MODAL-SHIFT STRATEGY FOR MITIGATING ROAD TRAFFIC CONGESTION IN NAIROBI: A STUDY OF THE NAIROBI- SYOKIMAU COMMUTER RAIL CORRIDOR

BY

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DECLARATION

This project report is my original work and has not been presented for the award of a degree in any other university. Every effort has been made to clearly indicate the contributions of others involved and literature referenced.

This work has been done under the guidance of Dr. Owiti K'Akumu and Dr. Samuel Obiero at the Department of Architecture, University of Nairobi.

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This project report has been presented for approval with my/our knowledge as university supervisor(s)

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LIST OF ACRONYMS

BUPT	Bombay Urban Transport Project
CBD	Central Business District
CCTV	Closed Circuit Television
EARC	East Africa Railways Corporation
KNBS	Kenya National Bureau of Statistics
KRC	Kenya Railways Corporation
MRVC	Mumbai Railway Vikas Corporation
MUTP	Mumbai Urban Transport Project
NACOSTI	National Commission for Science, Technology and Innovation
NIUPLAN	Nairobi Integrated Urban Development Masterplan
NCR	Nairobi Commuter Rail
RVR	Rift Valley Railways
SPSS	Statistical Package for the Social Sciences
USA	United States of America
WEH	Western Express Highway

ABSTRACT

Kenya aspires to become a prosperous industrializing middle income country (Kenya Vision 2030) and for this vision to be realized, efficient transport infrastructure and services must be developed. A properly planned and efficiently operated urban rail transit system holds the promise of making an immense economic contribution to this vision. The fiscal cost of traffic jams in Nairobi and its environs is estimated at Kshs. 57 million per day, taking into consideration the cost of additional time spent on travel due to congestion. This poses a continuing challenge to the achievement of the country's vision. A mass transit system through commuter rail service is increasingly appealing as a solution to this problem. However, despite numerous studies indicating overwhelming demand for convenient, efficient and decent commuter rail services within the Nairobi metropolitan region (Wahome, 2013), post-commissioning anecdotal evidence on the newly commissioned Nairobi- Syokimau route reveals continued low utilization of rail transport as a mode choice. This study sought to apply travel demand theory to comprehensively analyze factors underpinning the low utilization of Nairobi Commuter Rail services as a travel mode choice following the recent development and upgrading of the urban rail transit system. The study was conducted within the catchment areas of the three newly built railway stations along the Nairobi- Syokimau corridor. These are: Syokimau, Imara Daima and Makadara Railway Stations. Descriptive research design was used. Collection of data was done through survey technique and analyzed using Chi-square, Spearman's correlation and linear regression techniques as well as Mann Whitney U-test. The data was presented in appropriate figures and tables. Results showed that money cost savings and journey time had a direct influence on utilization of NCR. Distance to train station was inversely related to utilization of the NCR as a mode choice. Factors like typical daily activities were influential in determining demand for NCR as the utility of the train service was evaluated against the need to fulfill other household or recreational needs. Perceived image of rail transit system had a direct influence on the utilization of NCR. Service quality features of importance to commuters included less crowding and having a seat. Socio-demographic factors had no influence on the utilization of NCR. It was recommended that KRC should increase the frequency of trips of its rolling stock and review its schedules. KRC should address the problem of poor perceived service quality especially targeting private car owners through a concerted public relations campaign and image management tactics focusing on the benefits of NCR

to commuters. Furthermore, KRC should consider offering incentives to motorists and groups such as employers to encourage them to utilize NCR. Providing feeder services will increase ease of access as well as convenience for commuters thereby serving to increase patronage of the commuter train service. Traction technology should be introduced in the long term to increase train speeds and passenger capacity. KRC should take measures to attract strategic investors who can set up recreational, entertainment and shopping malls in both beginning and destination stations.

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CHAPTER ONE: INTRODUCTION

1.1   Background Information

The importance of effective urban mass transport service to an economy cannot be overemphasized. Transport service facilities are engines of economic integration and therefore constitute a precondition for facilitating trade as well as the movement of goods and persons (United Nations, 2005). Thus, while metropolitan cities need to have good road transportation infrastructure including arterial and sub-arterial ways, linking roads, highways and expressways to be able to function, mere roads do not lead to better transportation—they only encourage overindulgence of private vehicles (Nallathiga, 2008) thereby resulting in heavily congested roads and cities. Many cities in the developed countries having realized the threat of ever- increasing traffic- generated congestion, have adopted strategies such as mass rapid transit systems and regulatory instruments such as congestion pricing for private car users to limit the use of personal modes of transport thereby moving people efficiently and economically.

Many African cities have experienced a massive increase in mobility levels with complex travel patterns due to the rapid and sustained economic growth in the last quarter of the 20th century which in turn has resulted in an exponential increase in private vehicle ownership. The effect of the increase in private automobile ownership can be seen in the many urban areas experiencing transport problems such as traffic congestion, delays caused by traffic jams, numerous traffic accidents, environmental degradation, economic inefficiency as well as social inequity.

Kenya has not been left behind and faces great pressure to increase urban mobility through provision of an efficient public transit service. During 2003-2004, the rate of increase in motor vehicle ownership in Kenya was about 7% per annum, significantly higher than the rate of growth of population of 3% per annum. During the same period, public transport vehicles such as buses and matatus registered a growth rate of 5% per annum (Ministry of Transport, 2011). Nairobi accommodates approximately 30% of the total vehicle population in Kenya. It is estimated that Nairobi will have a private car population of 716, 138 by the year 2025 (JICA, 2006). Heavy traffic on the roads in Nairobi has resulted in long travel time, so that to cover 30-40 km of commuting distance, it takes 2 hours or more and in the 5-10 km central area radius, travel time may take up to 2 hours (Omwenga, 2011). The need for a properly functioning and sustainable mass

transit system as a step towards reducing the severe traffic congestion which is mainly caused by private modes is widely recognized as per numerous feasibility studies and master plans e.g. NIUPLAN (2014-2030). There are clear efficiency and environmental benefits to be derived from transferring urban travelers from private cars to public transport (Transport Reviews, 2003).

In terms of urban mass transit, commuter rail is hailed as the most sustainable transport mode which provides benefits in facilitating travel and movement of goods and services (Brown & Werner, 2009). Commuter rail systems are rail-based mass transit systems that operate on an exclusive right-of-way, which is separated from all modes of transport in an urban area (Goel & Tiwari, 2008). Generally, benefits of commuter rail as a mode choice include relative energy efficiency, less pollution of the environment (Chaudhury, 2006), freedom from traffic jams and the capacity to move great numbers of commuters fast- an advantage over all other modes. To the consumer, the benefits accrue in the form of reduced travel costs, reduced traffic congestion and economic savings in time and fuel besides better safety (Kinuthia, 2014).

Commuter rail is increasingly emerging as the most ideal mode of travel within and around large cities throughout the world (Wahome, 2013). In recognition of the benefits that accrue from rail transport as an urban mass transit system, the past three decades have seen 139 new urban rail systems, light rail systems and metros being constructed worldwide (Wambui, 2012). In Sub-Saharan Africa, most of the railway network was developed during the colonial regimes and not much investment in railway infrastructure has been undertaken since then (Wambui, 2012). Thus, African railway transport systems are still largely structured by the infrastructure, legislation and institutions inherited from the colonialists and by policies adopted during the first decades after independence which have played a major role in the deterioration of the rail transport system (Kinuthia, 2014).

According to the Organization for Economic Cooperation and Development (2013), geographic, demographic and economic features of different countries strongly influence the ability of alternative travel mode choice to constrain potential market power in the rail sector. In Kenya, as a mode of transport, railway transport is the second to road transport for both freight and passenger traffic (Kinuthia, 2014). The vast majority of trips in Nairobi when it comes to public transit are carried by matatus while commuters undertake

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the remaining trips by buses on traditional fixed routes, a commuter rail and other shuttle services (Gonzales, Chavis, Yuwei & Daganzo, 2009). This is despite significant problems with road transport especially in the urban area such as traffic congestion and increased traffic death rates – a chaotic state of affairs characterized by unsafe roads, unreliable service and daily shoving at a majority of Nairobi City's transport terminals (Kinuthia, 2014; Orero, Mccormick, Mitullah, Chitere, & Ommeh, 2014; Wahome, 2013). Various efforts have been put in place by the public and private sectors to address this problem such as the road infrastructure expansion aimed at increasing capacity, with limited impact (Gachanja, 2015).

The Nairobi metropolitan commuter rail services were introduced by the Kenya Railway Corporation in the 1990s to facilitate transportation to Nairobi's environs; a service that was well received notwithstanding the high fares charged (Wahome, 2013; Wambui, 2012). However, the commuter rail has faced numerous challenges including inadequate route coverage, competition from other transport modes especially matatus, inefficient regulatory system, insufficient facilities for intermodal transfer, inadequate funding and deficient infrastructure (Kinuthia, 2014). According to Wahome (2013) the services were initially offered by operating 62-class locomotives which were later changed to 93/94 in 1997 to respond to increased demand.

There is urgent need to cater for the increased traffic demand in a sustainable manner through an efficient mass transit system and it is line with this need that KRC seeks to provide a mass transit service through upgrading of the existing rail infrastructure, development of new lines and the attendant stations in addition to the procurement of rolling stock.

According to its 2012-2017 Strategic Plan, KRC embarked on an ambitious plan to revamp commuter rail service in Nairobi as part of its urban transport master plan that fits within the World Bank- funded Nairobi Urban Transport Improvement project. The company planned to transport half a million passengers per day within the Nairobi metropolis by year 2017. Some of the initiatives it planned to make this workable included activities aimed at improving the railway infrastructure such as the building of new lines and the rehabilitation and improvement of existing core systems. Other measures included the refurbishment of passenger coaches and hiring of experienced

commuter operators (KRC, 2012). Currently, the commuter rail is operated during the morning and evening rush hours along Nairobi-Embakasi Village, Nairobi-Kikuyu, Nairobi-Ruiru (Wahome, 2013) and Nairobi- Syokimau routes.

This study most importantly is cognizant of the need to ease traffic congestion in Nairobi and its environs and the immense potential of the existing commuter rail to contribute towards decongestion as commuter rail is one of the most effective modes for shifting large numbers of people. With this in mind, the study attempts to provide a focused analysis of commuter travel behavior in the endeavor to encourage a modal shift to commuter rail by making Nairobi Commuter Rail the preferred travel mode. The study was undertaken following recent infrastructural development and facility enhancement made by KRC such as the completion and commissioning of the landmark Syokimau Railway Station in the year 2012 and subsequently Imara Daima and Makadara Stations in 2013. Through the assessment of commuter mode choices within the catchment areas of the afore- mentioned stations, the study provides feedback on the upgraded services along the Nairobi- Syokimau corridor that will inform efforts to position commuter rail travel as an essential transport mode within Nairobi and its environs. The study is also expected to inform further expansion of Nairobi Commuter Rail in the hope of creating a viable and sustainable mass transit system.

1.2   Problem Statement

For Kenya to realize its vision of becoming a globally competitive and flourishing nation with a high quality of life for its citizens, it must prioritize the development of efficient transport infrastructure and services. A properly planned and efficiently operated urban rail transit system can contribute immensely to this vision. It is estimated that the cost of traffic jams including the cost of additional time added to travel because of congestion in the Nairobi metropolis is Ksh 1.9 billion annually (Gachanja, 2015). This poses a continuing challenge to the achievement of the country's vision of making Kenya an advanced country by the year 2030.

The Government has realized that the expansion of road infrastructure alone falls short in efficiently serving travel demand. As demand for transport increases, the need for sustainable modes of travel becomes more pronounced. A high capacity public transit system is essential as a step towards reducing traffic congestion and thus securing

mobility. A mass transit system through commuter rail service is increasingly appealing as a solution to congestion in the Nairobi metropolitan region.

As suggested in KRC's 2012-2017 strategic plan, the metropolitan commuter rail service's implementation was aimed at decongesting major city roads through the provision of reliable, efficient, affordable and safe passenger services. However, despite numerous studies indicating overwhelming demand for commuter rail services that are efficient, reliable and convenient within Nairobi and its environs (Wahome, 2013), post-commissioning anecdotal evidence from media reports on the newly- commissioned Nairobi- Syokimau route reveals continued low utilization of rail transport as a mode choice (Andae, 2013; Gibendi, 2014) despite the recent infrastructural development and facility enhancement.

According to Beck, Bente and Schilling (2013), for railways to be more efficient, there should be high utilization of railway assets including rolling stock and track infrastructure because the railway sub-sector is asset- intensive. Beck *et al.* proceed to argue that since these assets have high fixed maintenance costs as well as depreciation costs, each kilometer of track must be used as frequently as possible. Therefore, understanding what influences commuter rail as a mode choice can help transportation and planning agencies implement more effective rail travel demand management towards a more efficient and effective rail service.

The underutilization of rail transport as an alternative mode choice and the problems that surround the provision of urban commuter rail service in Kenya has been the subject of much academic interest. Studies on various aspects of commuter rail have been undertaken such as the potential impact of railway infrastructure on connectivity within the Nairobi metropolitan area based on the case of Limuru Town (Kinuthia, 2014) while Wambui (2012) investigated sustainable management of rail land focusing on Nairobi commuter rail network. The fundamental premises that limit the implementation of an effective metropolitan rail system in Kenya have been studied (Wahome, 2013) whereas Buluma (2014) studied Rift Valley Railways Corporation with a focus on service quality and passenger satisfaction.

With the exception of Buluma's (2014) study, all the prior studies were undertaken before the commissioning of the revamped service on Nairobi- Syokimau corridor and the three

landmark railway stations and therefore their findings did not reflect the full impact of these new services and facilities. While the study by Buluma (2014) is the most recent among them, it did not capture the views of a cross section of Nairobi commuters since data was collected from train passengers only. Further, the studies were not grounded on travel demand models which offer the most credible explanation for travel behavior and commuter mode choice decisions. Through the application of travel demand theory, this study sought to analyze the travel behavior of commuters along the Nairobi- Syokimau rail corridor to shed light on the continued low utilization of Nairobi Commuter Rail (NCR) services as a travel mode choice despite the recent development and upgrading of the urban rail transit system.

1.3   Research Questions

In order to provide focus and to guide all stages of inquiry for the research being undertaken the following questions were formulated:

i)   Is there any influence of generalized cost of travel on the utilization of NCR services?

ii) Does perceived image of rail transit system have any influence on the utilization of NCR services?

iii) What role do socio-demographic factors have on the variability in utilization of NCR services?

iv) Does the type of activity have any influence on the utilization of NCR services?

v)   What measures can be instituted to encourage a modal shift from road- based commuter travel to NCR?

1.4   Objectives

The general objective of this report was to establish the influence of travel behavior on the utilization of NCR service as a travel mode choice. In order to achieve this broad objective, the following specific objectives guided the study:

i)   To determine the influence of generalized cost of travel on the utilization of NCR services.

ii) To establish the influence of perceived image of rail transit system on the utilization of NCR services.

iii) To evaluate the role of socio-demographic factors on variability in the utilization of NCR services.

iv) To establish the effect of the type of activity on the utilization of NCR services.

v) To suggest strategies which will encourage a modal shift from road- based commuter travel to NCR.

1.5   Hypothesis

i) H_0 Commuter travel behavior influences utilization of NCR services as a travel mode choice.

ii) H_1 Commuter travel behavior does not influence utilization of NCR services as a travel mode choice.

1.6   Justification of the Study

Traffic congestion continues to be a hindrance to urban mobility within the greater Nairobi region. Interventions have been mostly geared towards increasing road capacity thereby providing relief in the short- term but leading to worse congestion in the long- term as commuters acquire even more automobiles to take advantage of the shortened travel time. The government has commissioned numerous studies to look at the provision of an effective and efficient mass transit service and in line with this, KRC is currently implementing a development masterplan with the aim of modernizing the existing railway facilities, constructing new stations and expanding the railway network within Nairobi. The masterplan is to be undertaken in phases, with Phase 1 underway in which the three stations of Syokimau, Makadara and Imara Daima are complete and operational. This study comes at a crucial time, taking the Nairobi- Syokimau rail corridor as a pilot project to provide feedback on a service model that has the potential of causing a modal shift from road- based commuter travel to commuter rail. Through attracting the critical numbers necessary for a viable mass transit service, it will be possible for Nairobi to increase the modal share of NCR and in the long run benefit from the decongesting capacity of commuter rail.

1.7   Scope

This study was conducted within the environs of the three newly built railway stations along the Nairobi- Syokimau rail corridor. These are: Syokimau, Imara Daima and Makadara Railway Stations.

1.8 Location of the Study

The residential areas within the catchment areas of Syokimau, Imara Daima and Makadara Railway stations were the study locations. Syokimau Railway Station targets the residents of Embakasi, Mlolongo and Kitengela Estates. The catchment area of Syokimau Railway Station is a growing middle income residential area just south of Nairobi and bordering Jomo Kenyatta International Airport. According to the 2009 KNBS census, Syokimau and Mlolongo area has a population of 42, 154 persons. Of the three stations, Syokimau Railway Station is the farthest from the city. The service model adopted at the station is a park-and-ride system where the residents in its catchment area drive to the station, park their cars and then board the train to the city (Filho, Muthu, Golda & Sima, 2015).

Imara Daima Railway Station with a population of 70, 641 persons, targets commuters from Mombasa Road, Imara Daima, Embakasi North as well as Industrial Area. This catchment area is characterized by middle and low income residential estates and industrial parks. Of the three stations, Imara Daima is the smallest in size and has parking slots for 150 park –and- ride commuters.

Makadara Railway Station targets commuters from Jogoo Road, Hamza, Jerusalem, Jericho, Donholm, Buruburu and Umoja. With the exception of Buruburu Estate, this catchment area is characterized by densely populated, low income residents. Makadara has 218, 641 persons. The station itself is the largest in terms of capacity, with parking space for 500 cars.

Figure 1-1 Map showing location of Syokimau, Imara Daima and Makadara Stations

Source: Google Maps

Figure 1-2 Map showing Syokimau Station catchment area

Source: Google Maps

Figure 1-3 Map showing Imara Daima Station catchment area
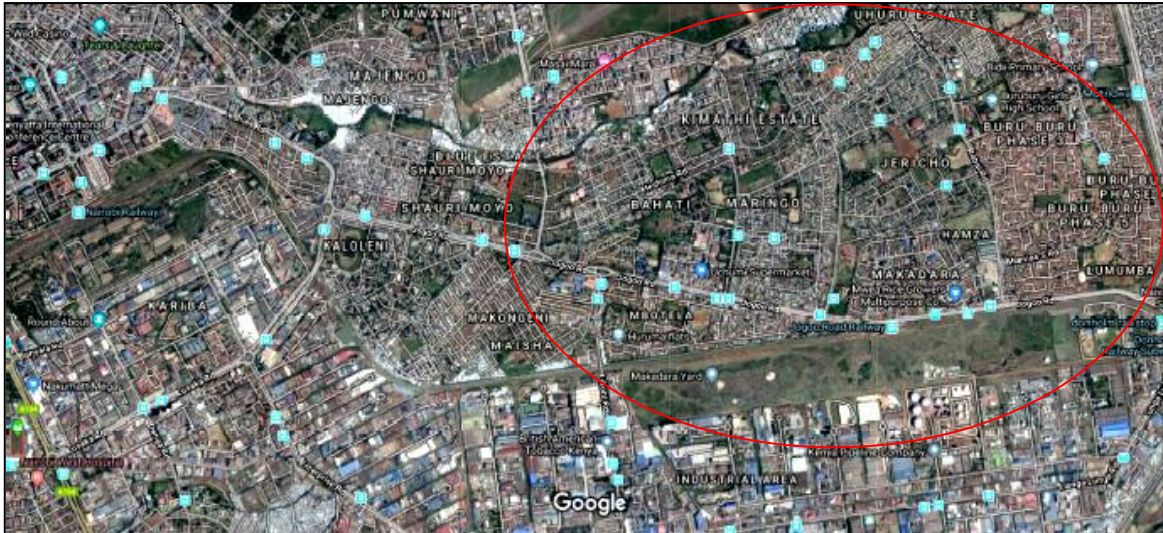
Source: Google Maps

Figure 1-4 Map showing Makadara Station catchment area

Source: Google Maps

1.9   Expected Solution

It was anticipated that the application of travel behavior modeling approaches to the analysis of travel mode choice would lead to the determination of the critical factors influencing utilization of commuter rail services as an efficient mode choice for Nairobi and its environs. This should culminate into the development of a commuter rail service model with a bundle of services that will make rail transport not only the most efficient mass transit mode but also promote a modal shift from traditional road- based travel to NCR within Nairobi and its environs.

1.10   Structure of the Report

Chapter One presents the background of the research including a general outline of the topic, the importance of the study as well as the statement of the problem. The research questions together with the general and specific objectives of the study are stated. In addition, the hypotheses, scope of the research and a description of the study area are included and the expected intervention is declared. Finally, there is a definition of terms as pertains to the study.

Chapter Two reviews literature on the current thinking, findings and approaches to the problem. This involved a review of urbanization and its effects on travel demand followed by a discussion on public passenger transport and an appraisal of travel demand modeling theories that informed the study. An overview of rail transport is included together with an assessment of the railway system in Kenya. Empirical findings from previous studies were analyzed and discussed and a review of relevant case studies for best practices was included. Finally, the conceptual framework which guided the data collection process is described.

Chapter Three details the research methodology used in the research. This entails a description of the sources of data, the procedures which were used in the collection of data, the specific steps that were taken to select the data, ethical considerations made and the analysis plan used to make sense of the data collected.

Chapter Four states the findings. The findings are presented and interpreted thematically based on the specific objectives. Appropriate graphs and tables have been included.

Chapter Five discusses, evaluates and analyzes the findings in view of the literature outlined in the literature review. This entailed a consideration of the important findings and implications of the findings.

Chapter Six gives the results for all research questions and objectives stated in the first chapter. Conclusions, recommendations and an outline of further research opportunities relevant to the present study are included in this chapter.

1.11 Definition of Terms

Commuter rail: This is a heavy rail transit system operating on exclusive right-of-way tracks which are grade- separated from all other modes of transport within an urban area and characteristically carries passengers between suburban and urban locations.

Generalized cost: Refers to the total monetary and non-monetary cost elements of a trip; where monetary elements relate to out-of-pocket cost while non-monetary elements are the qualitative attributes such as safety and time consumed.

Mass transit: This denotes a shared urban passenger transport service operating at high levels of performance, particularly with respect to travel times between destinations and passenger- carrying capacity.

Matatu: Also referred to as paratransit, matatus are privately operated small- scale commuter vehicles (vans or minibus) with seating capacity of 14-25 passengers. They offer feeder connection between mainline bus routes and nearby neighbourhoods.

Metro: This is a generic term that refers to all underground or elevated rail mass transit systems in a city.

Modal shift: This is the process by which passengers and freight transfer from one mode/means of transport to another and it involves an increase in demand of one mode of transport possibly to the detriment of another.

Mode: Refers to a differentiated transport system with inherent characteristics such as speed and capacity. Common modes are buses, paratransit, rail and air and can either compete against or complement each other.

Perceived image: This consists of the impressions that commuters form of the commuter rail service based on the symbols and messages sent by the commuter rail to the public.

Public transport: Refers to all modes of shared passenger transport available for use by the general public irrespective of ownership.

Standard gauge railway: This term is used to describe railways which use a standardized distance of 1435mm between the rails of a railroad track. The distance is what is referred to as the 'gauge'.

Travel behavior: This term refers to choices that individuals and households make about their daily travel as influenced by generalized cost of travel, attitudinal and perceptual factors as well as socio- demographic factors.

Travel demand: Commuter's desire and willingness to travel from place to place.

Utilization: This is the extent to which commuters make use of a travel mode.

CHAPTER TWO: LITERATURE REVIEW

2.1   Introduction

The first section discusses urbanization and its implication on travel behavior. This is followed by a review of travel demand factors and characteristics. Travel demand modeling theories and public passenger transport are discussed followed by an overview of rail transport and a look at the rail system in Kenya. The chapter then reviews a case study in India. Finally, a conceptual framework for the current study is presented.

2.2   Urbanization

Urbanization is the rapid growth in population and land use through processes such as rural-urban migration and economic development (Newbold, 2010). Zhang defines it as the evolution of human settlement (Zhang, 2015). Different yardsticks have been used to measure urbanization. Boone and Fragkias (2012) identify definitions based on four criteria: demographic, economic, administrative and functional definitions. In terms of demographic definition, Boone and Fragkias (2012) noted that urbanization is often defined by the population percentage residing in urban centers in terms of concentration, size, density and heterogeneity. From the economic perspective, identification is made of locations in space where certain types of economic activities such as non-agricultural work occur. The administrative dimension defines urbanization based on political considerations; that is, whether an area serves an administrative or government role. Another method identified by Boone and Fragkias (2012) is the functional approach which examines the functional aspects of different places and the supporting infrastructure such as electricity, roads, rail, water and sewerage.

According to Sridhar and Wan (2013), by the year 2007, half of the world's populace became urban. It is estimated that by the year 2030, the urban population of the world will hit nearly 5 billion, representing over 60 percent of the total world population (Bhattacharya, 2010). According to Newhold (2010), the population living in urban areas in the developing world is projected to grow rapidly in the coming decades. The author notes that the number of cities in the developing world with populations exceeding one million will jump exponentially as urban areas experience natural increase, net rural to urban migration, and urban reclassification as cities.

Sridhar and Wan (2013) argue that urbanization has been managed well in some countries with regards to the provision of reasonable levels of public services and infrastructure. However, other countries particularly in the developing world have not been as successful and grapple with rapid urbanization which has led to slums, pollution and traffic jams. This is characteristic of much of the developing world where Newbold (2010) finds that urbanization has led to informal and squatter settlements, inadequate urban infrastructure provision as well as degradation of resources.

In Africa, Falola and Salm (2004) identified urban growth rates as among the highest at nearly 5 percent on aggregate; with growth rates for countries such as Mozambique and Tanzania experiencing urban growth rates of over 7 percent. These authors however argue that the cities cannot keep up with the demands placed upon them. Consequently, mounting population pressure from rapid urbanization coupled with the declining capacity of cities to mobilize resources for investment in social infrastructure has created problems ranging from the sprawling slums of Nairobi to choking traffic congestion and poor sanitation in Lagos as well as pollution in Bamako to crime and social exclusion in Durban (UN-Habitat, 2006).

In Kenya, towns are developing at a high rate but no proper planning has been put in place to meet the challenges of increasing urbanization (Cruz & Tempra, 2005). Nairobi is one such town grappling with the challenges of urban sprawl. Nairobi, Kenya's capital city is of strategic importance as an international, regional, national and local hub supporting commerce, transport, regional cooperation and economic development (Cruz, Sommer & Tempra, 2006). The city connects together eastern, central and southern African countries. 43% of the country's urban workers reside in Nairobi. Nairobi generates more than 45% of the country's GDP (Cruz et al., 2006). The city has been overwhelmed by rapid urbanization, with repercussions such as traffic congestion, pollution, poor waste management and water shortages being felt (Cruz et al., 2006).

JICA (2014) developed a masterplan for Nairobi with integrated urban development. According to JICA, the afore- mentioned problems are experienced because the city has not implemented a broad guiding spatial framework for urban development. The master plan acknowledged that a Nairobi Metropolitan Growth Strategy was prepared in 1973 which had a planning timeframe up to the year 2000. However, the strategy was not fully

implemented and since then Nairobi has lacked a guiding master plan and sector specific plans have been fragmented at best. Consequently, the city's urban structure continues to be characterized by urban development that is uncontrolled, lack of adequate infrastructure, inadequate social facilities, transport problems, influx of population accompanied by poor living conditions and by extension, high demand for low cost housing.

According to Naess (2006), urban structure creates conditions that facilitate some kinds of travel behavior while discouraging other types of travel behavior. Urban structure refers to how the physical and social parameters such as housing density, arrangement of transportation networks, patterns of land use, population density and employment are spatially organized (Francis & Chadwick, 2013). The urban structure of Nairobi is concentric in form, with the tendency to sprawl along the main roads exiting its central core (UN-Habitat, 2011). The physical street network is radial and consists primarily of paved roads which emanate from the center of the city to the outskirts. Only a few roads link the arterials outside of the Nairobi CBD (Gonzales et al., 2009). This structure is therefore suitable for commuter rail. Recognition of the interrelationship between Nairobi's urban structure and transport is of particular importance at a time of unprecedented urban expansion (Rode, Floater, Thomopoulos, Docherty, Schwinger, Mahendra, & Fang, 2014). This interrelationship influences travel demand and mode choice selection.

2.3   Mode Choice Selection in Urban Areas

Commuters within an urban area have to make a decision on the means by which they will travel from one point to another to engage in various activities. Modes can be classified into two broad categories- public and private. Public modes refer to transport that can be accessed by the general public while private modes are used by the individual owners and/or individual households. Mode choice is directly related to the behavioural aspect of the human nature. There are various factors which influence mode choice and they can be generally classified into:

i) Attributes of the trip maker (socio- demographics) - this refers to factors such as gender, age, income, household structure, occupation, vehicle ownership.

ii) Characteristics of the journey- refers to factors such as the time of day when the trip is undertaken, the purpose of the trip, whether the trip is undertaken individually or collectively.

iii) Transportation facility characteristics- covers aspects related to monetary cost of the trip, journey time, availability of parking and the respective cost, reliability of travel time, convenience, comfort and safety.

People tend to choose a mode based on the above factors. Car ownership is high in many urban areas in developing countries because it is fast, comfortable, convenient (increases freedom to move from one point to another thereby allowing user/s to engage in activities in different places) and provides privacy for the user/s. However, as compared to alternative modes and especially public transport, it is an expensive travel mode. Due to traffic congestion, urban areas are implementing policies to shift vehicle users who tend to be single- occupants to high occupancy vehicle models.
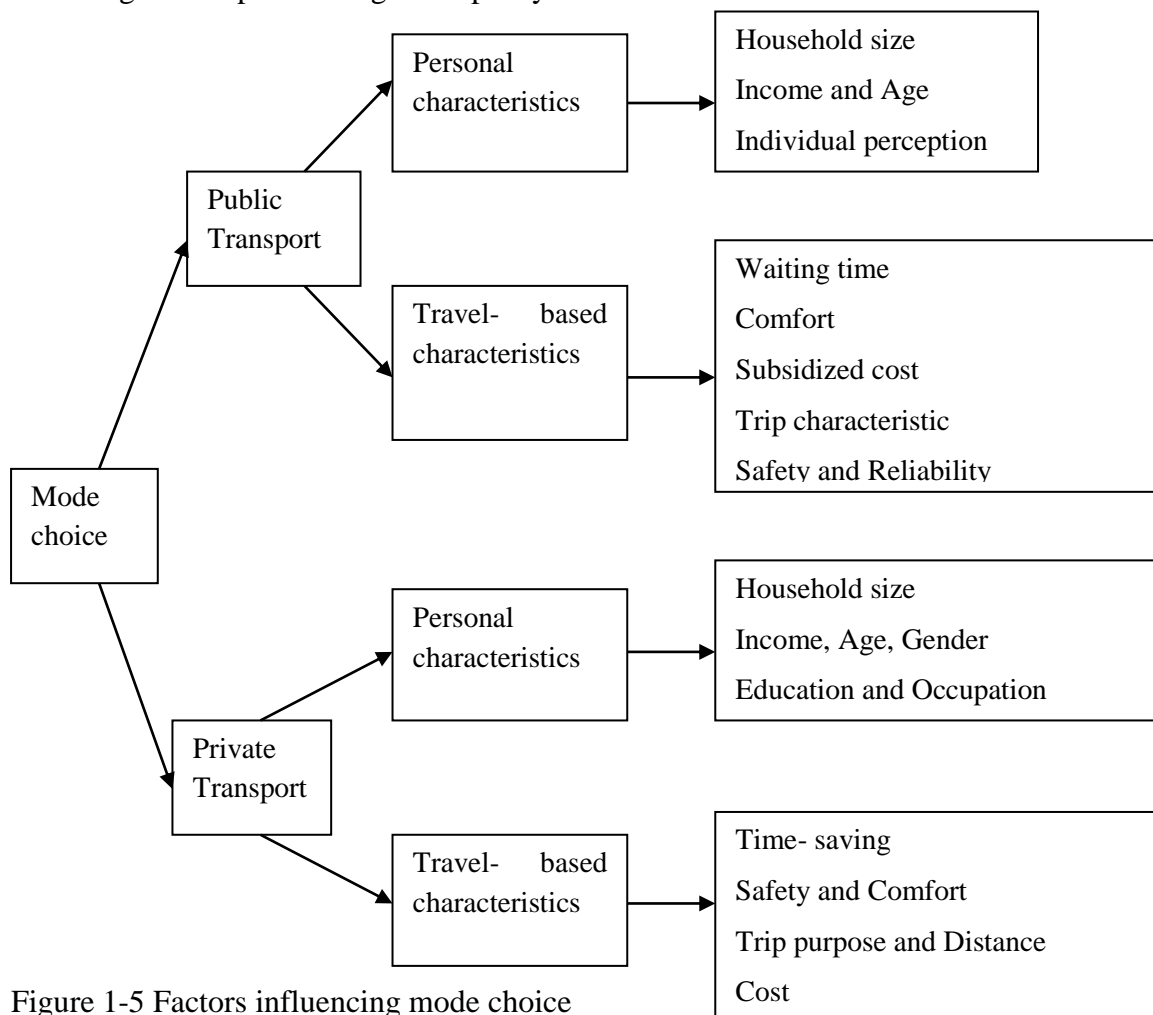
Figure 1-5 Factors influencing mode choice

Source: Author

People with high levels of income, greater levels of education and good occupations tend to use private cars. Other factors that contribute to high levels of car ownership are security, time- saving and comfort which are estimated to be higher in the private automobile than in public transport modes.

2.3.1 Modal Shift

Modal shift occurs when commuters select one mode over another because of the greater perceived value offered in terms of travel time from point of origin to final destination, cost of travel, quality of travel and environmental benefits. An important performance measure for public transport providers is commuter satisfaction as it is a determining factor which affects mode choice. For policies encouraging a shift from private vehicle use to public transit to be successful, it is necessary to put in place a public transit system that satisfies commuters' travel needs and has competitive advantage over private car use (Madhuwanthi et al, 2015).

As has been mentioned, commuter attitudes and preferences shape travel decisions and for many commuters, the main barriers to modal shift include cost, time, limited route network, public transport capacity, reliability of travelling by public transport as well as personal needs such as security, comfort and information. Changes in commuter behavior can only be achieved once all the relevant barriers have been addressed and it is this attitude change that drives a shift to alternative modes of travel. There are numerous ways in which individuals can be encouraged to switch travel modes from extensive automobile usage towards more sustainable means of transport as listed below:

i) Travel demand management policies to reduce driving such as congestion pricing, parking management, fuel taxes, distance- based pricing, road pricing, speed reductions etc.

ii) Provision of high quality public transit service that is fast, reliable and has attractive vehicle and station design to attract automobile users.

iii) Commuter financial incentives to promote public transit use such as discounted seasonal tickets, parking cash out (employers can subsidize the parking cost incurred by commuters who use parking facilities at train stations).

The above strategies affect travel behavior in various ways including changes in travel time, reduction of overall automobile travel and increase in transit use. For a modal shift to occur from private cars to public transport, the public transport service provided must be a viable competitor to personal car use thereby reducing the need and desire for car ownership.

This study regards commuter rail as a step towards improved urban mobility and based on the objectives which analyze travel behaviour, intends to suggest strategies to encourage a modal shift from road- based transport to commuter rail.

2.4 Travel Demand Factors and Characteristics

This section presents a review of findings from past scholarly work that informs current thinking and approaches to the problem of travel demand forecasting and commuter decision- making on preferred mode of travel. The main variables under travel behavior being reviewed are: generalized cost (journey time and money cost), perceived image of the rail transit system, influence of socio-demographic characteristics of commuters and the type of activity generating travel.

2.4.1 The Influence of Generalized Cost of Commuter Rail as a Mode Choice

Generalized cost simply refers to the sum of monetary and non-monetary cost elements of a trip; where non-monetary elements are the qualitative attributes that may not be quantified immediately using a monetary index but are important in the perception and selection of a transport mode by commuters (Grosso, 2011). The monetary elements of a trip relate to price or out-of-pocket cost which affects consumption (Litman, 2013a). The law of demand suggests that all else held constant, price reductions usually increase consumption and the converse is true. Thus, transport price changes can affect type of service commuters choose, trip frequency, trip route, destination, scheduling and parking location. In their research on factors affecting transport mode choice, Mohammed and Shakir (2013) found that reducing the travel cost highly influenced the utilization of mass transit modes. Their study suggested that the lower the cost, the higher the utilization of urban mass transit modes such as commuter rail systems. Litman (2013a) is in concurrence, arguing that increased prices tend to reduce consumption and sometimes cause shifts to alternatives.

In travel demand modeling, non-monetary costs are aggregated from the perspective of journey time which includes access time and trip duration. The time that a commuter takes to arrive from their point of origin to the bus stop or commuter rail platform is included in determining the access time of a public transport system (Goel & Tiwari, 2014). Commuter rail has additional waiting/walking components once the passenger reaches the entry of the station including walking down the stairs/escalators, queuing to purchase a ticket and being frisked by security forces which result in long queues followed by baggage checks using scanner machines (Goel & Tiwari, 2014). Goel and Tiwari (2014) further highlight that the components of walking within the station, obtaining a ticket and security checks forming part of the boarding process for commuter rail are not present in the bus system as passengers buy the tickets once they board the bus and this occurs during the in-vehicle time. These aspects of commuter rail service consume time, potentially influencing mode choice.

The accuracy of transport timetables is important as this allows people to control their travel without having to wait stationary for long periods of time or experiencing in-travel delays on the commuter system (Wahome, 2013). A study on the short-run market demand for commuter rail service in USA found that rail demand is most sensitive to changes in time cost, irrespective of whether these changes result from changes in travel time or in the opportunity cost of this time (McDonough, 1973).

Distance to the station is also a factor in commuters' decision- making and this is related to time cost. A study found that if the distance to the station exceeds a certain threshold, users will not consider transit alternatives (Chakour & Eluru, 2014). In keeping with this view, Rak and Lep (2014) argued that when locating stations, the time taken walking to the station by commuters is one of the most important factors to consider. This includes both walking time from the point of origin (home) to the railway station in addition to time taken walking from the railway station to the final destination. Debrezion, Pels and Rietveld (2007) modeled the choices of commuters on the Dutch railway based on access mode and departure from railway stations and found that distance negatively impacted the utility of departure stations.

Chakour and Eluru, 2014 investigated station characteristics and the role levels of service parameters on the behavior of commuter train users and determined that travel time

significantly impacted station choice. The less time it takes to transport passengers from a point of origin to their destination, the more likely they are to patronize a particular mode choice. For instance, Mohammed and Shakir (2013) used the logit model to identify factors that determine transportation mode choice. Results indicated that reduction of travel time by 70 percent would reduce the amount of private car users by 84 percent. It can be inferred from these empirical evidences that commuters tag money value on their time, which they use to evaluate the service quality of mode choice alternatives.

2.4.2   The Influence of Perceived Image of Rail Transit System

Perceived image is the mental picture that commuters have of the rail transit system which stems from beliefs and attitudes resulting from the quality of services they have experienced over time (Nguyen, 2014). It is argued that the image of a transport system has an impact on demand (Scherer, 2012). A study undertaken by Debrezion et al. (2007) concluded that an increase in the quality of service for a railway station contributes to a favorable image of service which then translates to an increase in demand for commuter rail services.

According to Lago, Mayworm and McEnroe (2009), research studies have identified service quality attributes such as reliability, comfort and convenience as the most important factors in the choice of transport modes besides travel time and money cost; with characteristics such as arriving when planned and having a seat carrying more important weight than lower fares. This is in line with the claim that transport characteristics are often misunderstood and that users rank costs as less important when making decisions on mode choice, less than the expectations of planners (Scherer, 2012).

Research on the choice of boarding station indicates that train frequency at the station, availability of parking, station facilities and travel time to the station (which is always considered alongside mode choice) play a major role in the decision process (Chakour & Eluru, 2014). Similar results have been reported in Africa. Agunlonye and Oduwaye (2010) for instance undertook a study in metropolitan Lagos on factors influencing the quality of rail transport services based on users' opinions. Inferential evidence showed that there is a significant relationship between the arrival times of trains at stations and patrons' trip frequency. The authors concluded that to enhance the quality of the rail

service operation, it would be necessary to review time schedules, departure time and to clean the coaches from time to time.

Litman (2008b) investigated the value transit travelers place on qualitative factors such as comfort and convenience on making mode choice decisions and suggested that commuters placed great value on less crowding, increased service frequency, comfortable waiting areas and better user information. In a study of determinants of the commuter rail mode share in England conducted by Morgenroth (2013), measures of service quality and in particular frequency explained a larger proportion of the variation in rail mode share; implying that an increase in service frequency would significantly increase utilization of commuter rail services.

Research carried out in Kenya suggested that most urban commuters perceive the commuter train as lacking safety and comfort (Wahome, 2013). They are also of the opinion that the commuter rail service has limited routes and services, inadequate transfer facilities between modes and long walking distance between places of residence and the railway station and from the railway station to places of work.

2.4.3   The Influence of Socio-demographic Factors

The importance of including socio-demographic characteristics as statistical control variables in a mode choice analysis is emphasized by Lund, Cervero and Wilson (2004) who argue that this is necessary in order to account for the association between socio-demographic factors and utilization of the commuter rail transit system. According to Chakour & Eluru (2013), decisions on mode choice are influenced by socio-demographic characteristics at the individual and household level such as age, gender, education level, occupation, income and vehicle ownership.

McDonough (1973) argued that a low- income commuter for whom time is assumed to be less valuable and the monetary constraint more severe should opt for a mode with a comparatively lower money cost even at the price of higher travel time. Conversely, since a higher income increases the valuation of time, modes with relatively low travel times should become increasingly desirable as income increases. An interesting finding is that the results suggested that rail commutation is not intrinsically an inferior good as within the higher income range, where presumably private transport is used for the home-

station trip, higher income levels are associated with increased rail demand (McDonough, 1973). This however contradicts the findings of a study by Lund et al. (2004) which found that vehicle ownership was negatively correlated with transit travel.

Empirical findings of a study undertaken by Zahabi, Miranda-Moreno and Patterson (2012) investigating the choice of mode of travel by commuters within the commuter rail line catchment of Montreal, Canada found that socio-demographic variables such as age, income and gender had statistically significant impacts on mode choice. That is, being male decreased the probability of choosing public transit supply by 62 percent; every year of age increase was related to 1 percent decline in the probability of using public transit supply and an increase in annual income of $10,000 corresponded to a 10 percent reduction in probability of using public transit supply.

2.4.4   The Influence of the Type of Activity on Mode Choice

Commuters value time minimization for peak-hour trips, which generally tend to be work trips, than on leisure-oriented trips which tend to be occasional and are usually undertaken during off-peak periods (McDonough, 1973). This finding suggests that mode choice is influenced by the purpose of the trip, consistent with activity-based models. Obligatory activities such as work and school, which usually have specific reporting times, potentially have more explanatory power on commuter mode choice decisions.

2.5   Travel Demand Modeling Theories

It is important for research to have a theoretical grounding to increase its generalizability value and make sense of findings (Gratton & Jones, 2004). This section critically discusses Travel Demand Modeling Theories which have been proposed to analyze travel behavior with respect to mode choice. The study will draw from Utility Maximization Theory and Activity- Based Models to underpin the research.

2.5.1   Utility Maximization Theory

The central idea of Utility Maximization Theory is that a rational commuter facing a choice between various alternative modes of travel chooses the one that maximizes his utility function (Aleskerov, Bouyssou & Monjardet, 2011). Utility, in this context, is defined as the net benefit derived from choosing a particular model of travel (Street & Burgess, 2007). The theory assumes that commuters make a travel mode choice by

evaluating the cost and quality of a mode's service and the uncertainty of choosing that particular mode (Nkurunziza, Zuidgeest, Brussel & Van Maarseveen, 2012). When making choices, the theory assumes that "individuals strive for the highest possible satisfaction of their needs, ordered as preferences, within their budget constraints" (Jan van de Kaa, 2010). Expounding further on the theoretical assumptions of utility maximization, Hall (2003), posits that given a choice set, travellers will select alternatives that offer the highest utility.

Cascetta (2009) observes that the theory is widely employed in modelling travel choices. Lain and John (2014), as supported by other researchers, note that people who are in a position to make a choice between modes tend to use a specific mode of transport based on how they perceive the 'utility' of that mode as compared to other modes. The variables considered by travellers that the theory proposes are journey time, money cost of travel together with the way that mode is perceived. Perception is based on aspects such as crowding, safety, security, convenience, status and independence, among others. Lain and John (2014) also argue that the factors that contribute the most in people's mode choice are journey time and money cost of a particular mode as compared against other modes.

Despite the utility maximization theory's popularity in the modelling of travel behaviour, it is not without its limitations as its analysis primarily focuses on the trip thus overlooking activities such as walking to the bus stop (Burbidge, 2008). Furthermore, the theory assumes the commuter is perfectly rational and has perfect information. Therefore, it fails to include behavioural characteristics of the commuter into its framework (Jan van de Kaa, 2010).

The limitations of utility maximization theory led to the need to involve social sciences and psychology to better understand what drives travel behaviour (Button, Vega & Nijkman, 2010). Numerous studies have been undertaken which question the ability of utility maximization models to accurately represent the set of decisions made by travellers. Reibstein, Lovelock and Dobson (1980) looked at how perceptions, affect and behaviour are related with regard to choice of transportation modes. Reibstein et al. (1980) confirmed that attitudes and behaviour of commuters have a positive relationship, mutually influencing each other. Therefore, research is geared towards an activity-based

framework which attempts to understand travel behaviour as a derivative of participation in activities and of time use behaviour.

2.5.2   Activity-Based Models

Jovicic (2001)defines an activity as a physical engagement of an individual in something that satisfies his/her needs. It is the lists of either work or non-work activities that are undertaken daily which are subject to travel constraints that may be related to the traveller or may be situation- related (Stern & Richardson, 2005). The economical, sociological and physiological needs of the individual determine the activities to be undertaken. Activities can be broadly grouped into various classes such as mandatory e.g. work, optional e.g. shopping, recreation; official or leisure- oriented.

Activity- based approaches assume that besides time, space and budget constraints, engagement in an activity is construed as an intricate interaction of: individual and household roles and responsibilities, a particular lifestyle of an individual and his family, options on activity type, location and duration (Jovicic, 2001). Activity-based approaches describe those activities which are pursued. They study what locations and times the activities are carried out and the scheduling of these activities given the location and characteristics of destinations, the transport network condition, the institutional context and their socio- demographic characteristics (Burbidge, 2008). Thus, unlike trip-based models, the focus of this approach to modelling travel demand is on sequences of activities (Jovicic, 2001). This is based on the argument that demand for activities produces the demand for travel; and because the activities engaged in a day are linked to each other, trips made to pursue them and the mode used to make the trips are also linked to each other (Milimol, Sreelatha & Soosan, 2013).

Earlier, Brill (1986) proposed that activity-based models study activities undertaken by a person and the process of organization of these activities into a schedule, describing how the person spends time. This means that the models attempt to go beyond simply observing the trips made by a sample of individuals and coming to conclusions on their travel behaviour as related to how they would act in response to changes to personal circumstances or external conditions. Typically, commuters balance the need to meet each need as it arises with the travel expense required in travel and this prompts them to

make a trade-off when comparing among alternative travel modes (Milimol, Sreelatha & Soosan, 2013).

According to Brill (1986), this model assumes that travel is a demand derived from the need to participate in activities at different locations as per the individual's circumstances, obligations and preferences. Constraints include obligations which must be undertaken at specific times and locations e.g. work/school/hospital, institutional requirements e.g. banks/libraries which are only open during specific times of day and travel considerations such as the availability of public transport at particular times and locations.

Looking at the demand-side, the activity- based model provides an appealing approach compared to the trip-based travel demand forecasting which has been traditionally employed (Lin, Eluru, & Waller, 2008). Proponents of activity-based models argue that they give "a rich and accurate framework in which travel is analyzed as a daily pattern of behavior related to and derived from differences in lifestyles and activity" (Jovicic, 2001, p4). However, its detractors argue that how well the advantages it promises can be achieved in practice is still debatable and the justification of the cost of developing the model and maintaining it remains challengeable (Virginia Department of Transportation, 2009).

This study applied various variables within both Utility Maximization Theory and Activity- Based Models to analyze commuter behavior towards utilization of Nairobi Commuter Rail service as a travel mode choice.

2.6 Evolution of Public Passenger Transport in Nairobi

There is extensive public transportation in Kenya and this is more so in Nairobi, the capital city. It is basically operated by private entities, a consequence of national policy which supports a deregulated market. Deregulation has led to little or no public control of route organization, operational procedures, fare structure and timetables for public transport. Numerous public transport operators provide services in Nairobi, including matatus, buses and commuter rail.

In 1934, the Kenya Bus Service (KBS) was formed and in 1966, the Nairobi City Council awarded it the monopoly of public transport service in Nairobi. KBS, a formal company with a fleet of large buses and minibuses, enjoyed the public transport monopoly within

Nairobi until 1973. However, KBS was incapable of effectively meeting the public transport demand of an expanding city and this necessitated the entry of other operators. Matatu transportation gained official recognition through a presidential decree enabling matatus to operate without barriers such as the requirement to obtain formal permits which applied to KBS. Matatu numbers grew rapidly, becoming a major competitor to KBS. KBS has been unable to maintain its foothold in the public transport sector since then, having encountered financial difficulties between 2003-2006, mismanagement and change of management   which led to its fleet progressively being reduced. Aside from matatus gaining the major share of public transport, these woes also encouraged other bus companies with larger buses to get into the public transport market e.g. Double M and City Hoppa.

Currently, matatus are the most commonly used mode of public transport. Matatus, originally considered as illegal commercial entities, started operating in Nairobi in the 1950s before being formally recognized in 1973. They are owned by individuals, except in cases where they are owned and operated by savings and credit cooperative societies (SACCOs). They have better frequencies than buses thereby providing relatively faster means of transportation and have flexible routes, stops and fares depending on various parameters such as passenger demand (UITP, 2008).

Taxis, referring to individually hired transport, are fast gaining prominence in the transport sector. Some taxis wait at specific places for customers and fares are agreed upon before departure while some are metered taxis that are hailed through mobile phone applications e.g. Uber, Taxify and Little Cab (author, 2018). For metered taxis, charges are based on time and distance.

The commuter train serves a few areas of Nairobi. The capacity of the train is low, carrying an estimated 20, 000 passengers per day which amounts to less than 1% of the total daily commuters in Nairobi (KRC, 2017).

Motorcycles (boda bodas) are popular for short distances as they are able to navigate traffic jams. There are also three wheeled motorcycle scooter vehicles (tuk tuks) which operate like taxis but cater for short trips and charge lower rates (UITP, 2018).

2.6.1 Public Passenger Transport in Nairobi

Public transport is the chief transport mode in most cities as well as for intercity and regional travel (Sarkar, Maitri, & Joshi, 2014). Most cities have multiple modes of passenger transport available to the public. According to the Integrated Urban Development Master Plan for the City of Nairobi (JICA, 2014), the different shared passenger transport modes include: matatu/bus, walking, motorcycle, cycling, taxi and rail. The most popular mode of public transport is the matatu, accounting for 75 percent of the public transport modal split. Most matatu fares depend on many factors including passenger demand and are therefore not fixed. Taxis are individually hired transport. The share of rail transport was negligible as there is very limited travel by train in Nairobi. The bicycle-motorcycle, collectively known as boda boda, is also available for short trips.

The report by JICA (2014) noted that walking occupies a large proportion of travel modes. Table 2-1 shows the modal share between different public passenger transport modes in Nairobi. The table shows that matatus and buses accounted for the highest mode of transport used by commuters (41%); followed by walking pedestrians (40%), taxi (14%) and two-wheel modes (5%). Terminals for buses and matatus are mostly located around Nairobi Railway Station but are not systematically located by direction or destination (JICA, 2014)

Table 2-1 Modal share of passenger transport in Nairobi

Mode	Survey Data
Public transport users (Matatu/Bus)	41%
Pedestrians (Walking)	40%
Taxi/truck	14%
Two-wheel mode (motorcyclists & bicyclists)	5%
Total	100%

Source: County Government of Nairobi (2013)

2.7 Rail Transport Overview

According to Kerr (2008), rail transport has been the subject of evolution, technological innovation and transformation for nearly 200 years. Robert (2011) traces the world's first rail transport back to the Middle Ages when Europeans created plate-ways to facilitate overland transport of cargo where canals and other waterways were unavailable. However, it was not until the 19th Century that railroad technology improved

considerably, first with the invention of steam engines and the development of sophisticated systems as the adoption and diffusion of rail transport spread to other parts of the world. Most cities of the world have since grown in conjunction with railways, and today, large cities cannot depend on motor vehicle modes of transportation alone (Okamoto & Tadakoshi, 2000). Some cities in industrialized nations such as Japan even launched high speed train passenger services as early as the 1960s and many more countries followed suit thus making high speed trains a distinct mode of transport between cities (Givoni, 2006). Generally, in most of the developed world, rail transport is an established sector, underpinned by the mode's capacity to move massive freight volumes as well as passengers in an economically and environmentally efficient way (Africa Development Bank, 2015).

In Africa, rail transport lags behind those of most other regions in the world (Africa Development Bank, 2015). Most of Africa's rail network is not much different from its state during the colonial era (Lowe, 2014). A large part of the rail infrastructure is over 100 years old and is in very poor technical condition (Olievschi, 2013). Further, the African railway network only carries 1 percent of the railway passenger traffic globally and only 2 percent of the freight traffic (United Nations, 2009). A number of landlocked countries in Sub-Saharan Africa such as Niger, Chad and Central African Republic do not even have rail network at all, and in the few countries that have, very few new tracks have been laid since colonial times (Lowe, 2014). Such countries are just part of 17 African Union countries which do not have rail network (United Nations, 2009).

According to AICD (2009), South Africa saw the construction of the first railways in Africa in the 1860s and 1870s with lines emanating from the ports of Cape Town and Durban and heading inland. Not much rail infrastructure development took place until the turn of the 20th century when other parts of the continent began large scale railway development. Development followed a similar pattern in most cases with isolated lines from a port heading inland to a trading centre or a mine. Over time, few branch lines were added to the existing lines. Nearly all lines were constructed during the colonial regimes and therefore many rail systems were state- owned. However, several were constructed as concessions or by mining companies to facilitate their mining operations. In the 1970s and 1980s, many railway systems in Sub-Saharan Africa dominated the freight transport traffic of their countries. Competing road transport infrastructure was poorly developed

and faced regulations in most countries. Furthermore, rail users were established businesses that preferred using rail due to the physical network.

As Sub-Saharan economies and transport in particular became liberalized, together with road infrastructure improvements, the result was stronger competition from road- based transportation so that the railway transport market share declined. At present, few railways have an impact on their countries' economies. The few remaining are facing a challenging future (AICD, 2009). 51 railways in 36 countries in Africa were in operation at the end of 2008. Africa's total network as a whole is approximately 82, 000 km. About 69, 000 km are at present in use (North Africa- 13, 000 km, West Africa- 9, 000 km, Central Africa- 6, 000 km, East Africa- 9, 000 km and Southern Africa- 33, 000 km) (AICD, 2009). Compared to a world network in excess of 1 million km of tracks, Africa's network accounts for only 5 percent of the worldwide network (Olievschi, 2013).

Almost all networks are single track. Most are either 'Cape gauge' (1.067 m, used as the main network in southern and central Africa) or the meter gauge (1000mm, used in much of East Africa). It is important to note that the Southern and North Africa networks have significant portions which are electrified.

Sub- Saharan railways generally have low densities when it comes to traffic with traffic densities of less than 300, 000 passenger-km classifying them as lightly loaded by world standards. Most African railways struggle to generate sufficient funds towards maintaining and renewing rail infrastructure as required. Since 1993, several governments have put their systems under concession. Southern Africa on the other hand dominates general rail freight (80%) as well as passenger traffic (85% of passenger kilometer) mainly due to its heavy commuter rail business. The Metrorail in South Africa, under South Africa Rail Commuter Corporation (SARCC) operates extensive electric multiple units (EMU) services over more than 2, 000 route-km running through Johannesburg, Pretoria, Durban and Cape Town. Some trains have a patronage of 500, 000 commuters or more daily. There are also loco- hauled commuter services at a smaller scale in Port Elisabeth and East London. South Africa's commuter rail lines carry over 500 million customers each year. South Africa also has a rapid regional line which is a standard-gauge railway(160km/h) running between Pretoria and Johannesburg and Pretoria.

Another regular commuter rail service worth mentioning that has operated over a considerable period is the Petit Train Bleu (PTB) from Senegal which was introduced in 1988 and provides commuter services between Dakar and Rufisque. It is operated on the main line which is under the Transrail Concession. Running over 80 km track length, it carries over 25, 000 passengers each day. Other African cities generally have small scale loco- hauled commuter services which are typically return services per day going into the city in the morning and returning in the evening. Examples of such services are found in Nairobi, Lagos, Harare and Accra. However, they face low annual patronage, in the low millions (AICD, 2009).

2.8   Rail System in Kenya

The history of rail transport in Kenya is well documented by the scholarly work of Kinuthia (2014). Rail transport in Kenya was first marked by the construction of the Kenya- Uganda Railway in 1895 to 1901 (Ndalilah, 2012) which comprises of a single-track metre- gauge (1000mm). This section presents a brief overview of the railway sector with a focus on the developmental issues pertaining to urban commuter rail service. The railway sub-sector in Kenya is controlled by Kenya Railways Corporation, a government parastatal established by an Act of Parliament (Cap 397) of the laws of Kenya (KRC, 2016). The history of the corporation dates back to the 1970s when it commenced operation, having taken over the Kenyan part of the railway from the East African Railways Corporation (EARC) after the collapse in 1977 (Kinuthia, 2014). Inherited from EARC was a 1000mm track gauge railway system that comprised about 2,765 km of track (Wahome, 2013).

Presently, the railway network in Kenya totals 2, 778 km (Kenya Railways Corporation Act) of which 2, 704 km is open to traffic (Kenya National Bureau of Statistics, 2009). As previously stated, railway operations in Kenya fall under the Kenya Railways Corporation. Currently, KRC and Magadi Railways (MR) provide rail transportation in Kenya. MR manages the line between Konza and Magadi (146 km) for the Magadi Soda Company Ltd whereas KRC operates the rest.

In the year 2005, the Act was amended to enable KRC to enter into concession agreements with investors for the provision of rail transport services. Subsequent to this amendment, the corporate sealed a 25-years concession agreement with Rift Valley

Railways (RVR) on November 2006 to provide freight services and a 1 year concession for passenger services based on leases of locomotives from KRC. The agreement took effect on November 1st 2006 and was to run until 2031. However, the corporation retained the mandate to promote and engage in the development of national and metropolitan railway facilities and services in the country (KRC, 2016).

The concession included provisions for commuter services (in the greater Nairobi area), passenger services (long distance services to Kenya's main cities) and freight (the line runs from the Indian Ocean Port of Mombasa to Malaba at the Kenya- Uganda border). It is important to note that RVR was a transporting company primarily dealing with freight which constituted 95% of all volumes and revenue. The remaining 5% was shared by the commuter services provided in Nairobi (4%) and the passenger business on long distance routes (1%). Over time, RVR failed to procure new rolling stock, rehabilitate the existing railway line as well as construct new lines as part of the concessioning agreement. As a result, the concession agreement was wound up in 2018 and KRC took over railway operations including commuter rail.

The year 2009 saw the commencement of an ambitious plan to develop modern commuter rail transport in the Nairobi metropolitan area, Coast region and Kisumu environs (Kinuthia, 2014). In Nairobi, the development of commuter rail service was to commence along existing rail network that runs between Nairobi and Ruiru; Githurai and Kahawa (24 km); Nairobi and Syokimau through Embakasi Village and Makadara (12.6 km); and Nairobi to Kikuyu through Kibera and Riruta (31 km). The first phase involved the development and provision of commuter rail services between Nairobi Railway Station and destinations such as Ruiru, Syokimau, Imara Daima and Embakasi (Kinuthia, 2014).

Between the year 2012 and 2013, three landmark developments were completed and commissioned. These are: Syokimau Railway Station, Imara Daima Railway Station and Makadara Railway Station. KRC (2016) has published train schedules and fares as shown in Tables 2 and 3 below. Table 2 suggests that a trip from Syokimau to Nairobi should last 40 minutes; from Imara Daima to Nairobi is 26 minutes; and Makadara to Nairobi should take 12 minutes. The train schedule suggests that the rail service may not be the most ideal mode choice for commuters working across town. It also suggests that

commuters who miss the peak time train would have to wait another two hours to catch the next train to Nairobi.

2.8.1   Commuter Rail in Nairobi

The existing Nairobi Commuter Rail system was developed as part of the rail system meant to serve long distance traffic. This means that no specific network has been developed for mass rail transit for Nairobi and its environs. Thus, the commuter rail network runs on existing sections of the main lines and branch lines meant for freight and long distance passenger profit and which radiate from the city to the hinterland. At present, there are 3 Kenyan Railways rail lines traversing the Nairobi metropolitan region. The railway line faces challenges such as circuitous alignment with poor geometrics, obsolete rakes and inadequate service (Wahome, 2006).

Commuter trains for public transport were introduced by Kenya Railways in 1992 to facilitate commuter travel to Nairobi's suburbs and were popular despite the then high fares charged (Obudho, 1997). The services were not as a result of deliberate planning but were introduced by KRC following a government directive in May 1992 to forestall a transport crisis after a series of strikes were staged by matatu operators country- wide, overwhelming the Kenya Bus Service. The commuter train services were meant to provide temporary relief, running morning and evening but became so successful that the services were later extended to include all existing lines within Nairobi (Wahome, 2006).

The commuter rail currently operates within Nairobi and its environs only, no services are offered in the other urban centres. Kenya Railway provides inter-city services from Nairobi Railway Station to a few areas namely Embakasi Village, Kikuyu, Kahawa and Ruiru. Currently, the train service carries an estimated 20, 000 passengers per day (500, 000 passengers per month) which amounts to less than 1% of the total daily commuters in Nairobi. The commuter service is provided by passenger trains hauled by locomotives. Commuter services serve the routes listed below:

- Nairobi- Embakasi Village (12.6 km)
- Nairobi- Syokimau (18 km)
- Nairobi- Kikuyu (31 km)
- Nairobi- Ruiru (32 km)

The trains employed for passenger traffic are typical commuter trains hauled by locomotives. For all routes, with the exception of Nairobi- Syokimau route for which two services each way are scheduled per day, only one trip each way per day is scheduled. In the evening, the locomotives return light without commuters to the CBD railway terminal and travel back the next day in the morning to pick up the commuters. The average speeds of the commuter trains range from 12- 20 km/h. Despite this being an economic mode of public transport, the commuter rail faces low ridership and has been confined to mainly carrying the peripheral urban poor at low tariffs thereby limiting its profitability.

The study focused on commuter rail services for Syokimau, Imara Daima and Makadara catchment areas.

Table 2-2 Train schedule for Nairobi Commuter Rail service

Syokimau to Nairobi				
Category	Syokimau	Imara Daima	Makadara	Nairobi
Peak time	06:55	07:09	07:23	07:35
Off-peak	09:05	09:19	09:33	09:45
Off-peak	18:50	19:04	19:18	19:30
Nairobi to Syokimau				
Peak time	08:00	08:14	08:28	08:40
Off-peak	17:50	18:04	18:18	18:30
Off-peak	19:50	20:04	20:18	20:30

Source: KRC (2016)

Table 2-2 shows that commuters from the farthest distance pay a return ticket of Kshs120 during peak time and save Kshs 40 during off-peak while a one-way trip costs half as much. According to KRC (2016), a prepaid card is issued at a cost of Kshs 2, 000 with a top- up bonus of Kshs 250 whereas from Kshs 3, 000 earns one a top-up bonus of 10 percent.

Table 2-3 Fares for Nairobi Commuter Rail Service

Destination	Peak (return)	Peak (one-way)	Off-peak (Return)	Off-peak (One way)
Syokimau – Nairobi	120	60	80	40
Park & Ride	220	220	220	220
Imara Daima – Nairobi	100	50	80	40
Park & Ride	200	200	200	200
Makadara – Nairobi	80	40	60	30
Park & Ride	180	180	180	180
Syokimau – Makadara	100	50	80	40
Park & Ride	200	200	200	200
Syokimau – Imara Daima	60	30	60	30
Park & Ride	170	170	170	170
Imara Daima – Makadara	60	30	60	30
Park & Ride	170	170	170	170

Source: KRC (2016)

Table 2-3 shows that commuters from the farthest distance pay a return ticket of Kshs120 during peak time and saves Kshs 40 during off-peak while a one-way trip costs half as much. According to KRC (2016), a prepaid card is issued at a cost of Kshs 250 or issued free if a commuter purchases at least Kshs 2,000 travel time whereas from Kshs 3,000 earns one a top-up bonus of 10 percent.

Two years after its launch, the ultramodern railway station at Syokimau, located in a growing middle income residential neighborhood, operated way below capacity as it served only 2,500 users daily against a capacity of 10,000 users (Ritho, 2014). Media reports also suggest low utilization of the other two railway stations along the railway line from Syokimau, especially the station at Makadara.

2.8.2 The Standard Gauge Railway

As part of the Kenya Vision 2030 development agenda, modernization of the railway infrastructure through the standard gauge railway (SGR) project was conceived in 2009 (www.transport.go.ke). On 11th May 2014, the Government of Kenya and China signed a financial agreement paving way for the first phase of the SGR to be constructed at an estimated cost of Kshs 327 billion. The railway line city of Mombasa to Nairobi is complete and was commissioned on 1st June 2017. It is expected to haul on each train a

trailing load of 4000 tonnes (www.ipsos.co.ke). Kenya Railways Corporation is the agency implementing the SGR while China Road and Bridge Corporation is undertaking the construction as the contractor.

Figure 2-1 Passenger train on the SGR

Source: Japan Times (2017)

The SGR involves the development of new rail different from the current meter gauge line as well as attendant infrastructure. The 472 km track, expected to transport both passengers and freight spans 7 counties- Mombasa, Kwale, Taita Taveta, Makueni, Machakos, Kajiado and Nairobi- and has 2 major stations, 1 port station, 7 intermediate stations and 23 crossing stations (a total of 33 stations) along the line. The 7 intermediate stations at Athi River, Emali, Kibwezi, Mtito Andei, Voi, Miasenyi and Mariakani have incorporated freight handling capacity.

The Mombasa-Nairobi SGR has shortened the travel time for passengers travelling from Mombasa to Nairobi and vice versa from approximately 8-10 hours to just 4.5 hours. Passenger trains, hauled by one passenger type locomotive, consist of 18 coaches with a total capacity of approximately 1,200 passengers. Freight trains complete the journey in about 8 hours. There are two main freight terminals, one located within Mombasa Port and the other at Nairobi South Hub which is adjacent to the Inland Container depot at Embakasi, Nairobi. The railway line has been designed to relay 22 million tonnes of freight per annum, or a projected 45% of Mombasa Port throughput by 2035. Traction is by diesel- electric locomotives but the line has been designed to allow for future electrification.

Upon completion, the SGR will connect Mombasa to Malaba on the border with Uganda. Phase 2 of the SGR from Nairobi to Malaba is expected to cost approximately Kshs 672 billion (www.ipsos.co.ke).

2.9   Case Study Review

This section analyzes a case study relevant to a developing country context. India was selected because it has the most complex, densely loaded and intensely utilized suburban rail system worldwide (MRVC, 2018).

2.9.1   Case Study: India

According to Beck, Bente and Schilling (2013), India, a fast growing developing country has greatly invested in rail infrastructure. The importance of the rail sector in India is depicted in the existence of a ministry of railways which is headed by a minister, an indication that the rail sector is both governed and managed by the state.

The case study selected in India is the Mumbai Suburban Railway system which serves the Mumbai Metropolitan Region located in Maharashtra State. The last few decades have seen Mumbai emerge as the commercial and financial hub of India. The population of Mumbai has increased from 4 million inhabitants in 1961 to nearly 18 million currently.

The Mumbai Suburban Railway serves Mumbai Metropolitan Region branching into three lines- the Central, Western and the Harbour. Each line links one part of the city to the other. The system is managed by two zonal railways under the Indian Railways namely Western Railways (WR) and Central Railways (CR). More than 7.24 million commuters are carried daily which is the highest passenger density as compared to other urban railway systems in the world.

Figure 2-2 Mumbai Suburban Rail network

Source: www.sibresearch.org

The city generates about 11 million trips (walk and bicycle excluded) per day, with about 88 percent of travel demand during the peak period being handled by public transport suburban trains together with buses. Millions use local trains to travel regularly over distances between 10 and 60 km each day (MRVC, 2018). According to a study conducted by the Society of Interdisciplinary Business Research in 2012, commuters from various socio- economic backgrounds use the trains for their daily travel. The service is pocket friendly (monthly season tickets allow commuters to cover a distance of approximately 500 km at a cost of US $ 1), convenient and speedy (normal trains run at 35 km/h). This has led to the popularity of the commuter trains. Thus, the Mumbai suburban rail system forms the backbone of the of the public transport system in Mumbai. The trains transport four times the traffic load buses in the city with regards to passenger kilometers of travel. Spread over 465 km, the Mumbai Suburban Railway network is the lifeline of Mumbai.

Nallathiga (2008) highlights that Mumbai was the first Indian city to have train connection, laid in 1853 by the British, to connect Chhatrapati Shivaji Terminus with the suburban town of Thane, over 34 km away. The non- electrified train services consisting

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of ordinary steel body coaches and hauled by steam locomotives were replaced in due course by diesel locomotives. However, they were incapable of meeting the basic requirements for commuter service and remained unpopular. Electric suburban trains, running on a 1500V Direct Current (DC) traction system, were then introduced in Mumbai in 1925 by the British colonialists. They consisted of wide body electrical multiple units (EMUs) which had large doorways, higher seating capacity, adequate standing room and greater speeds. Thus, they were very popular with commuters as suburban rail services progressed from the non- electrified railway system to an electrified system, becoming the core of Mumbai City's mass transportation system.

With the rapidly growing population exerting pressure on the existing suburban network, rail infrastructure started crippling and train services began to fall short of demand, resulting in the following major problems:

i)   Overcrowding whereby a train with nine cars carried more than 5, 000 passengers during peak hours (900 sitting and more than 4, 000 standing) instead of the 1, 800 passengers (900 sitting and 900 standing) envisioned in the original design.

ii) Poor travel comfort as passenger loading exceeded tolerable safe limits. This coupled with the small windows of coaches leading to lack of ventilation, poor quality grab handles and seats as well as insufficient illumination levels inside coaches led to poor overall ambience inside coaches.

iii) Mumbai suburban railway system, introduced in 1925, ran on 1500V DC traction system. Due to the increase in loading, the system experienced high energy consumption requiring an upgrade in the traction system.

iv) Difficulty in increasing the number of services as the existing corridors were being fully utilized. As such, additional corridors would be required to create extra carrying capacity so as to run additional trains.

Therefore, improvement in the public transport system to tackle the deteriorating conditions of suburban travel was conceived through the Bombay Urban Transport Project (BUTP) in the late 1970s and implemented during 1977-84 with funding support from the World Bank. The contribution of BUTP was found to be inadequate in the 1990s—thanks to the ever expanding transportation needs of the city population. The

above conditions necessitated the conceptualization of Mumbai Urban Transport Project (MUTP) as a follow-up of BUTP.

To address the worsening conditions of the Mumbai suburban railway system, the Maharashtra State government partnered with Indian Railways to finance the MUTP infrastructure project. They set up the Mumbai Railway Vikas Corporation Limited (MRVC) which was tasked with bringing down overcrowding during peak hours, capacity enhancement through the building of new lines, optimization of existing corridors and procurement of new rolling stock.

As such, the following measures were put in place to improve the suburban railway service:

i) To enhance capacity and reliability, high capacity urban rail vehicles with more coaches were introduced (coaches per train were increased from 9 to 12 to generate additional carrying capacity).

ii) Upgrading of passenger amenities in suburban trains through provision of coaches with larger windows for ventilation, comfortable seating, improved illumination and improved interiors.

iii) The 1500V DC traction system was replaced by a 25000V AC traction system resulting in electric energy savings of up to 30%.

Nallathiga notes that Mumbai's suburban rail network is quite large and extends to about 40 kilometers to the west and 60 km north-east; and another 50 km rail line that connects it to the satellite city, Navi. According to Nallathiga (2008), the suburban trains transport over 6 million commuters daily, which is roughly the population size of Sydney city, using 2 435 trains, making the suburban section of Mumbai the urban railway system with the highest passenger density in the world. The trains run at a very good frequency especially during peak hours with one train running every two minutes thereby providing the right travel option for commuters. They run from 4 am to 1 am each day. All stations along the rail corridors have a high degree of connectivity and accessibility with bus and auto/taxi services well-connected to the stations. Suburban railway services remain the most affordable and accessible means of travel for the working and middle classes in the metropolitan area.

Due to the ever increasing population which leads to overcrowding, the Mumbai Metropolitan Region Development Authority is looking towards modern high capacity heavy rail public transportation: the monorail and the metro.

India currently operates four metro rails. These are: Delhi Metro, Kolkata Metro in West Bengal, Bangalore Metro in Karnataka and Delhi Airport Express Link in the National Capital Region (NCR) of Delhi. Rail projects similar to the ones mentioned are at the planning stage while construction of others is ongoing in Jaipur in Rajasthan, Ahmedabad in Gujarat, Hyderabad in Andhra Pradesh among many more states (Goel & Tiwari, 2014).

Figure 2-3 Metro trains running on rail track in Mumbai
Source: India Today (2014)

Figure 2-4 People onboard a metro train in Mumbai
Source: India Today (2014)

Mumbai Metro construction comprised of the construction of 146 km of rail track. Of the 146 km of rail, 32 km is built underground. The Government of Maharashtra approved the project in August 2004 and construction of the first phase of Mumbai Metro started in February 2008. This phase, commissioned in 2014, covers a total length of 62.68 kilometres and serves around 600, 000 commuters daily. It has 12 stations which are located conveniently, originating from Versova and terminating at Ghatkopar.

2.10   Conceptual Framework

This chapter reviewed relevant literature informing the study. It has critically discussed the theoretical and empirical literature providing current thinking on commuter rail service as an urban mass transit system. The chapter has shown that extensive research has been undertaken in the western world. However, limited research has been documented in a developing country context such as Kenya. The applicability of the travel demand modeling theories to the Kenyan context is unknown. The case study reviewed depicts relevant best practices while also underscoring the unique context of commuter rail systems in a developing nation. The conceptual framework to be used is depicted in figure 2-5.

Generalized cost
- Journey time
- Money cost

Perceived image
- Comfort
- Safety
- Timeliness
- Convenience
- Accessibility/distance
- Ambience/cleanliness

Socio-demographics
- Age
- Gender
- Income
- Car ownership
- Distance   to
  railway station

Type of activity
- Work activity
- Non-work activity

Utilization
- Frequency
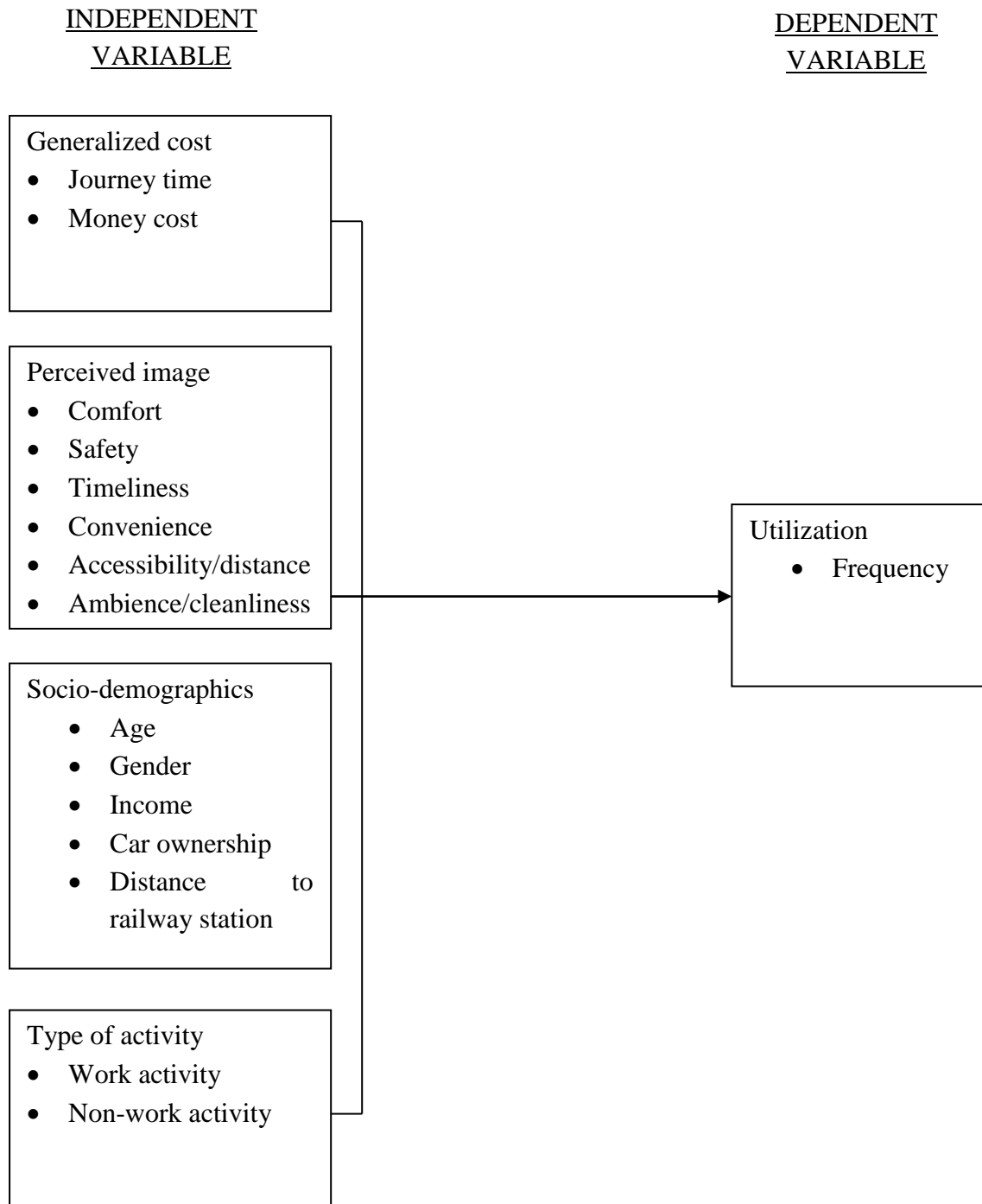
Figure 2-5 Conceptual Framework

Source: Author (2016)

Figure 2-5 shows the independent and dependent variables and the relationship between them. This framework was informed by the travel demand theories, the empirical findings from past studies and the two case studies as reviewed in Chapter Two. The figure shows that the independent variables are generalized cost which is a function of journey time and money cost; perceived image of commuter rail transit system as measured by levels

of comfort, safety, timeliness, convenience, distance, ambience and frequency of the trains; socio- demographic factors as determined by age, gender, income, car ownership and distance to the railway station; and the type of activity as related to either work or non- work activities. The researcher sought to determine the effects of the afore-mentioned variables on the utilization of commuter rail service in terms of frequency.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1   Introduction

The study set out to establish critical factors influencing the utilization of commuter rail services as an efficient mode choice for Nairobi and its environs. The chapter discusses the research methodology applied for the purpose of the research. This comprises of the research design description, discussion of the study population and sample size as well as sampling techniques, methods of data collection, procedures followed in undertaking the research and the techniques used to analyze the data.

3.2   Research Design

Descriptive research design was employed. According to Cooper & Schindler (2011), research design aims to provide information on the current status of the phenomena being studied and describes who, what, when, where and how of the study. Descriptive research design described factors influencing the utilization of the NCR service as a mode of travel within the city and its environs. Matthews & Kostelis (2011) determined that correlation research design establishes the relationship between two or more variables and complements the descriptive research design. Both research designs were complementary in the sense that descriptive research design was applied to study the socio-demographic variables and describe the activities that generate travel among commuters whereas correlation research design was applicable to the analysis of the association between the dependent and independent variables. The independent variables for this study were generalized cost, perceived image, socio- demographic factors and type of activity. The dependent variable was the commuter rail utilization. Data was collected through surveys and observation techniques. A survey questionnaire tool was designed for this purpose. This involved face to face interviews with Nairobi commuters.

3.3   Population

A population comprises all elements sharing a common characteristic from which a sample can be drawn (Cooper & Schindler, 2011). According to KRC (2016), 1.5 million people commute in Nairobi daily. The target population was adult commuters residing within the catchment areas of Syokimau, Imara Daima and Makadara railway stations.

3.4 Sampling Design

Cooper and Schindler (2011) state that sampling involves selecting some elements of a population with the goal of using these elements to draw conclusions about the entire population. Through sampling, a researcher can make inferences about the entire population using the data collected from the sample size. Sampling design is made up of three components- the sampling frame, the sampling technique and the sample size.

3.4.1 Sampling Frame

A sampling frame refers to "an operational definition of the population that provides the basis for drawing a sample" (Dixon, Singleton & Straits, 2015). It is therefore a list of population members which has complete and correct numbers and details of the population (Cooper & Schindler, 2011). In this study, the sampling frame was based on all adults within the three railway station's catchment areas who commute on a daily basis to and from the city centre.

3.4.2 Sampling Technique

Stratified random sampling technique was applied. The technique requires the population to be divided into non-overlapping groups/ subpopulations called strata from which the simple random sampling method is then used used to select the sample i.e. respondents in each stratum (Black, 2011). In this study, stratification was based on gender and station.

3.4.3 Sample Size

A sample size denotes to the number of items in a sample which is a subset of a population (Saunders, Lewis & Thornhill, 2012). Gill and Johnson (2010) provided the following formula which was applied to arrive at a representative sample:

$$n = \frac{P(100-P)Z^2}{E^2}$$

In the above formula:

n refers to the required sample size

P refers to the occurrence of a state or condition as is stated as a percentage

E refers to the maximum error required also expressed as a percentage. This study will accept a 10% maximum error margin.

Z is the z value which corresponds to the confidence level required. It represents the extent to which we can be certain that the population characteristics have been estimated accurately by the sample survey. Most researches apply 95% level of confidence which is equal to a z value of 1.96.

P (100-P) represents the variance of a proportion, whereby P denotes the percentage of a sample which has a characteristic. As most of the time the population variation is not known, Gill and Johnson (2010) recommend the use of 50% as an approximation of P so as to obtain maximum variance and therefore maximum sample size.

Thus,

$$n = \frac{50 \,(100\text{-}50)\, 1.96^2}{10^2}$$

$$= \frac{9604}{100}$$

$$= 96.04$$

The total sample was 96 commuters. The sampling matrix is illustrated in Table 3-1.

Table 3-1 Sampling matrix

Station	Gender	Sample Size	Percent
Syokimau Station catchment area	Male	16	16.67
	Female	16	16.67
Imara Daima Station's catchment area	Male	16	16.67
	Female	16	16.67
Makadara Station's catchment area	Male	16	16.67
	Female	16	16.67
Total		96	100.0

Source: Author (2016)

3.5   Data Needs

Primary and secondary data was gathered. Primary data was then analyzed to draw first-hand insights into the factors influencing utilization of commuter rail service as a mass transit system for Nairobi and its environs with focus on the Nairobi- Syokimau rail corridor. Primary data was obtained from residents living within the commuter rail

network's catchment areas of Syokimau, Imara Daima and Makadara. The data was collected via a structured questionnaire handed to each respondent. According to Saunders et al. (2012), a questionnaire is a general term that refers to all data collection techniques whereby respondents are asked a similar set of questions in a pre- determined order. The questionnaire method was used due to the convenience it offers to respondents as they have the easy task of selecting one or more answers which are already provided thus allowing the researcher to eliminate the possibility of having responses that are out of context as responses are limited to the ones already outlined.

The study questions were based on a Likert 5 Point Scale which contains a sequence of items showing concurrence or divergence with the question whose aim is to determine the respondents' feelings as they express their opinions through the set of responses availed to them. McNabb (2008) states that each item stands alone as a statement expressing a respondent's opinion on a topic. The first section of the questionnaire covered the influence of generalized cost of travel and type of activity on commuter rail utilization, seeking information such as the nature of daily travel undertaken by respondents, their typical daily schedules among others. The second section dealt with the respondents' perception of the commuter rail service while the third section gave an insight into the respondents' demographics e.g. age, employment status, income levels, car ownership etc.

Table 3-2 Data needs matrix

Objective	Type of data	Data source	Data collection method	Data analysis method	Method of data presentation
Generalized cost	Quantitative	Primary and Secondary	Observation and Questionnaire	Chi- square test	Tables
Perceived image	Qualitative	Primary	Questionnaire	Descriptive techniques	Charts and Graphs
Socio-demographics	Quantitative Qualitative	Primary	Questionnaire	Descriptive techniques	Charts and Tables
Type of activity	Quantitative	Primary	Questionnaire	Chi- square test	Tables

Source: Author (2016)

Secondary data provided historical information about NCR service and was obtained mainly from Kenya Railways Corporation Information Centre. This included

publications, service charters, quality policy statements, press releases, train fares and schedules. Other sources included publications of Kenya National Bureau of Statistics and the former Ministry of Nairobi Metropolitan Development.

3.6   Ethical Considerations and Confidentiality

Measures were taken to observe research ethics and ensure confidentiality of survey participants. Credibility of the research was observed by obtaining a letter of introduction from the University of Nairobi identifying the researcher as a student carrying out academic research for academic use only.

In order to observe confidentiality of survey respondents and to encourage them to respond freely and accurately, participants were asked not to divulge their identity anywhere on the questionnaire. Respondents were informed of the nature and purpose of the study as well as the use of findings and thereafter informed consent was obtained from them. Respondents were also informed that participation in the survey was voluntary, and therefore they could withdraw from the study if they so wished at any time.

3.7   Data Analysis Plan

The procedure data analysis entailed coding and keying in the data into the Statistical Package for the Social Sciences (SPSS). The statistical techniques used that were used to summarize data on perceived image and socio-demographic factors using measures that are easily understood by an observer are descriptive techniques namely mean, mode, median as well as standard deviation. Inferential techniques were applied to obtain inferences which were drawn using chi-square, Mann Whitney U-tests, correlation and regression techniques. The findings are appropriately presented using tables and figures to facilitate interpretation.

CHAPTER FOUR: RESULTS AND FINDINGS

4.1 Introduction

In this chapter, the analysis of findings is presented. Results are presented in four sections. The first part depicts the demographic results about the respondents while the second section analyzes and interprets the influence of generalized cost of travel and type of activity on the utilization of Nairobi Commuter Rail services. The third section presents findings on the influence of perceived image of rail transit system on the utilization of NCR services. The fourth section analyzes the role of socio-demographic factors on the variability in utilization of NCR services.

4.2 Descriptive Analysis of Demographic Profile of Respondents

The demographic data analyzed in this section are age, income, occupation and car ownership.

4.2.1 Age of Respondents

Table 4-1shows the respondents' distribution by age.

Table 4-1 Distribution of respondents by age

Age bracket	Frequency	Percent
18-24 years	38	39.6
25-50 years	54	56.3
Over 50 years	4	4.1
Total	96	100.0

Table 4-1 shows that respondents in the age bracket of 25-50 years were the majority at 56.3%, followed by 39.6% of the respondents aged 18-24 years while 4.1% of the respondents were aged over 50 years.

4.2.2 Income of Respondents

Information was sought on the respondents' approximate income per month. The finding is presented in Table 4-2.

Table 4-2 Approximate income per month

Income bracket	Frequency	Percent
Less than Kshs 24, 000	45	46.9
Between Kshs 24, 000-120, 000	46	47.9
More than Kshs 120, 000	5	5.2
Total	96	100.0

Table 4-2 reveals that 46.9% of the respondents earned less than Kshs. 24, 000, 47.9% of the respondents earned between Kshs. 24, 000 and 120, 000 whereas 5.2% of the respondents earned more than Kshs. 120, 000. The results suggest that majority of the respondents were in the lower or middle- income bracket.

4.2.3 Occupation of Respondents

The study sought to determine respondents' occupation. Their distribution by occupation is detailed in Table 4-3.

Table 4-3 Distribution of respondents by occupation

Occupation	Frequency	Percentage
Employed	36	37.5
Self employed	57	59.4
Student	3	3.1
Total	96	100.0

Table 4-3 indicates that self-employed respondents were the majority at 59.4%, followed by those who were employed at 37.5% while students accounted for 3.1% of the respondents. This means that most of the respondents were engaged in income generating economic activities.

4.2.4 Car Ownership

Respondents were asked whether they owned a car or not. Table 4-4 shows the results.

Table 4-4 Distribution of respondents by car ownership

Car ownership	Frequency	Percent
Yes	2	2.1
No	94	97.9
Total	96	100.0

As per Table 4-4 above, 97.9% of the respondents did not own a car whereas 2.1% of the respondents had a car. This implies that majority of the respondents potentially used public transport.

4.2.5 Utilization of NCR for Daily Commute

Respondents were asked whether they always utilized train for their daily travel.

Table 4-5 Utilization of NCR for daily Commute

Responses	Frequency	Percent
Yes	46	47.9
No	50	52.1
Total	96	100.0

Table 4-5 shows that 52.1 percent of the respondents did not always utilize the train for their daily travel to and from town whereas 47.9% of the respondents utilized the NCR daily. The finding suggests that majority of the residents in the catchment areas of NCR stations did not always utilize the train for their daily commute. Respondents who did not always utilize NCR services were asked to give reasons for not using the same. Thematic analysis of the reasons given revealed three underlying reasons as shown in Figure 4-1.
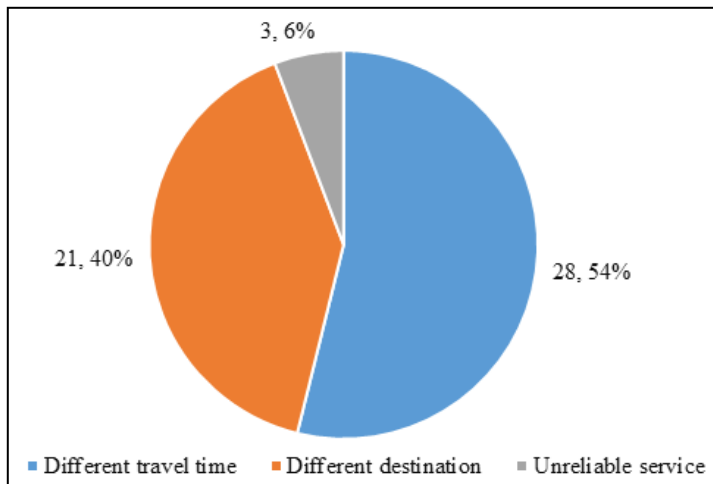
Figure 4-1 Reasons for not utilizing NCR service

Figure 4-1 reveals that 54% of the respondents cited different travel time as the reason for not utilizing the train service, 40% of the respondents mentioned different destination while some 6% of the respondents said the train service was unreliable. The results suggest that most of the respondents did not utilize the train either because of inconvenient train schedule and/or inconvenient destination.

4.2.6   Nature of Trip

Respondents were asked whether they always utilized the train for their daily travel to and from town. Table 4-6 displays the results.

Table 4-6 Type of trip

Type of trip	Frequency	Percent
Yes, round trip	38	40.0
No just one way	58	60.0
Total	96	100.0

As per Table 4-6, 60% of the respondents who utilized the train used it for one way whereas 40% utilized it for round trip. Respondents were further asked about their destination. Table 4-7 reveals the results.

Table 4-7 Respondent destination

Destination	Frequency	Percent
Usually alight before reaching town	47	49.0
My trips usually end in town	49	51.0
Total	96	100.0

Table 4-7 demonstrates that 51.0% of the respondents usually went to town whereas 49% of the respondents usually alighted before reaching town.

4.2.7 Respondents' Typical Daily Schedule

The study sought to determine respondents' typical daily schedule. Table 4-8 shows the outcomes.

Table 4-8 Respondents' typical daily schedule

Category	Frequency	Percent
From home-to work-and back	41	42.7
From home-to work/school-to shopping/ recreation-and back home	55	57.3
Total	96	100.0

Table 4-8 indicates that 57.3 percent of the respondents indicated that their daily schedule entailed travelling from home to places of work/school then to shopping/recreation and afterwards back home. However, 42.7% of the respondents traveled from home to work and back home.

4.2.8 Recent Travel by Train

Respondents were asked to indicate when they most recently travelled by train. The distribution is shown in Figure 4-2.

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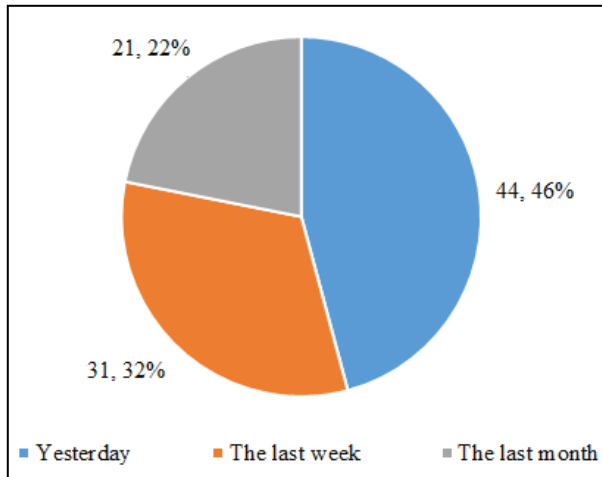
Figure 4-2 Respondents' recent travel by train

Figure 4-2 reveals that 46% of the respondents indicated that they recently traveled by train (a day ago), 32% utilized the train a week ago and 22% utilized train a month ago. Therefore, most of the respondents utilized the train the previous day, meaning that they did so most recently.

4.3   Influence of Generalized Cost of Travel on Utilization of NCR Services

This section presents the analysis of generalized cost elements namely journey time and money cost on the utilization of NCR services. This includes an evaluation of the total time to the station from the residence and from the station to the endpoint of the journey and the associated cost implications.

4.3.1   Approximate Distance from Residence to the Station

Respondents were asked to estimate how much time they take to the train station. Table 4-9 shows how the respondents are distributed based on time taken.

Table 4-9 Estimated time taken from the residence to the station

Estimated time	Frequency	Percent
5 minutes and less (500 meters)	48	50.0
6-15 minutes (about 1-1.5 km)	39	40.6
More than 15 minutes (2km or more)	9	9.4
Total	96	100.0

Table 4-9 shows that 50% of the respondents spent 5 minutes or less to reach the train station from their residence. However, 40.6% spent between 6-15 minutes to get there while 9.4% of the respondents spent more than 15 minutes to reach the train station.

4.3.2 Approximate Distance from the Station to Final Destination

Respondents were also asked to estimate how long it took them from the train station to their final destination. Table 15 presents the findings.

Table 4-10 Estimated time taken from station to final destination

Estimated time	Frequency	Percent
5 minutes and less (500 meters)	33	34.7
6-15 minutes (about 1-1.5 km)	40	41.1
More than 15 minutes (2km or more)	23	24.2
Total	96	100.0

As per Table 4-10, 34.7% of the respondents took 5 minutes or less to reach their final destination from the train station, 41.1% spent 6-15 minutes and 24.2% of the respondents took more than 15 minutes.

4.3.3 Comparison of Distance to Train Station and to Matatu Station

Respondents were asked to indicate which distance was shorter between the journey to the train station and the journey to the matatu station. The respondents' views are shown in Table 4-11.

Table 4-11 Comparison of distance to train station and to matatu station

Shorter distance	Frequency	Percent
Matatu station	89	92.6
Railway station	7	7.4
Total	96	100.0

Table 4-11 indicates that 92.6% of the respondents indicated that the distance to the matatu station was shorter while only 7.4% of the respondents said the distance to the railway station was shorter.

4.3.4 Effect of Distance on Utilization of Train

The study sought to determine the effect of distance to the train station on utilization of train services. Table 4-12 shows how respondents who utilized train by distance are distributed.

Table 4-12 Utilization of train by distance from residence to station

			Approximate distance from your residence to the station			Total
			5 mins or less (500 mtrs)	6-15mins (1-1.5 mtrs)	> 15 mins (2km plus)	
Do you always utilize train to travel to and from town	Yes	Count	28	15	3	46
		%	58.3%	38.5%	33.3%	47.9%
	No	Count	20	24	6	50
		%	41.7%	61.5%	66.7%	52.1%
Total		Count	48	39	9	96
		%	100.0%	100.0%	100.0%	100.0%

Table 4-12 indicates that a higher proportion (58.3%) of the respondents who lived within 5 minutes or less than 500 m distance from the train station always utilized the train to travel to and from town compared to the proportion of respondents who lived within 6-15 minutes or 1-1.5 km away (38.5%) and those who lived more than 15 minutes distance to the train station i.e. >2 km away from the train station (33.3%). The table suggests that the further the distance to the train station, the lower the utilization of the train to travel to and from town. The study also sought to establish the effect of distance from the train station to the final destination on utilization of train services. Table 4-13 presents the distribution of respondents who utilized the train by distance from the train station to the endpoint of the trip.

Table 4-13 Utilization of train by distance from train station to final destination

			Approximate distance from train station to final trip destination			Total
			5 mins or less (500 mtrs)	6-15mins (1-1.5 km)	> 15 mins (2km plus)	
Do you always utilize train to travel to and from town	Yes	Count	18	20	8	46
		%	54.5%	51.3%	34.8%	48.4%
	No	Count	15	19	15	49
		%	45.5%	48.7%	65.2%	51.6%
Total		Count	33	40	23	96
		%	100.0%	100.0%	100.0%	100.0%

Table 4-13 shows that a higher proportion of respondents whose final destination was 5 minutes or less from the train station (54.5%) and those who travelled 6-15 minutes from the train station (51.3%) always utilized the train than respondents whose final destination was more than 15 minutes from the train station (34.8%). The finding suggests that if the final distance from the train station is far, then the number of commuters utilizing the train will be low.

4.3.5 Access to the Stage of Preferred Mode of Transport

The study sought to establish respondents' access to their preferred mode of transport. Figure 4-3 displays the distribution.
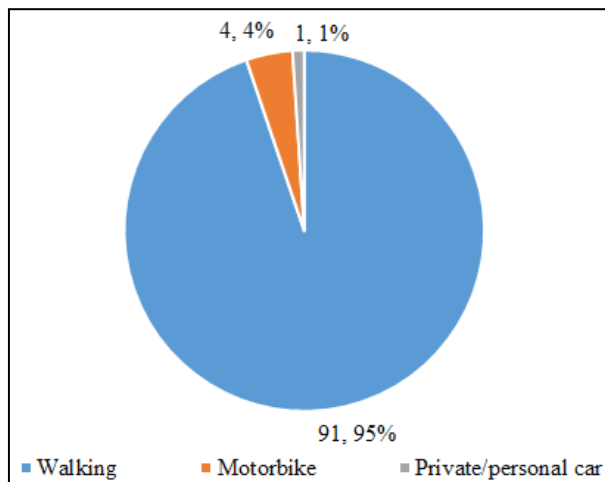
Figure 4-3 Respondents' access to preferred transport mode

Figure 4-3 shows that 95% of the respondents accessed their preferred mode of transport by walking, 4% used a motorbike and 1% used personal car. Therefore, majority of the respondents walked to the bus or train station.

4.3.6 Effect of Train on Travel Cost

The study sought to establish whether the train reduced respondents' travel costs. The distribution of respondents' views is presented in Figure 4-4.
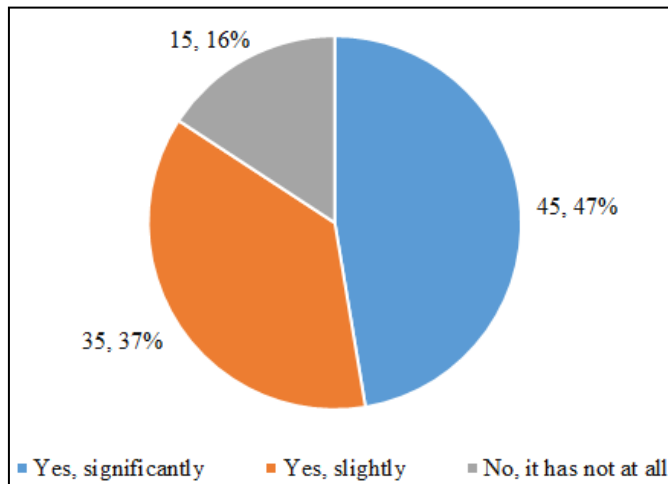
Figure 4-4 Effect of the NCR on travel costs

Figure 4-4 reveals 47% of the respondents were of the opinion that train travel reduced travel costs significantly, another 37% of the respondents said the travel cost has gone down slightly, while only 16% of the respondents said the train has not reduced travel costs at all.

4.3.7 Utilization of NCR by Travel Cost

The study sought to evaluate the utilization of the train against the perception that the train has reduced travel cost. Table 4-14 shows the results.

Table 4-14 Utilization of NCR by travel cost

			Do you always utilize train to travel to and from town		Total
			Yes	No	
In your view, has the train reduced your travel cost?	Significantly	Count	42	5	47
		%	91.3%	10.0%	49.0%
	Slightly/ not at all	Count	4	45	49
		%	8.7%	90.0%	51.0%
Total		Count	46	50	96
		%	100.0%	100.0%	100.0%

Table 4-14 reveals that a higher proportion (91.3%) of respondents who always utilized the train to travel to and from town perceived that the train reduced their travel cost

significantly compared to the proportion of the respondents who did not (10.0%). This implies that respondents who said the train significantly reduced their travel cost utilized the train more than those who said it slightly reduced or did not reduce their travel cost at all.

Table 4-15 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	63.377[a]	1	.000
Continuity Correction[b]	60.165	1	.000
Likelihood Ratio	73.354	1	.000
Linear-by-Linear Association	62.717	1	.000
N of Valid Cases	96		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.52.

b. Computed only for a 2x2 table

Table 4-15 indicates the statistically significant association between perceived reduction in travel cost and utilization NCR, $\chi^2(1) = 63.377$, $p<.01$. This means that perceived reduction in travel cost significantly influenced utilization of the NCR.

4.3.8   Correlation between Generalized Cost and Utilization of NCR

Spearman's rank correlation analysis was run to determine whether the relationship between generalized cost dimensions and utilization of NCR was statistically significant. Table 4-16 displays the output. The table reveals that there was a strong positive correlation between utilization of NCR and money cost in terms of cost savings ($r=.843$, $p<.01$), journey time in terms of time savings ($r=.747$, $p<.01$) and perceived image ($r=.801$, $p<.01$). This implies that utilization of the NCR increased with increase in cost savings, time savings and better perceived image. However, the table indicates there was a weak negative correlation between utilization of NCR and distance to train station ($r=.206$, $p<.05$), meaning that the farther the distance to train station, the lower the utilization of NCR.

Table 4-16 Correlation between generalized cost dimensions and utilization of NCR

Spearman's Rho		1	2	2	4	5
1. Utilization of NCR	Correlation Coefficient	1.000				
	Sig. (2-tailed)	.				
	N	96				
2. Cost Saving	Correlation Coefficient	.843**	1.000			
	Sig. (2-tailed)	.000	.			
	N	96	96			
3. Distance	Correlation Coefficient	-.206*	.198	1.000		
	Sig. (2-tailed)	.044	.053	.		
	N	96	96	96		
4. Time Saving	Correlation Coefficient	.747**	.719**	.178	1.000	
	Sig. (2-tailed)	.000	.000	.083	.	
	N	96	96	96	96	
5. Perceived Image	Correlation Coefficient	.801**	.812**	.118	.797**	1.000
	Sig. (2-tailed)	.000	.000	.252	.000	.
	N	96	96	96	96	96

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.3.9   Regression of Utilization of NCR on Generalized Cost and Perceived Image

Multiple linear regression analysis was run to establish the explanatory power of generalized cost and perceived image dimensions on the utilization of NCR. The regression output is presented in Tables 4-17 to 4-19. From Tables 4-17 and 4-18, it can be inferred that generalized cost variables and perceived image explained 73.2% of the variability in utilization of NCR services (R^2=.732, F>1, p=.000).

Table 4-17 Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.856[a]	.732	.720	.41837

a. Predictors: (Constant), Distance, Money Cost, Journey Time, Perceived Image

Table 4-18 ANOVAª

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	43.562	4	10.890	62.220	.000ᵇ
1	Residual	15.928	91	.175		
	Total	59.490	95			

a. Dependent Variable: Utilization of NCR

b. Predictors: (Constant), Distance, Money Cost, Journey Time, Perceived Image

Table 4-19 shows the influence of each independent variables on the dependent variable. The table reveals that perceived image had the highest explanatory power on utilization of NCR services (B=.757, p=.000), followed by money cost savings (B=.265, p=.000), distance to train station (B=-.065, p>.05) and journey time savings (B=.042, p>.05). The regression equation for the model is as follows:

Utilization of NCR   = -1.247 + .757 x Perceived Image + .265 x reduced Money Cost

+.042 x reduced Journey Time -.065 x Distance to train station.

Table 4-19 Coefficientsª

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	-1.247	.251		-4.963	.000
	Perceived Image	.757	.163	.586	4.652	.000
1	Money Cost	.265	.095	.257	2.785	.007
	Distance	-.065	.066	-.054	.985	.327
	Journey Time	.042	.091	.045	.458	.648

a. Dependent Variable: Utilization of NCR

4.4   Influence of Type of Activity on Utilization of NCR

This section analyzes the influence of type of activity on utilization of NCR in terms of frequency and number of trips.

4.4.1   Effect of Daily Schedule on Utilization of Train Service

The study sought to compare the utilization of train service by nature of daily schedule. Table 4-20 presents the results. Table 4-20 shows that a higher proportion (76.1%) of respondents whose daily schedule comprised of traveling from home to work and back always utilized the train service compared to the proportion of respondents (23.9%)

whose typical daily schedule entailed travelling from home to work/ school-to recreation/ shopping-and then back home. The study further sought to determine whether this association was statistically significant using the chi-square test to establish the level of significance as indicated in Table 4-20.

Table 4-20 Utilization of train service by typical daily schedule

			Do you always utilize train to travel to and from town		Total
			Yes	No	
What is your typical daily schedule	From home-to work-and back	Count	35	6	41
		%	76.1%	12.0%	42.7%
	From home-to work/ school-to shopping/ recreation-and back home	Count	11	44	55
		%	23.9%	88.0%	57.3%
Total		Count	46	50	96
		%	100.0%	100.0%	100.0%

Table 4-21 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.215[a]	1	.000
Continuity Correction[b]	37.639	1	.000
Likelihood Ratio	43.736	1	.000
Linear-by-Linear Association	39.796	1	.000
N of Valid Cases	96		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.65.

b. Computed only for a 2x2 table

Table 4-21 reveals a statistically significant association between typical daily schedule of respondents and utilization of the train service, $\chi^2(1) = 40.215$, $p<.01$. This means that the nature of respondents' daily schedule did influence their utilization of the NCR.

4.4.2 Effect of Daily Schedule on Train Trips

Among respondents who utilized the train service, the study further compared number of trips by respondents' daily schedule. The output is presented in Table 4-22.

Table 4-22 Number of trips by typical daily schedule

| | | | Nature of trip | | |
			Round trip	One way	Total
What is your typical daily schedule	From home-to work-and back	Count	17	18	35
		%	94.4%	66.7%	77.8%
	From home-to work/school-to shopping/recreation -and back home	Count	1	9	10
		%	5.6%	33.3%	22.2%
Total		Count	18	27	45
		%	100.0%	100.0%	100.0%

Table 4-22 shows that a higher proportion of respondents whose typical daily schedule comprised of travelling from home to work and back utilized the train for round trip (94.4%) compared to those who travelled from home to work/school then to shopping/recreation and afterwards back home (5.6%). The table nevertheless reveals that a higher proportion of respondents who utilized the train for one way trip had a schedule comprising of travelling from home to work and back home (66.7%) compared to their counterparts who travelled from home to work/ school to shopping/recreation and back home (33.3%).

Chi-square test was run to establish the significance of the association between type of trip and daily schedule. The output is presented in Table 4-23.

Table 4-23 Chi-square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.821[a]	1	.028
Continuity Correction[b]	3.348	1	.067
Likelihood Ratio	5.578	1	.018
Linear-by-Linear Association	4.714	1	.030
N of Valid Cases	96		

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.00.

b. Computed only for a 2x2 table

Table 4-23 reveals that there was a statistically significant association between typical daily schedule of respondents and type of trip, $\chi^2(1) = 4.821$, $p<.01$. This means that the nature of respondents' daily schedule did influence their utilization of the NCR.

4.5   Influence of Perceived Image of Rail Transit System on Utilization of NCR

This section presents descriptive and inferential analysis of the influence of perceived image of rail transit system on the utilization of NCR.

4.5.1   Perceived Image of Rail Transit System

The study sought to determine respondents' perception of the image of rail transit system. Table 4-24 presents the frequencies, mean (M) and standard deviation (SD) of the dataset on a 5-point Likert scale. 1=Strongly Disagree (SD); 2=Disagree (D); 3=Neutral (N); 4=Agree (A); and 5=Strongly agree (SD).

Table 4-24 Perceived image of rail transit system

Statements		SD	D	N	A	SA	Total	M	SD
The train has reduced my money cost of travel	f	0	15	38	27	16	96	3.46	0.95
	%	0.0%	15.6%	39.6%	28.1%	16.7%	100.0%		
Traffic congestion has reduced since the introduction of train	f	0	0	32	49	15	96	3.82	0.68
	%	0.0%	0.0%	33.3%	51.0%	15.6%	100.0%		
Use of the train saves me time compared to other modes of transport	f	0	2	42	28	25	96	3.79	0.86
	%	0.0%	2.1%	42.7%	29.2%	26.0%	100.0%		
I feel a lot more safer from accidents when travelling by train than by any other means	f	0	0	7	73	16	96	4.09	0.48
	%	0.0%	0.0%	7.3%	76.0%	16.7%	100.0%		
I find the train a more convenient mode choice for my daily travel needs	f	13	39	6	36	2	96	2.75	1.18
	%	13.5%	40.6%	6.3%	36.5%	3.1%	100.0%		
I am pleased with the overall service quality offered by train service	f	12	35	42	7	0	96	2.46	0.81
	%	12.5%	36.5%	43.8%	7.3%	0.0%	100.0%		
The train is always crowded	f	23	55	15	3	0	96	1.98	0.73
	%	24.0%	56.3%	15.6%	3.1%	0.0%	100.0%		
I feel more secure in train than other modes of transport	f	0	1	26	64	5	96	3.76	0.56
	%	0.0%	1.0%	27.1%	66.7%	5.2%	100.0%		
It is more prestigious to travel by train than by other public means	f	6	41	49	0	0	96	2.45	0.61
	%	6.3%	42.7%	51.0%	0.0%	0.0%	100.0%		
I associate train use in Nairobi with the high class in the society	f	15	57	24	0	0	96	2.09	0.63
	%	15.6%	59.4%	25.0%	0.0%	0.0%	100.0%		
I am happy with the train schedule and departure time	f	44	9	43	0	0	96	1.99	0.96
	%	45.8%	9.4%	44.8%	0.0%	0.0%	100.0%		
Train transport is more comfortable than other public means	f	11	29	37	19	0	96	2.67	0.92
	%	11.5%	30.2%	38.5%	19.8%	0.0%	100.0%		
Train services offered is reliable and predictable	f	34	19	43	0	0	96	2.09	0.90
	%	35.4%	19.8%	44.8	0.0%	0.0%	100.0%		

Table 4-24 reveals that 28.1% and 16.7% of the respondents agreed and strongly agreed that the train reduced their money cost of travel. However, 39.6% of the respondents did not support either side and 15.6% of the respondents disagreed. A moderately high mean score was obtained on a Likert scale (M=3.49, SD=0.95), which means that most of the respondents agreed that their money cost of travel has reduced.

Respondents were asked whether traffic congestion has reduced since the introduction of the train. Table 4-24 indicates that 51.0% of the survey respondents agreed while15.6% strongly agreed whereas 33.3% respondents surveyed were neutral. On the 5-point scale, the mean score was high (M=3.82, SD=068), meaning most respondents agreed that traffic congestion reduced with the introduction of NCR.

The study sought to determine whether train use saved respondents time compared to other modes of transport. Table 4-24 indicates that 29.2% and 26.0% of the respondents agreed and strongly agreed. However, 42.7 percent of respondents exhibited neutrality while respondents disagreeing accounted for 2.1%. A high mean score was obtained on a scale of 1 to 5 (M=3.79, SD= 0.86) which suggests that most of the respondents agreed that the use of the train saved them time in comparison to other transport modes.

The views of the respondents were sought as to whether they felt safer from accidents when travelling by train than by any other means of transport. Table 4-24 reveals that of the respondents agreeing and strongly agreeing account for 76.0% and 16.7% respectively while 7.3% of the respondents remained neutral. The mean score was high (M=4.09, SD=0.48) based on a scale of 1 to 5, which implies that majority of the respondents felt safer from accidents while travelling via train.

Respondents were asked whether they found the train a more convenient mode choice for their daily travel needs. Table 4-24 indicates that respondents disagreeing and strongly disagreeing account for 40.6% and 13.5% respectively. 6.3% of the respondents were neutral while respondents agreeing and strongly agreeing account for 36.5% and 3.1% respectively. A low mean score was obtained on a 5-point scale (M=2.75, SD=1.18), which means that most of the respondents did not find the train a convenient travel mode. The study sought to establish respondents' perception of the overall quality of services offered by the train. Table 4-24 indicates that 36.5% and 12.5% of the respondents disagreed and strongly disagreed, respectively, that they were pleased with the overall

service quality offered by train service. However, 43.8% of the respondents were impartial while 7.3% of the respondents disagreed. A low mean score was obtained on a 5-point scale (M=2.46, SD=0.81). This suggests that majority of the respondents were not pleased with the service quality of train as a travel mode.

Respondents were asked whether the train was always crowded. Table 4-24 reveals that 56.3% of the respondents disagreed while 24.0% of survey respondents strongly disagreed. The table also shows that 15.6% of the respondents exhibited neutrality and 3.1% of the respondents agreed. A low mean score was realized on a 5-point scale (M=1.98, SD=0.73), which means that majority of the respondents disagreed that the train was always crowded.

The opinions of respondents were sought with regards to whether they felt more secure in the train than in other modes of transport. As per Table 4-24 above, of the respondents accounting for 66.7% and 5.2% agreed and strongly agreed respectively. However, 27.1% of the survey respondents displayed neutrality while respondents accounting for 1.0% of disagreed. A high mean score was computed on a 5-point scale (M=3.76, SD=0.56), suggesting that most of the respondents felt secure travelling by train than by other transport modes.

The perception of respondents was sought concerning whether it was more prestigious to travel by train than by other public means. Table 4-24 reveals that 51% of the respondents displayed neutrality while respondents accounting for 42.7% disagreed and a further 6.3% strongly disagreed. A low mean score was realized on a 5-point scale (M=2.45, SD= 0.61), which means that a majority of the respondents did not feel that the train was a prestigious mode of travel as compared to other public means.

Respondents were further asked whether they associated train use in Nairobi with the high class in society. According to Table 4-24, 25% of the respondents exhibited neutrality while respondents accounting for 59.4% and 15.6% disagreed and strongly disagreed respectively. On a scale of 1 to 5, the mean score was low (M=2.09, SD=0.63), which means that a majority of the respondents did not associate train use with the high class in society.

The study sought to establish whether respondents were happy with the train schedule and departure time. Table 4-24 indicates that 9.4% and 45.8% of the respondents disagreed and strongly disagreed, respectively, that they were happy with the train schedule. However, 44.8% of the respondents were neutral. On a 5-point scale, the mean score was low (M=1.99. SD= 0.96). This means that a majority of the survey respondents were not happy with the train schedule/departure time.

Respondents were asked whether train transport was more comfortable than other public means. Table 4-24 indicates that respondents accounting for 30.2% and 11.5% disagreed and strongly disagreed respectively. However, 38.5% of the respondents displayed neutrality and respondents accounting for 19.8% agreed. A low mean score was obtained (M=2.67, SD= 0.92) which implies that a majority of the survey respondents disagreed that travelling by train was more comfortable.

The views of respondents were also sought as to whether train service offered was reliable and predictable. As per Table 4-24 above, 44.8% of the respondents were neutral, 19.8% disagreed and 35.4% of the respondents strongly disagreed. The mean score on a scale of 1 to 5 was low (M=2.09, SD=0.90), which means that most of the respondents disagreed that train services were reliable and predictable.

4.5.2 Inferential Analysis of the Influence of Perceived Image on Train Demand

This section compares the composite ranks of perceived image between respondents who always utilized train and those who did not using a Mann Witney U-test at 0.05 significance level. The output is presented in Tables 4-25 and 4-26.

Table 4-25 Composite ranks

	Do you always utilize train to travel to and from town	N	Mean Rank	Sum of Ranks
Perceived Image	Yes	46	71.83	3304.00
	No	50	27.04	1352.00
	Total	96		

Table 4-26 Test statistics

	Perceived Image
Mann-Whitney U	77.000
Wilcoxon W	1352.000
Z	-7.899
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Do you always utilize train to travel to and from town

The results in Tables 4-25 and 4-26 reveal that respondents who usually utilized train for travel had a more positive image of rail transit system (Mdn=71.83) than their counterparts who did not usually utilize train for transport (Mdn=2.04), U=77, p=0.000. This implies that perceived image of the rail transit system did influence demand for NCR.

4.5.3 Attributes of Train Service of Importance to Respondents

Respondents were asked to rank various service attributes in order of importance on a scale of 1=least important and 7=most important. Figure 4-5 ranks the attributes from highest to lowest mean ranking.
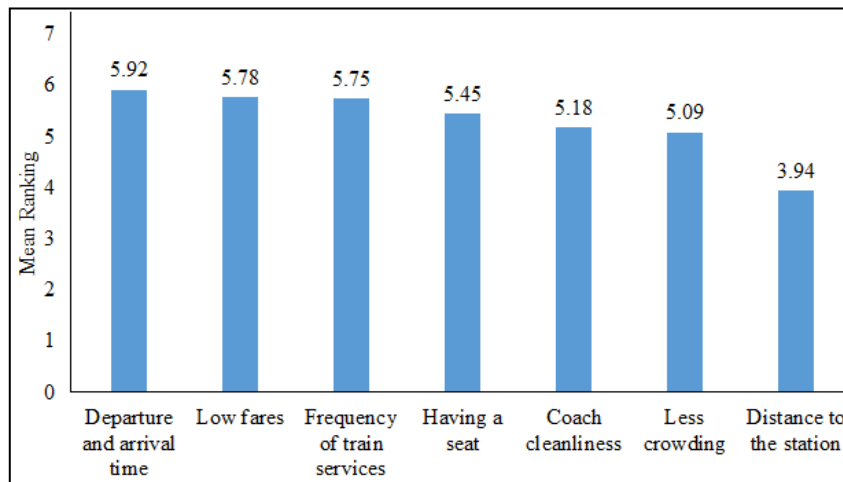
Figure 4-5 Mean ranking of importance of train service attributes

Figure 4-5 reveals that departure and arrival time was the most important train service attribute (M=5.92) followed by low fares (M=5.78), frequency of train services (M=5.75), having a seat (M=5.45), coach cleanliness (M=5.18) and less crowding (M=5.09). Distance to the station was the least important attribute (M=3.94).

4.6   Role of Socio-demographic Factors on the Variability in Utilization of NCR

This section analyzes the role of socio-demographic factors such as gender, age, income, occupation and residential location.

4.6.1   Role of Gender on Utilization of NCR

Chi-square test was run to determine whether the association between gender and utilization of NCR was statistically significant. The result is displayed in Table 4-27 and Table 4-28.

Table 4-27 Utilization of NCR by gender

			What is your gender		Total
			Male	Female	
Do you always utilize train to travel to and from town	Yes	Count	25	21	46
		%	53.2%	42.9%	47.9%
	No	Count	22	28	50
		%	46.8%	57.1%	52.1%
Total		Count	47	49	96
		%	100.0%	100.0%	100.0%

Table 4-27 indicates that a higher proportion (53.2%) of male respondents utilized the train to travel to and from town compared to the proportion of female respondents (42.9%).

Table 4-28 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.027[a]	1	.311
Continuity Correction[b]	.654	1	.419
Likelihood Ratio	1.028	1	.311
Linear-by-Linear Association	1.016	1	.313
N of Valid Cases	96		

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 22.52.

b. Computed only for a 2x2 table

Table 4-28 reveals that the difference between male and female utilization of train for transport was not statistically significant, $\chi^2(1) = 10.027$, $p>.05$. This means that utilization of train services did not vary by gender.

4.6.2 Role of Age on Utilization of NCR

The study sought to establish whether utilization of the train for travel varied by age. Tables 4-29 and 4-30 show the results. Table 4-29 indicates that a higher proportion of respondents over 25 years of age utilized the train for travel compared to their counterparts aged 18-24 years.

Table 4-29 Utilization of train by age

			What is your age in years			Total
			18-24 years	25-50 years	Over 50 years	
Do you always utilize train to travel to and from town	Yes	Count	16	27	4	47
		%	42.1%	50.0%	100.0%	47.3%
	No	Count	22	27	0	49
		%	57.9%	50.0%	0.0%	52.7%
Total		Count	38	54	4	96
		%	100.0%	100.0%	100.0%	100.0%

Table 4-30 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.683[a]	2	.431
Likelihood Ratio	2.069	2	.355
Linear-by-Linear Association	1.026	1	.311
N of Valid Cases	96		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is .47

Table 4-30 shows that the age difference in utilization of train for transport was not statistically significant, $\chi^2(1) = 1.683$, $p>.05$. This means that utilization of train services did not vary by age.

4.6.3 Role of Income on Utilization of NCR

The study sought to determine whether income influenced utilization of NCR. Findings are presented in Tables 4-31 and 4-32.

Table 4-31 Utilization of train by income level

			What is your approximate income per month		Total
			Less than Ksh 24,000	Between Ksh. 24,000-120,000	
Do you always utilize train to travel to and from town	Yes	Count	20	22	42
		%	44.4%	47.8%	46.2%
	No	Count	25	24	49
		%	55.6%	52.2%	53.8%
Total		Count	45	46	91
		%	100.0%	100.0%	100.0%

Table 4-31 shows that a slightly higher proportion (47.8%) of the respondents within income bracket of Kshs 24, 000-120, 000 always utilized train to travel compared to the proportion of respondents whose income was less than Kshs 24, 000.

Table 4-32 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.105[a]	1	.746
Continuity Correction[b]	.013	1	.910
Likelihood Ratio	.105	1	.746
Linear-by-Linear Association	.104	1	.748
N of Valid Cases	91		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.77.

b. Computed only for a 2x2 table

Table 4-32 indicates that income difference in utilization of train for transport was not statistically significant, $\chi^2(1) = .105$, $p > .05$. This means that utilization of train services did not vary by income.

4.6.4 Role of Occupation on Utilization of NCR

The distribution of respondents' utilization of train for travel by occupation is presented in Table 4-33 while Table 4-34 shows the chi-square test result.

Table 1 Utilization of NCR by occupation

			Occupation			Total
			Employed	Self employed	Student	
Do you always utilize train to travel to and from town	Yes	Count	14	29	3	46
		%	38.9%	50.9%	100.0%	47.9%
	No	Count	22	28	0	50
		%	61.1%	49.1%	0.0%	52.1%
Total		Count	36	57	3	96
		%	100.0%	100.0%	100.0%	100.0%

Table 4-33 reveals that a higher proportion (100.0%) of respondents who were students utilized the train for travel compared to respondents who were self-employed (50.9%) and the least users of the train were respondents who are employed (38.9%).

Table 4-34 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.637[a]	2	.098
Likelihood Ratio	5.802	2	.055
Linear-by-Linear Association	3.321	1	.068
N of Valid Cases	96		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.44

Table 4-34 reveals that occupation difference in utilization of the train for transport was not statistically significant, $\chi^2(2) = 4.637$, $p > .05$. This means that utilization of train services did not vary by occupation.

4.6.5 Role of Proximity to Town

The study sought to determine whether utilization of train services depended on how far respondents lived from the town center. Table 4-35 and 4-36 presents the results.

Table 4-35 Utilization of train by residential location

			Nearest train station			Total
			Syokimau area	Imara Daima area	Makadara area	
Do you always utilize train to travel to and from town	Yes	Count	13	16	17	46
		%	40.6%	50.0%	53.1%	47.9%
	No	Count	19	16	15	50
		%	59.4%	50.0%	46.9%	52.1%
Total		Count	32	32	32	96
		%	100.0%	100.0%	100.0%	100.0%

Table 4-35 indicates that the highest proportion of respondents who utilized the train for travel were from Makadara area (53.1%) followed by respondents from Imara Daima area (50%) and lastly, Syokimau area (40.6%).

Table 4-36 Chi-square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.085[a]	2	.581
Likelihood Ratio	1.090	2	.580
Linear-by-Linear Association	.991	1	.319
N of Valid Cases	96		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.33.

Table 4-36 shows that differences in utilization of the train for travel by distance was not statistically significant, $\chi^2(2) = 1.085$, $p > .05$. This means that utilization of train services did not vary by distance of residential location from town.

4.7 Chapter Summary

This chapter has displayed and interpreted the study findings. As per the major findings, the further the final distance to the destination from the train station, the lower the number of commuters utilizing the train. It was found that 47% of the respondents said that train reduced travel costs significantly and another 37% of the respondents said travel cost has gone down slightly. As per the results, 54% of the respondents cited different travel time as the reason for not utilizing the train service. Respondents who usually utilized the train for travel had a more positive image of the rail transit system (Mdn=71.83) than their counterparts who did not usually utilize the train for transport (Mdn=2.04), U=77, $p=0.000$. Generalized cost variables and perceived image explained 73.2% of the variability in utilization of NCR services ($R^2 = .732$, $F > 1$, $p = .000$). Perceived image had the highest explanatory power on utilization of NCR services ($B = .757$, $p = .000$) followed by money cost savings ($B = .265$, $p = .000$), distance to train station ($B = -.065$, $p > .05$) and journey time savings ($B = .042$, $p > .05$). Socio-demographic factors had no influence on the variability in utilization of NCR. The findings are summarized in the figure below and discussed in the next chapter.
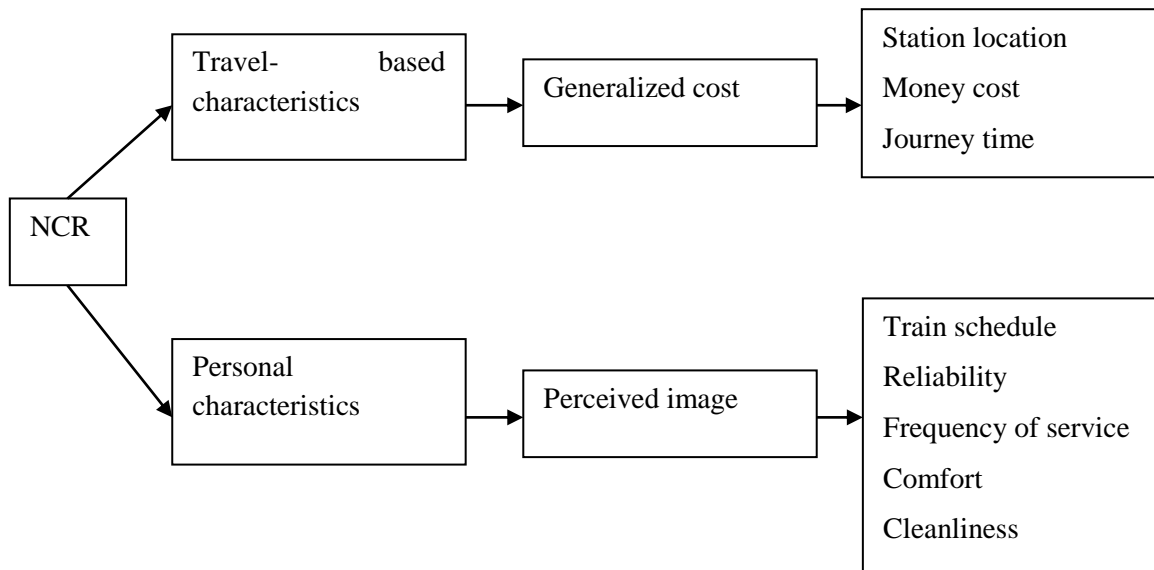
Figure 4-6 Factors influencing utilization of NCR as a mode choice

CHAPTER FIVE: DISCUSSIONS AND IMPLICATIONS

5.1   Introduction

This chapter reviews the findings and evaluates them within the broader context of utilization of commuter rail services as a travel mode choice. The important findings are summarized and implications discussed in relation to theory and practice. The discussion is thematically presented based on the study objectives. The first section discusses findings on the influence of generalized cost of travel on the utilization of Nairobi Commuter Rail services. The second section presents a discussion of the influence of perceived image of rail transit system on the utilization of Nairobi Commuter Rail services. The third section evaluates the role of socio-demographic factors on the variability in utilization of Nairobi Commuter Rail services while the last section discusses the influence of the type of activity on utilization of the NCR.

5.2   Influence of Generalized Cost of Travel on Utilization of NCR

The first objective of the study was to establish the influence of generalized cost of travel on the utilization of Nairobi Commuter Rail services. The results showed that for majority of the respondents, the distance to the matatu station was shorter. This means that in order to utilize the NCR as a mode choice, commuters had to factor in additional time cost which ranged anywhere between 6 to 15 minutes or more. In terms of influence of time cost, the results suggested that the further the distance to the train station, the lower the utilization of NCR to travel to and from town. Similarly, the further the final distance from the train station to the final destination, the fewer the number of commuters utilizing the train. The finding aligns with the study by Chakour and Eluru (2013) which determined that users will not consider transit alternatives if the distance to the station exceeds a certain threshold. The results therefore echo the perspective of Rak and Lep (2014) that when locating train stations commuter walking time to the station is one of the most important factors to be considered. In line with the findings of a study by Debrezion et al. (2007) in Amsterdam, it means that a longer distance to the train station had a negative effect on the utility of rail services. The finding underscores the importance of location consideration when designing train stations and rail network system.

For a modal shift from road- based transport to commuter rail to occur, location of stations is of great importance both at the point of origin as well as destination.

Transportation design should limit stations within a 400- 800m radius (Liu, 2017) of residential and activity centres thereby limiting commuter walking time to those acceptable threshold distances. Where it is impossible to locate stations within those distances, feeder services to the station should be provided as individuals who enjoy easier access to public transit stations are more likely to choose public transit over the car as a mode of transport.

The study established that about half of the respondents did not always utilize the train for their daily travel to and from town. Thematic analysis revealed that the leading reason for not doing so was different travel time. This finding echoes the results of a study by Chakour and Eluru (2013) which showed the significance of travel time which had a negative impact on station choice. Document analysis of the published train schedules of the NCR on Nairobi- Syokimau corridor suggested that commuters who miss the peak time train would have to wait another two hours to catch the next train to Nairobi CBD. This two hour gap means that commuters who are potential users of the NCR do not get a chance to utilize the train because of a mismatch between their travel time and the train schedule. This is reinforced by findings which show that departure and arrival time is the most important train service attribute and frequency of train service is the third most important service attribute. This resonates with McDonough's (1973) study of travel demand for commuter rail service in USA in the short run which found that changes in time cost greatly impacts rail demand. It also supports the findings of a study undertaken by Morgenroth (2013) in England which revealed that frequency explained a larger proportion of the variation in rail mode share; implying that an increase in service frequency would significantly increase utilization of commuter rail service.

Commuter rail can effectively compete with road- based transport if it can offer greater convenience to commuters in terms of the ability to determine the time to travel which is determined by the frequency of the train service as well as the reliability of departure and arrival time of the trains. Car owners tend to have a lower evaluation for public transport when it comes to convenience, reliability and satisfaction. Increasing public transport service provision and network density will make commuter rail more competitive as compared to car travel and therefore encourage modal shift.

The results also revealed that different destination was the second most cited reason for not utilizing NCR for daily commute to and from town probably due to the fact that the train stations are located far from the final destination of the respondents which makes rail service a less ideal mode choice. This result is in line with a previous study undertaken in Kenya by Wahome (2013) who identified long walking distance between places of residence and the railway station and from the railway station to places of work as a constraint to the utilization of rail as a mode choice. The finding also agrees with the observation made by Goel and Tiwari (2008) that the additional walking components that characterize the utilization of the train as a mode choice contribute to generalized cost that potentially influence demand for NCR services. This is reinforced by the finding which revealed that nearly all respondents (95 percent) accessed their preferred mode of transport by walking.

The rail transit system ought to put into consideration high quality pedestrian infrastructure that facilitates access to train stations and the distance commuters would have to cover to and from the train station. This finding resonates well with the Utility Maximization Theory as explained by Aleskerov et al. (2011) who explicated that a rational commuter facing a choice between various alternative modes of travel chooses the one that maximizes his utility function. In this case, the NCR is not being utilized to its full potential because it does not maximize commuters' utility function. Quick and easy interchange at stations through the integration of commuter rail and other transport modes is necessary to deal with the competition offered by the convenience of car use when it comes to the issue of different destination. Waiting time and accessibility to effect an interchange from one mode to another should be as short as possible for car users to consider a mode switch to commuter rail.

The study also established that most of the respondents said that NCR reduced their travel cost significantly and a higher proportion of these respondents always utilized the train to travel to and from town as compared to the proportion of the respondents who said the train only slightly reduced their travel cost or did not at all. This is in line with the observation made by Kinuthia (2014) that utilization of the train service benefits commuters by way of reduced travel cost. Chi-square result indicated the presence of a statistically significant association between perceived reduction in travel cost and train utilization, meaning that perceived reduction in travel cost significantly influenced

utilization of the NCR. This is consistent with Mohammed and Shakir's (2013) finding that reducing the travel cost highly influenced utilization of mass transit modes. The finding also supports the view of Litman (2013a) that increased prices tend to reduce consumption and sometimes cause shifts to alternative mode choices. In this study, a lower fare was the second most important service attribute of the NCR for most of the respondents. This means that utilization of the train as a mode choice is price sensitive but this sensitivity varies with the value commuters attach to the price relative to the generalized cost and the options open to them.

The study determined that the impact of rail service on cost of travel must be significant to cause a demand shift, otherwise slight reductions in cost do not influence utilization of the train service as a mode choice. To address costing of commuter rail service, the cost to car users must be significantly higher than train use for a mode shift to occur. Policies at the national level that institute measures such as charging motorists directly for the costs of driving will make car travel less attractive than alternative modes. For commuter rail to provide reliable service and competitively price services, KRC must reduce operation costs through measures such as upgrading rail network. This will enable it to operate heavier and longer trains at higher average speeds which will increase commuter rail capacity. Higher speeds will allow commuter rail to effectively compete with road-based transport and encourage a mode shift. KRC should also consider flexible ticket options as well as ticket purchase options to encourage behavior change among commuters.

Related results revealed that majority of the respondents agreed that traffic congestion reduced with the introduction of NCR. This suggests that one of the objectives for which the NCR was put in place was achieved in line with KRC's 2012-2017 Strategic Plan. However, the implication of this is that alternative travel modes such as bus and matatu system increased their value proposition since a decongested traffic means they reach their destination relatively faster. This potentially reduces the competitiveness of rail system as a travel mode choice. Given that most of the respondents did not always utilize the train for their daily travel to and from town, it can be inferred that commuters resort to alternative travel modes which explains the low utilization of NCR as a travel mode choice. The finding is in line with previous observations at Syokimau and Makadara stations by Gibendi (2014) that showed low utilization of rail transport as a mode choice.

This also agrees with the views of Kinuthia (2014) that NCR has faced numerous challenges including competition from other transport modes.

5.3   Influence of Perceived Image of Rail System on the Utilization of NCR

The second objective of the study was to establish how perceived image of rail transit system influences the utilization of Nairobi Commuter Rail services. Results revealed that respondents who usually utilized the train for travel had a significantly more positive image of the rail transit system than their counterparts who did not usually utilize the train for transport. It can thus be inferred that perceived image did influence utilization of NCR. This is in line with Scherer's (2012) assertion that the image of a transport system has an impact on demand. Changing commuters' behavior towards commuter rail is vital for the viability of the service. Commuter attitude determines mode choice and therefore improving the level of service together with the image of NCR can increase potential users' intention to use the commuter rail and result in a mode shift. This implies that the image of the rail transit system is just as important as other elements of rail service, meaning that equal attention and investment in improving the NCR's image is necessary to influence demand.

The findings revealed that most of the respondents agreed that they felt safer from accidents while travelling via train and felt more secure travelling via train than other modes of transport. However, majority of the respondents disagreed that train was a more convenient mode choice for their daily travel needs, did not feel that train was a prestigious mode of travel more than other public means, did not associate train use with the high class in society, were not happy with the train schedule/departure time, disagreed that travelling by train was more comfortable, disagreed that train services were reliable and predictable and were not pleased with the overall service quality of NCR. These results align with a study conducted by Debrezion et al. (2007) which indicated that if service quality of a railway station is increased, this leads to a favorable image of service which translates to an increase in demand for commuter rail services.

The implication is that each of all the afore- mentioned elements that constitute the transport mode's image has a significant impact on utilization of NCR as a mode choice. Therefore, it was not enough for KRC to merely launch the ultramodern rail service. KRC needed to equally invest on changing commuter perceptions of the image of rail as a

travel mode choice. Marketing and information campaigns focused on the improved level of service and advantages of the train service over road- based transportation e.g. safety, lack of traffic jams contribute to greater acceptance of commuter rail as an efficient travel mode. Education on sustainable transportation and urban mobility are also necessary to influence a mode shift.

In terms of service quality, the study found that out of seven service quality attributes mentioned by respondents, having a seat was the fourth most important meaning that an image of travelling in comfort was a key aspect of service influencing demand for rail transit as a mode choice. This agrees with the observation made by Lago et al. (2009) that comfort was an important quality attribute with implications on demand for rail services. The study also established that less crowding ranked within the top 5 most important service attributes to respondents. This corresponds with findings of a research by Litman (2008b) which revealed that commuters place a great value on less crowding. This has implications on the maximum capacity that NCR should carry.

5.4   Influence of Socio-Demographics on the Utilization of NCR

The third objective of the study was to evaluate the role of socio-demographic factors on the variability in utilization of NCR. The study revealed that utilization of train services did not vary by gender, age, income or occupation. This finding contradicts the results of a study by Zahabi et al. (2012) in Montreal which found that these socio-economic variables significantly influenced utilization of rail transit as a mode choice. The implication of this finding is that market- targeting and segmentation is not necessary in the Kenyan context as opposed to the western world and in India where demographic segmentation may make sense. The difference in research results may be explained by the fact that although there were income differences among the respondents, the differences were probably not materially significant to affect commuters' utilization of NCR services.

The results showed that nearly all of the respondents did not own a car. This means that a segment of the population within the catchment areas continues to view the private automobile as the prime mode of transport. This sets back efforts towards traffic decongestion and challenges the service model adopted by the new ultra-modern NCR whose stations offer a park-and-ride transport model whereby residents in its catchment area drive to the station, park their cars and board the train to the city. Concerted efforts

to draw in automobile users to commuter train travel by operating it as a customer-oriented service provider through addressing convenience, reliability, waiting time, comfort and incentives such as discounted parking fees at train stations will encourage car users to shift to commuter rail as an alternative mode of travel.

The findings indicated that the highest proportion of respondents who utilized the train for travel were from Makadara area, followed by respondents from Imara Daima area, and lastly, Syokimau area. However, the test for the significance of these differences showed that utilization of train services did not vary significantly by distance of residential location from the City. This was surprising as it was expected that the nearer the commuter to the city, the more the mode choice options available to them at a favorable generalized cost and therefore, the higher the variability in utilization of NCR as a mode choice.

5.5   Influence of the Type of Activity on the Utilization of the NCR

The fourth objective of study as pertains to the type of activity and its influence on NCR utilization established that the association between the typical daily schedule of respondents and utilization of the train service was statistically significant; with a higher proportion of respondents whose daily schedule comprised of traveling from home to work and back always utilizing the train service compared to the proportion of respondents whose typical daily schedule entailed travelling from home to work/ school-to recreation/ shopping and afterwards travelling back home. Given the finding which showed that most of the respondents' daily schedule comprised travelling from home to work/school to shopping/recreation and back home, this potentially explains the high utilization of the train service for one way rather than round trip.

This finding lends credence to activity- based approaches to travel demand modelling which suggest that apart from time and budget constraints, travel mode choice is a function of individual as well as household roles and responsibilities and the specific lifestyle of the individual and his family (Jovicic, 2001). In this case, and in line with the trade-off hypothesis fronted by Milimol et al. (2013), commuters balance the need to engage in each activity with the travel expense required for travel and this leads them towards making a trade-off when comparing NCR against alternative travel modes. This

means that travel is a demand derived from the need to engage in activities and this depends on an individual's circumstances as explained by Brill (1986). In this case, the need to engage in either shopping or recreation potentially explains the relatively low utilization of the NCR service for round trips. The implication of this is that NCR management may need to rethink its investment in incentives for round trip tickets. It may also need to take into account additional recreational and social infrastructure within each station and stimulate investment in the same.

Transit station and network planning is intertwined with land use planning. Land use is an important factor that influences travel behavior. Density of development and land use diversity has an impact on travel demand, trip frequencies, travel distances and mode choice. To reduce automobile dependence and shift commuters to public transport, there is need to provide high quality public transport within a highly connected urban structure that is characterized by high density and mixed land use. At the national level, policies encouraging dense development within walking distance of transit stations will provide a positive relationship between land use and NCR as both leisure and work trips are generated and this will result in a mode switch as commuters will be able to engage in a variety of activities using public transport without limitation.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter draws conclusions as per the findings, discussions and implications of the study. The conclusions are thematically presented according to the study objectives. Subsequently, the study makes recommendations for theory and practice and suggests future research directions.

6.2 Conclusions

6.2.1 Influence of Generalized Cost of Travel on Utilization of NCR

Generalized cost of travel had a negative impact on the utilization of NCR. The choice of NCR as a travel mode depended on how far away the train station was from the point of origin -commuter's residence- to the train station and from the train station to the journey endpoint-final destination. Distance to the train station was inversely proportional to the utilization of NCR as a mode choice. Feeder (access/egress) mode to the train station played a great role in commuter decision- making. This was further complicated by the mismatch in commuter's travel time with the train schedule and the wide gap between departure/arrival times. Generalized cost also manifested in the utility of the train as a mode choice owing to destination mismatch. In addition, significant reduction in travel cost caused a corresponding increase in the utilization of NCR as a travel mode choice.

6.2.2 Influence of Perceived Image of Rail Transit System on the Utilization of NCR

Perceived image of the rail transit system had a direct influence on the utilization of NCR. Respondents' perceptions and attitudes informed their mode preferences and choices. This had a relationship with the quality of services provided by KRC. NCR was negatively perceived by commuters in many respects. Although travelling by train confers a sense of safety and security and reduced generalized cost relative to other travel mode choices, it did not provide convenience, comfort and prestige and neither was it reliable. However, a dichotomy existed in the perceived image of the NCR, with frequent users having a positive image than occasional or non-users. Service quality features of importance to commuters included less crowding and having a seat, both of which are associated with a comfortable train ride.

6.2.3   Influence of Socio-Demographics on Utilization of NCR

Socio-demographic factors have no influence on the utilization of NCR. None of the socio-demographic variables were significant in determining demand of rail transit as a mode choice. Utilization of NCR as a mode choice was similar across age, gender, income levels, occupation and even residential distance to the city.

6.2.4   Influence of Type of Activity on Utilization of NCR

The typical daily schedule of respondents plays a significant role on the utilization of NCR. Travel is a derived demand and factors like typical daily activities were influential in determining demand for NCR as the utility of train service was evaluated against the need to fulfill other household or recreational needs and their respective opportunity costs.

6.3   Recommendations

6.3.1   Recommendations for Improvement

In order to stimulate demand for NCR as a travel mode choice and encourage mode shift from road- based transport to commuter rail, KRC should increase the frequency of trips of its rolling stock and have better- organized timetables. This should resolve both the problems of mismatch between commuter travel time and train schedule and the waiting time in between trips. Feeder modes to train stations (walking, cycling, bus rides, matatu) should be effectively integrated to achieve maximum benefit from rail investment especially at Imara daima and Makadara Stations. There might be need to change the role of the bus and matatu in order to achieve a sustainable train travel system whereby they act as feeder services and their fares and timetables are integrated with the rail system. The review of schedules can accommodate an extension of early and late services. This will reduce crowding and increase seat availability thereby increasing commuter comfort.

Analysis of commuter perception of NCR showed that attitudinal factors are significant predictors of travel behavior. Travel awareness campaigns and provision of quality information to commuters will contribute to a more favourable reception of NCR as a travel option. KRC should address the problem of poor perceived service quality through a concerted public relations campaign. The communication campaign should focus on benefits to the commuter such as reduced generalized cost, comfort, safety and security as

the value points. KRC should look at rehabilitation of the rail line and introduction of traction technology to increase passenger capacity as this will allow more trains to operate on the line and will also allow more coaches to be added to the trains thereby leading to less crowding and availability of seats for commuters. With traction technology, trains will operate at greater speeds than the current 12- 20 kph thus leading to time savings for commuters and allowing the NCR service to compete favourably with road transport.

The study revealed that a majority of train users walk to the station meaning that the private car- owning demographic is almost excluded from commuter rail use despite the provision of parking space at stations (park- and- ride model). To mitigate traffic congestion in Nairobi, there is need to influence individuals through demand management to shift from private automobile use to mass transit alternatives, and in this case, the NCR. Studies have shown that cities that have successfully implemented public transport systems have in the past restrained private car use over long periods while those that operate urban rail in environments that are highly motorized have failed to realize the expected modal shift so that the viability of the rail system is undermined. Car restraint is necessary through measures such as:

i) Incentives e.g. discounted tickets for those who utilize the park-and-ride model.

ii) Provision of feeder services from residential areas to the train stations. KRC can be given the opportunity to institute bus enterprises and organize routes to feed rail services in the event that it is not possible to utilize the existing bus and matatu services. This will offer convenient connections to stations and increase the patronage of NCR.

iii) At the national level, policies can be adopted at a greater level such as making the opportunity cost higher for private automobile users by instituting user fees such as high parking costs, high insurance rates and barring private vehicles from accessing the CBD. Regulatory instruments such as congestion pricing also work in reducing the role of the private car as a prime mode of transport.

iv) Transit pass programmes for employers, students and civil servants.

As travel is a derived demand in response to individual and household requirements for activity participation, KRC should take measures to attract strategic investors who can set up recreational, entertainment and shopping malls in both beginning and destination stations. Additionally, KRC should review the current origin- destination points and readjust them to match the current commercial and socio- economic demands.

There is need to review the origin- destination points as commuter rail benefits immensely from a larger route km due to its asset- intensive nature. Nairobi is facing urban sprawl whereby high density development has spread into areas adjoining its edge e.g. Kitengela, Athi River, Mlolongo etc thereby creating distances and travel demand concentration which the road- based system cannot efficiently handle. An urban rail system with coordinated feeder services is therefore the most efficient public transit mode and therefore, KRC should look into rehabilitating the existing line from Syokimau to Athi River. This will effectively capture the potential of the densely populated areas of Mlolongo, Athi River and Kitengela. By building stations at these areas, there will be ease of accessibility and convenience for these populations thereby increasing NCR ridership and decongesting Nairobi.

KRC in conjunction with the Nairobi County should look at providing pedestrian access to the stations since many commuters walk to and from the stations. Easy access to destinations will have a significant impact on traffic decongestion efforts by drawing in commuters as evidenced by Mumbai Suburban local train system whereby stations are connected to extended walkways in many parts of the city and this provision has been embraced by pedestrians who reach destinations swiftly without having to negotiate road traffic.

Other measures of encouraging a modal shift from road- based transport to NCR and thus mitigating traffic congestion include interconnectivity to increase accessibility whereby stations have increased number of links originating from them to the surrounding residential, commercial and economic centres. This will contribute to seamless journeys and thereby influence individuals to use NCR. Integration of NCR with other transport modes will also enhance convenience, connectivity and accessibility for commuters and this would have greater impact if it includes integrated automated fare systems allowing

commuters to access multiple transit modes using a single ticket without having to pay multiple fares once the trains arrive at stations.

| Enablers | Short- term Outcome | Long- term Outcome |

Customer- oriented service-
Increased service frequency, schedule review, feeder services, non- motorized access to station, modal integration, reviewed origin-destination points

Encouraging positive perception –
awareness campaigns on benefits of using commuter rail

Strengthened commuter rail, Modal shift from road- based

Traffic decongestion

Increased passenger capacity-
rehabilitation of rail infrastructure, introduction of traction technology

Car restraint measures- Incentives e.g. discounted tickets; regulatory instruments e.g. vehicle user taxes,

Figure 6-1 Diagrammatic representation of expected outcomes
Source: Author

6.3.2 Recommendations for Further Studies

This study should be followed up by an in- depth analysis of the travel pattern of commuters to establish why there was a mismatch between commuter travel time and the established train schedules and what time adjustments should be made to reduce this mismatch. This would help to determine train schedule that is most responsive to commuter needs. Future researchers could expand the methodological scope of this study by adopting a mixed methods design with a bigger sample to increase reliability of statistical estimates.

In-depth studies on incentives to increase ridership of NCR should be undertaken. More research focused on making the NCR the backbone of the public transit system with the aim of decongesting Nairobi should be undertaken. The opportunity offered by NCR to improve the physical structure and support the socio- economic growth of areas located along the Nairobi- Syokimau rail line such as Mbotela, Makongeni, Kaloleni and Kariba should be studied.

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APPENDICES

Appendix I: Cover Letter

Dear Respondent,

This is an academic research on "*Modal- shift strategy for mitigating traffic congestion in Nairobi: A study of the Nairobi- Syokimau commuter rail corridor*". As such, your responses will be handled with utmost confidentiality and findings will be used for academic purposes only. The names of individuals will not be mentioned nor will they appear anywhere in the report. Please do not reveal your identity anywhere in this questionnaire. The questionnaire is divided into 3 sections with brief questions which should take only a few moments of your time. Please place a tick (✓) or fill in your response in the blanks as and where appropriate. Thank you in advance for your cooperation.

For any further inquiries, please feel free to contact:

Linda Onguka
Researcher
(0722 300 306)
University of Nairobi

Appendix II: Questionnaire

SECTION A: THE INFLUENCE OF GENERALIZED COST OF TRAVEL ON THE UTILIZATION OF NAIROBI COMMUTER RAIL SERVICES

1. Do you always utilize train for your daily travel to and from town?

   Yes ❑   No ❑   If No, why not? _____

   _____

2. If Yes to (1), do you mostly utilize the train for round trip?

   Yes, round trip   ❑

   No, just one way   ❑

   If No, why not? _____

   _____

3. What is usually the nature of your daily travel?

   I usually alight before reaching town ❑

   My trips usually end in town   ❑

   I always go across town   ❑

4. Approximately what distance do you cover to board the train?

	5 mins or less (about 500m)	6 to 15 mins (about 1 to 1½km)	More than 15 mins (2km or more)
From your place of residence to the station?			
From your workplace/destination to the station?			

5. Compare your journey to the matatu station and to the railway station, which distance is shorter?

   Matatu station   ❑

   Railway station   ❑

6. How do you usually access the stage where you board your preferred mode of transport? *Please tick one only*.

   Walking   ❑

   Motorbike (Bodaboda)   ❑

   Private/personal car   ❑

7. What is your typical daily schedule like? (*Please tick one*)

From home – to work/school – and back home   ❑

From home – to work/school – to shopping/recreation – and back home ❑

Other (please specify) _____

8. When did you most recently travel via train?

Today   ❑

Yesterday   ❑

The last one week   ❑

The last one month   ❑

More than a month ago   ❑

Never   ❑

9. In your view, has the train reduced your travel costs?

Yes, significantly   ❑

Yes, slightly   ❑

No, it has not at all   ❑

Not Applicable   ❑

Please explain? _____

SECTION B: THE INFLUENCE OF PERCEIVED IMAGE OF RAIL TRANSIT SYSTEM

Please indicate whether you agree or disagree with the following statements:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. The train has reduced my money cost of travel					
11. Traffic congestion has reduced since the introduction of train					
12. Use of the train saves me time compared to other modes of transport					
13. I feel a lot safer from accidents when travelling by train than by any other means					
14. I find the train a more convenient mode choice for my daily travel needs					
15. I am pleased with the overall service quality offered by train service					
16. The train is always crowded					
17. I feel more secure in the train than other modes of transport					
18. It is more prestigious to travel by train than by other public means					
19. I associate train use in Nairobi with the high class in the society					
20. I am happy with the train schedule and departure time					
21. Train transport is more comfortable than other public means					
22. Train services offered are reliable and predictable					

23. Please rank the following service attributes in order of importance to you (where 1= most important and 7= least important):

Departure and arrival time   _____

Having a seat   _____

Lower fares   _____

Coach cleanliness   _____

Less crowding   _____

Frequency of train service   _____

Distance to station   _____

SECTION C: COMMUTER DEMOGRAPHICS

This section is intended to capture the general information about participants in the survey to determine trends and patterns. Kindly provide the following information:

24. What is your gender?

    Male   ❑

    Female   ❑

25. What is your age in years?

    18 – 24   ❑

    25 – 50   ❑

    Over 50   ❑

26. What is your approximate income per month?

    Less than Kshs 24,000   ❑

    Between Kshs 24,000 – 120,000   ❑

    More than Kshs 120,000   ❑

27. Occupation?

    Employed   ❑

    Self employed   ❑

    Student   ❑

    Other (please specify) _____

28. Do you own a car?

    Yes   ❑

    No   ❑

29. Which of the following Railway Stations is the nearest to where you live?

    Syokimau Station   ❑

    Imara Daima Station   ❑

    Makadara Station   ❑

===THANK YOU FOR YOUR TIME AND COOPERATION====