PT modes	• Daily Transport Modal Share for CMA; 48% PT, 44% Private vehicles, 8% NMT. • Daily modal share for Cape Town CBD – Private 67%, Public 33%. • Daily PT Modal share – 54% Rail, 17% Bus, 29% Minibus-taxi. • Car ownership – 200 cars per 1000 capita. • Daily more than 1,1 million public transport passenger trips are made in CMA. • 2004 Daily passenger volumes; rail (601,940), bus (197,444), minibus-taxi (332,407).
Infrastructure	• 97 rail, 132 bus, 203 minibus-taxi and 47 metered-taxi facilities in Cape Town. • Most of the infrastructure is in poor condition due to under-investment.
	3. Public Transport Modes
Commuter Rail	• Services are provided by Metrorail. • Backbone of Cape Town's public transport system. • Provides transport to more than half of the daily public transport commuters in Cape Town. • 601,940 daily passengers in 2004, 634,837 daily passengers in 2007. • 246,431 passenger trips in morning peak period, 194,360 passenger trips in evening peak. • Daily services are provided on 14 service lines with 227 train trips in peak period. • Lack of investment in rail infrastructure & fleet, train sets are old and in poor condition.

Table 4.17 (Continued): Summary of Cape Town's Public Transport System	
Commuter Bus	• Services are provided by GABS. • 197,444 daily passengers in 2004, 270,000 daily passengers in 2009. • Provides services 1,530 routes per day. 771 in forward direction, 759 on return trip. • Bus fleet of 1160 buses that operate 5295 vehicle trips per day. • Most of the bus fleet are old and not in a good condition, although GABS are busy upgrading their bus fleet.
Minibus-taxi	• Services are provided by private owners. • 332,407 daily passengers in 2004, 378,995 daily passengers in 2005. • Approximately 55,998 daily trips made by minibus-taxis. • Operates on 556 routes daily. • Large percentage of illegal operators in Cape Town& overtrading occurs on most of the routes. • Vehicle fleet of 7,576 minibus-taxis in 2007 and 7,467 in 2004.
	4. Financial Issues
Economic background of the city	• Annual economic growth rate – 5.4% • Vast disparities between the wealthiest communities and the poorest. • High levels of unemployment, but better than the Nation levels of unemployment. • 39% of households earns less than R20 000 per annum.
Fares	• Rail fares (2012) – ranged between $0.73 – $1.52 • Bus fares (2012) – ranged between $0.77 - $4.87 • Minibus-taxi fares (2012) – ranged between $0.97 - $3.41
Affordability of PT services	• 11% of households spend more than 20% of their HH income on PT (2007). • 23% of households spend more than 10% of their HH income on PT (2007).
Subsidies	• Commuter rail & bus receives subsidies.

4.6. Evaluation of Cape Town's Public Transport System

This section will evaluate Cape Town's Public Transport system using key performance indicators. Public transport objectives will help to identify the key performance indicators that are necessary to evaluate the public transport system of Cape Town.

4.6.1. Public Transport objectives

The vision for Cape Town's public transport is to provide "*A safe, effective, efficient, equitable and affordable public transport system that supports sustainable, social and economic development in an environmentally responsible manner.*" (COCT, 2009)

The following are the public transport goals and objectives for Cape Town (COCT, 2009; COCT, 2007a; COCT, 2006e):

- To give priority to public transport over private transport.
- To bring about a shift from the use of private vehicles to public transport through improved public transport and restraint measures in the use of private transport through travel demand management, to motivate a shift in the use of public transport towards the national strategic objective of a ratio of 80:20 between public and private transport.
- To provide public transport that meets the needs of all users and improves public transport for the benefit of existing and potential users.
- To provide a good quality public transport system.
- To ensure safety and security of the public transport service provided.
- To provide reliable public transport service.
- To improve accessibility of public transport for all users and people having access to opportunities, services and goods, specifically the poor and people with special needs.
- To provide affordable public transport services.
- To promote sustainable travel patterns by encouraging walking, cycling and the use of public transport.

The next section will discuss the KPIs that were chosen for the selected goals and objectives.

4.6.2. KPIs and data required to quantify the public transport objective

For most of the objectives mentioned above more than one KPI can be selected and used to evaluate the performance of the public transport system. These KPIs also need certain public transport data in order to be evaluated (see table 4.18). The objectives that were selected in section 4.6.1 to estimate the KPIs for Cape Town are listed below with their KPIs.

Table 4.18: KPIs & Data Required to evaluate the public transport objectives			
	Objective	**KPI**	**Data required**
1	To promote public transport over private transport.	% of motorised transport users using public transport.	# Motorised transport users. # Public Transport (PT) users.
		% of motorised transport users using private transport.	# Motorised transport users. # Private transport users.
		% of dedicated PT road km's out of the total road network for the city.	Dedicated PT lane km's. Total road-km's in city.
		Number of daily PT passengers per 1000 people.	Daily PT passenger volumes. Population size.
		Vehicle ownership per 1000 people.	Number of registered light vehicles. Population size
		% of Population within 15 minutes' walk from a PT facility.	# Population within 15 minutes' walk from PT facility. Population size.
2	To improve the quality of public transport service provided to meet the needs of all users.	Average daily load factor (passengers per seat).	# Daily PT passengers. # PT seats available daily.
		Average travel time to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel time per PT trip in the peak period.
		Average travel speed of public transport vs average travel speed of private transport in peak hour.	Average Public transport travel speed. Average Private transport travel speed (Peak hour)
		Total road-based public transport seat capacity per 1000 people.	# Road-based PT seats available daily. Population size.
		Total public transport seat capacity per 1000 people.	# PT seats available daily. Population size.
		Peak-hour frequency of the PT services: -Rail, - Bus, - Paratransit	Peak-hour frequency (min).
		Passengers carried per train per day	# Trains daily in service # Daily rail passengers
		Passengers carried per bus per day	# Buses daily in service # Daily bus passengers
		Passengers carried per minibus taxi per day	# Minibus taxis daily in service # Daily minibus taxi passengers
3	To improve the safety and security of the public transport services	# Road accidents per 100,000 people.	Annual accidents. Population size.
		# Road Fatalities per 100,000 people.	Annual road fatalities. Population Size.
		# Road Fatalities per 10,000 vehicles.	Annua; road fatalities # Registered light vehicles
4	To provide reliable public transport services.	% of Scheduled PT services that arrives on-time.	# Scheduled PT trips (daily). # Of PT trips that departs On-time.
5	To improve the accessibility of the public transport services to all.	% of Population within 1000 m walking distance from a PT facility.	# Population within 1000 m from PT facility. Population size.
		# PT stops per 100 km^2.	# PT stops in city. Area of city.
	To provide universal accessible public transport services	% of PT vehicles that are universal accessible.	# Universal accessible PT vehicles. Total PT vehicle fleet
		% PT facilities that are universal accessible.	# PT facilities that is universally accessible. Total # of PT facilities.

Table 4.18 (Continued): KPIs & Data Required to evaluate the public transport objectives			
	Objective	**KPI**	**Data required**
6	To provide affordable public transport.	Average % of household income spent on PT services per month.	Monthly household income spent on PT. Monthly household income.
		% of Public transport users that spent more than 10% of their household income on PT services.	# PT users that spent more than 10% of HH income on PT services per month. Total PT users. Average monthly household income. Average monthly PT expenditure.
		Average fare per PT trip.	PT fares per trip. # PT trips. Total monthly expenditure on PT. Number of monthly PT trips.
7	To promote the use of NMT and PT.	Modal split of the transportation system. - % PT, Private vehicle & NMT users	# PT users # Private vehicle users. # NMT users.

The KPIs listed above will be used in the next section to quantify the performance of the public transport systems of the case cities. In the case where some of the data required to evaluate a KPI were not available, the KPI will be excluded from the list of KPIs that will be used.

4.6.3. Data needed to calculate KPIs

Table 4.19 lists all the data required to evaluate the KPIs listed in table 4.18.

Table 4.19: Data for calculation of KPIs (sources of data shown in column *)

(Sources: [1] COCT, 2009; [2] Behrens & Wilkinson, 2009; [3] Scott, 2010; [4] Haskins & Smith, 2006; [5] COCT, 2005; [6] COCT, 2006e; [7] Worldbank; [8] IMF, 2007; [9] http://www.tradingeconomics.com; [10] DOT, 2007a; [11] http://www.statssa.gov.za; [12] http://www.sacities.net/workwith; [13] PGWC, 2011, [14] http://gabs.co.za; [15] http://www.metrorail.co.za; [16] Personal observation 2012)

	Data	**Cape Town**	*****
Performance Indicator	Area (km^2)	2,487	1
	Density (people/ km^2)	1,504 (2011)	
		1,407 (2007)	
		1,246 (2004)	
		1,166 (2001)	
	GDP per capita - Country (US$)	10,200 (2009)	7
		5,916	8
	GDP per capita - City (US$)	9,991 (2010)	12
		11,404 *(2004)*	4
	Currency	R1 = $0.15574 (2004) R1 = $0.12216 (2012)	9
	Population size.	3,740,026 (2011)	11
		3,500,000 (2007)	1
		3,100,000 (2005)	5
		2,900,000 (2001)	1
1	# Daily PT users.	1,131,791 *(2004)*	1
	# Daily Private transport users.	320,000 (entering CBD)	1
	Dedicated PT lane km's.	19	6
		39 (2011)	
	Total road-km's in city.	8500	1

Table 4.19 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Cape Town**	*****
	Modal Split - Public transport - Private transport - NMT	 48% 44% 8%	13
	Modal Split - Public transport - Private transport - NMT	39% 48% 13%	5
	Modal Split (entering CBD) - Public transport - Private transport	33% 67%	5
	Registered light passenger vehicles	691,000 *(2009)* 570,000 *(2004)*	1 2
	% of Population within 15 minutes walk from a PT facility	85%	1
2	Number of Buses	1160 (GABS)	1
	Seat Capacity - Buses - Per bus	89,900 90 (50% of fleet) - *assumption* 65 (50% of fleet) - *assumption*	
	Number of Paratransit vehicles	7467	1
	Seat Capacity - Paratransit	116,485 80% (15 seater) 20% (18 seater)	
	Number of train sets	83	1
	Seat Capacity	166,000 +/- 2000 *(per train set)*	
	Road-based Average travel speed	35 (Car during peak hour) 15 (Bus during peak hour)	
	Peak-hour frequency (min). - Rail - MBT - Bus	 13 2 15	3 1
	Daily PT users.	1,131,791 *(2004)*	1
	Daily bus passengers	270,000 *(2005)* 197,444 *(2004)*	5 1
	Daily paratransit passengers	332,407 *(2004)*	1
	Daily rail passengers	634,837 *(2005)* 601,940 *(2004)*	1
	Average travel time to work - all public transport commuters (morning peak period).	55 min Varies between 1 hour to 2 hours depending on distance.	10 1
	Peak-hour frequency of the PT services: -Rail - Bus - Paratransit	 20 minutes Range between 15 – 60 minutes 2 minutes	 15 14 2
	Passengers per train set per day	83 601,940 (2004)	1
	Passengers per bus per day	1160 197,444 (2004)	1
	Passengers per minibus taxi per day	7467 332,407 (2004)	1

Table 4.19 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Cape Town**	*****
3	Total Accidents	92,203 *(2007)* 78,333 *(2004)*	5 1
	Fatal Road Accidents	367 *(2007)* 591 *(2004)*	5 1
	Registered light passenger vehicles	691,000 *(2009)* 570,000 *(2004)*	1 2
4	% of PT trips that departs on-time.	(Not available)	
5	# PT stops in city.	4500	5
	% of Population within 1000m (15 minutes) walking distance from a PT facility.	91%	1
	Universal accessible PT vehicles - Rail - Bus - MBT	 some stations & trains 0 (IRT & new buses will be) (30 special service vehicles)	1
	Total PT vehicle fleet	8657 (Road) 83 (Rail)	1
	# PT facilities that are universally accessible.	(Not available)	
	Total # of PT facilities.	3344 Bus Stops 479 PT facilities	1
6	Monthly household income spent on PT - Percentage (Range)	5-10%	2
	Monthly household income spent on PT - Value	(Not available)	
	% HH's that spent more than 10% of HH income on PT services per month.	23%	1
	Average PT fares per trip - Rail - Bus - MBT Average PT fares per trip - Rail - Bus - MBT	 US$ 0.99 US$ 1.28 US$ 0.87 US$ 0.93 US$ 2.38 US$ 1.94	5 16
7	Daily PT users.	1,131,791 *(2004)*	1
	Daily bus passengers	197,444 *(2004)* 270,000 *(2005)*	5
	Daily paratransit passengers	332,407 *(2004)*	5
	Daily rail passengers	601,940 *(2004)* 634,837 *(2005)*	5
	Daily motorised trips	3,300,000	1
	Registered vehicles	1,023,107 *(2009)* 570,000 *(2004)*	1 2
	Modal Split - Public transport - Private transport - NMT	 48% 44% 8%	2
	Public transport Modal Split - Rail - Bus - Paratransit	 54% 17% 29%	5

Section 4.6.4 will present and discuss the evaluation of the KPIs and will use the data listed in table 4.27.

4.6.4. Quantification of KPIs

The outcomes of the quantification of the selected KPIs for Cape Town are presented in table 4.20.

Table 4.20: Cape Town KPIs			
	KPI	**Cape Town**	
1. To promote public transport over private transport.			
	% of Motorised transport users using public transport. (All day)	45%	(2004)
		52%	(2003)
	% of Motorised transport users using public transport. (All day) – entering CBD	33%	(2004)
	% of Motorised transport users using private transport. (All day)	55%	(2004)
		48%	(2003)
	% of Motorised transport users using private transport. (All day) –entering CBD	67%	(2004)
	% Non-Motorised transport	13%	(2004)
	% Public Transport	39%	
	% Private Transport	48%	
	% of Dedicated PT road km's out of the total road network for the city.	1%	(2011)
	Number of daily PT passengers per 1000 people.	365	(2004)
	Vehicle ownership per 1000 people.	197	(2007)
		184	(2004)
	% of Population within 15 minutes' walk from a PT facility.	91%	(2004)
2. To improve the quality of public transport service provided to meet the needs of all users.			
	Average daily load factor (passengers per seat).		(2005)
	- Rail	3.13	
	- Bus	3	
	- MBT	2.85	
	Average travel time to work, for all public transport commuters during the morning peak period.	55 min	(2004)
	Total road-based public transport seat capacity per 1000 people.	66.58	(2004)
	Total public transport seat capacity per 1000 people.	120.12	(2004)
	Peak-hour headway of the PT services:		
	-Rail	20 min	(2011)
	- Bus	15-60 (Range)	
	- Paratransit	2 min	
	Passengers per train set per day	7252	(2004)
	Passengers per bus per day	170	(2004)
	Passengers per minibus taxi per day	45	(2004)
3. To improve the safety and security of the public transport services			
	Accidents per 100,000 people (Private and public vehicles).	2,635	(2007)
		2,527	(2004)
	Fatalities per 100,000 people (Private and public vehicles).	10.49	(2007)
		19.07	(2004)
	Fatalities per 10,000 vehicles (Private and public vehicles).	5.31	(2007)
		10.37	(2004)
4. To provide reliable public transport services			
	% of Scheduled PT services that arrive on-time.	n.a.	
5. To improve the accessibility of the public transport services to all.			
	% of Population within 1000 m walking distance from a PT facility. (15min walk = 1000m)	85%	(2004)
	# PT stops per 100 km^2.	181	(2009)
	% of PT vehicles that are universal accessible.		(2009)
	- Total (Road)	0.35%	
	% PT facilities that are universal accessible.	n.a.	
6. To provide affordable public transport			
	Average % of household income spent on PT services per month.	5-10%	(2004)
	% of PT users that spent more than 10% of their household income on PT services.	23	(2004)
Table 4.20 (Continued): Results of the KPIs			
6. To provide affordable public transport			
	Average PT fares per trip		(2004)
	- Rail	$ 0.99	
	- Bus	$ 1.28	
	- MBT	$ 0.87	
	Average PT fares per trip		(2012)

	- Rail - Bus - MBT	$ 0.93 $ 2.38 $ 1.94	
7. To promote the use of NMT and PT			
	Modal Split - NMT - Public transport - Private transport - NMT - Public transport - Private transport	 13% 39% 48% 8% 48% 44%	(2004) (2003)
	Are there efficient TDM Strategies for the city?	Yes, but could be improved, and better enforced.	
	Are there provision for bicycle lanes & walkways in the city	Yes, but more could be provided.	

Section 4.6.5 will discuss the results from the KPIs for the case cities.

4.6.5. Analysis of the KPIs

4.6.5.1. Promotion of public transport over private transport

Cape Town had a transport modal share of 56% for public transport and 44% for private transport in 2003. In 2004 the transport modal share was 52% for public transport and 48% for private transport. This suggests that there was an increase in the amount of private transport users. This need to be addressed in order to obtain the desired modal share of 80:20 (public transport: private transport).

The results from these KPIs indicate that the car ownership for Cape Town was 197 cars per 1000 people in 2007 and 184 vehicles per 1000 people in 2004. This indicates an increase in the private vehicles per capita from 2004 to 2007. Many of the public transport users in Cape Town are captive public transport users and usually as soon as people are able to afford a private vehicle, they will purchase a private vehicle to use as their preferred transport mode. The MyCiti bus service is likely to reduce some of the private transport users who will start using public transport as experienced on the phase 1 route of the IRT system. Currently, road-based public transport only has priority on 1% of Cape Town's road network, this will be improved by phase 2, 3 and 4 of the MyCiti IRT system. 91% Of the population live within 15 minutes' walk from a PT facility, but some of the public transport modes have low service frequency especially during the off-peak period.

4.6.5.2. Improvement of the quality of public transport service provided

Public transport commuters are unhappy with the quality of public transport services provided by rail, bus and minibus-taxis in Cape Town. The standard and quality of public transport services need to be improved in order to provide a "World-class" public transport system.

Rail has a slightly higher daily load factor (passengers per seat) than bus and minibus-taxi. The trains in Cape Town are overcrowded during the peak period. During the off-peak period the public transport modes experience lower-utilisation rates. Minibus-taxis only departs once they have enough passengers on-board which could lead to long waiting times, while the buses and trains have to operate according to a time-schedule. The total public transport seat capacity per 1000 people is 120.12. In order to cater for a 80:20 (public: private) modal share there need to be invested in more rolling stock and public transport fleet, the current public transport capacity per 1000 people is sufficient for the current public transport demand. It is also important to ensure that the optimum mode is used for a specific corridor depending on its public transport demand and length of route.

The average travel time to work ranges between 55 minutes to 2 hours depending on the travel distance that range between15-30 km. A 30km travel distance on a road-based public transport vehicle can take up to 2 hours to travel during the peak hour. Travel time is usually influenced by traffic congestion, frequencies of stops to pick up/drop-off passengers en-route and the distance travelled. Traffic congestion during the peak-periods in Cape Town is bad and the peak-periods usually continue for 2-3 hours in the morning and afternoon. The frequencies of public transport services provided are higher during the peak period than the off-peak period. The rail and bus services provided are less frequent than the minibus-taxi services. Minibus-taxis have a headway of 2 minutes in the peak-hour, whereas bus services have a headway of between 15 to 60 minutes depending on the route. Rail services have a headway of 20 minutes or shorter per route. While the provision of minibus-taxi services are more frequent than bus and rail in the peak period, their capacity is less which could lead to a situation where some passengers have to wait for the next minibus-taxi because there is no space available on the current minibus-taxi.

Cape Town’s public transport system is currently not very attractive to the existing public transport users and also to attract private vehicle users. The MyCiti IRT service that operates on phase 1 is however more attractive and private car users are starting to use this service. Currently the IRT only provides services on a small section of Cape Town’s road network.

4.6.5.3 Improvement of the safety and security of public transport services

Cape Town had 2,635 road accidents (Private and public vehicles) per 100,000 people in 2007 and 2,527 per 100,000 people in 2004. This number seems high, but it includes any type of road accident that was reported; fatal, serious or light damage only. There has been a reduction in the number of fatal accidents since 2004. This can be attributed to the improvement in law enforcement on Cape Town roads, focusing on drinking and driving, speeding and driving while speaking on a cell phone. Cape Town has a fatality rate of 10,47 fatalities per 100,000 people in 2007 and 19,07 in 2004. The number of fatalities per 10,000 vehicles was 5,31 in 2007 and 10,37 in 2004. Cape Town still compares poorly against the European rates of 1,2 to 1,8 fatalities per 100,000 population (Pendakur, 2005).

There is not enough information available to evaluate the security of the public transport system for Cape Town. Some of the taxi ranks in Cape Town are either controlled by taxi associations or gangs. Gangsters are also used as guards on Minibus-taxis and intimidation and extortion takes place of drivers and passengers. The main crimes reported on trains are robbery, assault, vandalism and stone throwing and most of these crimes are committed during the off-peak period. Stone throwing at buses and assault of passengers using bus services also takes place. (COCT, 2009)

There are not enough law enforcement officers in Cape Town and this makes it difficult for them to provide a good service. The public does not respect the rules and some of the law enforcement officers are guilty of unfair enforcement procedures.

4.6.5.4. Provision of reliable public transport services

There is not enough information available on the reliability and on-time performance of the public transport modes in Cape Town.

4.6.5.5. Provision of public transport services that are accessible to everyone

Cape Town has 4500 public transport stops, which enables Cape Town to have an accessible public transport system. 85% of the population has access to public transport facilities or stops within a 15 minutes' walk (1000m) from their houses. 73% of the population can reach a public transport facility or stop within a 10 minutes' walk from their houses. Although this percentage seems high, the frequency of the public transport services provided in Cape Town is low during the off-peak period.

Less than 1% of the public transport vehicle fleet in Cape Town was universally accessible, prior to the MyCiti IRT service. PRASA is currently upgrading its railway stations and rolling stock to be universally accessible and the MyCiti service will have universally accessible buses. The IRT stations are also universally accessible.

4.6.5.6. Provision of affordable public transport services

The average percentage of household income spent on public transport services per month in Cape Town is 5-10%. The percentage for Cape Town seems low, because it does show us the large income discrepancy in Cape Town. The real scenario is that households with the lowest monthly income spend more than 30% of their household income on public transport. This is mainly due to the cost of public transport fares per day compared to their earnings per day. Public transport users can spend more than R50 ($6) per day on public transport, depending on the public transport modes that they are using, the route that they are taking, distance travelled and whether they need to transfer between modes. 23% of Cape Town's households spend more than 10% of their household income on public transport services. One of the public transport goals and objectives is to make public transport affordable to everyone and that all households should spend less than 10% of their monthly income on public transport. This indicates that the affordability of public transport needs to improve for Cape Town.

4.6.5.7. Promotion of public transport service and NMT use

Cape Town's modal share in 2004 was NMT 13%, public transport 39% and private transport 48%. In 2003 the modal share was NMT 8%, public transport 48% and private transport 44%. This could indicate an increase in the percentage of NMT users, although it can also be argued that different study methods were used since it is only a one year difference. Private vehicles in Cape Town have the largest share, then public transport, while NMT only has a small modal share. In Cape Town most households will purchase a private vehicle as soon as they can afford it, due to the poor quality of public transport service. There are still a large percentage of people who are captive public transport users and the use public transport because they cannot afford private transport.

The public transport modal split for Cape Town indicates that rail transport has the largest modal share. In the peak hour period rail provides the quickest and most affordable public transport service. This is due to the fact that road-based public transport modes are stuck in traffic and congestion during the peak period. The rail network is the backbone of Cape Town's public transport system. Minibus-taxis have a higher percentage of modal share than bus services, this can be because of the penetration of the minibus-taxi services, whereas bus services are only provided on fixed routes.

TDM strategies are applied in Cape Town, but should be improved, and be better enforced. TDM strategies are necessary in order to reduce the number of private vehicle users, especially when all the phases of the IRT are working which will provide better quality of service to public transport users. There is also not enough dedicated public transport routes along major transport corridors in the city.

The provision of bicycle lanes in Cape Town to promote the use of NMT has improved over the last few years. City of Cape Town has provided dedicated bicycle lanes along various routes in the city, however more bicycle lanes should be provided to ensure that there is network coverage across Cape Town.

Chapter 7 will compare the results of all three cities with each other.

5. Nairobi

This chapter will describe the public transport system of Nairobi. Nairobi is the capital city of Kenya and serves as the seat of Government. Nairobi is well known as one of Africa's most important centres for commerce, industry and tourism (Mengesha *et al*., 2002; JICA, 2006).

Nairobi has grown significantly over the past years, in terms of population size and developed land area. The population was about 350,000 inhabitants in 1963 and has grown to about 2,143,254 in 1999 and 3,240,000 in 2006. The neighbouring districts around Nairobi are Thika, Kiambu, Muranga, Kajaido and Machakos. Many people from these districts come to Nairobi on a daily basis to work, go to school, for business, trading etc. (Mengesha *et al*., 2002).

The transport modes in Nairobi include road transport, rail transport, NMT and intermediate transport modes and air transport. The public transport system in Nairobi consists of commuter rail, commuter bus services and paratransit services (Matatus) (Graeff, 2009).

5.1. Institutional and Regulatory Framework

The transportation system in Nairobi suffers from institutional fragmentation and a lack of co-ordination between institutions, which creates an adverse effect on public transport planning. This leads to misunderstanding and poor collaboration at various levels and between various parties, and divisions usually occur between sector ministries and governments. There is also a lack of proper urban planning and organised public transport systems (Mengesha *et al*., 2002; Chitere & Kibua, 2004; KIPPRA, 2006).

The Nairobi Government has been decentralised for a while, but it has experienced difficulties because the local governments do not have enough resources to perform their duties and this results in inadequacies in their performance. When this happens, a centrally controlled Commission needs to look after the operations of the Local Government (Mengesha *et al*., 2002).

5.1.1. Stakeholders

There are several institutions through which urban transport is regulated and coordinated. These institutions are fragmented across government ministries and departments, which gives rise to duplication of duties among the institutions (Asingo, n.d.; Chitere & Kibua, 2004).

Figure 5.1 shows the key institutions that are involved in the administration and provision of transport services and the structure of the Nairobi transport sector.

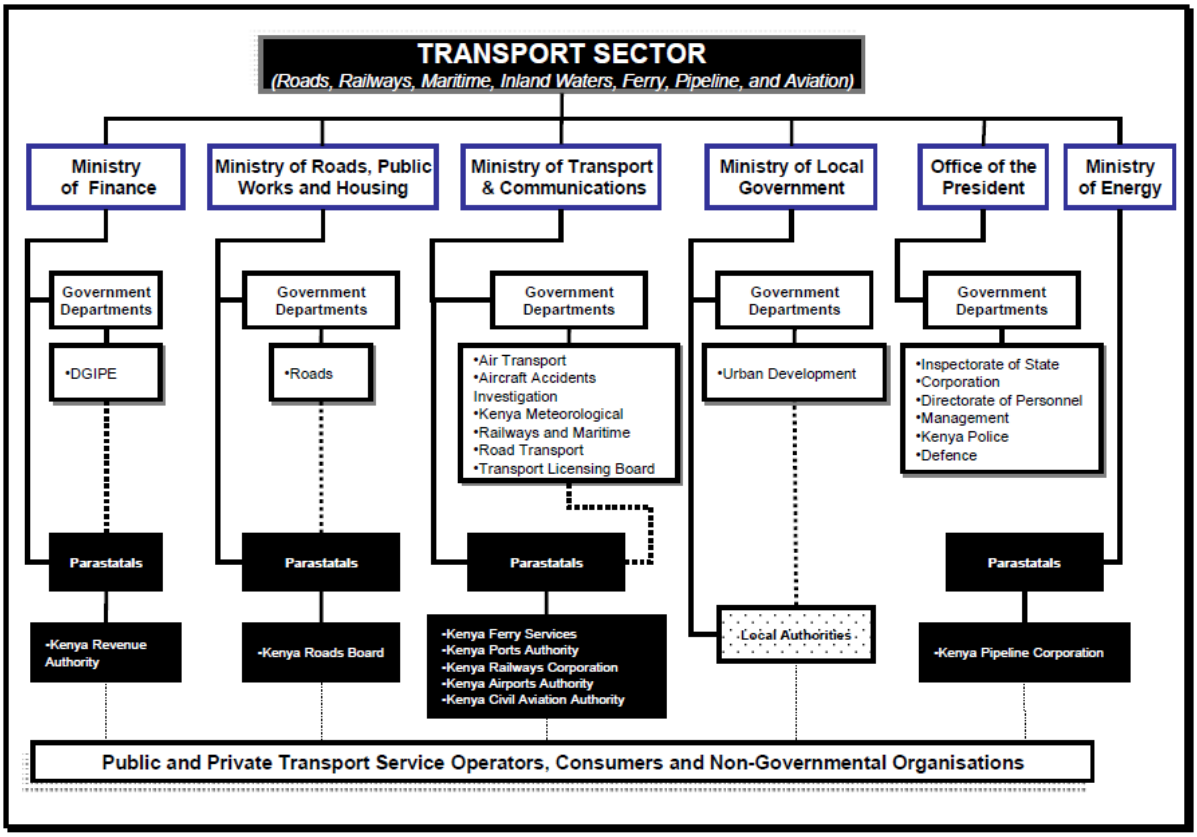

Figure 5.1: Key Institutions involved in Kenya's Transport System (Source: NTPC, 2004)

Table 5.1: Nairobi public transport stakeholders. (Source: Asingo, n.d.; Koster 1999; Mengesha *et al.*, 2002; Chitere & Kibua, 2004; NTPC, 2004; Gairy, 2009; Graeff, 2009; Mukabanah 2009; Obiero & Opiyo, 2009; UITP, 2010)	
Planning, Coordination and Strategy Stakeholders	
Central Government	• Main role is to create laws, set standards and guidelines, source funds and control budgets. • The laws and standards that influence transport involve a wide range of sector ministries in the transportation industry.
Ministry of Local Government (MoLG)	• All the local authorities belong to this ministry. • Responsible for urban planning and infrastructure development and they also need to prepare a strategic plan for transportation. • Oversee the City Council of Nairobi. • The Local Government is the centre of transport development in Nairobi.
Ministry of Transport and Communications (MoTC)	• Responsible for the formulation of national transportation policies, vehicle licensing, motor vehicle inspections and transport service regulations. • They are also concerned with the traffic law, although in practice they have very little involvement in the road sector.
Local Authorities (Nairobi City Council)	• Local Authorities through the various City, Municipal or Town Councils are responsible for the management of urban transportation planning. • The councils are also responsible for the maintenance of transportation infrastructure. • The Local Authorities have limited human resource capacities and have a large number of young staff who lack experience. There is also a lack of financial resources, which is a constraint on any immediate improvement of services. • The tasks of the local government are not matched with their available resources.

	• Nairobi City Council acts as a transport authority with a limited range of intervention, since the deregulated market principle resulted in little public control of the route structure, operational practices, timetables and fares.
Kenya Roads Board (KRB)	• Main institution responsible for the national road infrastructure network in Kenya. • Responsible for the management of the Road Maintenance Levy Fund, which local authorities can only access through the MoLG.
Transport Licensing Board (TLB)	• Responsible for the allocation of passenger service vehicle (PSV) licences and also ensures that the vehicles are in good condition. • Responsible for the regulation of public transport and the law enforcement of public transport rules. • The performance of the TLB has not been satisfactory, they have not been able to successfully allocate routes to the public transport operators and monitor their compliance with route allocations. • This has led to the situation where the paratransit operators and owners decide on which route to operate. • Many people blame the TLB for the congestion in Nairobi, because the board continues to allocate PSV licenses simply to ensure revenue for the government.
Traffic Police	• The traffic police are a central function in Nairobi. • Responsible to enforce traffic rules, examine PSV drivers and issue certificate of good conduct to Matatu crews. • The traffic police are struggling to enforce the traffic rules and thus the traffic rules are still being violated by the public transport operators. This is due to massive corruption, poor equipment and the impracticality of some of the rules.
Operations	
Commuter Rail Operator	• The main stakeholders for commuter rail in Nairobi are the Kenya Railways Corporation (KRC) and the Central Government. • The Government owns the railway infrastructure. • KRC has a monopoly on the provision for railway services in the country and in Nairobi.
Bus Operators	• Three main bus companies who provide commuter bus services in Nairobi are: Kenya Bus Services (KBS), Citi Hoppa and Double M. • KBS is a private enterprise and is run by Kenyan businessmen. It operates as three separate units: Express, Metro Shuttle and Bus Track. • There are also private bus operators who own one or more buses. • The Nairobi City Council is responsible for the operations of the bus services in Nairobi, while the TLB is responsible for allocating route operating licences to the bus operators.
Paratransit Operators	• Paratransit services (Matatus) are provided by private operators. • The following stakeholders are involved in the Matatu industry; Matatu Owners, Matatu Operators (Driver & Conductor), Commuters, Commuter Welfare Association, Matatu Owners Association (MOA) and the Matatu Welfare Association (MWA). • There are also cartels involved in the Matatu industry and they are called the Mungiki and Kamjesh Gangs. These gangs extort money from the operators before allowing them to operate on certain routes.

5.1.2. Regulatory Framework

Transport in Nairobi is regulated mainly by the Traffic Act (2004). Table 5.2 lists the key Statutes and Regulations governing the transport sector in Kenya, many of which are out-dated and urgently need to be reviewed.

Table 5.2: Key Statutes and Regulations governing the Transport Sector in Kenya (Source: NTPC, 2004)	
Overarching Statutes	The Constitution of Kenya
	The Kenya Police Act
	The Administration Police Act Cap 402
	The Way leaves Act cap 292
	The State Corporations Act
	The Environmental and Management Co-ordination Act 1999
	The Kenya Revenue Authority Act
	The Insurance Act
	The Exchequer & Audit Act
Rail Transport	The Kenya Railways Corporation Act Cap 397
	The East African Inland Water Transport Act
Road Transport	The Transport Licensing Act Cap 404
	The Kenya Roads Act, 1999
	The Road Maintenance Levy Fund Act 1993 as amended in 1994
	The Public Roads Toll Act, Cap 407
	The Local Government Act, Cap 265
	The Traffic Act, Cap 403
	The Streets Adoption Act, Cap 406
	The Road Authority Ordinance 1961
	The Valuation for Rating Act, Cap 266
	The Rating Act Cap 267
	The Wildlife Management & Conservation Act
	The Central Road Authority Act
	The Local Authority Transfer Fund, 1999
	The Agriculture Act
	The Physical Planning Act, 1996
	The Local Authority Service Charge Act Cap 274

The Traffic Act Cap 403

The new Traffic Act was established in 2004 (built on the old traffic act). The following were part of the new rules (Obiero & Opiyo, 2009):

- No standing of passengers in any public transport vehicle,
- There must be safety belts for all passengers in the vehicles and all the passengers must wear them,
- The bus and Matatus crews (driver, conductor etc.) must wear uniforms,
- There must be timetables and schedules for the public transport services provided,
- The crew are not allowed to work more than eight hours a day,
- The operators must operate on a specific route according to their route license.

These rules had a negative effect on the operation of Matatus (and buses) because the rules require Matatus to carry fewer passengers; which results in less fare income and in turn less finance for maintenance, etc. The Matatu Owners Association (MOA) and some members of the Matatu Welfare Association (MWA) were opposed to the measures stipulated in this Traffic Act, they threatened a country-wide strike and tried to have the courts prevent the minister from implementing the new Traffic Act. They lost the case and the act was implemented. The reforms led to a reduction in accidents by about 73% in the first six months of the implementation of the Traffic Act (Chitere & Kibua, 2004). The Minister was eventually removed from office and since then the quality of public transport has declined (Obiero & Opiyo, 2009).

5.1.2.1. Public Transport Regulation

Declining government resources have led to urban public transport provision with little or no government involvement or control (Koster, 1999). Public transport in Nairobi lacks capacity management and public transport regulation (Mukabanah, 2009). There is no clear transport and urban transport policy or overall policy direction for transport in Nairobi. Although there is no comprehensive road transport policy, there are fragments of policy statements issued from time to time to guide the sector. The government is busy with the formulation of a transport policy, but the process is taking very long. There was a Transport Policy Draft that went from the cabinet to parliament to be approved in 2004, but according to Gairy (2009) it has not yet been approved (Asingo, n.d; Mengesha *et al*., 2002; Gairy, 2009).

In 2004, the Ministry of Transport and Communications (MoTC) formulated the "*Recommendation on Integrated National Transport Policy*". The Policy aims to establish a world class transport system that will be integrated and responsive to the needs of the people and industry. The policy also emphasizes the importance of NMT.

The major Policy Principles are (NTPC, 2004):

- *The clarification of the roles of the central and local governments, statutory bodies, non-governmental bodies, and the private sector in the delivery and management of transport infrastructure and services*.
- *User pays and polluter pays principles to facilitate economic efficiency, generation of sufficient revenues to support development, operation and maintenance of transport infrastructure and services, eliminate distortions user choice of transport modes, eliminate to the extent possible externalities in production and consumption e.g. pollution and congestion.*
- *Stakeholder consultation in setting tariffs and other prices*.
- *Financing of economic infrastructure through user charge or cost recovery.*

- *Application of TDM in transport planning, operations and management.*
- *Financing of social and strategic infrastructure through subsidization.*

Regulatory Framework for commuter rail transport in Nairobi

KRC's operations are governed by the Kenya Railway Corporation Act and the State Corporations Act. These Acts inhibit decision-making processes, as KRC receives directions from various government agencies. These agencies include the Office of the President, the Treasury, the MoTC and the Inspectorate of Statutory Boards. The KRC has to receive approvals for the financing of major capital works and procurement and the KRC Board's decisions are subject to the approval from the Central Government of Kenya (NTPC, 2004).

Regulatory Framework for commuter bus industry

The need for bus services in Nairobi was recognised in the 1930's and Kenya Bus Services (KBS) Ltd was given the exclusive franchise of carrying fare-paying passengers in and around the Municipality of Nairobi. KBS originally operated in terms of a city franchise tender under which KBS provided scheduled services and the fares were controlled by the City Council. The City Council was responsible for the provision and maintenance of the transport infrastructure. KBS has lost significant value since 1973, when they had direct competition with the Matatus, and also with Nyayo Bus Services (between 1986 to 1992). KBS is currently operating as a private operator. The operations of the commuter bus operators are governed by the Traffic Act (2004) (Khayesi, 2002; Mengesha *et al*., 2002).

Regulatory Framework for the Minibus-taxi industry (Matatus)

The legal provisions for the Matatu Industry include the Employment Act, Regulation of Wages & Condition of Employment Act, Traffic Act and the Transport Licensing Act. The Matatus started operating in Nairobi in the 1950's. The emergence of the Matatus as a transport mode in Nairobi faced restrictions as they were seen as a challenge to the monopoly of KBS and competitors to local government authorities; especially in the 1960's and early 1970's. They operated as pirate and illegal transport service operators until 1973 when President Mzee Jomo Kenyatta issued a presidential decree which allowed Matatus to carry fare-paying passengers without obtaining a trade licence (Khayesi, 2002).

The operators are organised into route associations that attempt to limit new entrants to the routes. There is a quasi-control of fares by the authorities, but individual drivers are allowed to vary fares with the time of day and month. The authorities try to impose some control on routing and parking in the central areas of Nairobi. Some of the politicians are owners of Matatus and this makes the regulation of the Matatu Industry more complicated (Mengesha *et al*., 2002; Obiero & Opiyo, 2009).

The bus industry feels that the government failed to regulate the informal transport industry and this has led to Matatus taking over the public transport market.

5.1.3. Industry Structure

The Public transport system consists of the following public transport modes and operators (Gleave *et al*., 2005):

- Commuter rail services operated by KRC.
- Commuter bus services operated by KBS, Citi Hoppa, Double M and private operators.
- Paratransit services operated by private operators.

Mukabanah (2009) describes the public transport market as being liberalized and that public transport is left completely to private sector and free market sources. Central Government, Local Government and the Nairobi City Council are responsible for the regulation of the commuter rail services in Nairobi, while KRC is responsible for the operation of the commuter rail services. The commuter bus system is fully privatised and operates in a largely deregulated environment. There is no government control on the route structures, timetables or fares of these services (Koster, 1999; Gairy, 2009).

The paratransit services are provided by private Matatu owners. They are mostly operating on the same routes as KBS and other bus operators, but they operate without any timetables and largely ignore the official bus stops. Entry into a route by a new operator is difficult; the new operator has to negotiate effectively with cartels before being allowed to operate on a route (Koster, 1999; Khayesi, 2002).

5.2. Network Structure

Nairobi lies at the southern end of Kenya and was made the capital of Kenya in 1907. The boundary of Nairobi was extended in 1963 to cover an area of approximately 696 km^2. Nairobi is situated along the Great North Road that links Uganda and other countries to the port of Mombasa (Mengesha *et al.,* 2002). Uganda relies heavily on this transport corridor, which passes through the CBD of Nairobi. This creates the situation where there is additional transport demand added onto the transport demand of Nairobi which could lead to congestion and an over capacity situation if the additional demand is not taken into consideration.

The Nairobi Metropolitan Area has an area 4,477km^2 and had a population of 3,229,624 in 1999. The urban population of the NMA increased at an average rate of 5.20% per annum during 1979-89, and 7.23% per annum during 1989-99. It is projected that Nairobi will reach approximately 9 million

persons by the year 2030, if the current growth and settlement patterns are maintained (JICA, 2006; KIPPRA 2006; Kumar & Barret, 2008).

Table 5.3 indicates the 1999 population and density for Nairobi and nearby districts which shows that the density for Nairobi is much higher than the other districts. Figure 5.2 shows the Nairobi Metropolitan Area and the location of some of the nearby districts. There are wide population density variations across the Nairobi Metropolitan Area (NMA). The population density for Nairobi City was 3,079 per km^2 in 1999 and 721 per km^2 for the NMA. Most of the areas outside Nairobi City had a population density lower than 2,500 per km^2, except for areas along the city boundary. This indicates the low density urban sprawl in the NMA.

Table 5.3: Population volumes for Nairobi and nearby districts (Source: Mengesha *et al.*, 2002)

	1979	1989	1999				
			Male	Female	Total	Area (km^2)	Density (per/km^2)
Kenya			14,205,589	14,481,018	28,686,607	581,677	49
Nairobi District	828,000	1,325,000	1,153,828	989,426	2,143,254	696	3,079
Thika District			323,479	322,234	645,713	1,960	329
Kiambu District			369,101	374,909	744,010	1,324	562
Muranga			164,670	183,634	348,304	930	375
Kajiado			206,353	199,701	406,054	21,903	19
Machakos			442,891	463,753	906,644	6,281	144

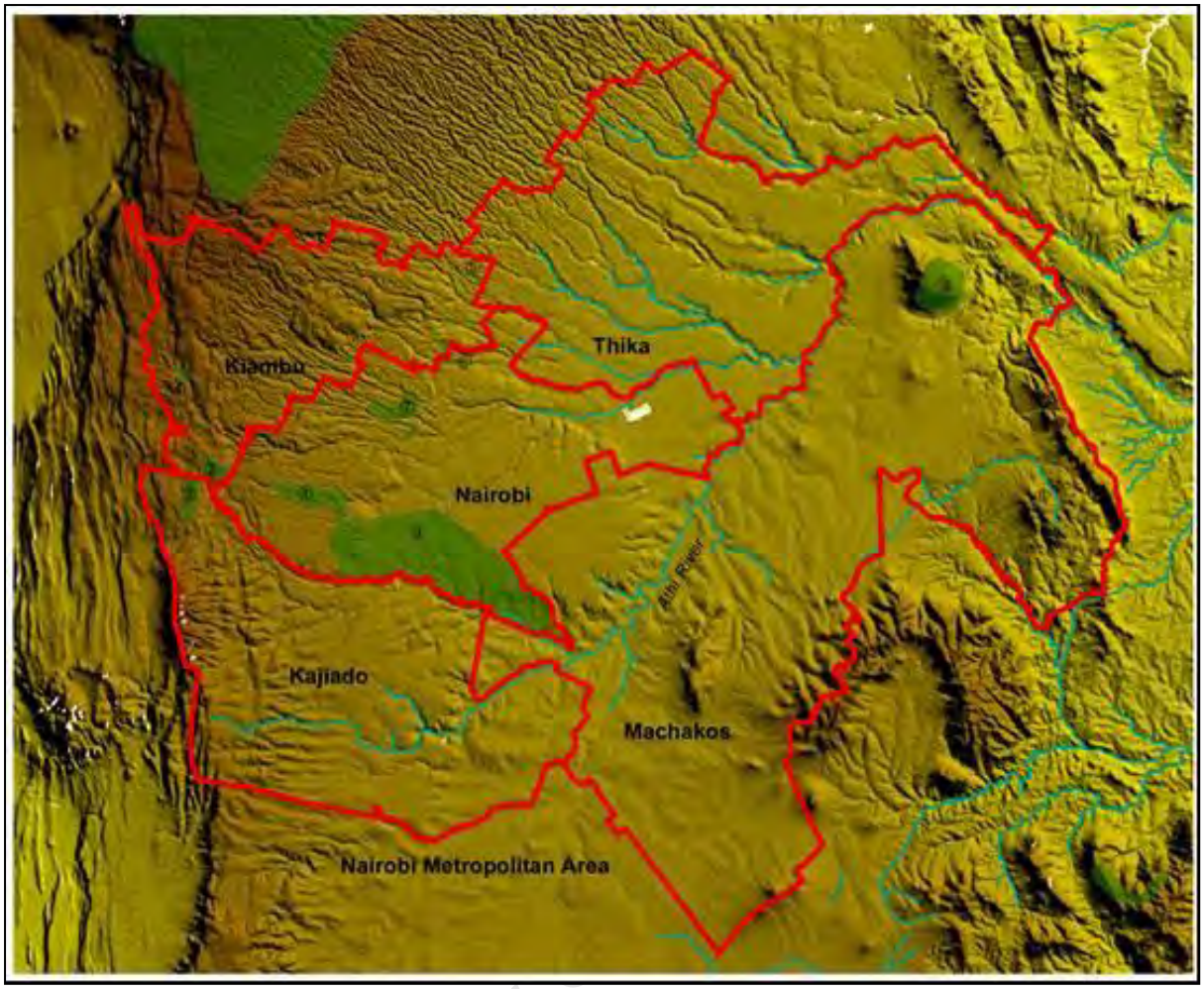

Figure 5.2: Nairobi Metropolitan Area (JICA, 2006

By 1963, Africans, who formed a major part of the population, lived in the eastern part of Nairobi while the Europeans and Asians lived in the western suburbs. There was segregation between the European, Asian and African residential areas. This layout is still present today, but rather in terms of incomes and population densities, than in terms of race. The corridors serving the higher income areas receive better infrastructure and have better mobility, especially for the private car, while the middle and low income areas, with higher demand for public transport, have poor road networks and related infrastructure (Aligula *et al*., 2005).

Much of the development growth that has taken place since the 1990's is unplanned. The building of single-storey housing areas within the city boundaries has created urban sprawl, making trip distances longer and transport costs much higher. The low-income settlements vary in size and they are widely distributed. In 1993 there were about 110 informal settlements with a population of approximately 750 000 persons situated around Nairobi CBD. At that time, they occupied more than 5.84% of the land area used for residential purposes but housed about 55% of the city's population (Mengesha et al., 2002).

The pressure of large population influx and the increase of the urban poor have changed the distribution of residential areas as follow (Aligula *et al.*, 2005; JICA, 2006):

- Middle-income residential areas were formed along the Thika Road, Mombasa Road and Kangundo Road and intensive residential area development has taken place in the areas of Thika, Ruiru and Athi River.
- Slum areas and informal settlements are expanding and burgeoning in the areas where land is available, regardless of rights. Newly emerging slums and informal settlements tend to locate remotely from the central area of Nairobi.
- Private developers, most of whom are large land owners, have started with land subdivision. The subdivision is commonly observed along the Thika and Kangundo Roads, and in Embakasi, where basic infrastructure is not sufficient. Land subdivision has also taken place in the former residential areas of the high-income class.
- The eastern area had a large population increase. The Dagoretti, Embakasi and Kasarani settlements are located 12 to 18km from the main employment and service centre of the CBD and the Industrial Area.
- The smaller and older settlements, Parklands and Pumwani, are closer to the centre in the range of 4 to 6km and Kibera is about 5km from the CBD. For all settlements the average distance from the CBD was around 11km's.

According to Aligula *et al.* (2005) the spatial structure of Nairobi comprises a strong CBD with most of the formal jobs within a radial road network leading to major cities along which development, (primarily residential) has occurred. The major roads include Thika Road, Langata Road, Ngong Road, Mombasa Road and Waiyaki Way.

There is a lack of sufficient ring roads around the CBD to divert the through traffic or intra-urban traffic away from the city centre. Currently the city centre road infrastructure accommodates three types of traffic namely: the through traffic, the city centre traffic, and inter-zonal or inter-city traffic, which is creating unnecessary congestion within the city. All of these traffic types do not necessarily need to pass through the CBD. (Aligula *et al*., 2005) Figures 5.3 and 5.4 indicate the location of towns and settlements around Nairobi.

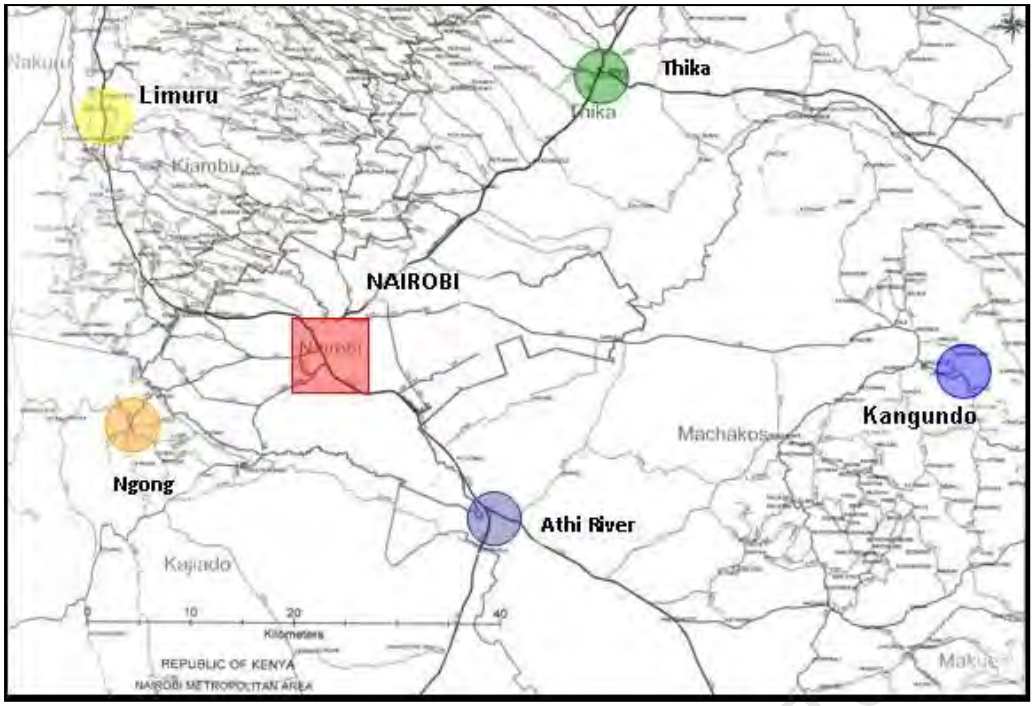

Figure 5.3: Location of the five towns in the Nairobi Metropolitan Area (Source: JICA, 2006)

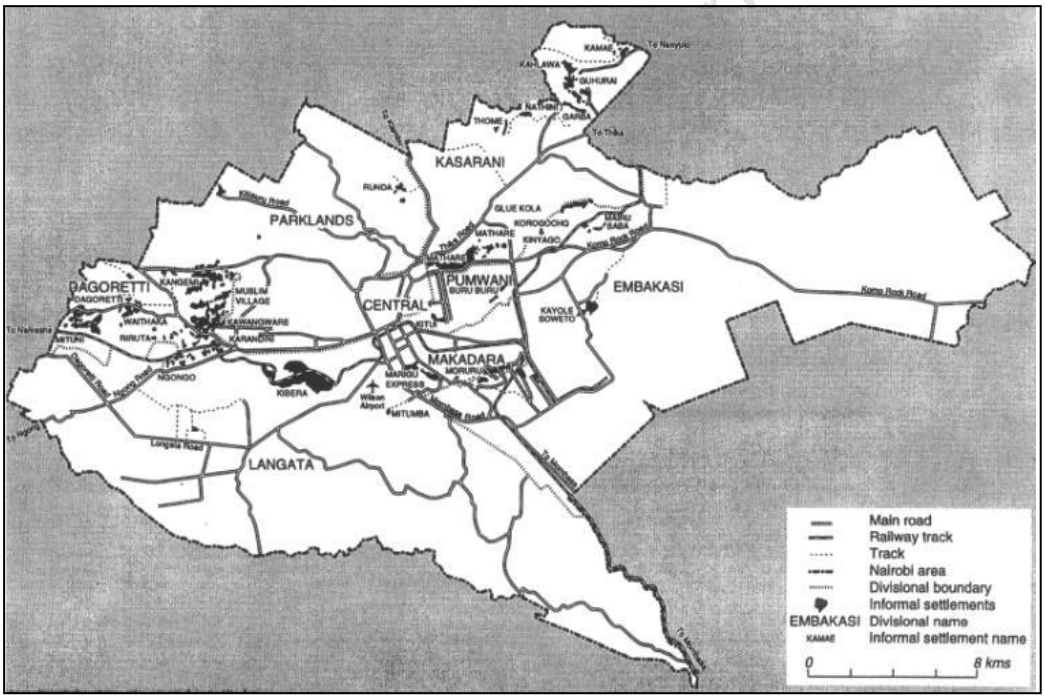

Figure 5.4: The main informal settlements in Nairobi (Source: Aligula et al., (2005)

5.2.2. Transport Network

Mengesha *et al.* (2002) identified that there are about 300 km of main and 850 km of access roads in Nairobi. There are 964 km of paved roads and 188 km of unpaved roads and more than 60% of the road network is in a much deteriorated condition.

Nairobi has six major arterial routes into the city centre with Jogoo Road and Mombasa Road carrying the heaviest traffic flows between 30,000 and 50,000 vehicles per day. However, sections of the ring road on the western side of the city centre, Uhuru Highway, carry the highest flows with levels of over 90,000 (see figure 5.5). Three regional arterial roads pass through the NMA; the Uhuru Highway leading to Athi River and Mombasa, the Limuru Road to Kisumu, and the Thika Road to Murang'a, Nanyuki, Embu and Meru. Parallel to these arterial roads are railway lines that lead to Mombasa, Eldoret, Kitale and Nanyuki (JICA, 2006).

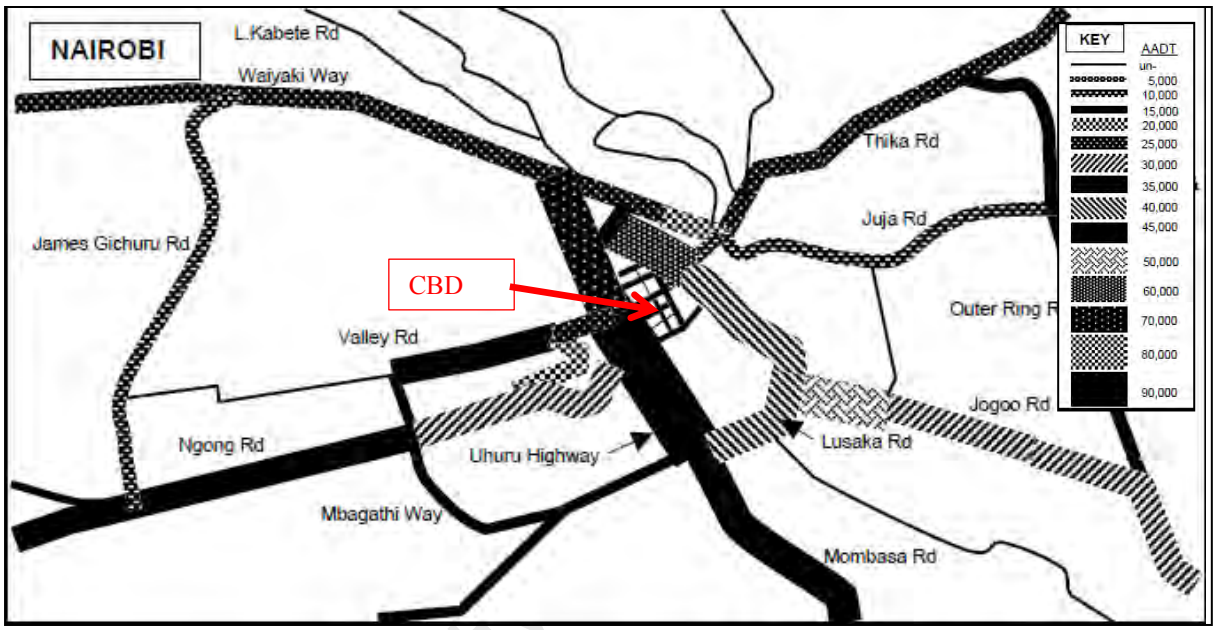

Figure 5.5: Major routes and traffic volumes (Source: Mengesha et al., 2002)

The urban network pattern in the 1920s was dominated by a major trunk road commencing from the CBD to the surrounding areas with a branch to the industrial area (Aligula *et al*., 2005). By 1928 Nairobi had very high motorized traffic volumes, most of them being private vehicles. It presented the problem of how to improve road access to the industrial area, and how to accommodate the increasing motorization, which was mainly focused or centred on the CBD. In the 1930s, motorized public transport commenced operations with only a few buses, which were just enough to serve the existing population's transport demand. The need for transport services increased as urbanization, migration and motorization volumes increased. Africans slowly started hiring and buying vans, which led to the emergence of informal public transport services within these areas. As these residential areas grew larger and travel demand increased, these services became very popular, especially in the 1950s, which led to the emergence of Matatus. The word 'Matatu' is derived from the local term "*mang'otore Matatu*" which meant thirty cents, which was the standard fare charged then. These movement patterns with the additional travel demands exerted pressure on the urban form and its infrastructure, which was ill-equipped to serve them. After independence in 1963, deterioration in the

infrastructural facilities began to show, which was partly due to the lack of financial resources and investment in the road infrastructure as well as the increasing urban population (Aligula *et al.*, 2005).

The main transport problem for Nairobi was the centralization of activities in the CBD and the lack of available space on the road infrastructure. Since the 1970s, a large proportion of the low income transport users moved further away from the CBD, partly due to the introduction of housing schemes and the general policy of demolishing squatter settlements near the CBD to give way to other developments, although more than 75% of commuters worked in the CBD. This led to the growth of public transport services mainly by the demand from middle and low-income population (Aligula *et al.*, 2005).

5.2.3. Transportation demand and usage of public transport modes

During the 1960's, the modal share for commuter trips in Nairobi was 47.2% NMT trips, 39.1% private vehicle trips and 13.7% public transport trips (Aligula *et al.*, 2005). The transport modal share identified by Mengesha *et al.* (2002) for Nairobi in 2002 was 48% NMT, 42% public transport and 10% private transport (see figure 5.6), which is very different from the 1960's modal share. The percentage of private vehicle trips has reduced, while the percentage of public transport trips has increased. Currently NMT and public transport have the highest modal share in Nairobi. Cycling as a means of transport became insignificant in Nairobi City, largely due to the unsafe environment created by motor vehicles as well as the absence of dedicated infrastructure (Mengesha *et al.,* 2002).

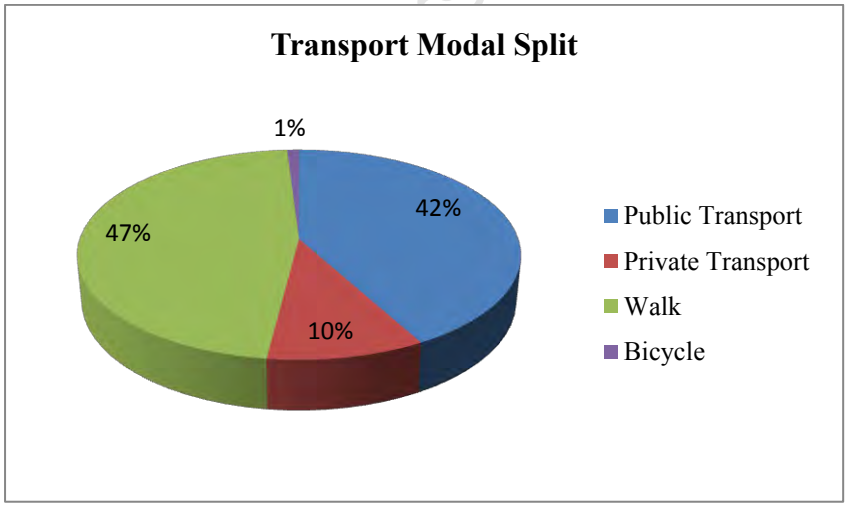

Figure 5.6: Transport Modal Split for Nairobi (Source: Mengesha et al., 2002)

The road-based public transport modal share consists of 30% commuter bus and 70% Matatus (JICA, 2006). Mengesha *et al.* (2002) strongly feel that income has an influence on the transport modal share for Nairobi. Most of the poor are captive public transport and NMT users and 68% of the NMT

commuters earn less than $60 per month. It was estimated that Nairobi had about 230,478 motor vehicles registered in 1998 (Mengesha *et al.,* 2002).

Table 5.4 indicates the transport modal share for the main corridors in Nairobi in terms of the ridership for public and private transport. The ridership breakdown provides an indication of the modal choice options by people and also provides an indication of the utilisation level at which transport facilities are being used. This transport study was carried out by Aligula *et al.* (2005) in 2004.

Table 5.4: Transport Modal share on Main Corridors (Source: Aligula *et al.*, 2005)

Main Corridors	Modal share (Passengers %)		Vehicle Traffic Volume (Vehicles %)	
	Private Vehicles	Public Transport	Private Cars	Public Vehicle
Mombassa Road	31.3	68.7	76.5	23.5
Jogoo Road	13.4	86.6	55.65	44.35
Thika Road	13.8	86.2	49.1	50.9
Kiambu Road	23	77	62.1	37.9
Limuru Road	31.2	68.8	70.3	29.7
Mbagathi/Valley Road	41.1	58.9	87.5	12.5
Waiyaki Way	25.6	74.4	71.7	28.3
Nyong Road	20.9	79.1	67.1	32.9

Figures 5.7, 5.8 and 5.9 shows the data in table 5.4 plotted in various ways. Figure 5.7 indicates the private and public transport passengers and vehicle share on one graph. Figure 5.8 shows that on all eight corridors, public transport has a higher passenger share than private vehicles and a lower vehicle share (see figure 5.9), except for Thika Road where it is almost equal to the vehicle share for private vehicles. This shows that public transport is much more efficient in terms of the usage of the capacity of transport facilities. Figure 5.7 also indicates that at Mbagathi/Valley Road there is an increase in the passenger and vehicle share for private vehicles is higher than those for public transport.

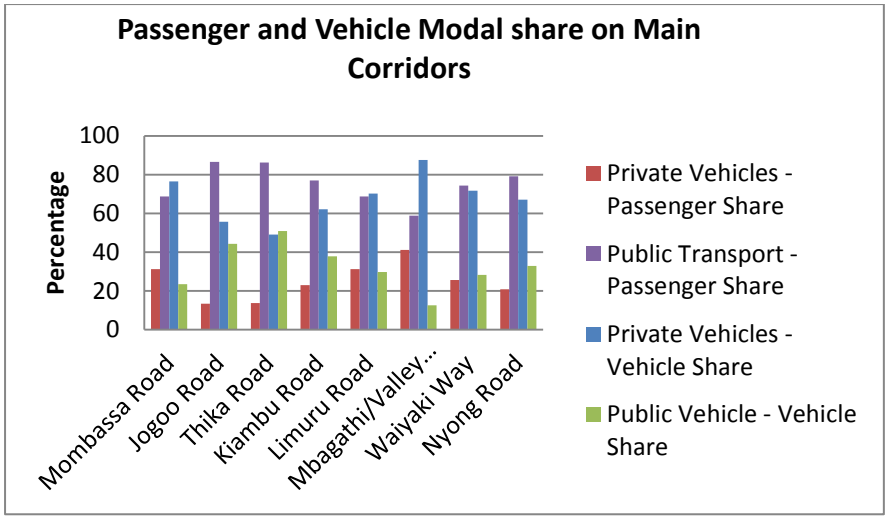

Figure 5.7: Modal Split on Main Corridors for Public and Private Transport

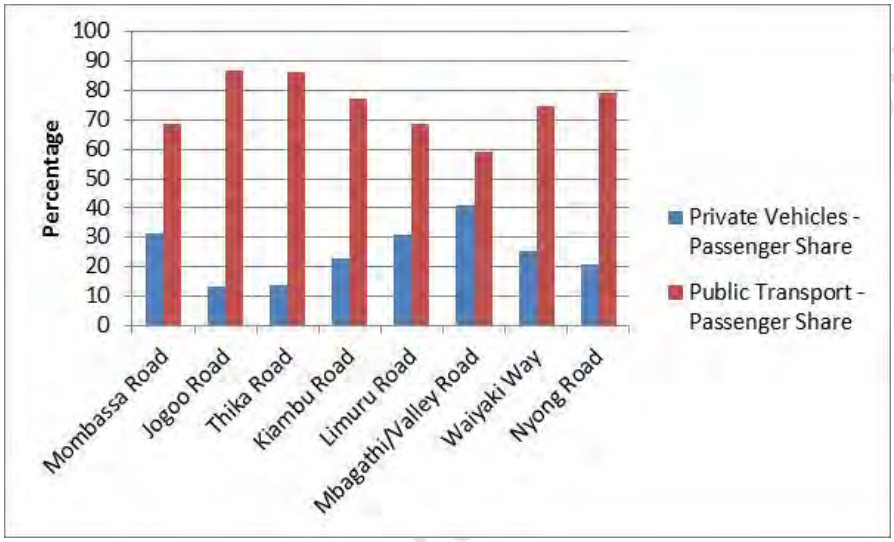

Figure 5.8: Passenger Share on Main Corridors for Private and Public Transport

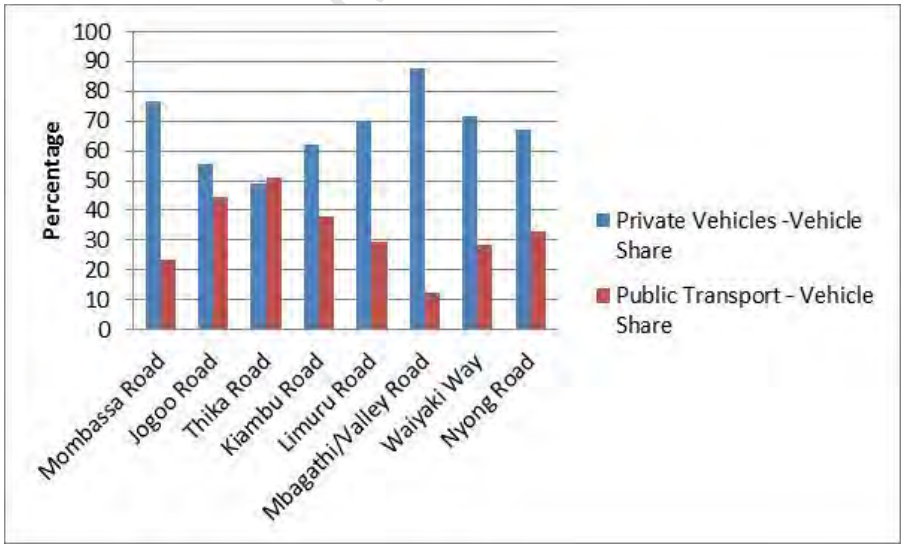

Figure 5.9: Vehicle share on Main Corridors for Private and Public Transport

Table 5.5 shows a summary of the vehicle trips for the different transport modes on the main corridors, as well as the average ridership per hour. Mombasa Road and Waiyaki Way have the highest ridership, with more than 3000 passengers per hour.

Main corridor	Road section	Mode of travel						Average ridership ps/hr	
		Car	*Matatus*	*Buses*	*Lorries*	*% Cars*	*% PSV*	*With Lorries*	*Without Lorries*
Langata Road	Bomas to Nyayo	14,835	3,688	137	927	80	20	1,632	1,555
Mombasa Road	Athi River to Nyayo	20,677	6,678	405	97	74	26	2,321	2,313
	Nyayo to Haile Selasie	35,896	9,516	344	1,931	78	22	3,974	3,813
Mombasa Rd Average		28,286	8,097	375	1,014	76	24	3,148	3,063
Jogoo Road	Donholm to City Stadium	14,690	9,955	816	58	58	42	2,127	2,122
	Landhies Road	20,792	16,651	1,347	2,488	54	46	3,440	3,232
Jogoo Road Average		17,741	13,303	1,081	1,273	56	44	2,783	2,677
Juja Road	Huruma to Kariokor	5,854	6,298	624	1,188	46	54	1,164	1,065
Thika Road	KU to Roysambu	9,768	7,887	403	2,584	41	59	1,394	1,179
	Roysambu to GSU	12282	11,449	662	3,665	45	55	2,129	1,823
	GSU to Pangani	26,669	17,782	891	3,221	59	41	4,047	3,778
	Pangani-Ngara	17,604	16,188	397	883	51	49	2,923	2,849
Thika Road Average		16,580	13,326	588	2,588	49	51	2,623	2,407
Kiambu Road		4,663	2,833	15	389	62	38	658	626
Limuru Road		12,407	4,834	408	2,059	70	30	1,642	1,471
Waiyaki Way	Waiyaki Way	15,335	7,343	732	1,790	66	34	2,100	1,951
	Westlands To UON	35,150	9,560	408	2,059	78	22	3,931	3,760
Waiyaki Way-Average		25,243	8,451	570	1,924	72	28	3,016	2,855
Ngong Road	Ngong to Karen	4,536	1,199	178	445	77	23	530	493
	Karen to Dagoretti Corner	5,864	2,131	195	613	72	28	734	682
	Dagoretti Corner to KNH	10,688	5,795	900	567	61	39	1,496	1,449
	KNH To Haile Selassie	12,303	8,040	713	452	58	42	1,792	1,755
Ngong Road Average		8,348	4,291	496	519	67	33	1,138	1,095
Mbagathi/Valley Road		26,360	2,471	1,310	492	87	13	2,553	2,512
Grand Total		306,371	150,292	10,880	25,904	1,217	683	40,585	38,426
Overall Average		16,125	7,910	573	1,363	64	36	2,136	2,022

Table 5.5: Summary of passenger trips per day (Source: Aligula et al., 2005)

In 2004 it was estimated that 2.32 million trips out of 4.82 million person trips per day in Nairobi, consisted out of walking or cycling trips (JICA, 2006). Walking is the only travel option for the majority of the population who cannot afford the public transport fares. Urban sprawl and population growth lead to city expansion and thus the walking trips are becoming longer as the employment opportunities and important services remain centralized in the CBD and the industrial areas. A big problem for the pedestrians is that most of the roads are only designed for vehicles making no provision for NMT users. Most of the sidewalks that currently exist are gravel sidewalks. These walking routes are often obstructed by waste, parked vehicles, or hawkers (see figure 5.10) and are generally unsafe and uncomfortable to use. There are a few constructed footways in Nairobi, although those that do exist are generally filthy and in very poor condition. Figure 5.11 indicates NMT movement during the morning, which demonstrates the large NMT modal share for Nairobi (Mengesha *et al.,* 2002).

Figure 5.10: Conflict of hawkers, pedestrians and motorist. (Source: Mukananah, 2002)

Figure 5.11: Commuters walking to work in Nairobi (Source: Mengesha et al., 2002)

There is a lack of properly designed and formal pedestrian crossings across major roads in Nairobi which leads to dangerous pedestrian conditions and causes accidents. Walking in the late afternoon, when it becomes darker, is risky and the lack of effective street lighting adds to the danger of walking at night. There is also a lack of law enforcement for security and safety. This is a concern for the poor and especially for women. They are often victims of harassment from thugs, council officials and the police. The situation is so bad that some women and children are forced to use public transport and have to pay for a transport mode that they cannot afford, even for short distances, or they are forced to take long detours. Insecurity restricts the mobility of many woman and girls in Nairobi. Mengesha *et al.* (2002) identified that there are households who own bicycles, but mainly for their children's recreation, although some use them as a basic means of personal transport. The commuters are scared to use bicycles, because of safety and security issues. The aggressive and uncaring behaviour of motorists, poor condition of roads and the lack of secure facilities to park bicycles, makes cycling as a transport mode unfavourable (Mengesha *et al.,* 2002).

5.2.4. Infrastructure

Urban transport infrastructure in Nairobi consists of the road network, termini, parking facilities and bus stops. There is no dedicated ROW available for road-based public transport in Nairobi and buses and Matatus have to share the congested carriageways with other road users.

Nairobi has approximately 1,150 km of roads of which 964 km are paved and 188km are gravel. Nairobi has seven major radial roads (see figure 5.12) that handle mainly international and intercity traffic. The radial roads consist of Waiyaki Way, Limuru Road, Kiambu Road, Thika Road, Uhuru Highway, Langata Road and Ngong Road, and two International Highways. All the radial roads start from Nairobi CBD and then go through commercial and administration centres to the suburbs and surrounding cities and towns (JICA, 2006).

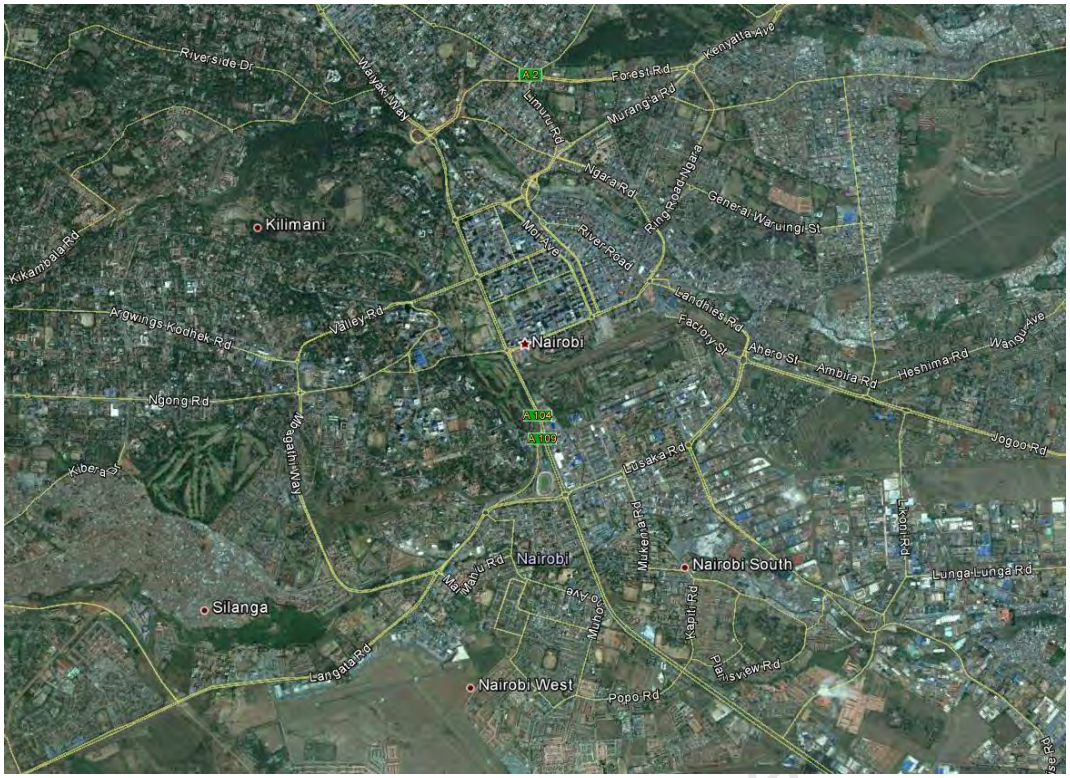

Figure 5.12: Major radial and ring roads in Nairobi (Source: Google Earth: 2012)

There are two types of termini found in Nairobi: internal and external. The major external terminus for road-based public transport is along Landhies Road. This terminus is located away from the main railway terminus and has an internal and external public transport terminus for Matatus. The internal public transport provides transport within the Nairobi area, while the external public transport provides long distance transport outside the NMA. Internal public transport shelters are found along the roads within the city centre, although there are some stops that lack adequate shelter.

Nairobi Railway Station and Bus Track Terminal in the CBD are the most used modal interchange areas in the NMA. The Nairobi Railway Station has a station plaza that is used predominantly as a Matatus terminal and is currently not used effectively as a modal interchange area. The Bus Track terminal in the city centre is well developed as a modal interchange area, but the terminal's narrow entrance and exit points are usually characterized by heavy traffic congestion. Some passengers have to transfer between modes during a trip which is an inconvenience to them due to waiting time and walking distances between the varying transport modes. Designing efficient interchange areas to facilitate smooth transfer of passengers would improve the service quality of the public transport system (JICA, 2006).

5.3. Public Transport Modes

The public transport system of Nairobi consists of some limited commuter rail operations, but mostly of road-based services, which are fully privatised. The current public transport system consists of private road-based services, commuter bus (KBS and other private companies) and Matatu operators, and limited commuter rail operations. KBS and the Matatus have the largest public transport modal share and often compete along the same routes. Since 2002, other privately owned large buses have entered the market. Taxis, tuk tuks (three wheeled taxis), and motorcycle taxis have started providing public transport services in the metropolitan area (Kumar & Barret, 2008).

Table 5.6 shows a summary of the public transport system serving Nairobi and the surrounding settlements. This study will only focus on rail, bus and Matatus (paratransit). Table 5.7 shows a summary of the public transport operations in Nairobi that were identified during the JICA study in 2006. On average each vehicle carried 18 passengers per trip.

Table 5.6: Public transport systems in Nairobi and surrounding settlements (Source: JICA, 2006)

Items			Nairobi M.A.	Nairobi City	Thika	Limuru	Ngong	Athi River (Mavoko)	Kangundo
1	Area (1999, sq. km)		4,477	696	94	115	348	957	178
2	Population (1999)		3,229,624	2,143,254	89,232	65,503	119,339	48,936	91,238
3	Population Density (pop./sq. km)		721.4	3,079.4	949.3	569.6	342.9	51.1	512.6
4	Population Growth Rate (1979 - 1999, % p.a.)		4.4	4.9	3.9	2.5	6.9	6.2	2.4
5	Distance from Nairobi (km)		-	-	44	33	23	29	63
6	Public Transport Modes	Bus	○	○	○	○	○	○	○
		Matatu	○	○	○	○	○	○	○
		Taxi	○	○	○	○	○	○	○
		Tuk tuk		○					
		Rail	○	○	○	○	-	△ (Inter-city)	-
		Others (Cycle taxi)	-	-	○	-	-	○	○
7	No. of Public Service Vehicles		-	12,376	1,400	-	-	-	-
8	No. of Bus Routes		-	50		-	1	-	-
9	No. of Matatu Routes		-	125	37	20	2	3 (passing through)	7 (Tala) 4 (Kangindo)
10	Daily PT Passenger		-	847,227	12,400	9,664	-	-	-
11	Bus/Matatu Terminals		○	○	○	○	○	-	○
12	Railway Station		○	○	○	○	-	○	-
13	No. of Accidents/month		-	350.5	23.8	5.8	-	11.2	-

Table 5.7: Summary of public transport provision in Nairobi (Source: JICA, 2006)

Mode		No. of routes	No. of fleet	No. of daily trips	No. of daily pass.	% of pass.	Pass/vehicle per day
Bus	Bus Track	25	266	-	122,479	14.7	460
	Met. Shuttle	6	75		8,364	1.0	112
	City Bus	19	76		14,242	1.7	187
	Total	50	417		145,085	17.4	348
Matatu	Small	72	9,362		482,793	58.1	52
	Big	53	2,597		203,349	24.5	78
	Total	125	11,959		686,142	82.6	57
Grand Total		175	12,376	47,338	831,227	100.0	67

5.3.1. General

For two and a half decades, KBS were the only official public transport service provider in Nairobi. Matatus were seen as illegal operators who were operating in a disorganised manner without licenses. As Nairobi's population grew larger, the Matatus started to provide more public transport services. Nyayo Bus Services was formed in 1986 as a publicly owned bus company. Poor road infrastructure, lack of financial support from government, lack of consistent traffic enforcement and unfair competition from the Matatus, caused KBS and Nyayo bus companies to struggle during the 1990's. As a result the Matatus grew to serve more than 50% of the city's population by the mid-2000s (McCormick *et al.*, 2011).

Kenya Bus Services (KBS) has existed since 1934 when they were granted exclusive rights to provide public transport services in Nairobi. They started their operations with 13 buses on 12 routes. KBS had a monopoly franchise for road-based public transport services until 1992, but after 1992 KBS did not renew this franchise agreement. KBS were jointly owned by United Transport Overseas Ltd (75% shares) and the Nairobi City Council (25% shares). The support from government did not protect them from the gradual encroachment of the Matatus. KBS is now operating as a private company without any shares owned by the City Council. The central government created and invested in its own bus parastatal, Nyayo Bus Service Corporation. They started operating in 1986 and provided commuter bus services with a vehicle fleet of 300 buses. They could not compete with the private sector and terminated their services in 1992 (Mengesha *et al*., 2002; Chitere & Kibua, 2004; Aligula *et al.,* 2005; Mukabanha 2008; Gairy, 2009).

Stagecoach Holdings, a British transport operator, took over the operations of KBS in the early 1990s. They attempted to take advantage of the recently liberalized market regulations by raising the fares in belief that passengers would be willing to pay higher fares for a better service. This was not financially successful and in 1998 Stagecoach sold out to a consortium of local investors. KBS restructured into two divisions, Bus Track and KBS. The KBS division provides two services, Express service and Metro Shuttle service. The Express service uses new buses and is for inter-city transport, while the Metro Shuttle services provides services to the high and medium income areas in Nairobi. There are 30 Metro Shuttle minibuses with a capacity of 33-seats. The Metro Shuttles were bought new, are well maintained and clean and they do not carry standing passengers. Metro Shuttle operates according to a timetable. The fares that they charge are about 50% more expensive than the Matatus fares, due to the better quality service that they are providing to the middle- and high-income urban residents who value their comfort, safety and time, and are willing to pay the higher fares. They had a small commuter bus modal share of only 2,5% in 2002. Bus Track operates on fixed routes with fixed fares, although they have withdrawn services on certain routes due to the poor condition of roads and

intense competition from the Matatus (Mengesha *et al.,* 2002; Aligula *et al*., 2005; Kumar & Barret, 2008).

KBS started experiencing competition from the Matatus which lead to a decrease in the transportation modal share for KBS. Kumar & Barret (2008) notes that the Michuki Rules that were brought into regulation by John Michuki (Minister of Transport) had a negative impact on the long-term financial viability of KBS. Commuter bus services in Nairobi are provided by KBS, Citi Hoppa, Double M and private operators. KBS has the largest commuter bus modal share of the three main operators. They are a private company that operates traditional buses on fixed routes and schedules (Koster, 1999; Mengesha *et al.,* 2002; JICA, 2006; Kumar & Barret, 2008).

Rapid urbanization has led to an increase in the demand for transportation services, but high operating costs and the poor conditions of transport infrastructure has depleted the public transport services provided by bus and railway operators. This situation created the perfect opportunity for the Matatus to gain a large share of the public transport market and has led to a rapid increase in the number of Matatus as they grew from 375 vehicles in 1973 to 1,567 vehicles in 1979 and to 10,000 vehicles in 2002 (Mengesha *et al*., 2002). The lack of paratransit regulation and the manner in which the Matatus operate, have led to a number of undesirable effects which include high accident levels, drivers working long hours, drivers racing between stops to pick up passengers and high congestion levels. The operators experience corruption from cartels who believe that they 'regulate' the routes and stops and conflicts between operators, route associations and other interest groups sometimes breakout in violence. The Michuki rules also had a negative impact on the operations of Matatus in Nairobi, because they were forced to transport fewer passengers per trip and had to spend extra money on their vehicles (Mengesha *et al*., 2002; McCormick *et al*., 2011).

Commuter rail services were introduced in Nairobi in August 1966. Commuter rail services are provided by Kenya Railway Corporation (KRC). They have a public transport modal share of 1.5% of the total public transport demand in Nairobi. KRC provides commuter rail services from the outskirts of Nairobi, through the high density areas into the CBD area. The extent of the operations and service provided is limited by the railway infrastructure, although there is a demand for services in urban areas. There is a lack of subsidy from central government and this has prevented KRC from expanding the network to cater for more commuters (NTPC, 2004; Gleave *et al*., 2005; JICA, 2006; Obiero & Opiyo, 2009).

5.3.2. Passenger volumes

This section will discuss the public transport passenger demand for the public transport modes in Nairobi. The total daily public transport passengers in 2003 were 847,227 (JICA, 2006). The road-based public transport modes in Nairobi have the largest modal share, with commuter rail having a very small public transport modal share.

It was difficult to determine the actual passenger trips from the literature available, due to conflicting values. Table 5.8 indicates person trips per day based on data available from JICA (2006) and Mengesha *et* al. (2002). This shows that the same source reflects two very different estimates of daily trips; 2 million versus 4,8 million.It could be that the 2004 data indicates two-way trips, while the 2003 data indicates one-way trips. NMT accounts for 48% of daily trips, private transport accounts for 10% of the daily trips, Matatus accounts for 34% of the daily trips, commuter bus accounts for 7.2% of daily trips and the train accounted for less than 1% of the daily trips.

Table 5.8: Person trips per day (Source: Mengesha *et* al, 2002; JICA 2006)

	2003	2002	% Total	% Motorised	% Public Transport	2004
PT: Rail	16 000		0.8%	1.5%	1.9%	
PT: Bus	145 085		7.2%	13.8%	17.1%	
PT: Matatu	686 142		34.0%	65.4%	81.0%	
PT: Bajaji			0.0%	0.0%	0.0%	
PT: Total	847 227	42%	42.0%	80.8%	100%	
PvT: Total	*201 721*	10%	10.0%	19.2%		
Total Motorised	1048 948	52%	52.0%	100%		2500 000
NMT	*968 259*	48%	48.0%			2320 000
Total Trips	2017 207		100%			4820 000
Source	JICA, 2006					JICA, 2006

Numbers in Italics are all derived values.

The major bus corridors such as Juja Road, Jogoo Road, Waiyaki Way and Ngong Road (see figure 5.13) has daily passenger volumes that range from 10,000 to 33,500 passengers (JICA, 2006).

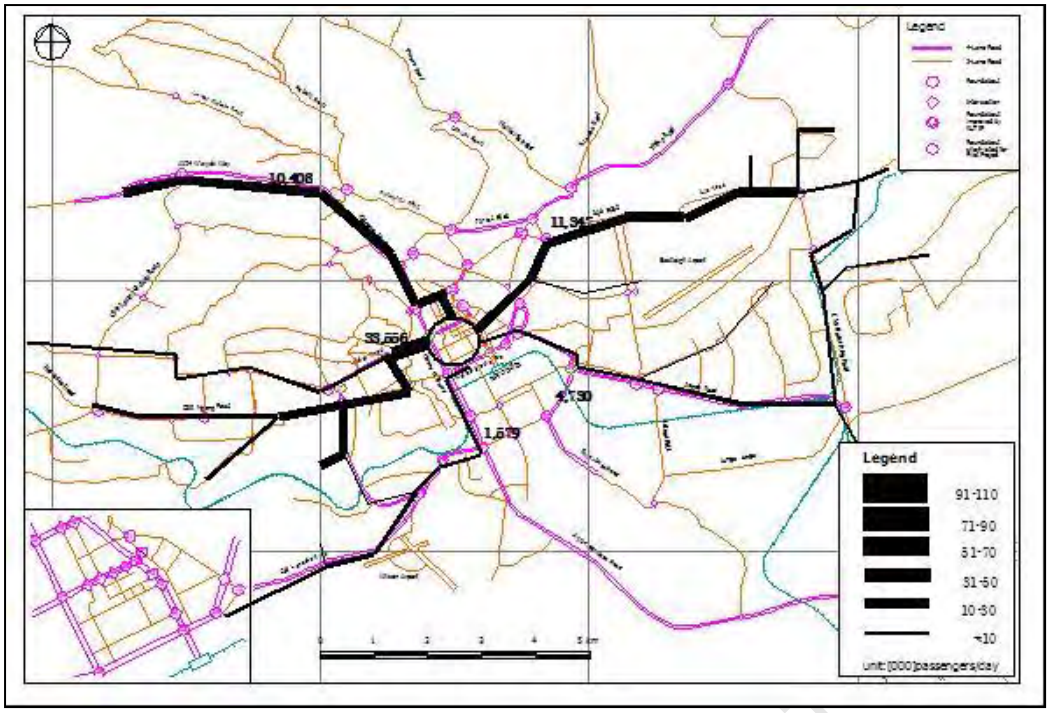

Figure 5.13: Bus passenger volumes on major commuter bus routes (Source: JICA, 2006)

The daily passenger volumes on the major Matatu routes range from 62,000 to 108,000 passengers. These routes are Thika Road, Juja Road, Jogoo Road, Uhuru Highway and Ngong Road (see figure 5.14 (JICA, 2006).

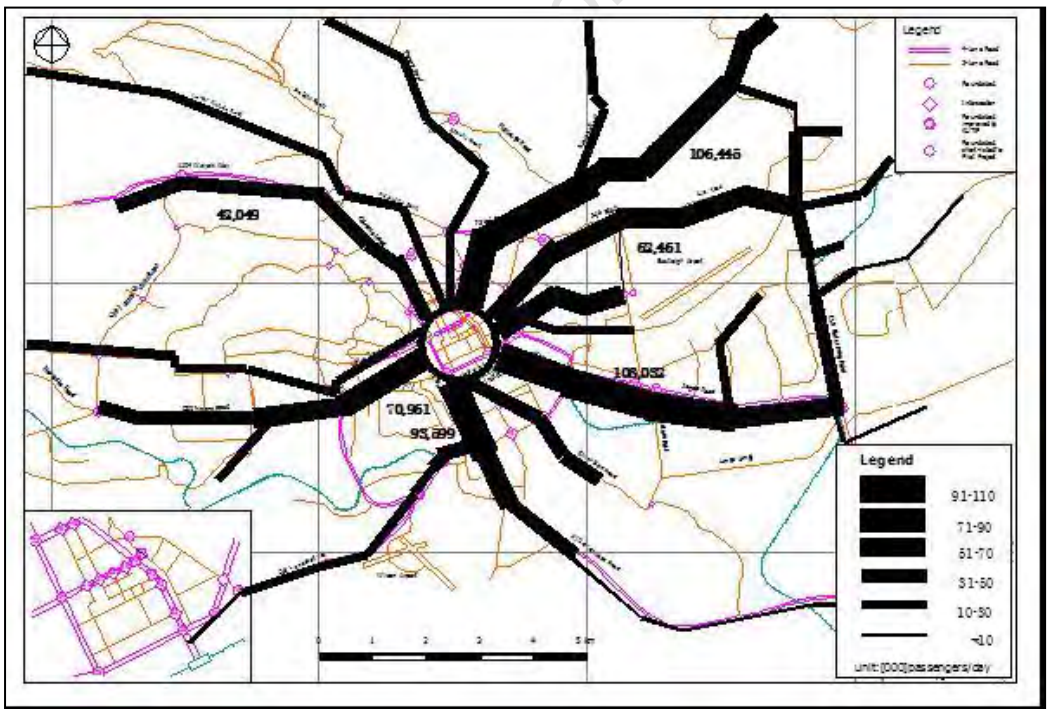

Figure 5.14: Matatu passenger volumes on major Matatu routes (Source: JICA, 2006)

5.3.3. Infrastructure & Vehicle Fleet

Nairobi has 175 public transport routes which consist of 50 bus routes and 125 Matatu routes. These routes are served by 300 buses and approximately 12,000 Matatus. The commuter bus services provided by KBS are operated on fixed routes and schedules. Most of the routes on which KBS operates are radial, passing through the city centre. This reduces the need for passenger transfers and provides a competitive advantage over the Matatus. Bus corridors on the east side of the city centre, which consists of Juja Road and Jogoo Road, merge onto the west side bus corridor comprising of Ngong Road. Some of the routes have their origin and/or destination in the city centre. These routes are connected to Limuru and its adjoining area via Waiyaki Way and Ngong Road. Matatus mostly operate on the same routes as KBS, but they operate without designated timetables which gives them a competitive advantage. On some routes such as the north-south routes, they compete among themselves, while most of the east-west routes overlap with the commuter bus routes. Matatu routes have been mostly formed to match passenger demand (Aligula *et* al., 2005; JICA, 2006).

The total length of the commuter rail network in Kenya is 2,735 km and consists of a main line and 7 branch lines. Some of these lines connect to Tanzania and Uganda. The commuter rail operations in Nairobi are very limited. Currently, there are three commuter lines operating in the NMA from Nairobi Central Station. One line operates to Thika and Kahawa (northeast direction from Nairobi), another to Limuru (northwest direction) and the third to Embakasi (south direction), see figure 5.15 (JICA, 2006).

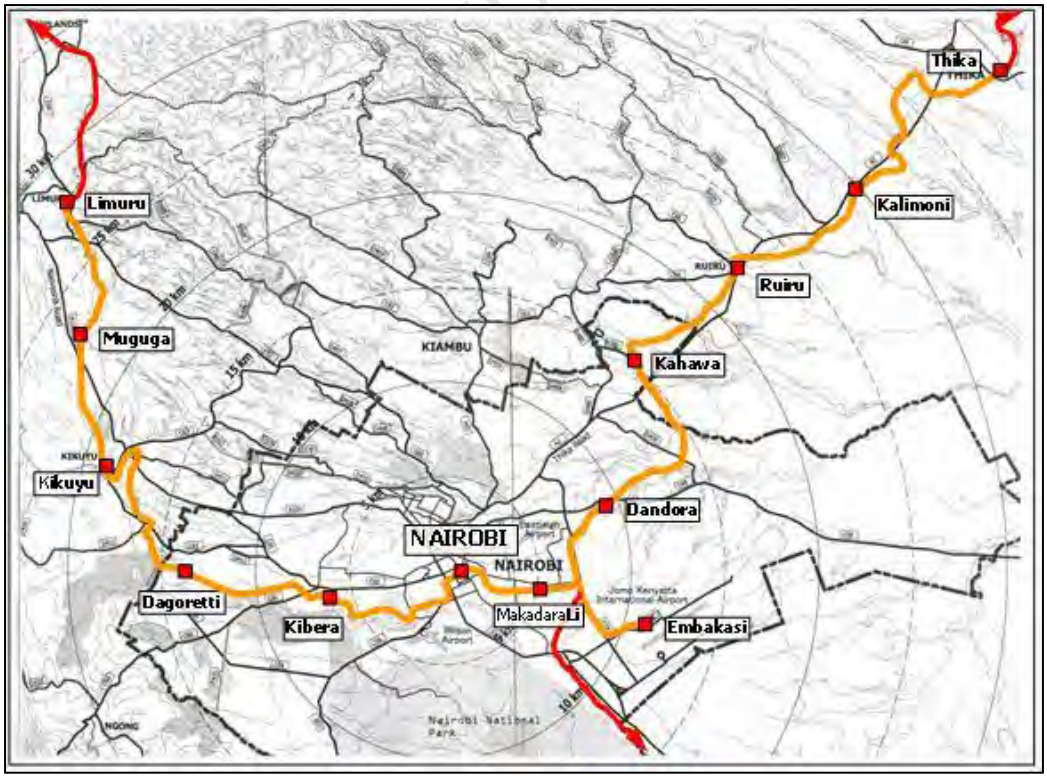

Figure 5.15: Commuter Rail Network for Nairobi (Source: JICA, 2006)

The public transport facilities are poor and almost non-existent. While there is a formal railway station, Nairobi Railway station, which is situated in Nairobi CBD the other stations are rather poor and without platforms or dedicated walkways (see figure 5.16) (Obiero & Opiyo, 2009).

Figure 5.16: Nairobi Railway station (Source: JICA, 2006)

The major bus terminus is along Landhies Road and is located away from the main railway terminus. Another two terminals are Mlana Market, where hawkers and public transport are all integrated in one place, although it was mainly built as a terminal for public transport, and Maran terminal that was mainly built as a market but is now also a terminal for commuter bus and Matatus. There is not enough public transport infrastructure provided for commuter bus services in Nairobi. Most of the bus stops lack shelters and the passengers have no shelter during extreme weather conditions; this creates a negative experience for passengers. Currently, bus shelters at lay-byes are provided by the private sector in return for advertising rights on them. The City Council only provides the lay-byes on the routes and the private sector has to pay a license fee to the City Council to own and brand a stop at each lay-bye (Aligula *et al*., 2005; Mukabanah, 2009).

One of the major termini for Matatus is along Landhies Road which has a terminus for internal and external operating Matatus. Most of the bus stops in Nairobi are currently used by KBS, Matatus and other private buses (see figure 5.18). There are also many Matatu terminals around the Bus Track terminal (see figure 5.17) in the city centre. This creates congestion and interferes with the traffic flow. Matatus largely ignore the official bus stops, especially during peak hours. They only depart from the termini when the vehicle is full and then they generally drive non-stop to their final destination. During the off-peak periods the drivers try to pick-up as many passengers as possible on the route, which leads to poor driving and stopping behaviour. Commuters wave down Matatus when they wish to board and signal to them when they wish to alight and most of the times the chosen spots for boarding and alighting are not the formal bus stops. The Matatus do not necessarily adhere to the route that they are supposed to operate on, many vehicles deviate from their routes to avoid heavy

traffic, to get ahead of competitors and also to avoid the police. The positive outcome of these deviations is that passengers sometimes reach their destinations earlier than they would have if the vehicle had remained on its route, although the passengers who had expected to alight along the designated route are now dropped at different locations from which they must either walk or take another vehicle. The rapid growth in the number of Matatus has put a great strain on the use of terminal facilities, particularly in the city centre, the lack of termini in the city centre or at the outskirts to match the growing demand has contributed to the traffic flow problems during peak hours (Mengesha *et al*., 2002; Aligula *et al*., 2005; JICA, 2006; McCormick *et al*., 2011).

Figure 5.17: Matatus at a terminus on Latema Road (Mukabanah, 2009)

Figure 5.18: Kenya Bus Track Terminus (Source: JICA, 2006)

There are about 60 coaches that are being utilised for commuter rail in Nairobi.

The bus fleet for KBS consists out of 270 single-deck vehicles (62-seat) for Bus Track Division and 30 midi-buses (33-pass capacity) for the Metro Shuttle's bus fleet. The bus fleet of KBS is old, with most of the vehicles not having been refurbished or replaced since the mid-1990s. Prior to 2004, the licensed capacity of the buses was 100 (standing & sitting passengers), but after the introduction of the Michuki rules that restricted any standing passengers, the seat capacity was reduced to 62 passengers. This means that there are less passengers carried per vehicle trip, leading to a reduction in the income made per vehicle trip (Aligula *et al*., 2005; Kumar & Barret, 2008).

The Matatu fleet consist of a mixture of 14-seater Nissans, minibuses with a capacity of between 25 to 33 passengers and midi-buses with 45 seat capacities. In September 2000, the number of Matatus operating in Nairobi was estimated at 9,894 units, out of which 2,946 units were 25 or more-seaters and 6,948 units were between 14-18-seaters. About 63% of the small Matatus (14 seater capacity, see figure 5.19) are over 10 years old, while 70% of the rest of the Matatus are less than 10 years old. Graeff (2009) estimated that 15,000 Matatus operated within Nairobi during 2008/2009. There are no

standard requirements for the size and type of vehicles that can be operated by small operators, but according to the observation by McCormick *et al*. (2011), there has been a trend among Matatu investors in Nairobi to move towards acquiring higher capacity vehicles due to the declining profit margins of the average14 seater Matatus (Mengesha *et al*., 2002; Aligula *et al*., 2005).

Figure 5.19: 14-Seater Nissan Minibus (Source: JICA, 2006)

5.3.4. Main Routes

The service provision for commuter rail for NMA is shown in table 5.9. It indicates that there are only four services provided in the morning peak and five services provided in the afternoon peak. The Embakasi line has two trips from Nairobi CBD to Embakassi in the evening peak period. Commuter rail services are only provided from Monday to Saturday and only during the peak hours (Obiero & Opiyo, 2009). The average route distance is 35 km, while the daily frequency for each line is one round trip which consists of a trip from the suburban terminal to Nairobi CBD in the morning and another trip from Nairobi CBD to the suburban terminal in the evening (JICA, 2006).

Table 5.9: Commuter rail service provision for Nairobi Metropolitan Area (Source: JICA, 2006)

COMMUTER SERVICE								
Route	Distance from Nairobi (km)	Current rate (Ksh)	No. of coaches	Morning		Evening		Current Matatu Fares (KSh)
				dep	arrival (NRB)	dep (NRB)	arrival	
Thika								
NRB-TKA	56.75	20	20	5:30am	7.45am	5.30pm	7.55pm	60
NRB-RUI	31.63	20						50
NRB-KAA	24.03	20	20	5:45am	6.47am	6.10pm	7.15pm	30
NRB-DDA	12.10	15						20
NRB-UMOJA	-	15						20
NRB-MKR	5.16	15						20
NRB-DON	-	15						20
Embakasi								
NRB-EKV	14.28	15	5	6.30am	7.05am	5.05pm	5.30pm	30
NRB-MKR	5.16	10				6.25pm	6.55pm	20
NRB-DONHM	-	10						20
Limuru								
NRB-LMU	46.86	20	14	5.40am	7.40am	5.40pm	7.45pm	50
NRB-KYU	30.62	20						30
NRB-KBE	9.93	10						20

There are 50 commuter bus routes in Nairobi (see figure 5.20) (Aligula *et al*., 2005). The major bus routes in Nairobi are Mbagalhi Valley Road, Jogoo Road, Mombassa Road, Juju Road, Thika Road, Waiyaki and Ngong Road (see table 5.10). Table 5.8 indicates the number of bus trips observed in a 12 hour period on the corridors. The number of bus routes has been gradually reduced over time, as routes have been abandoned and taken over by Matatus. KBS provides services on urban routes, intra-urban routes, suburban routes, intercity routes and rural routes (Mukabanah, 2009).

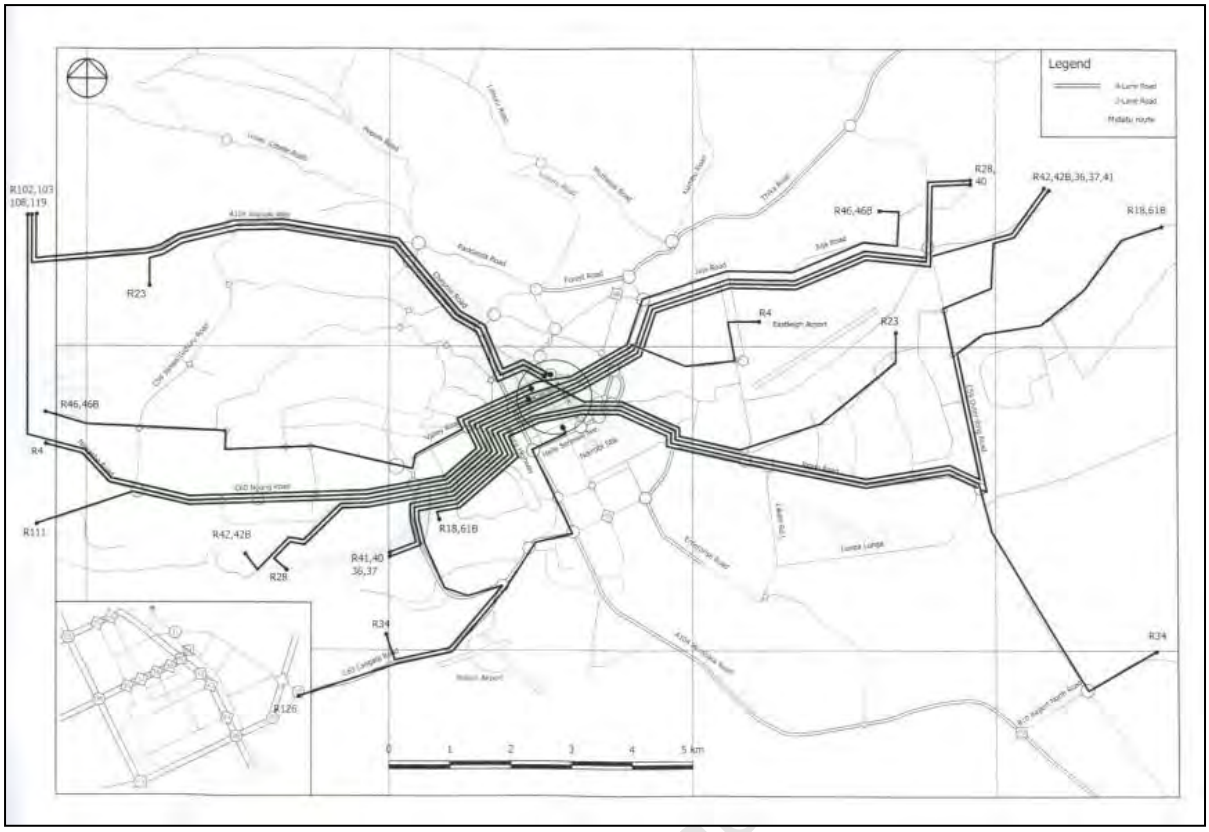

Figure 5.20: Commuter Bus routes in Nairobi (Source: JICA, 2006)

Table 5.10: Busiest bus routes in Nairobi (Average) (Source: Aligula *et al*., 2005)	
Routes	**Number of a bus trips observed in a 12h period on the corridors**
Mbagalhi Valley Road	1310
Jogoo Road	1081
Mombassa Road	375
Juju Road	624
Thika Road	588
Waiyaki	570
Ngong	496

Table 5.11 indicates the number of routes for the different commuter bus operators as well as the number of daily passengers in order to calculate the number of daily passengers per bus. The data is collected from daily operating statistics for December 2003. It indicates that Bus Track has the most passengers per bus per day. Most of the commuter buses do not operate according to a fixed time schedule, although it can be assumed that the frequency is quite high during the peak period.

Table 5.11: Number of bus routes and daily passenger volumes in Nairobi (Source: Aligula *et al*., 2005)					
Mode	**Number of routes**	**Fleet**	**Daily Passengers**	**% of Total Daily Passenger Volumes**	**Passengers per bus per day**
Bus Track	25	266	122,479	14.7	460
Metro Shuttle	6	7	8,364	1	1195
City Bus	19	76	14,242	1.7	187
Total	50	417	145,085	17.4	348

The main Matatu routes are Thika Road, Juja Road, Uhuru Highway and Ngong Road, see figure 5.21 (JICA, 2006). Matatus are only permitted to enter the city centre along specific routes. The Matatu routes are generally shorter than the KBS routes, because they do not operate full radial routes across the town, in order to fit as many trips in as possible, and because they are not allowed in and through the CBD. Syndicates have developed over time and today most of the routes are controlled by associations that act as self-declared owners of the route (cartels) (McCormick *et al*., 2011). Table 5.12 shows the average number of Matatu trips observed on these routes. Table 5.13 indicates the number of routes that the Matatus provide services on, as well as the number of daily passengers per vehicle per day. It shows that the small Matatus have more daily passengers than the Metro Shuttle (Midibuses). The data was collected from daily operating statistics for December 2003.

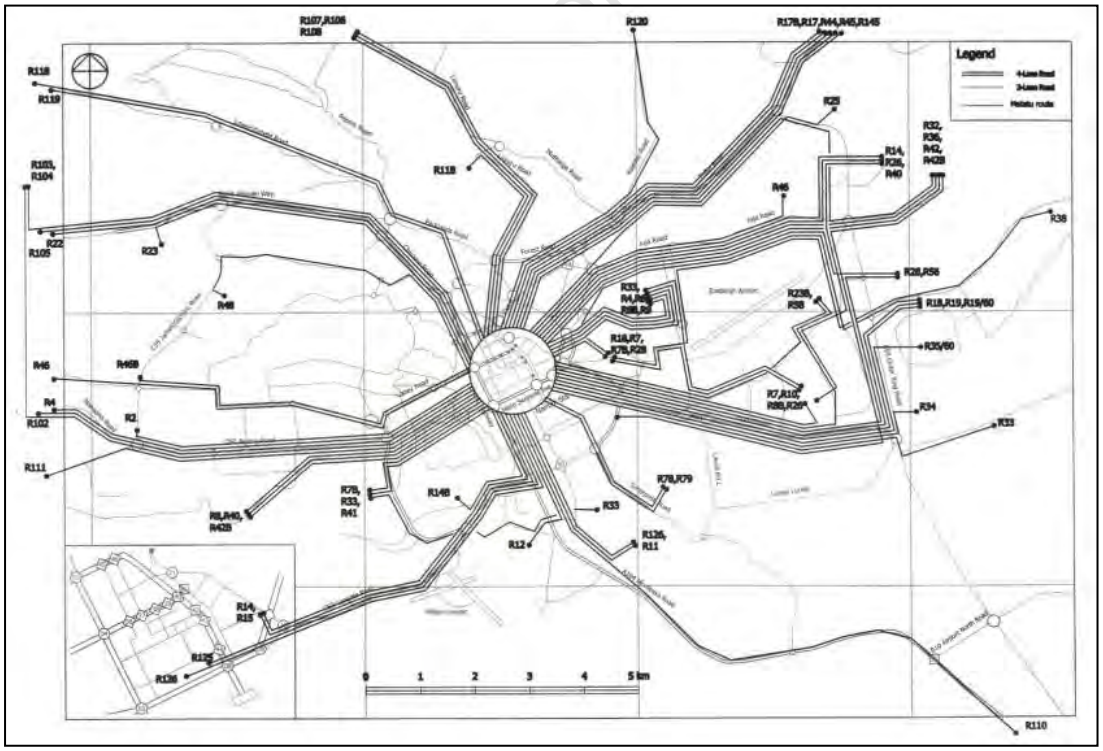

Figure 5.21: Matatu routes in Nairobi (Source: JICA, 2006)

Table 5.12: Busiest Matatu routes in Nairobi (Source: Aligula *et al*., 2005)	
Routes	**Average number of Matatu trips observed in a 12h period operating on these routes**
Mombassa Road	8097
Jogoo Road	13303
Thika Road	13326
Waiyaki	8451
Ngong	4291
Mbagalhi Valley Road	2471
Juju Road	6298

Table 5.13: Matatu Routes (Source: Aligula *et al*., 2005)					
Mode	**Number of routes**	**Fleet**	**Passengers**	**% of Total Passenger Volumes**	**Passengers per vehicle per day**
Matatus - Small	72	9 362	482 793	58.1	52
Metro Shuttle	53	2 597	203 349	24.5	78
Total	125	11959	686 142	82.6	57

5.4. Financial Issues

5.4.1. Economic background of the city

During 1986-1990, the GDP of Kenya attained an average annual growth rate of 5%. After this period, the Kenyan economy experienced a continuous decline throughout the 1990's. The annual average GDP growth rate decreased to 2.5% during 1990-1995 and further to 2.0% during 1996-2000. Data on wage earnings by province and district indicate that the contribution of Nairobi City to the national economy decreased from around 40% during the 1990's to slightly over 30% after 2000. In 2002 the NMA (including the neighbouring districts of Thika, Kiambu, Limuru and Athi River) contributed 32% of the totel earnings for Kenya to the national economy. Table 5.14 indicates the key socio-economic indicators for Nairobi (JICA, 2006).

Table 5.14: Key socio-economic indicators for Nairobi (Source: Mengesha *et al*., 2002; JICA, 2006) (1 US$ = 84.06 KSh – 2004, 1 US$ = 92,9 KSh - 2011 Value (http://investing.money.msn.com))	
Area – NMA - Nairobi	4,477 km^2 696 km^2
Population - NMA - Nairobi	4,736,000 (projected 2010), 4,042,000 (2004) 3,079,000 (projected 2010), 2,657,000 (2004)
GDP - Kenya	KSh 1,036 billion, US$ 12.34 billion (2004)
GDP per capita – Kenya GDP per capita – Nairobi	KSh 31,600 (2004), US$ 400 (2004) US$ 442 (2007)
Working Population – Wage employment NMA -Informal sector employment, Nairobi	457,547 (2002) 1,343,100 (2003)

5.4.2. Fares

The government only has control over the rail fares charged in Nairobi. The commuter bus and Matatus fares are determined by drivers, depending on the state of the market. Both commuter buses and Matatus operate commercially in Nairobi (McCormick *et al*., 2011).

KBS implemented a new strategy after the previous owners of KBS could not sustain their continual financial loss. The strategy is to substantially reduce its cost by contracting-out most of its big-bus operations (Bus Track) and to target the more affluent commuters with premium services. This has helped to raise the average fare revenues. KBS's services cause a damping effect on the fares charged by Matatus. The Matatu operators charge a higher fare on the routes where KBS do not provide any services. The fares charged by KBS do not change in response to bad weather or congestion. The minimum fare charged, even in off-peak periods, is KSh 20 (Mengesha *et al*., 2002; Kumar & Barret, 2008).

The fare strategy for Matatu operators and owners is designed to maximise profits by charging a zonal fare which is increased in peak periods and doubled or more when it rains or when there is heavy traffic congestion. The applicable fare is usually shown inside the vehicle windscreen, although the fares charged by Matatu drivers vary with the demand on the route. Fares in the off-peak periods can drop by 30 to 50% or more to ensure that there are enough passengers that will use their services. Under "normal" operations the fares are supposed to be fixed by the particular route operators/associations, although the fixed fare only applies for 20% of the time due to internal competition. The Matatu drivers are more concerned about profit than the quality of service that they provide. The Matatu crew is given a daily income target which they must deliver to the owner on a daily basis and the rest they can keep. This increases their incentive to do whatever is necessary to maximise their revenues (Mengesha *et al*., 2002; Kumar & Barret, 2008; McCormick *et al*., 2011).

Taxis, tuk tuks and motorcycles also provide public transport services in Nairobi. The taxis are unmetered taxis that charge a minimum fare of KSh 200. Kumar & Barett (2008) noted that there are about 40 tuk tuks that operate from one city terminal. They charge fares of about KSh 100 per trip. Although the tuk tuks are less expensive than taxis, they are relatively unsafe, and can only transport two passengers per trip. The minimum fare for motorcycle taxis is KSh 10 per trip, which is relatively cheap compared to the fares of the other public transport modes (Kumar & Barret, 2008).

Table 5.15 shows fares charged by the various public transport modes in Nairobi and also the average cost per km as calculated.

Table 5.15: Public Transport fares for Nairobi					
	Rail	Bus		Matatus	
	2002 [1]	2002 [1]	2008 [2]	2002 [1]	2008 [2]
Maximum	20 Ksh, US$ 0.26				
Minimum			20 KSh,US$ 0.31		
12km		21.3 KSh, US$ 0.27			30 KSh, US$ 0.47
14km				24.4 KSh, US$ 0.31	
Cost per km		1.75 KSh, US$ 0.02		1.74 KSh, US$ 0.02	2.50 KSh, US$ 0.04

[1]Mengesha *et* al. (2002); [2] Kumar & Barret (2008)

5.4.3. Affordability of public transport services

Low-income households in Nairobi spend between 10-30% of their monthly income on public transport. Some of these public transport users can only afford public transport during the first two weeks of a month, after which they have to walk (JICA, 2006). Table 5.16 indicates the expenditure on public transport by commuters.

Table 5.16: Expenditure on urban public transport in Nairobi (Source: Mengesha *et al.*, 2002)	
Estimated proportion of household income spent on public transport	10-15%
Estimated average daily expenditure on public transport fares (all the public transport commuters together)	KSh 47.3 million US$ 606,410

5.4.4. Subsidies

National Government provides funds for the road infrastructure and maintenance. Only commuter rail receives subsidies from Government, while commuter bus and Matatus are not subsidised.

5.5. Summary of Nairobi's Public Transport System

This section will summarise Nairobi's Public Transport System.

Table 5.17: Summary of Nairobi's Public Transport System	
	1. Institutional and Regulatory Framework
Stakeholders	• PT Regulation is fragmented across different institutions & stakeholders. • There is a lack of coordination between institutions. • Planning, Coordination & Strategy Stakeholders: Central Government, MoLG, MoTC, Nairobi City Council, KRB, TLB, Traffic Police. Operations: KRC, KBS, Citi Hoppa, Double M, Matatu Operators, Matatu Owners, MOA, MWA.
Regulatory Framework	• Provision of PT governed by Traffic Act (2004). • Lack of PT regulation in Nairobi, No clear urban transport policy. • Central Government, Local Government and Nairobi City Council - Responsible for the regulation of commuter rail services. • Central Government, Nairobi City Council – Responsible for regulation of bus and Matatus operations.
Industry Structure	• Commuter rail services operate under a monopoly. • Commuter Bus and Paratransit industry (Matatus) operates in a deregulated environment.
	2. Network Structure
City Characteristics	• Nairobi - Area of 696 km^2. • Nairobi - Population of 3,24 million people in 2006. • Nairobi - Annual population growth rate of 4,94%. • NMA – Area of 4,477 km^2. • NMA – Population of 3,2 million people in 1999. • NMA – Annual population growth rate of 7,23%. • Population Density – 4,655 inhabitants per square km (Nairobi City, 2006). - 724 inhabitants per square km (NMA, 2006) • Low density urban sprawl in NMA. • 1993 – 110 Informal settlements with a population of approximately 0.75 million situated around Nairobi CBD.
Transport Network	• Lack of sufficient ring roads around CBD. • Road Network of over 1,150 kms. • Six major arterial routes into CBD. • 1928 – Nairobi had high private motorized traffic volumes. • Need for transport services increased as urbanization, migration and motorization volumes increased. • 1950's – Informal public transport services became popular. • Main transport problem – Centralization of activities in CBD & lack of available space on road infrastructure. • Urban sprawl further away from the CBD led to increase in demand for PT services. • PT services provision: Commuter rail services – 3 lines Commuter bus services - 50 routes Minibus-taxi services - 125 routes
Transportation demand and usage of PT modes	• Daily Transport Modal Share for Nairobi; 48% NMT, 10% Private vehicles, 42% PT (2002). • Road-based PT Modal share – 30% Bus, 70% Minibus-tax • 230,478 motor vehicles registered in 1998. • Daily public transport commuters in 2003 – 847,227 passengers. • Commuter rail – 350,000 average monthly passengers, 16,000 average daily passengers (2002/03). • Commuter bus – 145,085 daily passengers (2003). • Matatus – 686,142 daily passengers (2003). • NMT – 2,32 million trips per day consist of walking or cycling trips.

	2. Network Structure (Continued)
Infrastructure	• Urban infrastructure consists of the road network, termini, parking facilities and bus stops. • Nairobi Railway Station and Bus Track Terminal – Most common modal interchange areas in NMA. • Infrastructure in poor condition due to under-investment.
	3. Public Transport Modes
Commuter Rail	• Services are provided by KRC. • Current railway infrastructure limits the provision of commuter rail services. • 16,000 daily passengers in 2002. • 3 Lines with four trips in the morning peak and five in the evening peak.
Commuter Bus	• Services are provided by KBS, Citi Hoppa, Double M and other private operators. • KBS has largest commuter bus modal share. • 145,085 daily passengers in 2003. • Provides services on 50 routes per day. • KBS Bus fleet of 300 buses. • Most of the bus fleet are old and not in a good condition.
Minibus-taxi	• Services are provided by private owners. • Backbone of Nairobi's transportation system. • 686,142 daily passengers in 2003. • Operates on 125 routes daily. • Vehicle fleet of 9,894 Matatus in 2000.
	4. Financial Issues
Economic background of the city	• Annual GDP growth rate for Kenya – 2.5%. • NMA contributes 32% of total earnings for Kenya. • GRDP per capita – US$ 442 (2007).
Fares	• Rail fares (2002) – Maximum fare 20 KSh. • Bus fares (2002) – Minimum fare 20 KSh. • Matatu fares (2002) – Ranged between 24 KSh – 30 KSh, 12,5-14km.
Affordability of PT services	• 10-15% of households (HH's) incomes spend on PT. (Low-income HH's, 10-30%)
Subsidies	• Commuter rail receives subsidies.

5.6. Evaluation of Nairobi's Public Transport System

This section will evaluate Nairobi's Public Transport system by making use of key performance indicators. Public transport objectives will help to identify the key performance indicators that are necessary to evaluate the public transport system of Nairobi.

5.6.1. Public Transport objectives

The vision for public transport in Nairobi is to have "*a world-class transport system that is integrated and responsive to the needs of people and industry*" (NTPC, 2004), while the mission for public transport is "*to develop, operate and maintain an efficient, cost effective, reliable, safe, secure and integrated transport system and link transport policy with other sectorial policies, in order to achieve national and regional development aspirations in a socially, economically and environmentally sustainable manner*". (NTPC, 2004)

The following are the public transport goals and objectives for Nairobi (Ministry of Transport and Communications. 2003; NTPC, 2004; JICA, 2006; KIPPRA, 2006; Chitere & Kibua, 2004):

- To implement priority of public transport over private transport. To provide dedicated bus lanes and NMT facilities to encourage the use of public transport.
- To improve the quality of public transport service provided to meet the standards of a world-class public transport system.
- To improve the safety and security of the public transport systems and services provided.
- To provide a reliable public transport service.
- To provide accessible public transport services for all the users.
- To ensure the provision of a low cost and affordable public transport system.
- To implement effective travel demand management strategies.
- To expand and improve the urban rail commuter services.

5.6.2. KPIs and data required to quantify the public transport objective

For most of the objectives mentioned above more than one KPI can be selected and use to evaluate the performance of the public transport system. These KPIs also need certain public transport data in order to be evaluated (see table 5.18). The objectives that were selected in section 5.6.1 to estimate the KPIs for Nairobi are listed below with their KPIs.

Table 5.18: KPIs & Data Required to evaluate the public transport objectives			
	Objective	**KPI**	**Data required**
1	To promote public transport over private transport.	% of motorised transport users using public transport.	# Motorised transport users. # Public Transport (PT) users.
		% of motorised transport users using private transport.	# Motorised transport users. # Private transport users.
		% of dedicated PT road km's out of the total road network for the city.	Dedicated PT lane km's. Total road-km's in city.
		Number of daily PT passengers per 1000 people.	Daily PT passenger volumes. Population size.
		Vehicle ownership per 1000 people.	Number of registered light vehicles. Population size
		% of Population within 15 minutes walk from a PT facility.	# Population within 15 minutes walk from PT facility. Population size.
2	To improve the quality of public transport service provided to meet the needs of all users.	Average daily load factor (passengers per seat).	# Daily PT passengers. # PT seats available daily.
		Average travel time to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel times per PT trip in the peak period.
		Average travel distance to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel distance per PT trip in the peak period
		Total road-based public transport seat capacity per 1000 people.	# Road-based PT seats available daily. Population size.
		Total public transport seat capacity per 1000 people.	# PT seats available daily. Population size.
		Peak-hour frequency of the PT services: -Rail, - Bus, - Paratransit	Peak-hour frequency (min).
		Passengers per train per day	# Trains daily in service # Daily rail passengers
		Passengers per bus per day	# Buses daily in service # Daily bus passengers
		Passengers per minibus taxi per day	# Minibus taxis daily in service # Daily minibus taxi passengers
3	To improve the safety and security of the public transport services	# Road accidents per 100,000 people.	Annual accidents. Population size.
		# Road Fatalities per 100,000 people.	Annual road fatalities. Population Size.
		# Road Fatalities per 10,000 vehicles.	Annual; road fatalities # Registered light vehicles
4	To provide reliable public transport services.	% of Scheduled PT services that arrives on-time.	# Scheduled PT trips (daily). # Of PT trips that arrives On-time.
5	To improve the accessibility of the public transport services to all.	% of Population within 1000 m walking distance from a PT facility.	# Population within 1000 m from PT facility. Population size.
		# PT stops per 100 km^2.	# PT stops in city. Area of city.
	To provide universal accessible public transport services	% of PT vehicles that are universal accessible.	# Universal accessible PT vehicles. Total PT vehicle fleet
		% PT facilities that are universal accessible.	# PT facilities that are universally accessible. Total # of PT facilities.

Table 5.18 (Continued): KPIs & Data Required to evaluate the public transport objectives			
	Objective	**KPI**	**Data required**
6	To provide affordable public transport.	Average % of household income spent on PT services per month.	Monthly household income spent on PT. Monthly household income.
		% of Public transport users that spent more than 10% of their household income on PT services.	# PT users that spent more than 10% of HH income on PT services per month. Total PT users. Average monthly household income. Average monthly PT expenditure.
		Average fare per PT trip.	PT fares per trip. # PT trips. Total monthly expenditure on PT. Number of monthly PT trips.
7	To implement effective Travel Demand Strategies.	Modal split of the transportation system. - % PT, Private vehicle & NMT users	# PT users # Private vehicle users. # NMT users.
		Are there efficient TDM Strategies for the city?	Yes/No?
8	To expand and improve the urban rail commuter services.	% Increase in commuter rail passenger volumes	# Commuter Rail passengers (2002) # Commuter Rail passengers (2008)
		% Increase in commuter rail network km.	Commuter Rail network km (2002) Commuter Rail network km (2008)

The KPIs listed above will be used in the next section to evaluate the performance of the public transport systems of the case cities. In the case where some of the data required to evaluate a KPI were not available, the KPI will be excluded from the list of KPIs that will be used.

5.6.3. Data needed to calculate KPIs

Table 5.19 lists all the data required to evaluate the KPIs listed in table 5.18.

Table 5.19 : Data for calculation of KPIs (sources of data shown in column *)

(Sources: [1] Mengesha *et al*., 2002;[2] JICA, 2006, [3] Wikipedia, 2009; [4] KIPPRA, 2006; [5] Gleave *et al*., 2005; [6] Pendakur, 2005; [7] Worldbank; [8] IMF, 2007; [9] http://www.tradingeconomics.com; [10] Kumar & Barret (2008)

	Data	**Nairobi**	*
Performance Indicators	Area (km^2)	696, 4477 (NMA)	1
	Density (people/ km^2)	4,655 (2006)	2
		4,509 (2005)	
		3,075 (2001)	
	GDP per capita - Country (US$)	1,662 (2009)	7
		780 (2007)	8
	GDP per capita - City (US$)	442 (2007)	9
		390 (2004)	5
		350 *(2002)*	1
	Currency	1US$ = 92.9 Ksh (2011) 1US$ = 75 Ksh (2005)	9 2
	Population size (Nairobi).	3,240,000 (2006)	4
		3,138,295 (2005)	3
		2,140,000(2001)	1

Table 5.19 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Nairobi**	*****
1	# Daily PT users.	831,227 *(2005)*	2
	# Daily Private transport users.	201,721 (*2006)*	2
	Dedicated PT lane km's.	0	
	Total road-km's in city.	1150km	4
	Modal Split - Public transport - Private transport	 80.8% 19.2%	1
	Registered light passenger vehicles	90,000 *(2001)*	1
	% of Population within 15 minutes' walk from a PT facility	73%	4
2	Number of Buses	270 (Bus Track) 30 (City Bus)	1
	Capacity – Buses (Sitting & Standing)	35,000	1
	Number of Matatu vehicles	9,894 (Matatus) 33 (Metro Shuttle) 2,946 (Big Matatus)	1
	Seat Capacity - Paratransit	327,203	1
	Number of train sets	60 coaches	4
	Seat Capacity - Trains	200 *(per coach)* 5,000	4
	Road-based Average travel speed	34	2
	Peak-hour frequency (min). - Rail - MBT - Bus	*Not Frequent*	
	Daily PT users.	847 227 *(2002)*	1
	Daily bus passengers	145,082 *(2002)*	1
	Daily paratransit passengers	686,142 *(2002)*	1
	Daily rail passengers	16,000 *(2002)*	1
	Average travel time to work - all public transport commuters (morning peak period).	58 min	2
	Average travel distance to work, for all public transport commuters during the morning peak period.	4km – 15km's	6
	# Train Sets Daily passengers	60 coaches 16,000 (2002)	1
	# Buses Daily passengers	300 145,085 (2002)	1
	# Matatus Daily passengers	12,873 686,142 (2002)	1
3	Total Accidents (Private & Public vehicles)	6,469 *(2001)*	1
	Fatal Road Accidents (Private & Public vehicles)	521 *(2001)*	1
	Registered light passenger vehicles (Private & Public vehicles)	90,000 *(2001)*	1
4	% of PT trips that arrive on-time.	(Not available)	
5	# PT stops in city.	(Not available)	
	% of Population within 1000m (15 minutes) walking distance from a PT facility.	73%	4
	Universal accessible PT vehicles - Rail - Bus - MBT	 0 0 0	
	Total PT vehicle fleet	13,173 (Road) 20 (Rail)	1
	# PT facilities that are universally accessible.	(Not available)	
	Total # of PT facilities.	(Not available)	

Table 5.19 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Nairobi**	*****
6	Monthly household income spent on PT - Percentage (Average)	10-15%	1
	Monthly household income spent on PT - Value	US$ 25,97	1
	% HH's that spent more than 10% of HH income on PT services per month.	63%	1
	PT fares per trip - Rail - Bus - MBT	 US$ 0.16 (min) US$ 0.26 US$ 0.31 (US $0.20 – US $0.40, Road-based)	2
7	Daily PT users.	847,227 *(2002)*	1
	Daily bus passengers	145,085 *(2002)*	1
	Daily paratransit passengers	686,142 *(2002)*	1
	Daily rail passengers	16,000 *(2002)*	1
	Daily motorised users	201,721 *(derived)*	1
	Registered vehicles	90,000 *(2001)*	1
	Modal Split - Public transport - Private transport - NMT	 42% 10% 48%	1
	Public transport Modal Split - Rail - Bus - Paratransit	 1,9% 17.1% 81%	1
	Are there efficient TDM Strategies for the city?	No	
8	# Commuter Rail passengers (2002) # Commuter Rail passengers (2008)	16 000 (Not available)	1
	Commuter Rail network km (2002) Commuter Rail network km (2008)	(Not available) (Not available)	

Section 5.6.4 will present and discuss the evaluation of the KPIs and will use the data listed in table 5.19.

5.6.4. Quantification of KPIs

The outcomes of the quantification of the selected KPIs for Nairobi are presented in table 5.20.

Table 5.20:Nairobi KPIs			
	KPI	**Nairobi**	
To promote public transport over private transport.			
1	% of Motorised transport users using public transport. (All day)	80.8%	(2001)
	% of Motorised transport users using private transport. (All day)	19.2%	(2001)
	% of Dedicated PT road km's out of the total road network for the city.	0%	
	Number of daily PT passengers per 1000 people.	309	(2004)
	Vehicle ownership per 1000 people.	42	(2001)
	% of Population within 15 minutes' walk from a PT facility.	73%	(2005)
To improve the quality of public transport service provided to meet the needs of all users.			
2	Average daily load factor (passengers per seat). - Rail - Bus - MBT	 3.2 4.14 2.09	 (2001) (2001) (2001)
	Average travel time to work, for all public transport commuters during the morning peak period.	58 min	(2005)
	Average travel distance to work, for all public transport commuters during the morning peak period.	4km – 15km's	(2005)
	Total road-based public transport seat capacity per 1000 people. Total public transport seat capacity per 1000 people.	169.25 171.59	(2001) (2001)
	Peak-hour headway (frequency) of the PT services: - Paratransit - Bus - Rail	 Very frequent Not frequent	
	Passengers per train set per day	3200	(2001)
	Passengers per bus per day	483.62	(2001)
	Passengers per minibus taxi per day	53.30	(2001)
To improve the safety and security of the public transport services			
3	Accidents per 100,000 people. (Public and Private)	301.87	(2001)
	Fatalities per 100,000 people. (Public and Private)	23.35	(2001)
	Fatalities per 10,000 vehicles (Public and Private)	57.89	(2001)
To provide reliable public transport services			
4	% of Scheduled PT services that arrive on-time.	n.a.	
To improve the accessibility of the public transport services to all.			
5	% of Population within 1000 m walking distance from a PT facility. (15min)	73%	(2005)
	# PT stops per 100 km^2.	n.a.	(2001)
	% of PT vehicles that are universal accessible. - Total (Road)	 0	
	% PT facilities that are universal accessible.	n.a.	
To provide affordable public transport			
6	Average % of household income spent on PT services per month.	10-15%	(2001)
	% of PT users that spent more than 10% of their household income on PT services.	63	(2001)
	PT fares per trip - Rail - Bus - MBT - Bus - MBT	 $ 0.26 (max) $ 0.27 (12km) $0.31 (14km) $ 0.31 (min) $0.47 (12km)	(2002) (2008)
To promote the use of NMT and PT			
7	Modal Split - NMT - Public transport - Private transport	 48% 42% 10%	(2001)
	Public transport Modal Split - Rail - Bus - Paratransit	 1.9% 17.1% 81%	(2001)
	Are there efficient TDM Strategies for the city?	No	
	Are there provision for bicycle lanes & walkways in the city	No	
To expand and improve the urban rail commuter services.			
8	% Increase in commuter rail passenger volumes	n.a.	
	% Increase in commuter rail network km.	n.a.	

Section 5.6.5 will discuss the results from the KPIs for the case cities.

5.6.5. Analysis of the KPIs

5.6.5.1. Promotion of public transport over private transport

Public transport had an 80.8% share of motorised transport in Nairobi and 19.2% for private transport in 2001. Nairobi has a high percentage of public transport users, which consist of an almost 50:50 split between public transport and NMT users. Most of the public transport users are captive users who cannot afford private vehicles, while the NMT users cannot afford public transport.

The car ownership level for Nairobi was 42 cars per 1000 people in 2001, which is relatively low compared to Cape Town's car ownership levels. Currently, road-based public transport has no priority on the road, with no dedicated public transport lanes. Congestion in Nairobi is a serious problem and by providing dedicated public transport lanes, the travel times of the public transport vehicles will be improved because they will have their own dedicated lanes.

73% of the population is within 15 minutes (1000m) walk from a PT facility. Most of the walkways are gravel or informal walkways, which makes the walking conditions for commuters unpleasant and can increase their travel time.

5.6.5.2. Improvement of the quality of public transport service provided

Public transport commuters are unhappy with the quality of public transport services provided by rail, bus and Matatus in Nairobi. The touts working with the Matatus drivers are harassing passengers, instead of attracting them to use Matatus. The competition between the Matatu and bus drivers leads to poor and reckless driving by the drivers which creates a safety concern for the passengers. The vehicles of the different public transport modes are dirty and old, while overloading of the vehicles happens during the peak-hour periods. There are also cartels and criminal gangs who have organised themselves to control the access to roads and extort money from Matatu operators and owners, this creates unsafe travel conditions for the commuters.

Commuter bus has the highest daily load factor (passengers per seat) of the public transport modes in Nairobi, while Matatus have a much lower daily load factor than commuter bus and rail. This could possibly indicate overtrading of Matatus on some routes. The trains, buses and Matatus are overcrowded during the peak period, although they experience lower utilisation during the off-peak period. The total public transport seat capacity per 1000 people is 172, which is sufficient for the current public transport demand during the peak period, based on a 42% public transport modal share and 847 227 daily public transport users.

The average travel time to work is 58 minutes, while the average travel distance for public transport commuters during the peak-period ranges between 4-15km. Travel time is usually influenced by

traffic congestion (which is bad during the peak periods in Nairobi), frequency of stops to pick up/drop-off passengers enroute and the length of the route. Commuter rail provides a very low frequency service (only one train per route in the morning and afternoon peak period), while Matatus and commuter bus (KBS) provide very frequent service during the peak-period.

5.6.5.3 Improvement of the safety and security of public transport services

Nairobi had 301.87 road accidents per 100,000 people in 2001. It should be noted that the record keeping of accidents in Nairobi might not include minor accidents or be up to date. The number of fatalities per 100,000 people was 23.35 in 2001, while the number of fatalities per 10,000 vehicles was 57.89 in 2001. Nairobi compares poorly against the European rates of 1,2 to 1,8 fatalities per 100,000 people (Pendakur, 2005).

There is not enough information available to evaluate the security of the public transport system for Nairobi. Some of the routes in Nairobi are controlled by cartels and criminal gangs who believe that they can control the routes and extort money from the Matatu operators and owners (as mentioned earlier). One of the major problems for public transport in Nairobi is extortion by the police and law enforcement officers from Matatu owners and drivers.

5.6.5.4. Provision of reliable public transport services

There is not enough information available on the reliability and on-time performance of the public transport modes in Nairobi.

5.6.5.5. Provision of public transport services that are accessible to everyone

73% of the population has access to public transport facilities or stops within a 1000m walking distance from their houses (15 minutes). Although this percentage seems high, the frequency of the public transport services provided during the off-peak period is low, which reduces the accessibility of the public transport service provided. The walkways from commuters' homes to public transport stops or pick-up points are usually informal, gravelled or in poor condition. This creates an unpleasant NMT environment, and can increase their walking time.

The public transport modes do not operate according to a time-schedule, which can lead to long waiting times at the public transport stops or pick-up points. These reduce the accessibility of the public transport service provided. Scheduled public transport services, designated public transport stops with proper shelter and the provision of NMT infrastructure will improve the accessibility of Nairobi's public transport system.

None of the public transport vehicle fleet in Nairobi is universally accessible. It is suggested that more time and planning is spend towards the provision of universally accessible public transport services in Nairobi.

5.6.5.6. Provision of affordable public transport services

The average percentage of household income spent on public transport services per month in Nairobi ranges between 10-15%. 63% of Nairobi's households spend more than 10% of their household income on public transport services which is a relatively large percentage of the population. Nairobi has a GDP per capita of US$ 442, which is low compared to Cape Town's GDP per capita of US$ 3548.

The minimum public transport fare in Nairobi is US$ 0.26 (Commuter Rail), with the maximum fare perceived being US$ 0.47 for a 12km trip with a Matatu.

5.6.5.7. Promotion of public transport service and NMT use

The transport modal share in Nairobi indicates the large percentage of Nairobi's population who cannot afford public transport or private vehicle transport. Even though 48% of the population in Nairobi use NMT as their main transport mode, there is a shortage of pedestrian crossings (especially in the CBD area) and dedicated NMT walkways. With such a high percentage of NMT users it is vital that the NMT infrastructure needs to be improved and increased.

The public transport modal split for Nairobi indicates that paratransit (Matatus) has more than twice the modal share of the other public transport modes. Matatus have a much higher seat capacity than than commuter rail or bus.

Commuter rail only has a modal share of 1.5% and the main reason for this is a lack of rail infrastructure, rolling stock and rail service provision. Currently the total length of commuter railway track in Nairobi is only 147km (12% of the total road-km in Nairobi). The improvement in rail services can lead to an increase in the percentage of public transport modal share for rail transport which could reduce and relieve the traffic congestion that is currently experienced on the roads in Nairobi, especially in the CBD area.

5.6.5.8. To expand and improve the urban rail commuter services

There is not enough information available on the commuter rail passenger volumes and network structure in Nairobi.

Chapter 7 will compare the results of all three cities with each other.

6. Dar es Salaam

This chapter will describe and evaluate Dar es Salaam's public transport system. Dar es Salaam is the largest city in Tanzania and is the principal centre of commerce and industry. It is an important transportation terminal with the port being one of the busiest East African ports. The Tanzania-Zambia Railway Authority (TAZARA) has its northern and main terminal in Dar es Salaam and the airport is the busiest in the country. (Mengesha *et al*., 2002)

6.1. Institutional and Regulatory Framework

The public transport system in Dar es Salaam suffers from a lack of a well-defined authority and administrative system that is responsible for the formulation and implementation of a coordinated strategy for public transportation (Kanyama *et al*., 2004).

6.1.1. Stakeholders

National and local government as well as their agencies make contributions towards the urban transport sector in Dar es Salaam. Mlambo (2009) describes the institutional framework as being very fragmented. The JICA (2008) study identified that there is a serious lack of clarity and consistency in the responsibility and authority of each unit. All the authorities have their particular area of influence and control with little coordination between them.

Dar es Salaam has been decentralized, although every now and again the National government takes control of the City Council because the City Council sometimes has difficulties with performance quality. Table 6.1 indicates the stakeholders that play a role in public transport in Dar es Salaam. The institutional arrangement for public transport is fragmented between various ministries. There is also a lot of duplication in responsibilities between the ministries and authorities and this creates gaps in these responsibilities. (JICA, 2008)

Table 6.1: Dar es Salaam public transport stakeholders (Source: Mengesha *et al*., 2002; Sohail et al., 2005; JICA, 2008; Mkupasi, 2009; Schelling, 2009)	
Planning, Coordination and Strategy Stakeholders	
Ministry of Communications and Transport (MoCT)	• Responsible for policy and guidelines, sector development, operational standards and the licensing of commercial vehicles. • They use the Draft National Transport Policy to help them with the strategies they need to adopt in planning urban transport services.
Ministry of Local Government Development and Regional Administration (MoLGRA)	• Local Authority (City Council), Dar es Salaam Regional Transport Licensing Authority (DRTLA) and Dar Rapid Transit Agency (DART) operate under this Ministry.
Ministry of Finance (Tanzania Revenue Authority)	• Responsible for the collection of taxes. • Public operators must pay provisional tax through the Tanzania Revenue Authority (TRA) before a road service license will be issued to them.

Table 6.1: Dar es Salaam public transport stakeholders - Continued (Source: Mengesha *et al*., 2002; Sohail et al., 2005; JICA, 2008; Mkupasi, 2009; Schelling, 2009)	
Ministry of Infrastructure Development (MoID)	• Responsible for establishing the national policy for all the major infrastructure development in Tanzania. • Surface and Marine Transport Regulatory Authority (SUMATRA) and Tanzania Roads (TANROADS) operate under this Ministry. • TANROADS – In charge of all the national trunk road system development, also for the national and main roads in Dar es Salaam. It is also responsible for the control and maintenance of signs and traffic lights. • SUMATRA – Responsible for the regulation and licensing of marine and surface transport in Dar es Salaam.
Ministry of Home Affairs	• Oversight over the traffic laws in Dar es Salaam.
The Prime Minister's Office – Regional Administration and Local Government Office	• Regional Commissioner represents this ministry, responsible for setting strategic policy and guidelines & assigning responsibilities. • Responsible for the development and maintenance of district, urban and unclassified roads. • District & city councils are responsible for the provision of transport services.
Dar es Salaam City Council	• Three Municipal Councils that operate under it are; Ilala, Kinondoni and Temeke. • Responsible for urban transport services in Dar es Salaam. • Responsible for road development, land-use and urban transport planning, policy formation and urban transport infrastructure development.
Dar es Salaam Regional Transport Licensing Authority (DRTLA)	• Responsible for licensing of public transport vehicles & route allocation. • Responsible for regulatory issues. • Imposes standards on the operations of Daladalas.
Dar Rapid Transit Agency (DART)	• Responsible for establishment, implementation and operation of the BRT in Dar es Salaam. • Under control of City Council. • Established in 2006 as an executive agency operating under the Prime Minister's Office – Regional Administration and Local Government Office under the Executive Agencies Act 1997.
Dar es Salaam Urban Transport Authority (DUTA)	• In 2009 the City Council was planning and working on the establishment of DUTA. • Will be responsible for all the public transport issues. • Will act as one controller with all other bodies underneath them.
Police Department	• Falls under National Ministry. • Main authority for traffic control and traffic management activities on roads. • Responsible for the enforcement of all traffic rules set by SUMATRA.
Operations	
Commuter Rail Operator	• No commuter rail services provided in Dar es Salaam.
Bus Operators	• Prior to 1983, Shirika la Usafiri Dar es Salaam (UDA) operated as a monopoly in the provision of public transport services. • UDA provides commuter bus services in Dar es Salaam but they have a very small modal share.
Paratransit Operators	• Paratransit services (Daladalas) are provided by private operators. • Dar es Salaam Commuter Bus Owners Associations (DARCOBOA) is the association of Daladala owners which provides representation of the interests of Daladala owners.

6.1.2. Regulatory Framework

The provision of public transport in Dar es Salaam is governed by the Traffic Act, the National Transport Policy (2003) and the SUMATRA Act (Mfinanga, 2009; Mkupasi, 2009; Shelling, 2009). Table 6.2 lists the key legislation and policy documents related to urban transport planning in Dar es Salaam.

Table 6.2: Key Legislation and Policy documents related to urban transport planning in Dar es Salaam (Source: Sohail et al., 2005; National Government, 2001; JICA, 2008)
Transport Licensing Act, 1973
The Road Traffic Act, 1973
The Roads Act, 2007
The Surface and Marine Transport Regulatory Authority (SUMATRA), Act, 2001
National Transport Policy, 2003
Tanzania Development Vision, 2025
Dar es Salaam Transport Vision, 2030

6.1.2.1. Public Transport Regulation

SUMATRA is currently in charge of the regulation of public transport in Dar es Salaam. Entry into the public transport market is regulated and the licensing authority imposes some quality standards before a new operator can enter into the market. (Mengesha *et al*., 2002)

Public transport regulation and management in Dar es Salaam usually fails due to the following reasons (JICA, 2008):

- Poor policy frameworks.
- Responsibility is sometimes vague and ill-defined and there is a gap in the responsibilities assigned to authorities.
- Responsibilities are duplicated or fragmented under departments and agencies.
- There is a lack of coordination and integration across sectors and between levels of government.
- The law enforcement of traffic rules in Dar es Salaam is inadequate and the legal and administrative framework for traffic management is out of date (Kanyama *et al*., 2004).

Regulatory Framework for the Bus Industry

Before July 1997, bus fares in Dar es Salaam were fixed by the Price Commission and these fares were fixed upon proposals made by UDA. In order to promote commuters' welfare, the fares were kept low and UDA received a subsidy from government although the government was unable to fund these subsidies which affected the performance of UDA severely (Sohail *et al*., 2005).

The deregulation of the public transport market in 1983 had a negative effect on UDA which led to a decline in UDA's modal share, leaving them with a public transport modal share of 2% in 2002. There

is minimum regulation with regards to market entry, level of service and safety for the bus industry (Mengesha *et al*., 2002).

Regulatory Framework for the Paratransit Industry (Daladalas)

The government has allowed private operators to provide public transport services in Dar es Salaam since 1983, when the Prime Minister, Edward M. Sokoine, directed the Minister of Communications and Transport to officially give licenses to privately owned vehicles known as Daladalas (Sohail *et al*., 2005). After this, the Daladala industry grew fast and has dominated the public transport market. In 1989, they had a 90% modal share (Mengesha *et al*., 2002).

Since 1999 the DRTLA is responsible for the licensing of public transport vehicles in Dar es Salaam. Figure 6.1 shows the steps that a prospective Daladala operator has to follow in order to obtain a license and a route permit.

Activity	Actors	Other requirements / Remarks
Submission of application for bus operation	• Private operator (applicant) • DRTLA	• A copy of vehicle registration card • Business license clearance certificate
Presentation of vehicle to traffic police for road worthiness inspection	• Private operator (applicant) • Traffic Police	-
Submitting of vehicle inspection certificate to DRTLA	• Private operator (applicant) • DRTLA	• Road worthiness inspection certificate
Present vehicle to DRTLA for physical inspection as a passenger vehicle	• Private operator (applicant) • DRTLA	Here the vehicle is inspected whether it meets the standards for a passenger vehicles e.g. seats arrangement, fire extinguishers, first aid tool kit, etc
Painting of the vehicle to reflect the route of operation	• Private operator (applicant) • Appointed workshops for painting of daladala vehicles • (VETA) workshops	Vehicles are usually painted a strip that distinguishes one route to other. This is done in designated garages and workshops by the DRTLA.
Issuance of license	• Private operator (applicant) • DRTLA	This is issued upon scrutiny and satisfaction of the above requirements.

Figure 6.1: Procedure for obtaining an operating license (Source: Kanyama, 2004)

SUMATRA has succeeded in changing the majority of small vehicles (minibuses) into Midi-buses and reduced the vehicle fleet from 10,000 to 7,000 Daladalas. Mr Schelling (2009) believes that the Daladalas are providing a much better public transport service than most of the paratrasit services in Africa due to the good regulatory capacity and control by SUMATRA. The Regional Licensing Authority has developed a colour-coding system for all the Daladala routes. The colour-coded license system makes it easier for policemen to identify vehicles that are not operating on the right route. They also encouraged the use of larger vehicles on some long-distance orbital routes (Mengesha *et al*., 2002).

6.1.3. Industry Structure

The public transport industry operates in a 'laissez-faire' environment which has caused the Daladalas to dominate the public and urban transport market. Currently no public transport services operate according to a time schedule. Public transport services are provided by too many individual operators who are not operating in a co-ordinated manner (Sohail *et al*., 2005). The public transport system operates with minimum regulation with regards to market entry, level of service and safety.

The Public transport system consists entirely of road-based services and has the following public transport modes (Mengesha *et al*., 2002):

- Commuter Bus;
- Paratransit: Minibuses (Daladalas) and Bajajis.

In 2005 there were between 20 and 30 UDA vehicles and between 6,000 and 7,500 Daladalas operating in the public transport market (Sohail *et al.,* 2005).

6.2. Network Structure

Dar es Salaam is situated on the Tanzanian coastal plain, between the Indian Ocean on the eastern side and the Pugu Hills to the west. The main city has developed mainly in the north-south direction along the Indian Ocean coast and also along the west trunk (Morogoro) road corridor.

Dar es Salaam is the largest city in Tanzania. The rapid population growth and land area of Dar es Salaam has led to the rapid increase in the number of vehicles in Dar es Salaam. (Mengesha *et al*., 2002)

The total area of Dar es Salaam is 1800 km^2. Industrial decentralization has resulted in a decline of Dar es Salaam's growth rate from 7.8% during 1967 to 1978, to 4.8% during 1978 to 1988. The 2007 population for Dar es Salaam was 3,03 million. (Mengesha *et al.,* 2002; JICA, 2008)

Table 6.3 indicates the population of Dar es Salaam over the years.

Table 6.3: Population Volumes for Dar es Salaam (Source: Mengesha *et* al., 2002; Logit and Inter-consult Ltd., 2006; JICA, 2008)	
Year	Population Volumes
1948	67,227
1957	128,742
1961	272,821
1967	356,286
1978	843,090
1988	1,360,850
2002	2,487,288
2007	3,030,000

Dar es Salaam is divided into three municipalities: Kinondoni, Ilala and Temeke (figure 6.2). Dar es Salaam consists of a fairly large area with a relatively low average population density of 1500 persons/km^2. The population density for each municipality in 2002 was:

- 2100 persons/km^2 in Kinondoni Municipality, 143 sub-wards.
- 1800 persons/km^2 in Ilala Municipality, 92 sub-wards.
- 1000 persons/km^2 in Temeke Municipality, 129 sub-wards.

There are 364 sub-wards in Dar es Salaam.

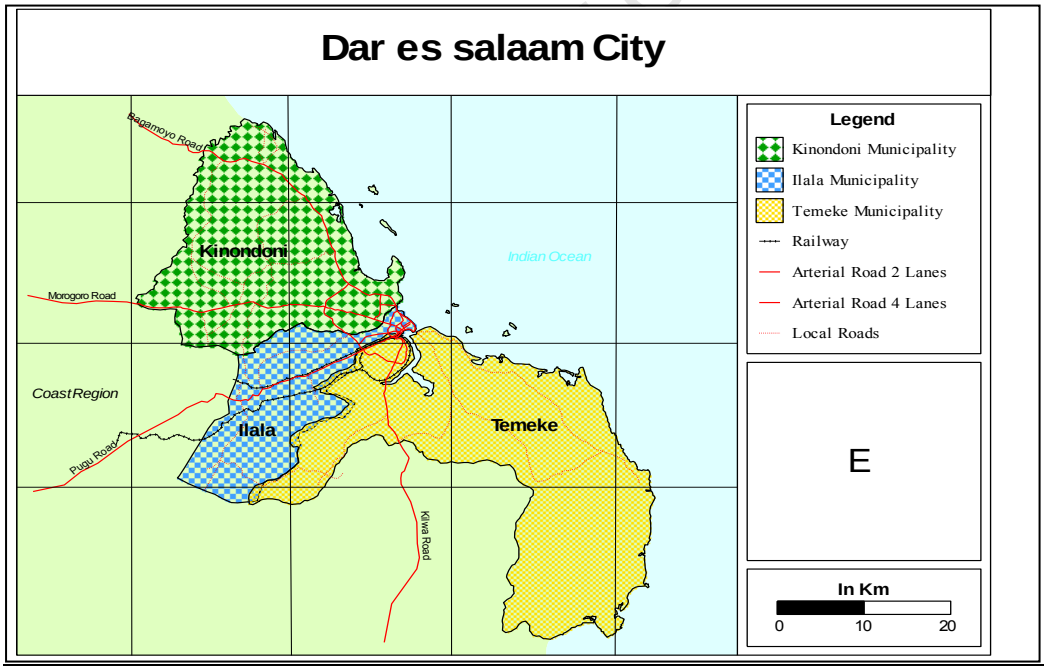

Figure 6.2: Sub-division of Dar es Salaam (Source: Mlambo, n.d.

Figure 6.3 shows that most of the areas in Dar es Salaam are low density areas, with sparse residential areas and less than 5000 persons/km^2. The areas with population density of over 10,000 persons/km^2

are located in areas within a 10 km radius from the CBD and also along major arterial roads (especially Nyerere and Kilwa roads). (JICA, 2008)

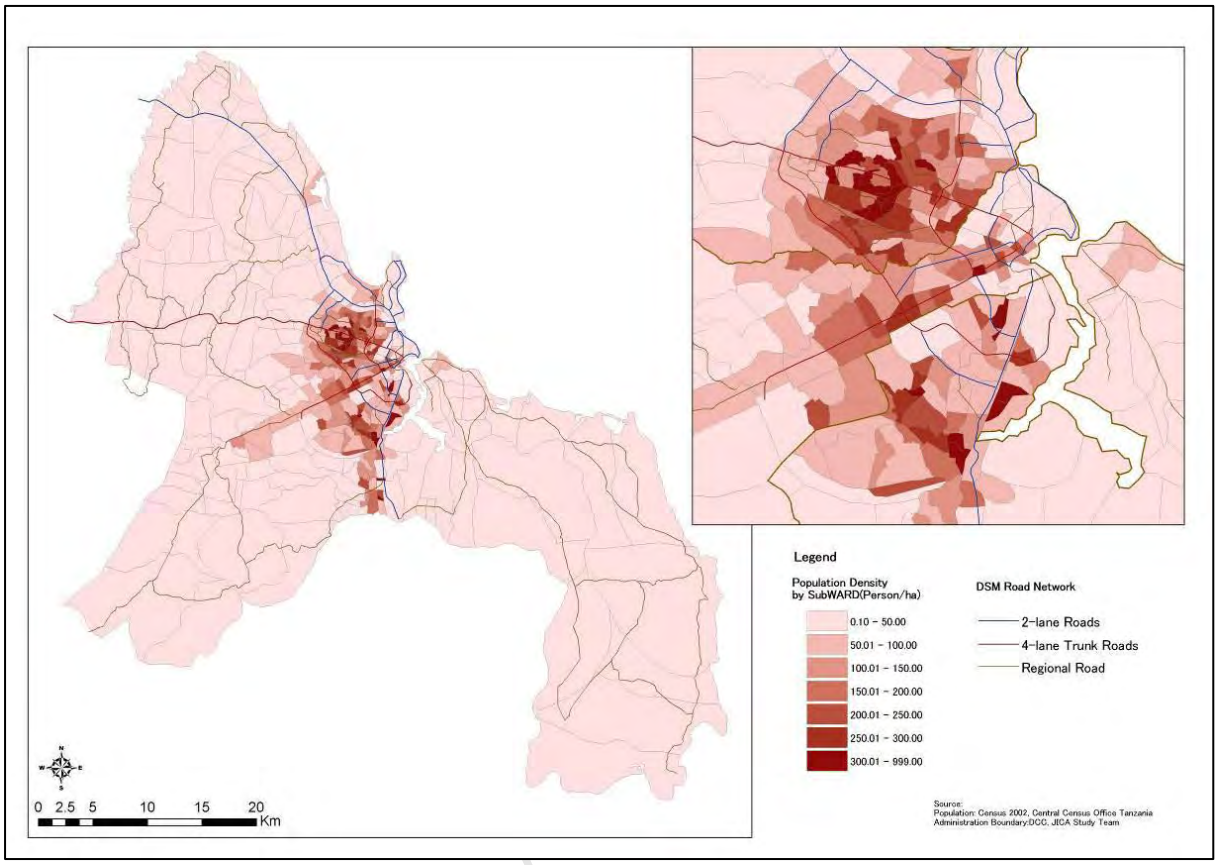

Figure 6.3: Population density by sub-wards (Source: JICA, 2008)

The spatial development of Dar es Salaam is characterised by urban sprawl in the form of low-rise buildings and a low-density built environment. Urban sprawl creates the situation where the government needs to spend more money on the provision of infrastructure in the newly built areas. Dar es Salaam consists of one city centre with a radial road network, while the central area serves as the focal point (Mengesha *et al.,* 2002). Figure 6.4 shows how Dar es Salaam has expanded over the years.

The built-up areas that include residential, commercial and industrial as well as other urban uses amount to 294 km^2 (17.4 %) of the total land area of Dar es Salaam. There are urban developments, "ribbon development", along the arterial roads that nearly reach a 30 km radius from the City Centre, especially along Bagamoyo and Morogoro Roads.

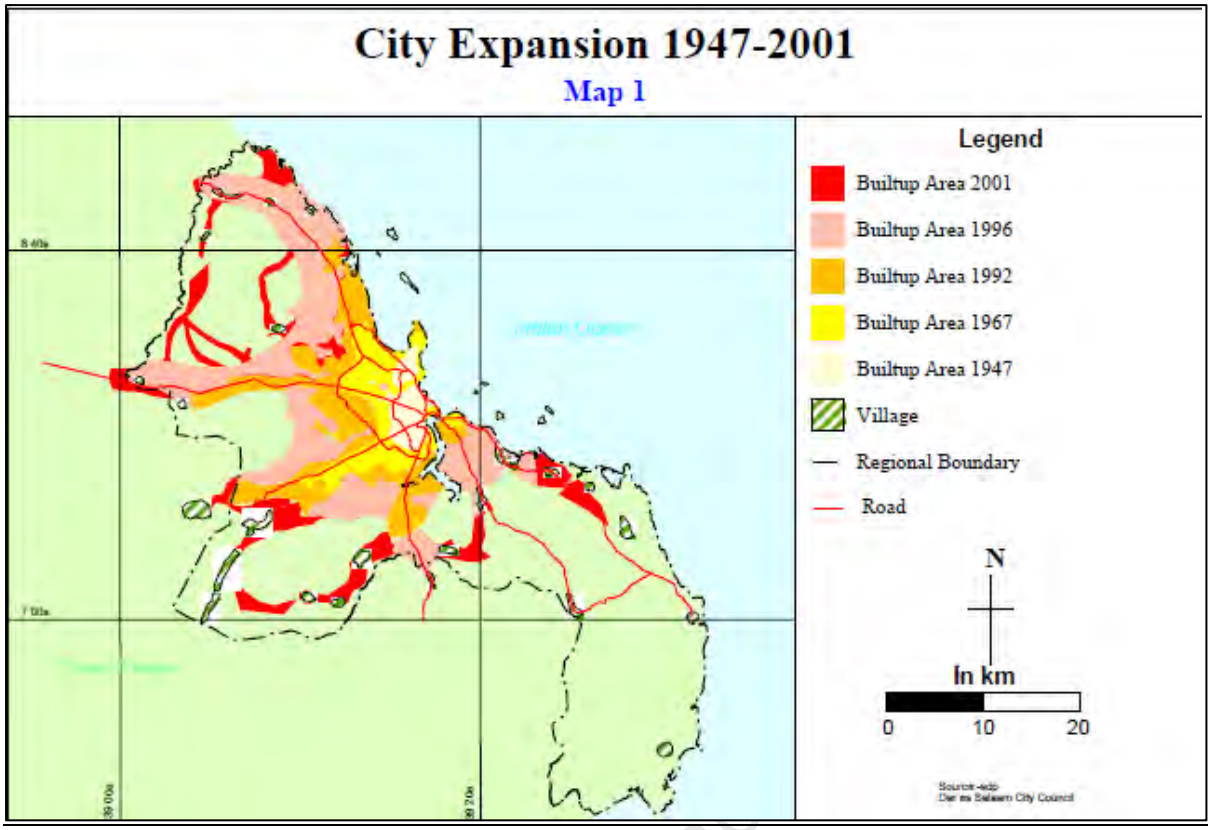

Figure 6.4: Expansion of Dar es Salaam (Source: JICA, 2008)

There are two types of residential areas in Dar es Salaam: "planned settlements" and "unplanned settlements". The planned settlements have basic infrastructure and services that are provided by the local government and are mainly located in the CBD and its surroundings. The unplanned settlements mostly have poor accessibility to basic infrastructure and services and they are scattered all over Dar es Salaam. These settlements accommodate more than 70 percent of the city's population. The largest residential areas are found in Kinondoni Municipality which has a residential area of $110km^2$, followed by Temeke Municipality with $62km^2$and Ilala Municipality with 52 km^2. (JICA, 2008)

Most of the commercial and business activities are concentrated in the CBD. New commercial and business activities have been developed along the arterial roads, especially along Bagamoyo and Morogoro roads and car-oriented large shopping centres have been developed on the outskirts of the city. Small-scale informal commercial and trading activities are located along major arterial roads as well as in the unplanned settlements. Industrial establishments, mainly small scale light manufacturing, are scattered throughout the city with the majority being located in Ilala and Temeke Municipalities, especially along Nyerere Road. Seaport facilities and related warehouses are located in Kurasini and Changombe in Temeke Municipality.

Kinondoni is the most populated district of the three and many of the high-income suburbs are located in this district. There are also low-income neighbourhoods in Kinondoni which are characterised by poor settlement planning, low quality housing and social services. Ilala was established during the colonial period and was designed as a high-density residential extension of Kariakoo designed as residential areas for 'Africans'. Ilala is accessible by Uhuru road that terminates at the city centre and joins the Mandela expressway to the far west. Ilala has low car ownership and many residents either walk or use public transport for their daily livelihood activities. The major land use activities in Ilala include residential, commercial, industrial and institutional uses. Ilala is close to the CBD and thus experiences traffic congestion originating from the north and west, during the peak periods. Temeke is an old low-income area in the middle of Dar es Salaam. Walking is the dominant mode of transport in Temeke. Most of the work places in Temeke are within 7 km of the residential areas and thus only 4% of the walking trips are longer than 5 km. (http://en.wikipedia.org/wiki/Dar_es_Salaam; Kumar & Barret, 2008)

6.2.2 Transport Network

The existing road network for Dar es Salaam is approximately 1,140 km, of which 450 km of this network is paved (JICA, 2008). Most of the road network is not in a good condition, capacity is limited, service lanes are absent and the pavement is also deteriorating. Poor road conditions reduce vehicle speed and also increase the vehicle's maintenance cost.

The commercial activity of the Dar es Salaam port and the geographical characteristic of the urban area have resulted in a radial road network. The CBD serves as the focal point where most of the public and government institutions are concentrated. The radial structure was developed when the travel needs were still strongly oriented towards activities contained in the CBD Area (see figure 6.7). Non-radial travel has become a major factor in commuting and the ring-road system to serve non-radial travel is incomplete. Four major roads radiate from the CBD which are: Nyerere Road, Morogoro Road, Ali Hassan Mwinyi Road and Kilwa Road (Mengesha *et al.,* 2002). Figure 6.5 shows the transport network for Dar es Salaam.

There are two arterial ring roads in Dar es Salaam (Mengesha *et al.,* 2002):

- The Nelson Mandela Road, this links Ali Hassan Mwinyi Road through Sam Nujoma Road with Morogoro Road, Nyerere Road, Kilwa Road and the harbour.
- Kawawa Road, this links Ali Hassan Mwinyi Road with Morogoro Road, Nyerere Road and Kilwa Road through Chang'ombe Road.

These two ring roads have contributed significantly to the efficient operations of commuter travel from the northern suburbs to the southwest industrial area and suburbs.

The most dominant two-lane road in Dar es Salaam (in terms of road length) is the New Bagomoyo Road, which extends over almost 38 km. Kilwa Road, Sam Nujoma Road and Old Bagomoyo Road are also part of the major two-lane road system. Kilwa road is currently experiencing high congestion levels during the peak period. (JICA, 2008)

Figure 6.6 shows the major roads and their traffic volumes. Pugu Road and Morogoro Road have the highest AADT of between 30,000 to 45,000 vehicles.

The sidewalks for NMT are mostly non-existent and even where they exist they are mainly occupied by parked cars. The sidewalks are generally not paved which creates a very poor NMT environment and leads to pedestrians walking in the road. (Logit and Inter-consult Ltd., 2006)

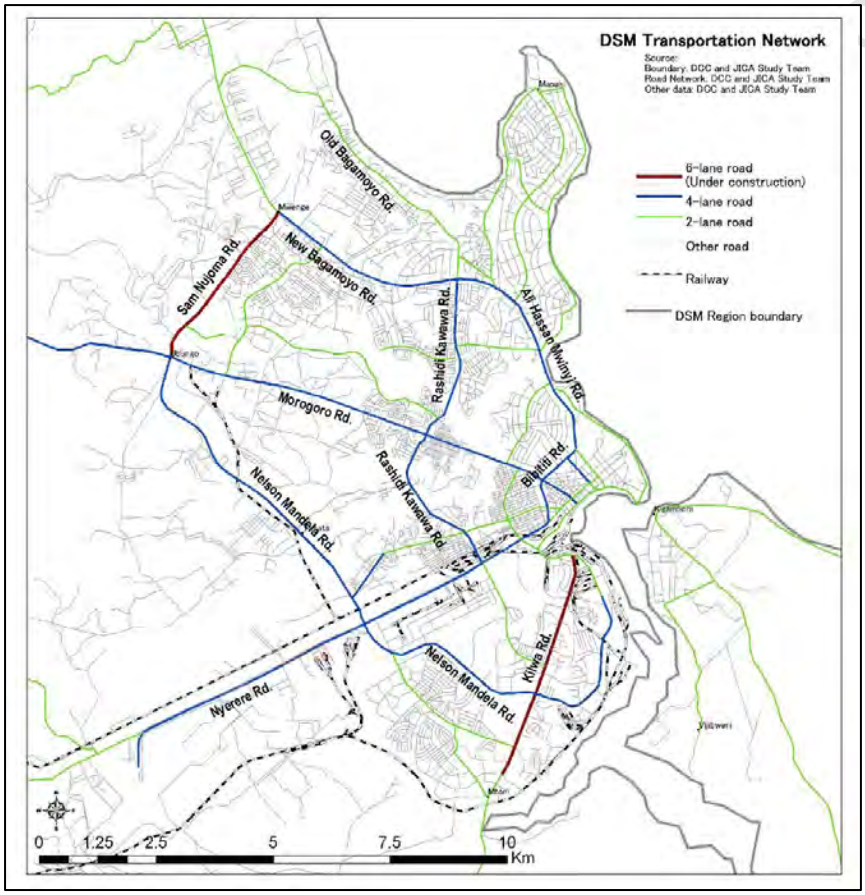

Figure 6.5: Dar es Salaam Transportation Network (Source: JICA, 2008)

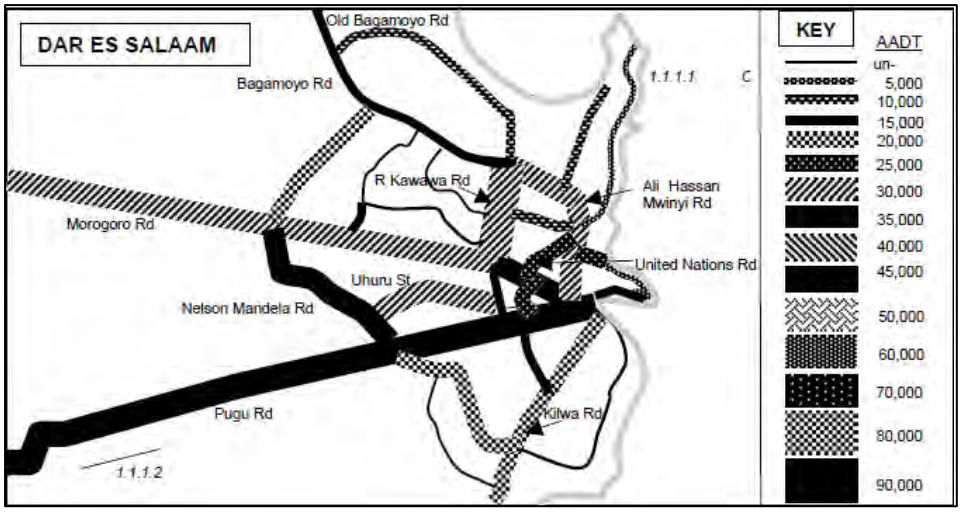

Figure 6.6: Major roads and their traffic volumes (Source: Mengesha et al, 2002)

Table 6.4 shows the travel characteristics of the transport modes in Dar es Salaam. It indicates that for a trip to work, the travel time on a Daladala is the longest.

Table 6.4: Travel characteristics of transport modes (Source: Mengesha *et al.*, 2002)

	Trips to the market		Trips to work		Average transport cost as a percentage of the household income
	Average travel distance (km)	Average travel time (min)	Average travel distance (km)	Average travel time (min)	
Car	7.5	25	12.2	33	19.7
Daladala	7	30	12	58	17.2
Bicycle	2,5	15	1,5	15	2,3
Walking	2,2	34	1	21	6,3

6.2.3. Transportation demand and usage of public transport modes

The demand for public transport has been growing faster than the resources available to satisfy it. The two factors contributing to this growth are the rapid growth in city population and the growth in the city size due to uncontrolled development. (Mengesha *et al*., 2002)

The modal share for transportation in Dar es Salaam in 2002 was (Mengesha *et al.*, 2002):

- 43% Public Transport;
- 45% NMT (42% walking and 3% cycling);
- 12% Private Vehicles.

The modal share for private vehicles in Dar es Salaam is low. Most of the private vehicles are concentrated in the CBD area and along Old and New Bagamoyo Roads, where the higher income population lives (Logit and Inter-consult Ltd., 2006). The public transport market consists of services

provided by UDA, Daladalas and Bajajis, although Bajajis are not seen as formal public transport providers. Daladalas have the largest modal share in the public transport market (98%), while UDA have a modal share of 2%. (Mengesha *et al.*, 2002).

A study done by Kanyama *et al* (2004) shows that the highest private vehicle volumes are in Mikocheni, Tabata and Kurasini. The largest number of walking trips is in Kawe, Ilala and Mbagala. Figure 6.7 shows the modal split for different settlements in Dar es Salaam, while figure 6.8 shows the locations of these settlements.

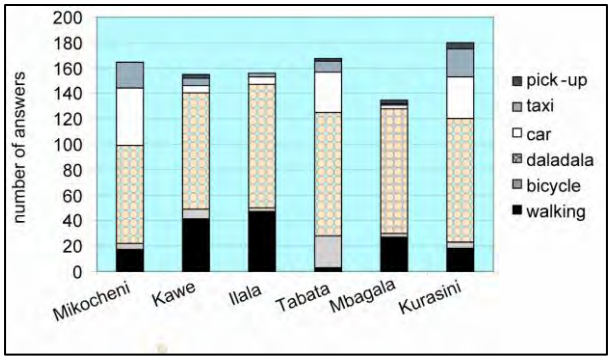

Figure 6.7: Modal split per settlement area (Source: Kanyama et al., 2004)

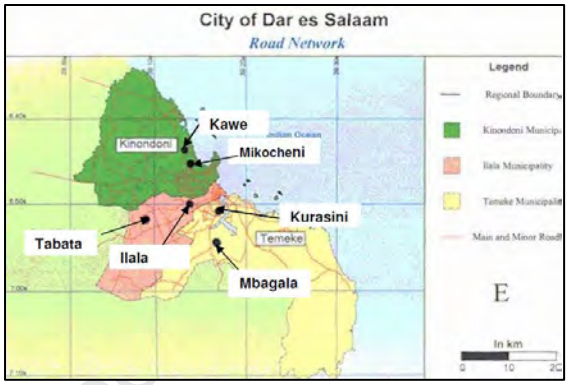

Figure 6.8: Locations of the settlements in figure 6.7 (Source: Kanyama et al., 2004)

Kanyama *et al*. (2004) observed that the proportion of residents who use Daladala services in high income areas was regarded to be as high as that in low income areas i.e., 90% at Kawe, 97% at Ilala, 98% at Mbagala, 77% at Mikocheni, 96% at Kurasini and 96% at Tabata. This indicates that Daladalas are the most common mode of motorised public transport in Dar es Salaam, irrespective of income.

The private vehicle fleet is estimated at 46,953 vehicles, with a car ownership rate of 18,9 cars per 1000 population (Logit and Inter-consult Ltd, 2006). Table 6.5 shows the estimated number of private vehicles per municipality. Temeke has a really low volume with a higher NMT and public transport modal share than the rest of the municipalities.

Table 6.5: Private vehicles per Municipality (Source: Logit and Inter-consult Ltd, 2006)

Municipality	Population	Student Population	Estimated Number of Cars	Cars/ 1000 Inhabitants
Kinondoni	1,083,913	163,618	28,408	26,2
Ilala	634,924	114,123	16,225	25,6
Temeke	768,451	146,442	2,320	3,0
Total	2,487,288	424,183	46,953	18,9

Dar es Salaam has a very low mobility rate; one of the main reasons for this is that a large number of residents cannot afford public transport. Commuters that use walking as their primary public transport mode contributes n 42% of the transport modal share, cycling has a modal share of 3%. Safety is a big reason why people are not using cycling as a main transport mode. Unsafe traffic conditions have an overall negative effect on mobility, especially the high speed of motorized traffic and also the poor driving behaviour of Daladala drivers. Also, many households cannot afford to buy a bicycle. (Pendakur, 2005)

There is a serious lack of NMT infrastructure and an absence of cycling and walking routes in many areas of Dar es Salaam. Pedestrians find it difficult to cross the roads at various intersections in Dar es Salaam and the space available for NMT infrastructure, footpaths and cycle lanes, is usually obstructed or occupied illegally by parked cars and kiosks. (Pendakur, 2005)

Table 6.6 shows the results from interviews held by Mengesha *et al.* (2002) with regards to NMT travel behaviour. It indicates that the average walking distance is below 3 km's and that the travel time of walking is twice the travel time for the same distance with a bicycle.

Table 6.6: Non-motorised Transport Travel Behaviour (Source: Mengesha *et al.*, 2002)

	Trips to the market		Trips to work	
	Average travel distance (km)	Average travel time (min)	Average travel distance (km)	Average travel time (min)
Bicycle	2,5	15	1,5	15
Walking	2,2	34	1	21

6.2.4. Infrastructure

Public transport infrastructure in Dar es Salaam consists of the road network, bus and Daladala termini, parking facilities and bus stops. Although there is no dedicated ROW for road-based public transport, authorities are busy with the planning phase of the Dar es Salaam Rapid Transit (DART) system; which will be a BRT service with dedicated ROW. There are no commuter rail services in Dar es Salaam.

The vision of DART is to have a modern public transport system at a reasonable cost for the users and yet profitable to the operators using quality, environmentally friendly, high capacity buses which meet international service standards and operate on exclusive lanes which will reduce travel time (Mlambo, n.d.).The City Council's BRT project was proposed in May 2003 by the mayor of Dar es Salaam. The planned BRT system would either replace the existing poor and chaotic public transport vehicles (Daladalas) or reorganise them to operate more efficiently alongside the BRT. Funds to execute the

DART project will be obtained from the World Bank, central government and municipalities. (Kanyama *et al*, 2004)

Public transport infrastructure in Dar es Salaam is in poor condition and Mfinanga (2008) stated that poor public transport infrastructure has an impact on the safety and convenience of passengers. Many of the Daladala terminals are in disrepair, with poor lighting, security and lack of cleanliness. Bus bays are not widely available or are on unpaved road shoulders, which cause Daladalas to stop on the carriageway. The inadequate road infrastructure causes vehicle damage and passenger discomfort.

There is one large terminal for long distance buses in Dar es Salaam and a number of smaller terminals, which serve the local public transport buses and Daladalas (Mengesha *et al.,* 2002). Mkupasi (2009) identified that the only big bus terminal is the Ubungo Bus Terminal for Upper Country Bus routes as mentioned by Mfinanga (2009) as well. The following terminals for Daladalas were identified by Mkupasi (2009): Mwenge, Ubungo, Temeke, Bugununi, Ukonga, Mbagala and Kivukone.

An interview with Mfinanga (2009) revealed that the Daladalas stop anywhere they want to stop in the road to drop-off or pick-up passengers. There are not sufficient bays available for Daladalas to stop at and the bays that are provided for them are very small. He also noted that there are no interchange facilities and integration between the various transport modes, although there is an Upper Country Bus Terminal (Regional) where the Daladalas will drop passengers off. Schelling (2009) confirmed that there are few bus stops provided in Dar es Salaam and Mabruk (2009) confirmed that there is no integration between the public transport modes.

6.3. Public Transport Modes

Dar es Salaam's public transport system consists of Commuter buses (UDA), Daladalas, Bajajis and people powered vehicles. Bajajis operate purely on an informal basis without any form of control or jurisdiction. SUMATRA has indicated its unwillingness to formally recognize the operations of the Bajajis because it does not wish to promote their use. However, the Bajajis play a part in ensuring accessibility, especially for those unable or unwilling to walk long distances to bus stops (Mfinanga, 2008).

Studies by JICA (2008) indicate that there has been an increase in the total number of public transport vehicles. Dar es Salaam continues to grow spatially and thus the demand for public transport increases. There has also been an increase in the use of 16-seat minibuses instead of the large standard

and midi-buses in the 1990's, which leads to an increase in the number of minibuses. (Kanyama *et al*., 2004)

Commuter bus services are provided by a state owned operator, Shirika la Usafiri Dar es Salaam (UDA) and paratransit services which consist of large, midi and minibuses are provided by private operators, all referred to as Daladalas. The public transport services provided do not operate according to a timetable. (Mengesha *et al*., 2002)

The public transport modes that will be discussed for Dar es Salaam are commuter bus and paratransit services (Daladalas).

6.3.1. General

Public transport started in Dar es Salaam in 1949, when a private British company, Dar es Salaam Motor Transport Company (DMT), began to provide bus services in the city. DMT were able to provide an efficient service because they had enough resources to cater for the demand and provided services within the 3 km's radius of the urbanised area (Kanyama *et al*, 2004). DMT was nationalised in 1970 and renamed 'Usafiri Dar-es-Salaam (UDA)'. UDA was owned jointly by Dar es Salaam City Council (51% share), and the National Transport Company (49% share) which is a government agency. UDA operated satisfactorily initially after acquiring the assets of DMT. UDA had to operate according to the fare levels set by government and these levels were too low for them to cover all their expenses. This led to a decrease and deterioration in their service quality. (Kanyama *et al*., 2004)

During this period there was a large growth in the population of Dar es Salaam (see figure 6.9) while the capacity of UDA's fleet continued to decrease (figure 6.10). They could not cope with the market demand and many private operators started to provide services in the public transport market. In 1972 private operators started to provide a public transport service parallel to UDA in an attempt to fill the gap in the public transport market. The government banned the operations in 1975. This caused the demand gap to increase and many informal operators started operating illegally. The operators operating illegal private services asked TShs. 5.00. The five-shilling coin was referred to as 'dala' and buses which were charging fares of TShs. 5.00 became known as 'Daladalas'. (Kanyama *et al,* 2004)

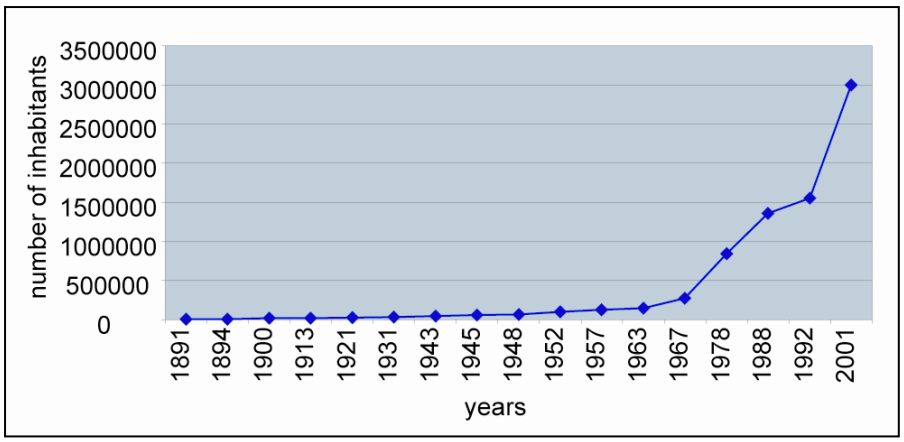

Figure 6.9: Population growth in Dar es Salaam (Source: Kanyama *et al*, 2004)

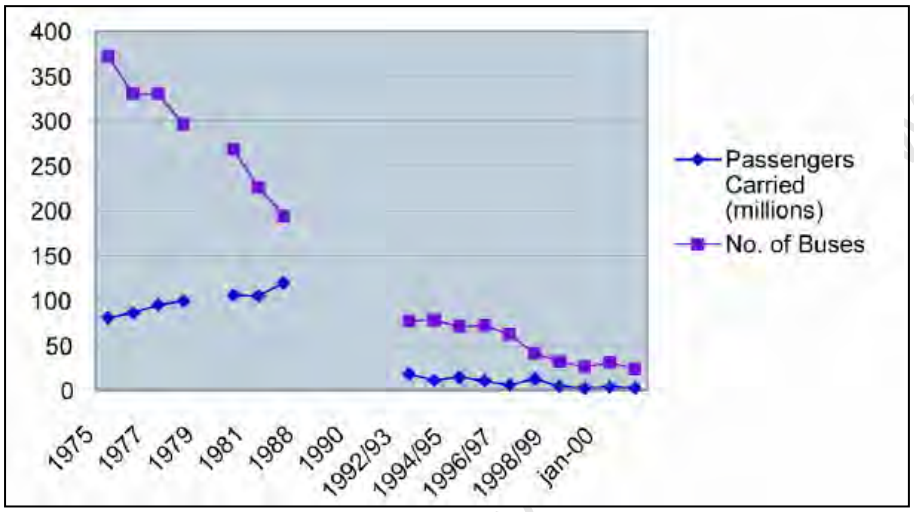

Figure 6.10: UDA Fleet size and number of passengers carried (Source: Kanyama *et al*, 2004)

In 1974 the commuter bus industry was split into two bus transport companies namely: 'Shirika la Usafiri Dar es Salaam (UDA)' and the 'Kampuni ya Mabasi ya Taifa (KAMATA)'. UDA was responsible for providing urban public transport in Dar es Salaam and KAMATA had the responsibility of providing inter-regional passenger transport services throughout Tanzania. UDA's operational fleet continued to decline. In 1980/81 the passenger demand was equivalent of 464 buses, but UDA only had 202 buses. (Sohail *et al*., 2005)

In 1983, due to UDA's lack of efficient capacity and the continuing decline in its operational fleet,the public transport market was deregulated and UDA quickly lost modal share to private operators of minibuses (Daladalas) (Kumar & Barett, 2008). The government of Tanzania issued a decree that officially allowed the operation of Daladalas in an attempt to solve the public transport problems in Dar es Salaam. During the initial phase, the private operators had to operate under UDA who was responsible for the control of the routes on which they operate. In 1991 UDA was relieved of its role in managing subcontracts for Daladalas and the control was placed under the Central Transport

Licensing Authority (CTLA) (JICA, 2008). (Mengesha *et al.,* 2002; Sohail et al., 2005; Kanyama *et al,* 2004)

UDA's services have become unreliable, irregular and rare, and their impact is insignificant on the current provision of public transport services in Dar-es-Salaam (Kanyama *et al*., 2004). Their role as public transport provider has greatly diminished and in 2002 they only had between 12-30 buses (Mengesha *et al.,* 2002).

Currently most of the public transport modal share belongs to the Daladalas. The predominance of the Daladalas leads to inefficiencies in terms of trunk corridor services relative to conventional stage buses. The capacities of Daladalas are not as large as big buses and they are less economic in road space utilisation. The Daladala public transport services are unscheduled and vehicles will depart only when they are full. The lengths of the routes on which the Daladalas operate, range from 3 to 30 km's. The Daladalas are currently operating in a more formalised manner. Currently, UDA receives no subsidies and is barely providing any urban transport services. UDA's fleet consists of 30 buses that operate mostly on out of town routes. (Mengesha *et al*., 2002)

6.3.2. Passenger volumes

There is no data available in the source data on passenger volumes for UDA. The deterioration in UDA's capacity has led to the situation where they were not able to provide an adequate number of buses for the public transport demand. UDA mostly provides services on out of town routes and have no service provision schedule for Dar es Salaam.

It is estimated by JICA (2008) that the Daladalas carry approximately 1.4 million passengers per day. On average males that uses public transport makes 1.26 trips/person/day and the females make 0.75 trips/person/day. The age of the Daladala users ranges between 10 to 49 years, with most of the passengers being workers and students. Only 0.7% of the Daladalas passengers indicated a preference for Daladalas over private vehicles during the JICA (2008) study. The study also indicated that out of the daily Daladala commuters only 56% of them do not have to transfer during their trip while the rest have to transfer and use two or more Daladalas per trip.

Origin-destination surveys by Logit and Inter-consult Ltd. (2006) have indicated that the destinations of Daladala trips are highly concentrated in certain regions such as Kariakoo market, Downtown Centre (Posta), and Muhimbili Hospital. Regions that have considerable demand are Ubungo, Mwenge and Kimara. Figure 6.11 shows the results from the surveys and indicates that most of the

walking trips come from Temeke district and also along Morogoro Road. (Logit and Inter-consult Ltd., 2006)

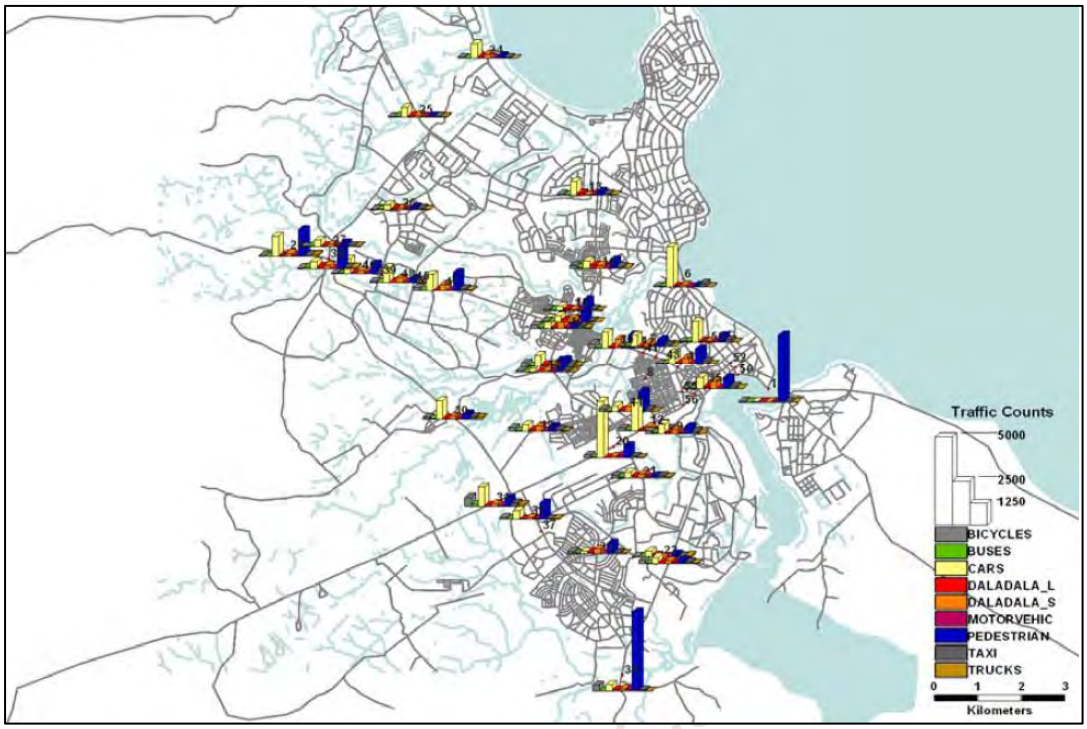

Figure 6.11: Flow Volumes on Major Counting Points (Source: Logit and Inter-consult Ltd., 2006)

Household surveys revealed that less than 50% of the trips made by a household are motorized transport trips. The average mobility of middle and low-income households is estimated at 1.96 motorized trips per person per day. This indicates that many people are immobilized around their homes. A major reason for the low mobility rate is due to the fact that a large number of residents cannot afford public transport fares or bicycles. A bicycle costs about four times the monthly minimum wage. The main trip purposes are work trips and school trips. (Mengesha *et al*., 2002; Pendakur, 2005)

6.3.3. Infrastructure and Vehicle Fleet

Many commuters have indicated through various studies that were carried out, that the condition of Daladala stops and terminals in Dar es Salaam especially at Kawe, Mikocheni, Mbagala, Tabato, Ilala and Kurasini are in a poor state. They are characterised by poorly built and maintained facilities and lack of bus bays, shelters and benches. Some of the problems mentioned through interviews by Kanyama *et al.* (2004) were overcrowding of buses at the terminals and congestion, which increases the air pollution in the residential area. The terminals tend to be chaotic, dirty and unsafe. Inadequate bus bays result in buses from different routes sharing lanes, which cause long delays. At Mwenge bus station (see figure 6.12), trading has contributed greatly to the congestion experienced. It is becoming

very difficult for commuters to establish where buses park for the different destinations (see figure 6.13). There is also a lack of toilet facilities at the bus terminals. The conditions of other Daladala bus terminals in Dar es Salaam are similar to that of Mwenge terminal. (Kanyama *et al*., 2004)

Figure 6.12: Mwenge bus terminal in Dar-es-salaam (Source: Kanyama et al., 2004)

Figure 6.13: Daladala termini in Dar-es-salaam (Source: Kanyama et al., 2004)

Since 1983, the vehicle fleet for Daladalas has been very diverse in both type and capacity. Most of the vehicles are imported as reconditioned or bought second hand from Japan and the Middle East. Currently the majority of vehicle types consist of Toyota Hiace, Toyota Coasters, Isuzu Deluxe and Mazdas. They have a passenger capacity ranging from 18 to 35. The Toyota Hiaces, with a capacity of 18 passengers, dominate on most routes. (Mengesha *et al*., 2002)

The Daladala fleet is old and not well maintained. 90% of the Daladalas are more than 10 years old, 54% are more than 15 years old, while 19% are more than 20 years old. The Daladala fleet is grouped into three main fleets, the Hiace "Kipanya" van of 17 seated passengers (max. 30), the "Coaster" minibus of 30 seated passengers (max. 50), and the "DCM" a slightly bigger minibus with a capacity of 40 seated passengers (max. 65). DCM's are the oldest and worst maintained fleet. The Kipanya type is the most common Daladala and they represents approximately 70% of the active fleet, while the Coaster and DCM types represents 20% and 10% of the fleet respectively. (Logit and Inter-consult Ltd., 2006)

The Daladala fleet increased from only 600 in 1991 to about 7,000 vehicles operating in 2001 (Mengesha *et al*., 2002; Kanyama *et al*. 2004). The total fleet size of buses in 2008 is estimated at 8,500 (7,000 registered and 1,500 unregistered), which consist of 6,800 minibuses and 1,700 midi-buses. Figure 6.14 and 6.15 shows images of the Kipanye and Coaster Daladalas. (Mfinanga, 2008)

Figure 6.14: Kipanye Daladala (Source: Kanyama et al., 2004; Logit and Inter-consult Ltd., 2006)

Figure 6.15: Coaster Daladala (Source: Kanyama et al., 2004; Logit and Inter-consult Ltd., 2006)

6.3.4. Main Routes

Prior to the survey done by Logit and Inter-consult Ltd. (2006), 181 Daladala routes were given as the number of authorized service routes in Dar es Salaam. After the frequency and occupation surveys, approximately 255 Daladala routes were identified. Most of the Daladala routes are concentrated along Morogoro Road (35 routes), Uhuru Street (38 routes) and Kilwa Road (25 routes).The survey indicated that there is a concentration of vehicle and passenger demand on the main corridors with the heaviest volumes on Morogoro Road followed by Kawawa Road and Uhuru Street. Uhuru Street is one of the major routes for buses travelling between the city centre and the settlements of Buguruni, Vingunguti, Gongolamboto, Temeke, Yombo and Tabata (Kanyama *et al*., 2004). The routes operated by Daladalas range from 3 km to approximately 30 km, the longer routes are peri-urban routes.

Logit and Inter-consult Ltd. (2006) shows that the following six routes are the main Daladala routes in Dar es Salaam; Morogoro Road, Uhuru Road, Kilwa Road, Kawawa Road, Nyere Road and Ali Hasson Road (see figure 6.16 for the Daladala routes in Dar es Salaam).

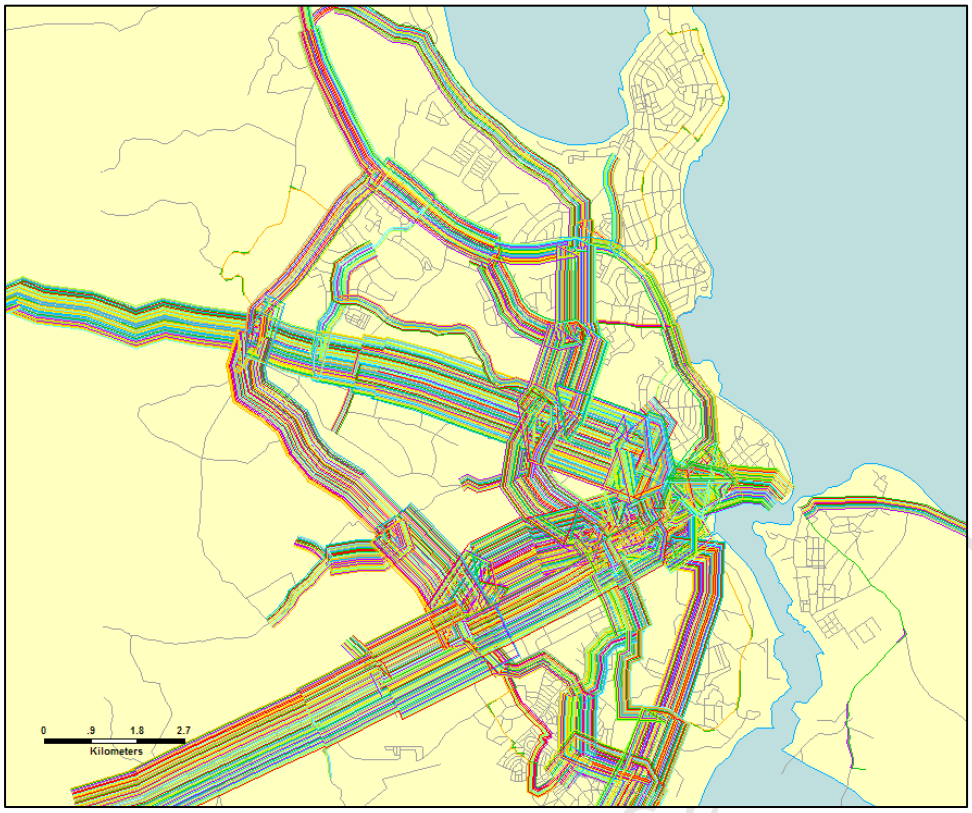

Figure 6.16: Daladala Routes in Dar es Salaam (Source: Logit and Inter-consult Ltd., 2006)

Table 6.7 indicates the 8 hour public transport vehicle volumes for the following three main roads in Dar es Salaam.

Table 6.7: 8-Hour Paratransit Volumes (Source: Mengesha *et al.*, 2002)		
Road	Daladala < 18	Daladala > 18
Morogoro	6,805	1,872
Nyerere	3,179	734
Kilwa	2,067	820

Table 6.8 shows the major trip attributes for Daladala service provision in certain locations and routes in Dar es Salaam.

Table 6.8: Daladala trip attributes (Source: Kanyama *et al*., 2008)			
Location	Travel Time by Daladala (min)	Waiting time (min)	Fare per trip (Tshs)
Mwenge	54.8	35.4	314
Tandika	53.7	34.3	331
Mbagala	52.5	32.6	315
Posta	61.9	36.8	327
Ferry	58.9	34.1	316
Kariokoo	58.9	36.2	364
Ubungo	65.9	34.5	358
TOTAL	56.7	34.9	324

Table 6.9 indicates the passenger and vehicle volumes during the peak hour for the main roads in Dar es Salaam. The highest passengers per vehicle volumes are on Kawawa Road and Nyerere Road, while the lowest volume is on Kilwa Road.

Table 6.9: Passengers and vehicles per peak hour for the main roads in Dar es Salaam (Source: Logit and Inter-consult Ltd., 2006)			
Road	Passengers/hour	Vehicles/hour	Passengers/vehicle
Morogoro Road	15,000	770	19
Uhuru Road	9,000	717	13
Kilwa Road	6,200	549	11
Kawawa Road	10,000	383	26
Nyerere Road	8,600	399	22
Ali Hassan Road	5,100	281	18

6.4. Financial Issues

6.4.1. Economic background of the city

In 2004, Tanzania produced a national GDP of US$11.8 billion (base year 2000). Tanzania was categorized as a low-income country with a GDP per capita of US$320 in 2004. The regional GDP in indicated that the Dar es Salaam region generated US$1.96 in 2006, which was 15.5% of the national GDP. Table 6.10 shows the GRDP for Dar es Salaam per year. (JICA, 2008)

Table 6.10: GRDP of Dar es Salaam Region (Source: JICA, 2008)			
Year	Tanzania Mainland	Dar es Salaam Region	
	GDP (Billion Tsh)	GRDP (Billion Tsh)	Percentage share of the National GDP
1992	1,276	232	18.2 %
1995	2,797	499	17.8 %
2000	6,706	1,159	17.3%
2005	13,063	1,962	15.0%
2006	14,995	2,324	15.5%

Figure 6.17 shows the population by the income level, it indicates that the majority of the population has an average monthly income ranging from US $100 to US $200 (236,363 Tshs). (Logit and Inter-consult Ltd., 2006) The average household income is estimated at 130,000 Tshs per month (US $110) and transportation cost account for between 7% and 18% of the monthly household expenditure.

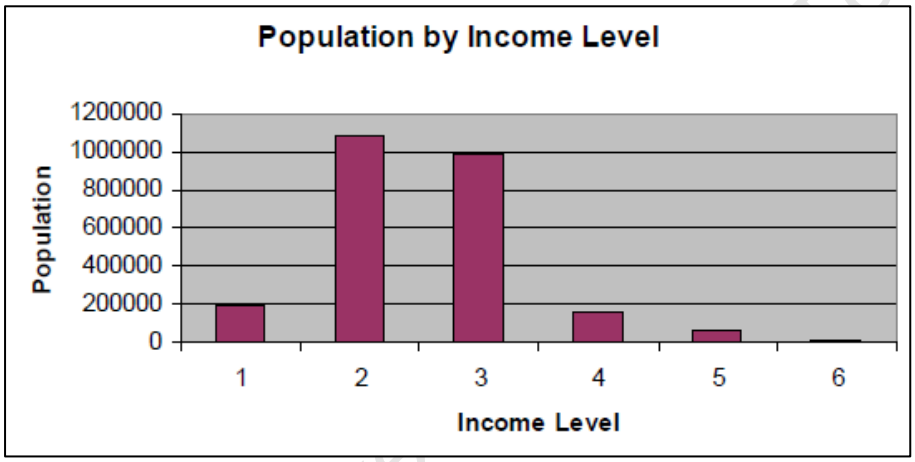

Figure 6.17: Population by income level (Source:Logit and Inter-consult Ltd., 2006)

6.4.2. Fares

Mengesha *et al.* (2002) indicated that the average fare charged by the Daladalas was US $0.21[1] (200 Tshs), while Kanyama *et al*. (2004) describes that the fares charged by Daladala bus operators was US $0.14[2] (150 Tshs) for adult passengers and US $0.05 (50 Tshs) for students/children in 2004. Kumar & Barret (2008) indicated that the fares charged in Dar es Salaam range from $0.16 to $0.26[3], while The Dar es Salaam Regional Authority issued a directive that students should pay 50 Tshs because most parents could not afford to pay the full fare for their children. The government does not pay any

[1] 2002: $1 = 952.38 Tshs
[2] 2004: $1 = 1080 Tshs
2006: $1 = 1180 Tshs
[3] 2008: $1 = 1210 Tshs
2009: $1 = 1300 Tshs

subsidy to the operators for student travel and the Daladala operators must bear the loss of fares due to students who travel on their vehicles. They also have to bear the cost of soldiers who travel free of charge. Mfinanga (2008) mentions that during 2008, students paid 100 Tshs (US$ 0.08), while normal fares were between 250 Tshs and 300 Tshs (US$ 0.21 and US$ 0.25).

Mabruk (2009) confirmed the following fare structure for Dar es Salaam in 2009:

- Daladala fares are negotiable, but the maximum fare is 350 Tshs per trip (US$ 0.29).
- UDA bus fares are fixed, 350 Tshs per trip for any destination, but sometimes they charge less.
- The fares charged by Bajajis are negotiable, but it is more expensive per kilometre than the other public transport modes, because only one or two passengers are transported.

Daladala operators complain that the fares that they currently charge are very low and not enough to cover and sustain adequate delivery of services. The price of oil had risen as well as the cost of vehicles, but the fares remained stagnant for many years (see table 6.12). (Kanyama *et al*. 2004)

Table 6.12: Fuel prices and Bus fares in Dar es Salaam - Tshs (Source: Kanyama *et al.* 2004)

Year	Price of Diesel/l	Price of Petrol/l	Bus fare - Adults	Bus fare - Students
1993	256	325	150	50
2003	680	720	150	50
2004	830	920	150	50

Interviews by Kanyama *et al*. (2004) have established that UDA had increased their fares from 150 Tsh. UDA had three categories of fares, 2004 prices (Kanyama *et al*., 2004):

- Monday to Friday - 250 shillings until 11:00 am
- Monday to Friday - 150 shillings from 11:00 am until night
- Monday to Friday - 50 shillings all day for pupils.
- On Saturdays, the rates are 250 shillings till 9:00 am and after 09:00 am the cost of travelling was 150 shillings.
- On Sundays the rate of travelling was 150 shillings all day.

The demand during the off-peak period is low, which leads to the reduction of the fares charged by some Daladala operators. The competition for passengers during off-peak hours is stiff and it is common to see half empty Daladala buses. (Kanyama *et al*., 2004)

6.4.3. Subsidies

The government used to subsidize UDA in order for them to keep the fares of public transport low, but currently there is no subsidy policy and there are no subsidies provided by government for commuter bus and paratransit services, or any public transport services in Dar es Salaam (Sohail *et al.,* 2005).

6.5. Summary of Dar es Salaam's Public Transport System

This section will summarise Dar es Salaam's Public Transport System into the four categories; Institutional and Regulatory Framework, Network Structure, Public Transport Modes and Financial Issues.

Table 6.13: Summary of Dar es Salaam's Public Transport System	
	1. Institutional and Regulatory Framework
Stakeholders	• PT Regulation is fragmented across government bodies and there is a lack of coordination between levels of government. • Planning, Coordination & Strategy Stakeholders: MoCT, MoLGRA, Ministry of Finance, MoID, Ministry of Home Affairs, The Prime Minister's Office, Dar es Salaam City Council, DRTLA, DART, DUTA, Police Department. Operations: Bus Operators, Paratransit Operators.
Regulatory Framework	• Provision of PT governed by the Traffic Act, the National Transport Policy (2003) and the SUMATRA Act. • Entry into the PT market is regulated. • Poor policy frameworks. • The DRTLA is responsible for the licensing of public transport vehicles in Dar es Salaam, SUMATRA is responsible for the regulation and control of Daladalas.
Industry Structure	• Commuter Bus and Paratransit industry (Daladalas) operates in a 'laissez-faire' environment.
	2. Network Structure
City Characteristics	• Dar es Salaam - Area of 1800 km^2. • Dar es Salaam - Population of 3,03 million people in 2007. • Dar es Salaam - Annual population growth rate of 4,3%. • Population Density – 1,500 inhabitants per square km (2002). • Mostly low density areas. • Urban sprawl with low-rise buildings and low-density built environment. • One city centre with radial road network. • New commercial and business activities have been developed along the arterial roads.
Transport Network	• Road Network of approximately 1,140 kms with only 450 km of paved network. • Four major roads originate from the CBD with two arterial ring roads. • NMT infrastructure is almost non-existent and in a poor condition. • PT system consists mainly of private road-based services (Daladalas) with very few public conventional buses (UDA). • 255 Daladala routes.
Transportation demand and usage of PT modes	• Daily Transport Modal Share for Dar es Salaam; 45% NMT, 12% Private vehicles, 43% PT (2002). • Road-based PT Modal share – 2% Bus, 98% Minibus-taxis (Daladalas) • Daily public transport commuters in 2006 – 1,4 million passengers. • 200,000 Daily trips are made by private vehicles. • Private vehicle fleet estimated at 46,953 vehicles.
Infrastructure	• Urban infrastructure consists of the road network, termini, parking facilities and bus stops. • Ubungo Bus Terminal for Upper Country Bus Routes and Mwenge, Temeke, Bungununi, Ukonga, Mbagala and Kivukone terminals were identified for Daladalas. • Infrastructure in poor condition and inadequate.

Table 6.13 (Continued): Summary of Dar es Salaam's Public Transport System	
	3. Public Transport Modes
Commuter Rail	• None
Commuter Bus	• Services are provided by UDA. • UDA has a 2% Public transport modal share. • UDA has a bus fleet of 20-30 buses.
Minibus-taxi	• Services are provided by private owners, Daladala operators. • 1,400,000 daily passengers trips in 2008. • Operates on 255 routes daily. • Vehicle fleet of 8,500 Daladalas in 2008.
	4. Financial Issues
Economic background of the city	• National GDP of US $11,8 billion in 2004. • GDP per capita of US $320 in 2004.
Fares	• Bus fares (2004) – Minimum fare US $0.14. • Daladala fares (2002) – Average fare of US $0.21 • Daladala fares (2008) – Between US $0.16 – US $0.26
Affordability of PT services	• Average household income is estimated at 130,000 Tshs (US $110) • Transportation cost account for between 7% - 18% of the monthly household expenditure.
Subsidies	• No Subsidies

6.6. Evaluation of Dar es Salaam's Public Transport System

This section will evaluate Dar es Salaam's Public Transport system by making use of key performance indicators. Public transport objectives will help to identify the key performance indicators that are necessary to evaluate the public transport system of Dar es Salaam.

6.6.1. Public Transport objectives

The vision of Dar es Salaam is "*the growth and development of Dar es Salaam towards becoming a world-class city*." (DESCC, 2004)

The 2003 National Transport Policy underwrites the principle of achieving; *"…efficient and cost-effective domestic and international transport services to all segments of the population and sectors of the national economy with maximum safety and minimum environmental degradation."* (JICA, 2008).

The following are the public transport goals and objectives for Dar es Salaam (JICA, 2008; UN-HABITAT, 2009):

- To promote public transport and non-motorised transport.
- To improve the service quality of the public transport system in order to meet the needs of all users.
- To improve the safety and security of the public transport services.
- To provide reliable public transport services.
- To provide accessible public transport services to all. To provide universal accessible public transport services.
- To provide affordable public transport services.
- To improve the public transport system infrastructure and to provide efficient NMT infrastructure.
- To establish an integrated public transport system.
- To provide a sustainable public transport system.
- To provide an efficient public transport system.

6.6.2. KPIs and data required to quantify the public transport objective

For most of the objectives mentioned above more than one KPI can be selected and used to evaluate the performance of the public transport system. These KPIs also need certain public transport data in order to be evaluated (see table 6.14). The objectives that were selected in section 6.6.1 to estimate the KPIs for Dar es Salaam are listed below with their KPIs. The table also indicates the data required to evaluate these KPIs.

Table 6.14: KPIs & Data Required to evaluate the public transport objectives

	Objective	KPI	Data required
1	To promote public transport over private transport.	% of motorised transport users using public transport.	# Motorised transport users. # Public Transport (PT) users.
		% of motorised transport users using private transport.	# Motorised transport users. # Private transport users.
		% of dedicated PT road km's out of the total road network for the city.	Dedicated PT lane km. Total road-km's in city.
		Number of daily PT passengers per 1000 people.	Daily PT passenger volumes. Population size.
		Vehicle ownership per 1000 people.	Number of registered light vehicles. Population size
		% of Population within 15 minutes' walk from a PT facility.	# Population within 15 minutes' walk from PT facility. Population size.
2	To improve the quality of public transport service provided to meet the needs of all users.	Average daily load factor (passengers per seat).	# Daily PT passengers. # PT seats available daily.
		Average travel time to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel times per PT trip in the peak period.
		Average travel distance to work, for all public transport commuters during the morning peak period.	# PT trips in the peak period. Travel distance per PT trip in the peak period
		Total road-based public transport seat capacity per 1000 people.	# Road-based PT seats available daily. Population size.
		Total public transport seat capacity per 1000 people.	# PT seats available daily. Population size.
		Peak-hour frequency of the PT services: - Bus, - Paratransit	Peak-hour frequency (min).
		Passengers per bus per day	# Buses daily in service # Daily bus passengers
		Passengers per minibus taxi per day	# Minibus taxis daily in service # Daily minibus taxi passengers
3	To improve the safety and security of the public transport services	# Road accidents per 100,000 people.	Annual accidents. Population size.
		# Road Fatalities per 100,000 people.	Annual road fatalities. Population Size.
		# Road Fatalities per 10,000 vehicles.	Annual road fatalities # Registered light vehicles
4	To provide reliable public transport services.	% of Scheduled PT services that depart on-time.	# Scheduled PT trips (daily). # Of PT trips that depart On-time.

Table 6.14 (Continued): KPIs & Data Required to evaluate the public transport objectives			
	Objective	**KPI**	**Data required**
5	To improve the accessibility of the public transport services to all.	% of Population within 1000 m walking distance from a PT facility.	# Population within 1000 m from PT facility. Population size.
		# PT stops per 100 km^2.	# PT stops in city. Area of city.
	To provide universal accessible public transport services	% of PT vehicles that are universal accessible.	# Universal accessible PT vehicles. Total PT vehicle fleet
		% PT facilities that are universal accessible.	# PT facilities that is universally accessible. Total # of PT facilities.
6	To provide affordable public transport.	Average % of household income spent on PT services per month.	Monthly household income spent on PT. Monthly household income.
		% of Public transport users that spent more than 10% of their household income on PT services.	# PT users that spent more than 10% of HH income on PT services per month. Total PT users. Average monthly household income. Average monthly PT expenditure.
		Average fare per PT trip.	PT fares per trip. # PT trips. Total monthly expenditure on PT. Number of monthly PT trips.
7	To improve the public transport system infrastructure and to provide efficient NMT infrastructure.	Average age of public transport vehicle fleet.	Average age of public transport vehicle fleet.
		Length of paved NMT walkways per 100km2.	Length of paved NMT walkways. Area of city.
		# PT stops and shelters per 100km2.	# PT stop/shelters Area of city
		% of Dedicated PT road-km's out of total road network.	# Dedicated PT road-km. # Total road network km.
8	To establish an integrated public transport system.	% of PT facilities that have transfer facilities for all the public transport modes.	# PT facilities that have transfer facilities for all the PT modes. # PT facilities.
9	To provide a sustainable public transport system.	Emissions per PT vehicle-km per year.	Emissions caused by PT vehicles per year. # PT vehicle-km per year.
		Average PT vehicle-km's per litre of fuel consumed.	# PT vehicle-km per year. Litres of fuel consumed by PT vehicles per year.
10	To provide an efficient and cost-efficient public transport system.	PT Operating cost per PT vehicle-km.	PT Operating cost per year. PT Vehicle-km per year.

The KPIs listed above will be used in the next section to quantify the performance of the public transport systems of the case cities.

6.6.3. Data needed to calculate KPIs

Table 6.15 lists all the data required to evaluate the KPIs listed in table 6.13. In the case where some of the data required to evaluate a KPI were not available, the KPI will be excluded from the list of KPIs that will be used.

Table 6.15 : Data for calculation of KPIs (sources of data shown in column *)

(Sources:[1] Mengesha *et al.*, 2002; [2] JICA, 2008; [3] Kanyama *et al.,* 2004; [4] Logit, 2006; [5] Worldbank; [6] IMF, 2007; [7] http://www.tradingeconomics.com; [8] Ahferam, 2009, [9] NBS, 2011. [10] Pendakur, 2005)

	Data	**Dar es Salaam**	*
Economic	Area (km^2)	1800	2
	Density (people/ km^2)	1683 *(2005)* 1850 *(2006)*	4
	GDP per capita - Country (US$)	539 *(2011)*	5
		506 *(2009)*	5
		320 *(2008)*	2
		394 *(2007)*	
		207 *(2006)*	4
		245 *(2001)*	1
	GDP per capita - City (US$)	886	9
		550 (2003)	2
	Currency	1US$ = 1,367.50 Tsh *(2011)* 1US$ = 1,271.26 Tsh *(2008)*	7 2
	Population size.	3,030,000 *(2006)*	4
		2,500,000 *(2002)*	3
		2,200,000 *(2001)*	1
1	# Daily PT users.	1,400,000 *(2006)*	4
	# Daily Private transport users.	200,000 *(2006)*	4
	Dedicated PT lane km's.	0	
	Total road-km's in city.	1140	1,4
	Modal Split - Public transport - Private transport - Public transport - Private transport	 88% 12% 93% 7%	1 10
	Modal Split - Public transport - Private transport - NMT - Public transport - Private transport - NMT	 43% 12% 45% 43% 7% 50%	1 10
	Public transport Modal Split - Rail - Bus - Paratransit	 0% 2% 98%	1
	Registered light passenger vehicles	46,000 *(2006)*	4
	% of Population within 15 minutes' walk from a PT facility	Not available (1-2km from home)	8
	Total km's of NMT infrastructure	Not avaialble	

Table 6.15 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Dar es Salaam**	*****
2	Number of Buses	30	1
	Seat Capacity - Buses - Per bus	3,000	1
	Number of Paratransit vehicles	7,782 (Daladalas) 7,000 (Daladalas)	4 1
	Seat Capacity - Paratransit	273,000	1
	Road-based Average travel speed	26 km/h 14,5 km/h (Peak period) 19 km/h (Off-peak)	2 4 4
2	Peak-hour frequency (min). - MBT - Bus	 4 minutes	4
	Daily PT users.	1,400,000 *(2006) Paratransit*	4
	Daily bus passengers	Not available, but very small amount	
	Daily paratransit passengers	1400,000 *(2006)*	4
	Average travel time to work - all public transport commuters (morning peak period).	48 min 58 min	2 1
	Average travel distance to work, for all public transport commuters during the morning peak period.	12 km	1
3	Total Road Accidents	5,995 *(2001)*	1
	Fatal Road Accidents	375 *(2001)*	1
	Registered light passenger vehicles	46,000 *(2006)*	1
4	% of PT trips that departs on-time.	40% *(2004)*	10
5	# PT stops in city.	(Not available)	
	% of Population within 1000m (15 minutes) walking distance from a PT facility.	(Not available) 10.2km from home	8
	Universal accessible PT vehicles - Bus - MBT	 0 0	
	Total PT vehicle fleet	7,812 (Road) *(2006)* 7,030 (Road) 0 (Rail)	4 1
	# PT facilities that is universally accessible.	(Not available)	
	Total # of PT facilities.	(Not available)	
6	Monthly household income spent on PT - Percentage (Average)	17%	1
	Monthly household income spent on PT - Value	US$ 12,04	1
	% HH's that spent more than 10% of HH income on PT services per month.	55%	1
	PT fares per trip - Bus - MBT	 US$ 0.14 *(2004)* US$ 0.29 *(2009)* US$ 0.21 *(2002)* (US $0.16 – US $0.26, Road-based) *(2008)*	 3 2 1 2
7	Average age of public transport vehicle fleet	15 years	4
	Length of paved NMT walkways	(Not available)	
	# PT stop / shelters	(Not available)	
	# Dedicated PT road-km	0 km	4
	Total road network-km	1140 km	4
8	# PT facilities that have transfer facilities for all the PT modes	(Not available)	
	# PT facilities	(Not available)	

Table 6.15 (Continued): Data for calculation of KPIs (sources of data shown in column *)			
	Data	**Dar es Salaam**	*****
9	Emissions caused by PT vehicles per year	(Not available)	
	# PT vehicle-km per year	(Not available)	
	Litres of fuel consumed by PT vehicles per year	(Not available)	
10	PT operating cost per year	(Not available)	
	PT vehicle-km per year	(Not available)	

Section 6.6.4 will present and discuss the evaluation of the KPIs and will use the data listed in table 6.14.

The following KPIs could not be calculated due to the data that is not available and the cost and time that is needed to collect these data;

- % of Population within 15 minutes' walk from a PT facility.
- % of Public transport facilities that are universal accessible.
- Length of paved NMT walkways per 100 km^2.
- # PT stops and shelters per 100 km^2.
- % of PT facilities that have transfer facilities for all the public transport modes.
- Emissions per PT vehicle-km per year.
- Average PT vehicle-km's per litre of fuel consumed.
- PT Operating cost per PT vehicle-km.

6.6.4. Quantification of KPIs

The outcomes of the quantification of the selected for Dar es Salaam are presented in table 6.16.

Table 6.16: Dar es Salaam KPIs			
	KPI	**Dar es Salaam**	
To promote public transport over private transport.			
1	% of Motorised transport users using public transport and NMT. (All day)	88% 93%	(2001) (2005)
	% of Motorised transport users using private transport. (All day)	12% 7%	(2001) (2005)
	% of Dedicated PT road km's out of the total road network for the city.	0	(2009)
	Number of daily PT passengers per 1000 people.	462.04	(2006)
	Vehicle ownership per 1000 people.	15.18	(2001)
	Average walking distance to PT facility	1-2 km	(2009)
	Modal Split - NMT - Public transport - Private transport - NMT - Public transport - Private transport	 45% 43% 12% 50% 43% 7%	(2001) (2005)
	Public transport Modal Split - Bus - Paratransit	 2% 98%	(2001)

Table 6.16 (Continued): Dar es Salaam KPIs			
	KPI	**Dar es Salaam**	
To improve the quality of public transport service provided to meet the needs of all users.			
2	Average daily load factor (passengers per seat). - Road-based Public Transport	5.07	(2006)
	Total public transport seat capacity per 1,000 people.	125.5	(2002)
	Average travel time to work, for all public transport commuters during the morning peak period. (Depending on travel distance)	58 min 48 min	(2002) (2008)
	Average travel distance to work, for all public transport commuters during the morning peak period.	12 km	(2002)
	Peak-hour headway (frequency) of the PT services: - Paratransit	4 min	(2006)
	Passengers per bus per day	n.a., but very few	(2001)
	Passengers per minibus-taxi per day	179.9	(2006)
To improve the safety and security of the public transport services			
3	Road-based Accidents per 100,000 people.	272.50	(2001)
	Road-based Fatalities per 100,000 people.	17.05	(2001)
	Road-based Fatalities per 10,000 vehicles	81.52	(2001)
To provide reliable public transport services			
4	% of Scheduled PT services that depart on-time.	40%	(2004)
To improve the accessibility of the public transport services to all.			
5	% of PT vehicles that are universal accessible. - Total (Road)	0%	
To provide affordable public transport			
6	Average % of household income spent on PT services per month.	17%	(2001)
	% of PT users that spent more than 10% of their household income on PT services.	55%	(2001)
	PT fares per trip - Bus - MBT	 US$ 0.14 US$ 0.21 ($0.16-0.26) US$ 0.29	 (2004) (2002) (2008) (2009)
To improve the public transport system infrastructure and to provide efficient NMT infrastructure			
7	Average age of public transport vehicle fleet	15 years	(2006)
	% of Dedicated public transport road-km's out of total road network.	0%	

Section 6.6.5 will discuss the results from the KPIs for the case cities.

6.6.5. Analysis of the KPIs

6.6.5.1. Promotion of public transport and NMT over private transport

The modal share for public transport and NMT in Dar es Salaam was 88% in 2001 and 93% in 2005. Out of the 93% modal share, NMT accounts for 50%, while public transport had a 43% share. The high percentage modal share for NMT is mainly due to affordability, many people cannot afford public transport. The GDP per capita for Dar es Salaam is US $886 compared to a GDP per capita for Cape Town of US$ 9,991. This is less than a tenth of the GDP for Cape Town. The percentage share for private vehicles is low, 12% in 2001 and 7% in 2005. The vehicle ownership ratio was 15 vehicles

per 1000 people in Dar es Salaam. This is also mainly due to affordability, most people cannot afford private vehicles. Most of the public transport users in Dar es Salaam are captive users.

Prior to 2012 road-based public transport had no dedicated public transport road space. The DART will have dedicated public transport lanes for buses to travel on. Although authorities have been planning the DART System since 2003, they have only started with construction in 2012. The complete DART system will consist of 137km, 18 terminals and 228 stations. The first phase of DART will consist of 20.9 km.

The average walking distance to a public transport facility in Dar es Salaam ranges from 1 – 2km, this is much further than the recommended walking distance of 500m to 1km. Most of the walkways are gravel roads and in poor condition. There are also places where no walkways exist. The quality of the NMT infrastructure in Dar es Salaam needs to be improved, to cater for the captive NMT users.

6.6.5.2. Improvement of the quality of public transport service provided

The quality of public transport services in Dar es Salaam is poor, and most of the public transport users are unhappy with the public transport services provided. 98% of the public transport services are provided by Daladalas, which operate in a deregulated market. The current Daladala industry is characterised by poor standards of comfort, safety and convenience. The drivers are speeding which leads to many accidents and their vehicles are overcrowded.

The Daladalas are overcrowded during the peak period due to peak-period passenger demand. Dar es Salaam has a total public transport seat capacity of 126 seats available per 1000 people. This is lower than the total public transport seat capacity for Nairobi. Currently there are 1,400,000 daily public transport trips, which indicates that there will be an average of 350,000 trips in the peak hour and with a 50/50 percent split per direction it will be about 175,000 trips per direction during the peak hour. In 2002 Dar es Salaam had a public transport seat capacity of 273,000 seats in total, which is sufficient for the current public transport demand. However, if the NMT users (45% modal share) and private vehicle users (12% modal share) starts to use public transport there will not be sufficient public transport seat capacity as indicated by the 126 seats available per 1000 people.

Public transport commuters have an average travel time to work of between 48 and 58 minutes with an average travel distance of 12km. This leads to an average travel speed of between 13 and 15km/h during the peak period. The travel speed of the public transport vehicles is influenced by traffic congestion which is a major problem in Dar es Salaam, while the travel time of commuters is influenced by the frequent drop-off/pick-up stops of the Daladalas en-route.

The frequencies of the public transport services provided by Daladalas are much higher during the peak period than the off-peak period. It was recorded that the Daladalas have headways of 4 minutes during the peak-hour, although the Daladalas do not operate according to a fixed time schedule.

6.6.5.3. Improvement of the safety and security of the public transport service provided

The -road-based accidents in Dar es Salaam that are recorded includes private and public transport vehicles. The modal split between private and public transport vehicles are 14% private vehicles and 86% public transport vehicles. An assumption was made that more than 75% of the accidents reported are accidents where public transport vehicles were involved.

Dar es Salaam had 273 road-based accidents per 100,000 people in 2001, with 17 road-based fatalities per 100,000 people and 82 road-based fatalities per 10,000 vehicles. This compares poorly against the European rates of 1,2 to 1,8 fatalities per 100,000 people. It is more than nine times the European rates.

Dar es Salaam is experiencing an increase in the number of accidents per year. The law enforcement in Dar es Salaam as well as the condition and quality of the public transport vehicles needs to be improved to reduce the number of road accidents in Dar es Salaam. Most of the Daladalas are in a poor condition and old vehicles.

6.6.5.4. Provision of reliable public transport services

Customer perception surveys undertaken during 2004 revealed that according to the public transport customers 40% of the public transport vehicles arrives on-time. Once again the Daladalas do not operate according to a fixed time-scheduled, and an assumption can be made that this is based on a "usual" pick-up time at public transport stops and terminals.

A 40% reliability factor is very low for public transport services and the reliability of public transport provision in Dar es Salaam needs to be improved in order to improve the quality of the public transport service provided. The DART system will be a scheduled public transport service and it is expected that the on-time arrival of vehicles will be more than 90% accurate which will greatly improve the reliability of the public transport provision in Dar es Salaam.

6.6.5.5. Provision of public transport services that are accessible to everyone

There is not enough data available to assess the percentage of public transport users that has access to public transport facilities within a 1000m walking distance from their homes. Data from 2009 indicates that the average walking distance to a public transport facility is 1.2km from home, which is more than the benchmark of a maximum walking distance of 1000m.

The current public transport vehicle fleet in Dar es Salaam is not universally accessible. The accessibility of public transport services in Dar es Salaam needs to be improved, focusing on the distance from commuters home's to public transport stops, the condition of the walkways that the commuters need to walk on and universal accessibility.

6.6.5.6. Provision of public transport services that are affordable to everyone

Households in Dar es Salaam spend an average of 17% of their income on public transport services per month. This percentage is high, especially with 55% of the public transport users spending more than 10% of their household income on public transport. The average household income for Dar es Salaam is US$110. Fromt these rates it is suggested that the poor households might not be able afford to spend so much on public transport. These percentages can also be related to the large NMT modal split, where some households cannot afford public transport at all.

The average public transport fare per trip is US$0.21, with fares ranging between US$0.16-0.26. The Daladala operators are complaining that the fares that they ask are too low and that they need to increase them to take inflation and rising petrol costs into consideration. The government is responsible for some regulation of the fares that the Daladala operators ask. There are no subsidies provided by government for public transport services. The government needs to provide public transport subsidies or change the fare system in order to make public transport more affordable for the poor.

6.6.5.7. Improvement of the public transport system infrastructure and provision of efficient NMT infrastructure

The average age of the public transport vehicles (Daladalas) in Dar es Salaam is 15 years; this is very old for minibus-taxis. Also, most of these vehicles have bad service records and are not in good condition. Most of the Daladalas are older than 10 years with some of the vehicles being up to 49 years old. It is important that the government improve their law enforcement and regulation on the quality and condition of the Daladala vehicles in Dar es Salaam. Older vehicles also tend to have more emissions and have a bigger impact on pollution than a new vehicle. The DART system will get rid of many of the old Daladala vehicles after successful negotiations with the Daladala operators.

The current condition of the road network in Dar es Salaam is not good, some of the roads that the Daladalas operates on are gravel roads. This has a negative impact on the condition of the Daladalas. Dar es Salaam has only 150 metres of paved roads per 1000 population, where the average for a developing world city is 1000 metres per 1000 population

There is not enough data available on the current NMT facilities and infrastructure in Dar es Salaam to evaluate the efficiency of the current NMT infrastructure. The sidewalks and pavements are in a poor condition and are a hindrance to NMT transport. There is an absence of continuous direct routes for NMT in many areas of Dar es Salaam. Existing pedestrian and cycling routes are also obstructed by parked cars or kiosks.

6.6.5.8. Establishment of an Integrated public transport system

Currently Dar es Salaam does not have an integrated public transport system, but it can be expected that once phase 1 of the DART system is completed and also the Dar Commuter Train project the integration between public transport modes in Dar es Salaam will be improved.

Chapter 7 will compare the performance of the three case cities with each other by making use of the results from section 4.6, 5.6 and 6.6.

7. APPLICATION OF METHODOLOGY

7.1. Overview

This chapter will discuss the results from the application of the methodology on the three case cities.

The first section will apply the methodology to describe and discuss the characteristics of the public transport systems of the case cities. The results from chapters 4, 5 and 6 will be used to provide a short summary of each component of the public transport system. A discussion on the results for the cities follows.

The next section will compare the urban public transport systems of the case cities. The results from chapter 4, 5 and 6 where the methodology were applied, will be used to compare the urban public transport systems of the case cities with each other. The goals and objectives that were selected in all three cities are listed, as well as the chosen KPIs for all three cities together. The analysis of the results will follow. The comparison of the public transport systems of a city with other cities helps to identify the areas where the system can be improved.

7.2. Public transport system characteristics

Table 7.1 indicates a summary of the characteristics of the case cities' public transport systems.

Table 7.1. Characteristics of the case cities' public transport systems

1	Institutional & Regulatory Framework	Cape Town	Nairobi	Dar es Salaam
1.1	Stakeholders	• Fragmented across different institutions & stakeholders. • NDOT, PRASA, SANRAL, ACSA, PGWC, COCT, Metrorail, GABS, MBT Operators,SATAWU, NATDO, SANTACO.	• Fragmented across different institutions & stakeholders. • Central Gvt, , MoLG, MoTC, Nairobi City Council, KRB, TLB, Traffic Police, KRC, KBS, Citi Hoppa, Double M, Matatu Operators, Matatu Owners, MOA, MWA.	• Fragmented across government bodies. • MoCT, MoLGRA, Ministry of Finance, MoID, Ministry of Home Affairs, Prime Minister's Office, Dar es Salaam City Council, DRTLA, DART, DUTA, Police Department, Bus & Daladala Operators.
1.2	Regulatory Framework	• Fragmented institutional framework. • PT governed by NLTA (2009)	• Lack of PT regulation. • PT governed by Traffic Act (2004)	• Poor policy frameworks. • PT governed by Traffic Act, the National Transport Policy, SUMATRA Act.
1.3	Industry Structure	• Commuter rail and bus operates under monopoly. • MBT industry operates in deregulated environment.	• Commuter rail operates under monopoly. • Commuter bus and Matatus (Paratransit) industry operates in deregulated environment.	• Commuter bus and Daladalas (Paratransit) industry operates in deregulated environment.

Table 7.1 (Continued). Characteristics of the case cities' public transport systems (Continued)				
2	**Network Structure**	**Cape Town**	**Nairobi**	**Dar es Salaam**
2.1	City Characteristics	• Area - 2,487 km^2. • Population – 3,5 Million people (2007). • Pop Density – 1,407 inhabitants per km^2.	• Nairobi Area - 696 km^2. • Nairobi Metropolitan Area - 4,477 km^2 • Population – 3,24 Million people (2006). • Pop Density – 3,079 inhabitants per km^2.	• Area - 1,800 km^2. • Population – 3,03 Million people (2007). • Pop Density – 1,500 inhabitants per km^2.
2.2	Transport Network	• Road Network > 8,500km. • Radially-oriented road system. • Promotes low density urban sprawl. • Decentralisation from Cape Town central CBD to other nodes. • Relatively long commuting travel times. • PT services provided over a dispersed network. • Rail – 14 service lines. Bus > 900 routes. MBT > 600 routes. • Limited off-peak services.	• Road Network > 1,150km. • Lack of sufficient ring roads around CBD. • 6 Major arterial routes into CBD. • Centralization of activities in CBD – Problem. • Urban sprawl – increase in PT demand. • Rail – 3 service lines. Bus - 50 routes. MBT - 125 routes.	• Road Network - 1,140km. • Lack of sufficient ring roads around CBD. • 4 Major roads originate from CBD with 2 arterial ring roads. • NMT infrastructure – almost non-existent & poor condition. • MBT – 255 routes.
2.3	Transportation demand and usage of PT Modes	• Transport Modal Share: Private 67%, Public 33%. • PT Modal Share Rail 54%, Bus 17%, MBT 29% • Car ownership –825,000 motor vehicles registered in 2001. • Daily > 1,1 Million PT passenger trips. • Passenger volumes; Rail – 601,940 Bus – 197,444 MBT – 332,407	• Transport Modal Share: Private 10%, Public 42%, NMT 48%. • PT Modal Share Bus 70%, MBT 30% • Car ownership – 230,478 motor vehicles registered in 1998. • Daily PT passengers – 847,227. • Passenger volumes; Rail – 16,000 Bus – 145,085 MBT – 686,142	• Transport Modal Share: Private 12%, Public 43%, NMT 45%. • PT Modal Share Bus 2%, MBT 98% • Car ownership – 46,953 motor vehicles (estimate). • Daily PT passengers – 1,4 Million PT passenger trips.
2.4	Infrastructure	• 97 Rail, 132 Bus, 203 MBT, 47 Metered taxi facilities. • Mostly in a poor condition due to under-investment.	• Poor condition due to under-investment.	• Poor condition and inadequate.
3	**Public Transport Modes**			
3.1	Commuter Rail	• Service provider - Metrorail • Provides service to more than half of the daily PT commuters in Cape Town. • 634,837 daily passengers (2007). • 14 Service lines. • Lack of infrastructure & fleet investment.	• Service Provider – KRC. • Infrastructure in poor condition. • Lack of infrastructure & fleet investment.	• None

Table 7.1 (Continued). Characteristics of the case cities' public transport systems (Continued)				
3	**Public Transport Modes**	**Cape Town**	**Nairobi**	**Dar es Salaam**
3.2	Commuter Bus	• Service Provider - Gabs • 270,000 daily passengers (2009). • 1,530 routes. • Bus fleet – 1160. • Many of the buses is old and not always in good condition.	• Service Provider – KBS, Citi Hoppa, Double M, private operators. • 145,085 daily passengers (2003). • 50 routes. • Bus fleet – 300 buses. • Most of bus fleet old and not in good condition.	• Service Provider – UDA • Only 2% PT modal share. • Bus fleet – 20-30 buses.
3.3	Minibus-Taxi (Paratransit)	• Service providers - Private owners. • 378,995 daily passengers (2005). • 556 routes. • Fleet – 7,576 minibus-taxis. • Illegal operators & overtrading on routes.	• Service Providers – Private owners. • 686,142 daily passengers (2003). • 125 routes. • Fleet – 9,894 Matatus.	• Service Providers – Private owners. • 1,400,000 daily passengers. • 255 routes. • Fleet – 8,500 Daladalas.
4	**Financial Issues**			
4.1	Economic Background of the city.	• Annual economic growth rate – 5.4%. • GDP per capita – US$ 3548 • High unemployment levels. • 39% of Households earns less than R20 000 per annum.	• Annual GDP growth rate – 2.5%. • GDP per capita – US$ 442 (2007).	• National GDP – US$ 11,8 Billion (2004). • GDP per capita – US$ 394 (2007).
4.2	Fares	• Rail fares $0.99 (2004). $0.93 (2012). • Bus fares $1.28 (2004). $2.38 (2012). • Minibus-taxi $ 0.87 (2004). $ 1.94 (2012).	• Rail fares $0.16 min (2002). • Bus fares $0.26 (2002). • Matatu fares $0.31 (2002).	• Bus fares $0.14 (2004). $0.29 (2009). • Daladala fares $0.21 (2002).
4.3	Affordability of PT services	• 11% of HH's spend more than 20% of HH income on PT. • 23% of HH's spend more than 10% of their income on PT. (2004)	• 10-15% of HH's income spend on PT. (2001)	• 7-18% of HH's income spend on PT. (2001)
4.4	Subsidies	• Urban rail & bus travel receives subsidies.	• Urban rail receives subsidies.	• No subsidies.

The public transport system characteristics for the three cities shows that for many of the components the three cities have very similar results, especially Nairobi and Dar es Salaam. Cape Town has different characteristics in terms of the Transport Network, Transportation demand and usage of public transport modes and Financial issues. Commuter rail does not have a large public transport modal share in Nairobi and is non-existent in Dar es Salaam.

The next section will compare the results of the KPIs for the three cities with each other.

7.3. Public transport system comparison

Public transport systems of a city can be compared with other cities to see in which areas the system can be improved. It is necessary to consider all the circumstances because the city might have different development goals, resources and contexts with regards to historical, economic, social, cultural, political, geographic, climate, spatial, etc. For many African cities there are a scarcity and lack of data that are needed to evaluate the KPIs in order to evaluate the performance of the public transport system.

Table 7.2 lists the public transport objectives of Cape Town, Nairobi and Dar es Salaam. The table shows that there is considerable agreement between the cities. Seven objectives were common to all three cities.

Table 7.2. Public transport objectives of the three case cities

Cape Town	Nairobi	Dar es Salaam
To promote public transport over private transport.	To promote public transport over private transport.	To promote public transport over private transport.
To improve the quality of public transport service provided to meet the needs of all users.	To improve the quality of public transport service provided to meet the needs of all users.	To improve the quality of public transport service provided to meet the needs of all users.
To improve the safety and security of the public transport services.	To improve the safety and security of the public transport services.	To improve the safety and security of the public transport services.
To provide reliable public transport services.	To provide reliable public transport services.	To provide reliable public transport services.
To improve the accessibility of the public transport services to all.	To improve the accessibility of the public transport services to all.	To improve the accessibility of the public transport services to all.
To provide universal accessible public transport services.	To provide universal accessible public transport services.	To provide universal accessible public transport services.
To provide affordable public transport services.	To provide affordable public transport services.	To provide affordable public transport services.
To promote the use of NMT and PT.	To implement effective TDM strategies.	To provide efficient NMT and PT infrastructure.
	To expand and improve the commuter rail service.	To establish an integrated PT system.
		To provide a sustainable PT system.
		To provide an efficient and cost-efficient PT system.

It can be assumed that the other four objectives for Dar es Salaam; i.e. to improve PT and NMT infrastructure, modal integration, sustainability and cost efficiency would be included in the common objectives.

The following six objectives were common to all three cities and will be used to compare the public transport systems of the case cities:

1. To promote public transport over private transport.
2. To improve the quality of public transport service provided to meet the needs of all users.
3. To improve the safety and security of the public transport services.
4. To provide reliable public transport services.
5. To improve the accessibility of the public transport services to all.

6. To provide affordable public transport services.

Table 7.3 compares the performance of the three cities in quantifiable terms. It must be noted that the data are not always for the same year across the three cities. It is also possible that data has not always been collected using exactly the same methods and levels of accuracy, but they provide a quantitative background to the following comments:

- The three cities can be contextualized as follows;
    1. They have similar populations of over 3 million, and approximating 3,5 million by 2012.
    2. The areas of the cities vary considerable and these are often as a result of administrative rather than functional areas. This is specifically the case for Nairobi where the area of Nairobi is 696 km^2 and for the metropolitan area it is 4477 km^2. This makes using the urban density as a measure of public transport performance difficult.
    3. The GDP per capita of Cape Town is about 8 times that of the other two cities; which might account for the resulting different public transport fares. The GINI coefficient of South Africa suggests that the poor people in Cape Town might be relatively poorer and the rich richer than their counterparts in the other two cities.
    4. The car ownership levels in Cape Town are significantly higher than those in Dar es Salaam and Nairobi, although it must be noted that the data for the latter cities are more than 10 years old.

Table 7.3: Comparison of public transport system performance						
Performance indicator	**Cape Town (Date)**		**Nairobi**		**Dar es Salaam**	
Population (million)	3.1	2005	3.24	2006	3.03	2006
Area (km^2)	2487		4477		1800	
Average density (pop/km^2)	1407	2007	724	2006	1683	2006
GDP/capita (US$)	3548	2007	442	2007	394	2007
National GINI	63.1	2009	47.7	2005	37.6	2007
Vehicle ownership/1000 people	197	2007	42	2001	15	2006
1. To promote public transport over private transport						
Non Motorised Transport (%)	13%	2004	48%	2001	50%	2005
Public Transport (%)	39%	2004	42%	2001	43%	2005
Private Transport (%)	48%	2004	10%	2001	7%	2005
Daily trips (Incl. NMT)/1000 pop	1001	2004	733	2004	1075	2005
Daily motorised trips/1000 pop	871	2004	381	2004	537	2005
Number of daily PT trips/1000 population (pop).	390	2004	308	2004	462	2005

Promotion of public transport over private transport

Cape Town, Nairobi and Dar es Salaam have similar public transport modal share, but Cape Town has a private modal share of 48% compared to 10% and 7% for Nairobi and Dar es Salaam. The results from these KPIs indicates that the car ownership for Cape Town is 197 cars per 1000 people whereas Nairobi and Dar es Salaam have a car ownership of 42 cars and 15 cars per 1000 people respectively. This clearly indicates that the private vehicles ownership rate in Cape Town is much higher than in the other two cities. Cape Town's car ownership results from its GDP/capita and its road infrastructure. Nairobi and Dar es Salaam has a Non-Motorised Transport (NMT) modal share of 48% and 50% respectively, which are probably a result of lower GDP/capita and the urban structure which might allow a better home-work balance than the 13% NMT share in Cape Town produced by decades of Apartheid planning. (This is also evident in the average commuting distances discussed below.)

Besides the 39 km dedicated public transport road space in Cape Town, all three cities have no other dedicated public transport road space. Phase 1 of the BRT (IRT) for Cape Town is almost finished and in Dar es Salaam, DART is currently busy with the planning and implementation of their BRT system.

2. To improve the quality of public transport service provided to meet the needs of all users.						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
PT spaces / 1000 people.	120.1	2004	171.6	2001	125.5	2002
Road PT spaces / 1000 people.	66.6	2004	169.3	2001	125.5	2002
Ave. PT commute in am peak (min)	55	2004	58	2005	48	2008
Ave. PT commute in am peak (km)	15-30 (Range)	2004	4-15 (Range)	2005	12	2002
PT Peak-hour headway -Rail (min) -Bus (min) -Minibus-taxi (min)	 20 15-60 2	 2011 2011 2011	 1 train Frequent		 4	 2006

Improvement of the quality of public transport service provided

Public transport commuters in all three cities are unhappy with the quality of public transport service provided. The standard and quality of public transport services need to be improved in order to provide a "World-class" public transport system.

From the KPI results it is evident that Nairobi offer almost 50% more PT spaces/person than the other two cities. This could imply significant over trading and there might be less control on vehicle entry to the market. By comparing only the road-based public transport seat capacity per 1000 capita, Cape Town has a much lower capacity than the rest, which indicates the importance of the railway service in Cape Town.

Cape Town experiences the longest travel distances, but not the longest travel times; while Nairobi reports the shortest travel distances but the longest travel times. Dar es Salaam has the shortest average PT commuting times, although the difference between the shortest and longest commuting times reported are just over 20%. These differences between the cities could be due to spatial structure reducing the need to travel long distances (i.e. Nairobi) or road and rail infrastructure that results in faster in-vehicle travel speeds (i.e. Cape Town). Traffic congestion and poor road condition can also have an impact on travel times. Differences in data collection could also have an impact on the differences between the cities travel times.

It becomes problematic to compare the frequency of PT service between the three cities. Only Cape Town has a rail service that has more than one train in the peak period, Nairobi only provides 1 train trip during the peak period and Dar es Salaam does not have any rail services. The bus services in Cape Town are frequent depending on the passenger volumes and the routes and the headways range between 15-60 min during the peak hour. Nairobi and Dar es Salaam do not have a sizeable bus fleet, to have information on the frequency of their services. The frequency of paratransit services provided in all three cities is very high during the peak period along the major corridors, due to their size. It is unlikely that significant differences will be noted, even though it was noted that Cape Town has a 2 minute average headway, while Dar es Salaam has 4 minutes.

3. To improve the safety and security of public transport services						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
Accidents per 100,000 population	2,527	2004	302	2001	273	2001
Fatalities per 100,000 population	19	2004	23	2001	17	2001
Fatalities per 10,000 vehicles	10	2004	58	2001	82	2001

Improvement of the safety and security of public transport services

Road accident statistics refer to all traffic and not just those involving public transport vehicles. Cape Town has a much higher number of accidents (private and public vehicles) per 100,000 population than Nairobi and Dar es Salaam, while Nairobi has a higher ratio than Dar es Salaam. Some of the reasons for the high number of accidents in Cape Town is that there are a large number of registered vehicles in Cape Town, the reporting of minor accidents in Nairobi and Dar es Salaam can also be less accurate than in Cape Town and the data collection methods for the three cities can be different. Nairobi has the highest number of fatalities per 100,000 population, but all three cities compare poorly against the European rates of 1,2 to 1,8 fatalities per 100,000 population (Pendakur, 2005). Fatalities per 10,000 vehicles are much lower for Cape Town than Dar es Salaam and Nairobi. All three cities need to improve their safety to decrease the number of accidents and fatalities per year.

There is not enough information available to compare the security of the public transport systems for the cities. Crime is very high in Cape Town, but Nairobi and Dar es Salaam also experiences security issues which all contribute to passengers feeling unsafe when they use public transport.

4. To provide reliable services						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
% of Scheduled PT services that arrive on-time.	n.a.		n.a.		40%	2004

Provision of reliable public transport services

There is not enough information available on the reliability and on-time performance of the public transport modes in Cape Town and Nairobi, although interviews with passengers indicate that they are not satisfied with the current reliability and on-time performance of public transport services. The on-time performance of public transport services provided by Daladalas in Dar es Salaam was estimated by making use of the study of Kanyama *et al*. (2004) in which they surveyed Daladala passengers in all the districts of Dar es Salaam and asked them to give a reliability percentage for the Daladalas. From the survey results it was found that the average on-time performance is 40%. This is the perception of the passengers and could be argued, especially with the Daladalas operating at 2 minute headways.

5. To improve accessibility of the public transport services to all (including universal access)						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
% Population within 1 km of PT facility	85	2004	73	2005	n/a	
# PT stops per 100 km^2.	153	2009	n/a		n/a	
% PT vehicles that are universal accessible	0.35	2009	0		0	
Ave. walking distance to PT facility (km)	n/a		n/a		1-2	2009

Provision of public transport services that are accessible to everyone

Cape Town and Nairobi have over 60% proportion of the population living within 1 km (15 minutes) of a public transport service. Dar es Salaam is slightly less well served with an average walking distance of 1.2 km from home to the nearest public transport pick-up point. Although this percentage seems high, it must be noted that it depends on the frequency of the public transport services provided. During the peak period the frequency of the public transport services in all three cities are high, although it is usually low during the off-peak period, especially for bus and train services in Cape Town.

Prior to the MyCiti IRT services, Cape Town had a PT fleet that was less than 1% universal accessible. GABS have quite a few low entry buses, however they are not fully universal accessible because they need a ramp for wheelchairs to access the bus. The MyCiti vehicle fleet as well as PRASA's refurbishment and upgrading project is currently increasing the percentage of universal accessible public transport vehicles in Cape Town. Currently Nairobi and Dar es Salaam do not have any universally accessible vehicles. There is still a lot of work that needs to be done in order to make the public transport system universally accessible in all three cities.

6. To provide affordable public transport						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
Average % household income spent on PT	5-10	2004	10-15	2001	17	2002
% Users spending > 10% income on PT	23	2004	63	2001	55	2001
Average fare/trip: Rail (US$) Average fare/trip: Bus (US$) Average fare/trip: Minibus (US$)	0.99 1.28 0.87	2004	0.16 0.26 0.31	2002	n/a 0.14 0.21	2004
Average fare/trip: Rail (US$) Average fare/trip: Bus (US$) Average fare/trip: Minibus (US$)	0.93 2.38 1.94	2012				
Ann. PT fare/GDP per capita: Rail Ann. PT fare/GDP per capita: Bus Ann. PT fare/GDP per capita: Minibus	0.13 0.16 0.11	2004	0.16 0.26 0.31	2002	n/a 0.16 0.24	2009
Ann. PT fare/GDP per capita: Rail Ann. PT fare/GDP per capita: Bus Ann. PT fare/GDP per capita: Minibus	0.13 0.30 0.25	2012				

Provision of affordable public transport services

Dar es Salaam and Nairobi households spend on average a far higher proportion of their monthly household income on public transport, 17% and 13% respectively, compared to Cape Town (say 8%). In all three cities more than 20% of the households spend more than 10% of their household income on public transport services, with Nairobi and Dar es Salaam being significantly higher than Cape Town. One of the public transport goals and objectives is to make public transport affordable to everyone and that all households should spend less than 10% of their monthly income on public transport; all three cities need to improve on this aspect.

The public transport fares vary significantly between Cape Town, Nairobi and Dar es Salaam, while Dar es Salaam and Nairobi have similar public transport fares. The fares in Cape Town are as much as five times higher than in the other two cities. This might be due to the difference in GDP/capita between the three cities or the urban form creating the home to work imbalances and long distance travel. The average GDP/capita was used to normalise the fares. When normalised, Nairobi and Dar es Salaam are shown to be higher than those in Cape Town. This is probably due to the subsidies enjoyed by train and bus services in Cape Town.

7. To improve operational efficiency						
Performance indicator	**Cape Town**		**Nairobi**		**Dar es Salaam**	
Average daily load factor (pax/space)						
Rail	3.13	2005	4	2005		
Bus	3	2005	4.29	2001		
MBT	2.85	2005	2.64	2001		
Road-based PT					5.07	2006

To improve operational efficiency

The achievement of operational efficiency is inherent in all the objectives. One of the components of operational efficiency would be cost, but this has already been reflected on in terms of the fares. The other aspect relates to the utilisation of public transport spaces provided. In Cape Town, buses, rail and Minibus-taxis have very similar daily load factors. In Nairobi buses and rail have high performance rates, but this is probably because the parameter is based on seats and considerable standing occurs in peak periods. Dar es Salaam has the highest utilisation for minibus-taxis, this is due to the high paratransit modal share (98% Daladalas). This might also be a reason why their average fares have been reported to be the lowest. Minibus-taxis have lower capacity than big buses or trains and thus need more vehicle trips to provide the same capacity as a large bus or train.

Chapter 8 will discuss the conclusions on the public transport systems of the case cities.

8. Conclusions and Recommendations

8.1. Literature Review

The literature review aims to identify the characteristics of public transport systems and to develop a methodology that can be used to describe, discuss and compare public systems. It is based on studies that have been done on the characteristics of public transport systems.

From the literature review it was evident that the four most important themes used to describe public transport systems are; Institutional & Regulatory Framework, City and Public transport network structure, Public Transport Modes and Financial Issues.

It was found that performance monitoring and evaluation is seen as an essential process in monitoring and improving public transport services. Performance data also provides public transport agency management with objective assessments of current circumstances. The literature review indicated that the KPIs that will be used to assess the performace of a city's public transport system need to be derived in relation to the goals and objectives of a city.

From the literature a list of performance measures were compiled that was used to create the list of KPIs used further in this study.

There was a lot of literature available on public transport characteristics and performance indicators, but very few literature on how to normalize the public transport data in order to compare across cities.

8.2. Research Design

The methodology used in this study consists of five phases: Literature review to determine the characteristics and performance measures of the public transport systems, a methodology to describe and discuss the public transport systems, the collection of the data from the three case cities, the methodology to evaluate and compare the public transport systems and the application of the methodologies to the three case cities; Cape Town, Nairobi and Dar es Salaam. The use of the different phases of the methodology worked well together in order to undertake a comprehensive study of the public transport systems of the case cities.

8.3. Application of the Methodology in three phases

8.3.1. Describing and discussing the public transport systems

Difficulty was experienced in determining the aspects to be included when describing public transport services for the following reasons.

- The list of possible characteristics to use is very long.
- The amount of data to feed this list is short.
- The data from different sources often do not agree.
- The data is not up to date and was collected for different purposes which required different levels of accuracy.

This methodology was used to reduce the number of components and characteristics that are required to describe a public transport system.

The following conclusions were made about this phase of the methodology.

- This phase provides a good method of setting up and displaying a structured list and summarising the components and characteristics from different sources.
- It was found that certain themes were under-represented and additional characteristics were identified as important and selected.
- Because of time limitations not all the possible literature on public transport systems was analysed and the review of additional literature could lead to some changes in the list of characteristics. However, the quality of the texts reviewed provides confidence that none of the most important characteristics have been omitted.

The application of this methodology to the case cities was acceptable although the chosen components and characteristics were still too many and provided too much information for a short summary on the public transport system of each city.

8.3.2. Data collection

A data collection tool was developed to collect public transport data from the case cities. Interviews in each city were held with public transport stakeholders in order to collect public transport data. The questionnaire was useful in the collection of public transport data, but the data collected from the interviews were not enough for the performance measurement of the case cities and additional data had to be collected through secondary data collection and desktop studies. The questionnaire was maybe too long and can be improved by selectively reducing the number of questions.

The following findings were made of the data collection tool, phase 1 of the methodology:

- The questionnaire was too lengthy, some of the interviews continued for over two hours.
- It was not possible to collect all the necessary data from each interview. There are two possible reasons for this: the questionnaire was too long and there was not enough time to go through all the questions or the respondent did not know the answer to specific questions.

- The perceptions of respondents in the same city sometimes did not agree with each other.

The questionnaire can be improved by reducing its length and the section on Financial Issues and Macro Performance Indicators can be omitted. None of the respondents were able to answer questions related to sections 6 and 7, they all referred to studies, survey results, financial statements and electronic data where the answers to these questions can be found. The Financial issues and Macro Performance questions should be in a separate questionnaire that would be sent to the respondent before the interview and would act as a request for electronic and/or printed data available to answer these questions.

Interviews in each city should be arranged at the least a month before the planned visit to the city and a copy of the interview questionnaires should also be sent a month before to enable the respondents to prepare for the interview. Interviews in each city should be arranged with all the stakeholders involved. If the budget of the project allows it, it would be valuable to do surveys with the public transport users on the macro performance indicators in each city.

8.3.3. Assessment of the performance of the public transport systems

This phase focused on the calculation of KPIs and the comparison of the calculated KPIs across the case cities. The problem that was faced during this phase was trying to compare the cities. The question to ask is whether this should be done on the basis of a set of quantums (e.g. km of road, or rail, or number of coaches) or should the comparison be contextualised. What is the purpose of comparing the quantums of cities with totally different sized economies, per capita incomes, geography, history or developmental objectives? In this study the comparison was based on the developmental objectives. The study indicated that the transport objectives for the three cities were very similar, which was surprising. The resources and constraints to achieve these objectives vary between the cities. Therefore, in comparing the transport systems of cities, they need to be compared in terms of how they contribute to development and how they perform with the resources they have.

The following conclusions were made about this phase of the methodology.

- The process of selecting the goals and objectives of a city in order to identify the KPIs worked very well, especially to ensure that the most important KPIs for a city are selected.
- For most objectives, more than one KPI can be selected from a set of KPIs to evaluate the performance of the public transport system.
- The socio-economic indicators of each city, eg. GDP per capita, area, population and car ownership, make it possible to contextualize the data for each city in order to compare them across each other.

- It was difficult to collect all the data needed to evaluate the selected KPIs and careful consideration needs to be given to the time and resources needed to collect the data versus the importance of the specific KPI.
- Some of the public transport data of the cities are not available for the same year and the data were selected from sources that were as close together in terms of the year, as possible. Growth factors might have to be used in order to make sure that the data used in the calculations are for the same year.
- One of the aspects that was lacking in this study was the data to estimate how the performance of the city and the public transport system has improved, for longitudinal studies.

The spread sheet model developed to evaluate the performance of the public transport systems of the case cities was successful and efficient in the application process. The model assists in the determination of the most appropriate KPIs and calculates and compares each KPI across the cities.

The different phases of the methodology worked well together in this comprehensive study of the public transport systems of the case cities.

8.4. Performance of the public transport systems of the case cities

This study quantified and analyzed the performance of the public transport systems of three case cities through the use of the methodology discussed in chapter three in order to describe, discuss and evaluate the public transport systems. The characteristics of the public transport systems in Nairobi and Dar es Salaam are very similar, with both markets dominated by paratransit services whereas Cape Town's public transport market is dominated by commuter rail services. Some of the characteristics of the public transport system in Cape Town are different from the other two cities, but all three cities have congested networks, poor quality of public transport services, struggle with the regulation of the paratransit services and have some of the population that cannot afford public transport.

The results from the KPIs once again showed that Nairobi and Dar es Salaam have very similar results, while Cape Town has different results which can be attributed to the much higher GDP/capita and significant higher car ownership levels. All three cities need to improve the quality of service and performance of their public transport systems in order to reach the standards of a "World-class" public transport system.

8.5. Interpretation and Discussions

The study conducted in this research has allowed for a comparative study of the public transport systems of the case studies.

It is recommended that the methodology used in this study can be improved with the following:

- By shortening the number of components and characteristics used to describe the public transport systems.
- A small study can be undertaken to create a model to rate the characteristics of the public transport system, like a Multi-Criteria-Analysis.
- During the evaluation process, the data collection process of the data required to estimate the selected KPIs could be improved by shortening the amount of time that is necessary to collect the data. This can be done by building up a database of data for each city and updating this database on a regular basis. It is also vital that the user of the methodology understands each KPI in terms of the data required, the estimating process and also the interpretation of the results.
- The current methodology does not have benchmarks for each KPI listed, and it is suggested that additional research should be obtained to update the methodology by adding benchmarks (for the public transport systems of developing countries) for all the KPIs. Benchmarks are important as they help to give a perspective on how good or bad the quality of PT service is for each city.
- Additional research on user preference studies and the users' perception of the quality of the public transport systems for each city should be obtained, as there are currently not many research studies available with these data.

The methodology used in this research is user-friendly and easy to understand and enables us to undertake a comprehensive study on the public transport systems of a city. This research process is very valuable as it provides relevant information on the quality of public transport systems; this is especially helpful as most African cities are struggling to improve the quality of their public transport systems. The KPI results will indicate to government and stakeholders where the problem areas are and how they compare with other cities.

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Annexure 1

ACET

VREF African FUT CoE for Studies in Public and Non-motorised Transport

ACET PROJECT 6: PUBLIC TRANSPORT

Project leader *Dr David Mfimanga, Department of transportation and Civil Engineering, University of Dar es* ***Salaam, Tanzania****.*
Researcher: Ms Yolandi Venter; Centre for Transport Studies, University of Cape Town, South Africa.

The ACET research project is a 4-year collaborative research initiative between the Universities of Cape Town, Dar es Salaam and Nairobi into public and non-motorised transport in developing countries sponsored by the Volvo Research and Education Foundation.

This interview serves to collect information on the existing public transport services in each of the three cities. The questionnaire serves as a prompt for questions and requests for printed and/or electronic information.

In each city, interviews will be arranged with transportation planning officials and transport planning consultants; as well as representatives of the major public transport sector to collect the following data:

a) The institutional context (stakeholders, regulation, policies, enforcement, funding) in which public transport services are provided.
b) The population demographics, land use structure, land density and public transport networks.
c) The numbers of passenger trips made using each mode (public and private) in the city as a whole; and the number of vehicle and passenger trips on major corridors.
d) The size of fleets and types of vehicles (capacity, age, condition, etc).
e) Operational issues (capital and operating costs, passenger numbers, fare structure and subsidies, operating speeds, road and stop infrastructure).
f) Performance indicators, difficulties and plans.

The intention is to have meetings in each city with:

1. Urban transport planner, city planner and/or City Council representative for regulatory framework
2. Urban transport planner (Private Company or consultancy)
3. Representatives of Commuter Rail (where applicable), Bus and/or Paratransit Operators

1. INSTITUTIONAL AND REGULATORY FRAMEWORK

(Please indicate where information is available elsewhere; i.e. person, organisation, report, data set, etc)

1.1 STAKEHOLDERS

1.1.1 Who are the different stakeholders of the Public transport system and what are their roles? (Hierarchy, also for the different modes)

1.1.2 Who is responsible for the planning, provision, enforcement of public transport services? (Refer to different modes)

1.2 REGULATION OF PUBLIC TRANSPORT

1.2.1 How is Public Transport regulated?

1.2.2. What are the most relevant pieces of legislation that regulate public transport services?

1.3 PUBLIC TRANSPORT POLICIES

1.3.1 Is there a fare policy? (Please describe).

1.3.2. Is there any subsidy policy? (Please describe).

1.3.3. Who provides funding for public transport? (Capital and operating)

1.3.4. Are there any Travel Demand Management policies or strategies? (Please describe)

1.3.5 What are other important policies (National and Local)?

1.3.6 How well are these policies working?

1.3.7 How do you think these policies can be improved?

1.4 DELIVERY OF PUBLIC TRANSPORT SERVICES

1.4.1. How is the planning of public transport and the planning of land use integrated?

1.4.2. Who is responsible for the safety and security issues of public transport?

1.4.3. Is the public transport provided, financially sustainable for the different modes?

1.4.4 Which of the public transport modes operates under contracts? (Describe the types of contracts)

1.4.5. What are the major problems facing public transport?

2. CITY STRUCTURE AND PUBLIC TRANSPORT NETWORKS

2.1. When was the last transportation planning study or public transport plan prepared for the city?

2.1 Is it possible to obtain an electronic or paper copy of the report?

2.3 Is it possible to obtain a map that shows the major land use elements (e.g. CBD, major employment centres, recreational areas and residential areas) *(In the planning report?)*

2.4 Is it possible to obtain a map that shows the transport zones; and also information for each traffic zone on the number of people and jobs, trip making characteristics (trip generation, trip distribution and modal split) *(In the planning report?)*

2.5 Is it possible to obtain a map that shows the major public transport corridors; and also information on the passengers per day, peak-hour passenger volumes, modes on route, modal split, surrounding land-use activities and residential density –low, medium or high *(In the planning report?)*

2.6 Is it possible to obtain a map that shows the major modal interchanges and information on the modes, number of passengers and vehicles using each interchange and the facilities provided? *(In the planning report?)*

2.7 Is it possible to obtain information on the number of passenger trips made per day and/or in the peak periods and the modal split (private vs public transport and (rail, bus and informal) *(In the planning report?)*

2.8 How are the public transport modes integrated?

2.9 How well do you think the public transport system is meeting the demand?

2.10 What are the difficulties with regards to public transport planning?

3. PASSENGER RAIL TRANSPORT

3.1 GENERAL
3.1.1 How has rail transport developed in the city and in the country?
3.1.2 Are there any important historical events that have affected the development of rail transport in the city?
3.1.3 Who is responsible for the regulation and management of the operations and operators of rail transport?
3.1.4 What is the passengers' volume per day for rail transport?
3.1.5 What are the operating and capital costs of passenger rail transport per year
3.1.6 What is the capital or operating subsidy provided for rail transport per year?

3.2 INFRASTRUCTURE *(Map showing network and stations?)*
3.2.1 What are the main routes for rail transport in the city?
3.2.2 What is the length of the rail network?
3.2.3 How many railway stations and terminals are there in the city?
3.2.4 What is the current condition of the rail infrastructure?
3.2.5 What is the capital expenditure on track, stations and depots?
3.2.6 How is this funded?
3.2.7 What are the main issues, difficulties and problems with rail infrastructure? What are the solutions?

3.3 VEHICLE FLEET
3.3.1 What types of vehicles are used for the rail transport, what is the capacity and cost of these vehicles?
3.3.2 How many vehicles are there in the fleet?
3.3.3 How many vehicles are operating in the peak-hour?
3.3.4 What is the fleet utilisation?
3.3.5 What are the average vehicle kilometres per day or per year for rail transport? (Or what are the vehicle-kilometres per day or per year?)
3.3.6 Average number of breakdowns?
3.3.7 Energy consumption per vehicle?
3.3.8 Amount of dead kilometres per day or per year?

3.4 SOME DETAIL *(For the main routes in peak and off-peak periods)*
3.4.1 What is the vehicle frequency?
3.4.2 What are the passenger volumes on these routes?
3.4.3 What is the average travel speed?
3.4.4 Number of vehicles on the route?
3.4.5 What is the fare structure?
3.4.6 What are the actual fares charged (amount)?
3.4.7 What fare collection method is used?
3.4.8 What is the load factor? (Passengers/seat)
3.4.9 What is the on-time performance?
3.4.10 How is this mode integrated with the other modes? (Feeders, non-feeders)
3.4.11 Are there any at-grade road crossings?

4. BUS TRANSPORT

4.1 GENERAL

4.1.1 How has bus transport developed in the city and in the country?

4.1.2 Are there any important historical events that have affected the development of bus transport in the city?

4.1.3 Who is responsible for the regulation and management of the operations and operators of bus transport?

4.1.4 What is the passengers' volume per day for rail transport?

4.1.5 What are the operating and capital costs of passenger bus transport per year?

4.1.6 What is the capital or operating subsidy provided for bus transport per year?

4.2 INFRASTRUCTURE *(Map showing network and stations?)*

4.2.1 What are the main routes for bus transport in the city?

4.2.2 What is the length of the bus network?

4.2.3 How many bus stations, depots and terminals are there in the city?

4.2.4 What is the current condition of the bus infrastructure?

4.2.5 What is the capital expenditure on roads, depots and stations?

4.2.6 How is this funded?

4.2.7 What are the main issues, difficulties and problems with bus infrastructure? What are the solutions?

4.3 VEHICLE FLEET

4.3.1 What types of vehicles are used for the bus transport, what is the capacity and cost of these vehicles?

4.3.2 How many vehicles are there in the fleet?

4.3.3 How many vehicles are operating in the peak-hour?

4.3.4 What is the fleet utilisation?

4.3.5 What are the average vehicle kilometres per day or per year for bus transport? (Or what are the vehicle-kilometres per day or per year?)

4.3.6 Average number of breakdowns?

4.3.7 Energy consumption per vehicle?

4.3.8 Amount of dead kilometres per day or per year?

4.4 SOME DETAIL *(For the main routes in peak and off-peak periods)*

4.4.1 What is the vehicle frequency?

4.4.2 What are the passenger volumes on these routes?

4.4.3 What is the average travel speed?

4.4.4 Number of vehicles on the route?

4.4.5 What is the fare structure?

4.4.6 What are the actual fares charged (amount)?

4.4.7 What fare collection method is used?

4.4.8 What is the load factor? (Passengers/seat)

4.4.9 What is the on-time performance?

4.4.10 How is this mode integrated with the other modes? (Feeders, non-feeders)

4.4.11 Are there any grade separated (dedicated) bus lanes?

5. PARATRANSIT

5.1 GENERAL

5.1.1 How has paratransit developed in the city and in the country?

5.1.2 Are there any important historical events that have affected the development of paratransit in the city?

5.1.3 Who is responsible for the regulation and management of the operations and operators of paratransit?

5.1.4 What is the passengers volume per day for paratransit?

5.1.5 What are the operating and capital costs of passenger paratransit per year?

5.1.6 What is the capital or operating subsidy provided for paratransit per year?

5.2 INFRASTRUCTURE *(Map showing network and stations?)*

5.2.1 What are the main routes for paratransit in the city?

5.2.2 What is the length of the paratransit network?

5.2.3 How many paratransit stations, depots and terminals are there in the city?

5.2.4 What is the current condition of the paratransit infrastructure?

5.2.5 What is the capital expenditure on road, stations, depots and terminals?

5.2.6 How is this funded?

5.2.7 What are the main issues, difficulties and problems with paratransit infrastructure? What are the solutions?

5.3 VEHICLE FLEET

5.3.1 What types of vehicles are used for the paratransit, what is the capacity and cost of these vehicles?

5.3.2 How many vehicles are there in the fleet?

5.3.3 How many vehicles are operating in the peak-hour?

5.3.4 What is the fleet utilisation?

5.3.5 What are the average vehicle kilometres per day or per year for paratransit? (Or what are the vehicle-kilometres per day or per year?)

5.3.6 Average number of breakdowns?

5.3.7 Energy consumption per vehicle?

5.3.8 Amount of dead kilometres per day or per year?

5.4 SOME DETAIL *(For the main routes in peak and off-peak periods)*

5.4.1 What is the vehicle frequency?

5.4.2 What are the passenger volumes on these routes?

5.4.3 What is the average travel speed?

5.4.4 Number of vehicles on the route?

5.4.5 What is the fare structure?

5.4.6 What are the actual fares charged (amount)?

5.4.7 What fare collection method is used?

5.4.8 What is the load factor? (Passengers/seat)

5.4.9 What is the on-time performance?

5.4.10 How is this mode integrated with the other modes? (Feeders, non-feeders)

6. FINANCIAL ISSUES

	Rail Transport	Bus Transport	Paratransit	Total
1. Operating cost per year				
1.1. % Fixed cost				
1.2. % Variable costs				
1.3. % Overhead costs				
2. Capital costs per year				
2.1. Infrastructure				
2.2. Vehicles				
3. Subsidies				
3.1. Any subsidies provided				
3.2. How much (% or amount)				
3.3. How much capital subsidy				
3.4. How much operating subsidy				
3.5. Subsidy structure (Form, per veh-km, or passenger based)				

With regards to section number 7, theseare indicators and values that can not be obtained through the interview only and the data required needs to be obtained from research or surveys that have been done on it. It would be valuable to get a copy of the most recent transportation planning report or some material, data or customer satisfactory survey that actually deals with these issues.

7. MACRO-PERFORMANCE INDICATORS

	Rail Transport	Bus Transport	Paratransit	Possible Data source
1. Accessibility - Average walking distance from a person's house to the public transport stop - What % of households have a private car - What % of households have access to this public transport mode				Transportation plan
2. General perception of comfort by users – in vehicle (on board) - at stops or terminals				Customer satisfactory survey
3. Reliability - Average waiting time				Customer satisfactory survey
4. Travel time - Average travel time to work - Average travel speed in peak hour traffic				Transportation plan
5. Affordability - Average amount spend on public transport per passenger per month - % of Household income spend per month on public transport - Affordable to everyone?				Transportation plan
6. Safety/ Security - Number of public transport accidents, (Fatality and casualty) - What is the current situation with regards to personal safety at public transport facilities and on-board of the vehicle				Transportation plan Transportation plan
7. Environmental - Current contribution to air pollution by various transport modes (%) and by private car - Energy consumption (kilojoules per passenger-kilometre)				Transportation plan
8. Economic - % Of labour force that are able to reach their work place with public transport - % Of population currently employed in the public transport sector				Transportation plan Or Demographic plan