MANAGING URBAN TRAFFIC CONGESTION: A CASE STUDY OF LAN`DHIES -JOGOO ROAD CORRIDOR

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DECLARATION

This Research Project is my original work and has not been presented for a degree in any other university

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DEDICATION

I dedicate this work to my extended family, all interested readers, all road users and the men and women charged with the responsibility to keep our cities moving and in order.

ABSTRACT

Nairobi is an economically dynamic urban area with rapid urbanization and population growth persisting over the recent years. This has encouraged increased demand for goods and services and hence increase urban mobility and movement of people within the city. Economic prosperity and social development generate the need for increased urban mobility. This demand promotes the use of private vehicles. Consequently, the increases in demand for transportation plays an important role in producing traffic congestion and degrading the urban environment within the city. Huge traffic snarl-ups, accidents, loss of productive man-hours, air pollution from both hooting vehicles and their exhaust pipe emissions are factors that contribute to Nairobi's inefficient urban transport system. Congestion management policies are paramount to enhance the management and performance of highly trafficked roads.

The overall objective is to assess how traffic congestion is managed within Nairobi City, a case of a selected corridor-Landhies- Jogoo Roads. In assessing the management of urban traffic congestion within Nairobi City, the specific objectives that guided the research are: examining the nature of traffic congestion along Landhies-Jogoo roads; evaluate existing traffic management strategies and their operationalization; propose effective traffic management policy framework. To achieve the objectives, a mixed-method approach incorporating qualitative and quantitative analysis was employed. In-depth literature reviews were done as well as a collection of primary data through field surveys, observation techniques, photography and administration of questionnaires.

Key Informant Interviews were administered targeting traffic management policymakers, policy enforcers and transport operators.

The study analyses the findings and concludes by giving a wide range of congestion management policy-oriented proposals, which focus on the characterisation of congestion in its wider context, congestion impacts, traffic management frameworks, institutional framework, and enforcement. These recommendations and implementation points are geared towards addressing the problems facing the Landhies-Jogoo roads as a case study for the larger Nairobi Transit Corridors.

Thus, it is the view of this research that long-term land-use and transport planning objectives and frameworks should be integrated and crafted to promote coordination with congestion management policies and guidelines.

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ACRONYMS

BRT- Bus Rapid Transit

CBD- Central Business District

CGA- County Government Act

ECMT-European Conference of Ministers of Transport

EMCA- Environmental Management and Co-Ordination Act

ETA-Expected Time of Arrival

HOV- High occupancy Vehicles

KEBS--Kenya Bureau of Standards

KENHA--Kenya National Highways Authority

KNBS-Kenya National Bureau of Statistics

KURA-Kenya Urban Roads Authority

NAMATA- Nairobi Metropolitan Area Transport Authority

NEMA- National Environment and Management Authority

NIUPLAN- Nairobi Intergrated Urban Development Plan

NTSA-National Transport and Safety Authority

OECD- Organisation for Economic Co-operation and Development & Transport,

PCU -Passenger Carrier Unit

PSV- Passenger Service Vehicle

PWD- Persons with Disability

SEA- Strategic Environmental Assessments.

STI- Science, technology and Innovation

TOD- Transit-Oriented Development

VTPI -Victoria Transport Policy Institution

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Urban traffic congestion is a common occurrence in many global cities. Global national statistics indicate growth in congestion in many parts of the world including developed countries like the United States where often this phenomenon is evident in reduced average speeds during peak hours (Rodrigue, Comtois, & Slack, 2007).

Cities grow as they attract more people (rural-urban migration) and activities as is the case of most African cities, resulting in increased traffic congestion. Congestion has become a common characteristic in the urban road transportation system of cities in developing countries (World Bank, 2002). Nairobi leads in the top five African cities with the worst traffic at 62.44 minute Index. It is followed by Cairo (51.56 minutes), Pretoria (49.00), Johannesburg (45.15), Cape Town (44.15) and Durban (53.12) (Traffic Index 2017). The traffic index is a composite index used to measure time consumed in traffic, estimation of time consumption dissatisfaction and overall inefficiencies (Traffic Index 2017).

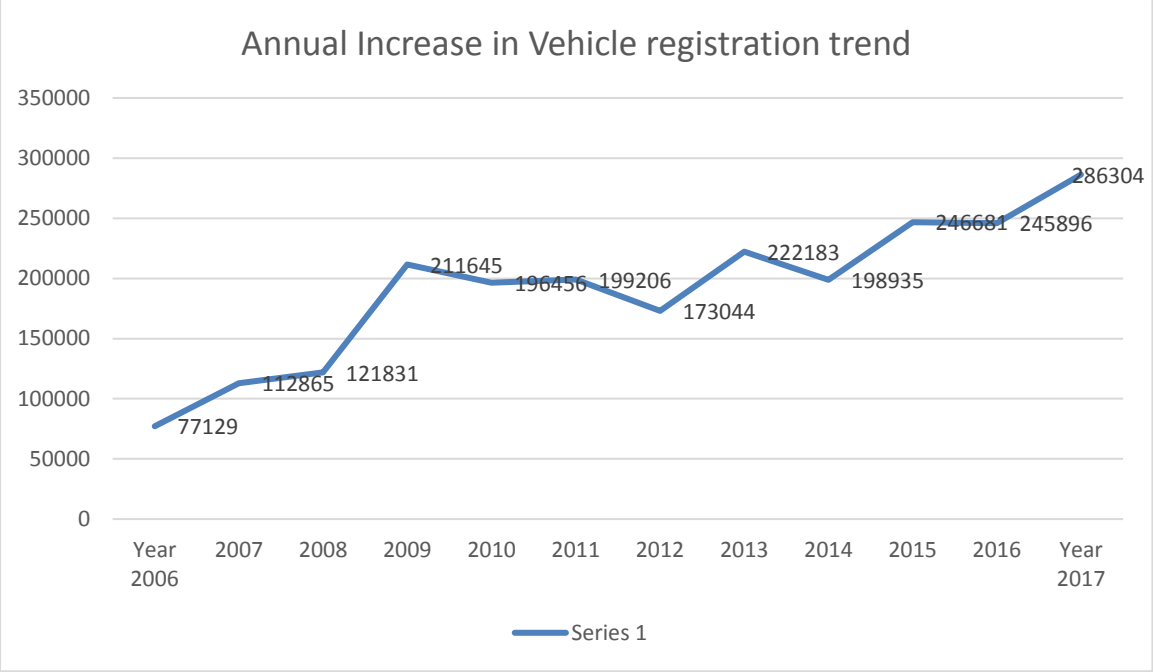
Traffic congestion results in various problems such as rising transport costs, minimised incomes, movement inefficiency, longer travel time, public transport inadequacy, psychological problems (stress, depression, road rage), increased energy consumption, accidents and fatalities, weakened family and social ties and traffic law violation. Increased vehicle emissions, high temperatures and degrading ambient air quality are some of the impacts of traffic congestion. Recent studies reveal trends of increased morbidity and mortality for drivers, commuters, and individuals living near major roadways (Zhang & Batterman, 2013).

As urbanites across the world generate wealth, this translates to higher vehicle ownership leading to more traffic on the roads. Urbanites with easier access to quality, reliable public transport modes, road congestion is not as frequent as cities that lack reliable easily accessible public transport that would provide alternatives to private car use (OECD & ECMT, 2007).

In 2018, Kenya had a total of 269,943 new vehicle registrations averaging 24,540 units per month (KNBS, 2018). This is a significant increase from 121,831 new vehicle registration in the year 2008, 161,813 in 2009, 196,456 in 2010, 205,841 in 2011 and 173,044 in 2012 (KNBS, 2013). This implies that as long as cities and urban areas continue to grow, it is

likely that higher levels of traffic congestion will be experienced.

Figure 1: Annual Increase in the vehicle registration



Source: Author's own from Literature review (KNBS 2013)

The total registered vehicles in Kenya as of 2018, was at approximately 3,259,731 vehicles (KNBS, 2018). Omwenga (World Urban Forum, 2008), postulates that Kenya's Capital City alone accounts for 30% of the car ownership in Kenya, translating to approximately 1 million units.

An urban transport system is a critical component of an urban area's social, economic and physical structure. Transportation plays a critical role in cities, municipalities and urban areas, which are engines of growth. These roles include providing necessary linkages, transfer of factors of production (raw materials, labour), transfer of goods and services, determination of spatial patterns of growth and spatial distribution of facilities.

Land uses are the determinants and destinations of all traffic. According to Kipgeno (1986), all journeys begin and terminate at either the place of residence, work or socialisation. The City of Nairobi is a multifunctional town with an agglomeration of major land uses, activities and highly specialised services. Being the capital city of Kenya, It serves as a commercial,

political, administrative, legislative and service (educational, medical) capital of the region. With these numerous land use activities, the city also generates a significant amount of traffic volumes.

Nairobi City until recently lacked an integrated urban transport plan. Originally established in the early 1900s the city has largely developed on an organic market-driven framework. There have been previous attempts to prepare a City Master plan including the First Plan of Nairobi in 1898, Settler capital plan of 1927, Colonial capital plan of 1948 and Nairobi metropolitan growth strategy of 1973 (NIUPLAN 2017).

However, the majority of growth and development in the city we see today has been market-driven. This implies that the city lacked an integrated transport system. Various stand-alone transport plan initiatives by different government agencies have been undertaken to ease the congestion. Various government efforts have tried to focus on the provision of additional infrastructure. However, these public investments do not always translate to the eradication of traffic congestion. In the short term, the facilities tend to be underutilized, in the medium term they tend to be well used, however, in the long term, these facilities are overused and stretched beyond their carrying capacities (OECD & ECMT, 2007). A practical example is the Thika superhighway into Nairobi's CBD which was completed about 10 years ago. Traffic congestion into the CBD is an observable daily common occurrence. However, the city is gradually grinding to a slow but certain halt if appropriate intervention measures aren't undertaken.

In the long-term management of Nairobi city, a congestion management policy to be operationalised by urban managers ought to enable enjoyment of agglomeration without compromise from the negative impacts of congestion. Eradicating congestion is neither an affordable exercise nor a feasible goal in economically dynamic urban areas. Nonetheless, congestion can be better and more effectively managed. "Effective management of congestion requires a holistic and integrated strategy beyond visible incidence of congestion to the management of the urban region" (OECD & ECMT, 2007, p. 18).

1.2. Problem Statement

Nairobi's CBD is a focal point where different actors and forces within the production line conglomerate to facilitate economic development, income generation, urban growth, and development. It is the heart of trade, commerce and the service industry in the East African region. Nairobi City has a population of approximately 4,174,952 as per the NIUPLAN year

2018 projection. Daily, approximately one-third of the city's population (1.4 million) commences their journey towards the CBD part of whom are passers-by in the CBD (Gonzales, 2011).

The large influx of people within a short period (peak hours) with different modes of transport generates a very high demand on the available transport infrastructure. Gonzales (2011) observed that Nairobi has a low network outflow since the numbers of vehicles exceed the road capacities. The accelerated demand creates an inelastic curve where demand surpasses available supply thus creating traffic congestion. It is worth noting that Nairobi has fewer streets compared to other cities like Cairo, Johannesburg, Cape town (Cities with moderate prosperity factors-secondary) with relatively equal/ higher traffic demand (UN Habitat, 2012, p.21). This is because the planning of Nairobi was based on a radial pattern, emanating radially from the center of the city to surrounding neighbourhoods. Streets occupy about 11 % of the land cover in Nairobi. (Warah, 2013).

IBM (2011) estimates the cost of traffic congestion to be KShs. 50 million daily translating to approximately 19 billion annually, this figure has risen to 59 Million daily and 22.4 Billion annually as of the year 2016. A majority of this population who primarily rely on the road network has to contend with such congestion. Congestion prevents fast and free movement of persons thereby disrupting the efficient conduct of business in urban areas. Congestion does affect the speed of mobility but in some circumstances, congestion may be accepted to some degree (OECD & ECMT, 2007). Nevertheless, certain degrees of congestion may greatly affect road users to a point where they have to disrupt and inconvenience their daily schedule. Acceptable degrees of traffic is where travel time is normal with light or free-flow conditions. On average, Nairobian's spend 62.44 minutes in traffic (Traffic Index 2017). This is against the accepted norm of 20 minutes to work (Pisarski, 2006).

In the situation of Landhies -Jogoo road as a case study, journeys that would otherwise take a few minutes during off-peak hours translate into longer hours spent in traffic queues during peak times. This causes great inconvenience to many road users who operate in and around the Central business district.

Nairobi CBD has faced perennial problems of congestion as dates back in 1986. Korir, (1986) postulated that congestion in Nairobi CBD is brought about by concentration of employment in the city centre, high usage of private motor vehicles, inadequate road infrastructure and

failure of public transport operators to serve public transport demands. It can be noted that 33 years later, these reasons are still evident.

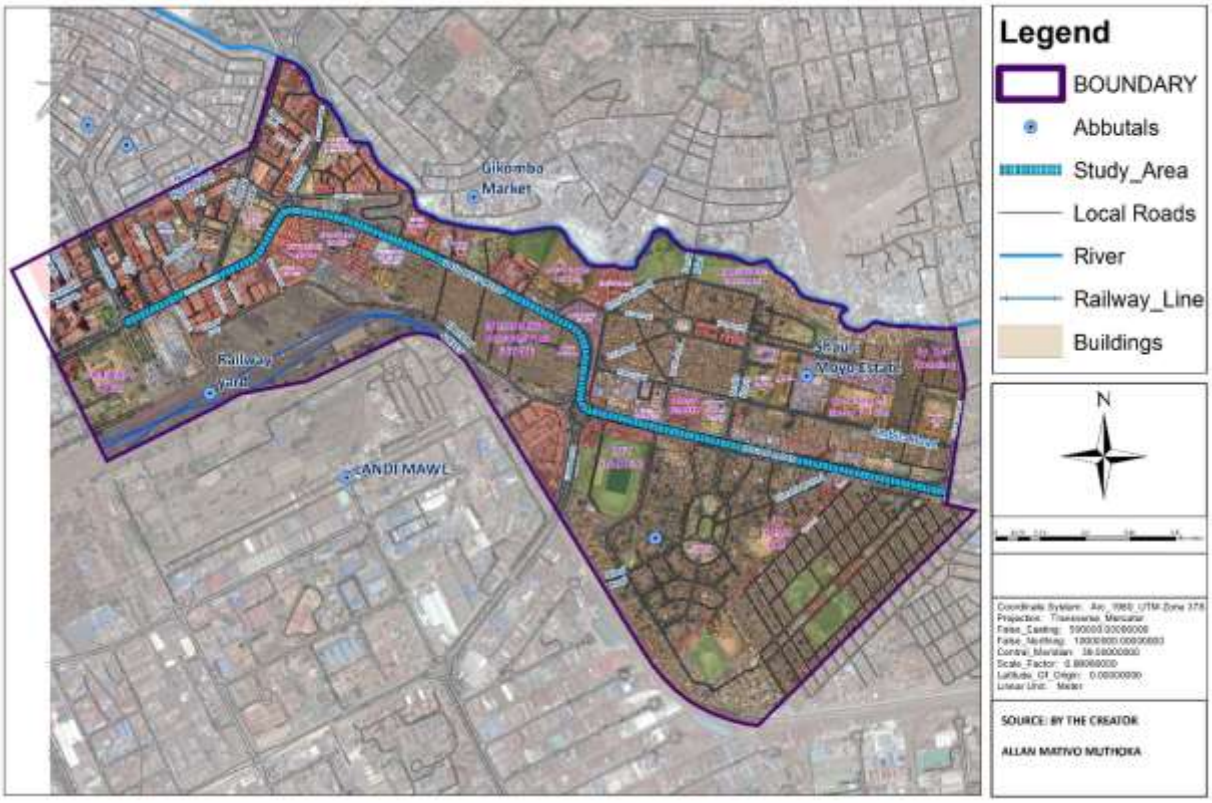
Various traditional approaches towards decongestion have been undertaken by successive governments, however, it is evident that the magnitude of congestion grows by the day. Today, the scale of congestion involves vehicles that are stationary, while engines are running, the distance between vehicles is less than a meter. The average vehicular movement speeds are slower than pedestrian movement speeds, cases of public service vehicles and motorcycles driving off pedestrian walk paths are evident.

Therefore, this research set out to examine traffic congestion experienced on a major corridor into Nairobi's CBD, along Landhies - Jogoo roads corridor. It also assessed existing traffic management strategies and their effectiveness. This is to propose a congestion management policy guided by the principle of urban governance and management.

1.3. Scope of the Study

The research focused on managing traffic congestion along Landhies- Jogoo roads. The study established the causes of congestion, nature, modes of traffic affected and impacts to be able to inform appropriate management interventions. The study area of this research is the Landhies-Jogoo Road Corridor as illustrated in map 1. Specifically, it begins along Jogoo Road at the round-about connecting to Likoni Road. It stretches to City Stadium Roundaboutt and connects to Landhies Road, then continues passed Muthurwa Market, and connects to Halie Selassie Avenue at Ring Road-Landhies Road Roundabout. The corridor then stretches along Halie Selassie Avenue up to the Railways Bus Terminus.

Map 1: Study Area



1.4. Research Objectives

The overall objective was to assess the management of urban traffic congestion within a selected transport route of Nairobi CBD and its environs.

To evaluate how traffic congestion is managed, specific objectives to guide the research were:

- To examine the nature of traffic congestion along Landhies-Jogoo roads.
- To evaluate existing traffic management strategies and their operationalisation
- To propose a policy framework for effective traffic management

1.5. Research Questions

The research question formulated from the objectives are as follows:

Table 1: Research objectives and questions

To examine the nature of traffic congestion along Landhies-Jogoo roads.	• What causes traffic congestion • What modes of transport are affected by congestion? • When and where does congestion occur? (place, time, predictability) • How much congestion is experienced? (speed, flow, queue length, duration) • What are the negative impacts of congestion? (time,

	monetary, opportunity, environmental, land uses)
To evaluate existing traffic management strategies and their operationalisation	• What traffic management measures are employed • What are the shortcomings of existing strategies? • What traffic management measures are proposed? • Who is responsible for traffic management?
To propose a policy framework for effective traffic management	• How can existing strategies be made more effective • What improvement measures are required? • Which actors are necessary to mitigate traffic congestion? • Is the current Institutional framework adequate to address traffic congestion?

1.6. Organization of the study

The study is organized into six major chapters as illustrated in Figure 1 below:

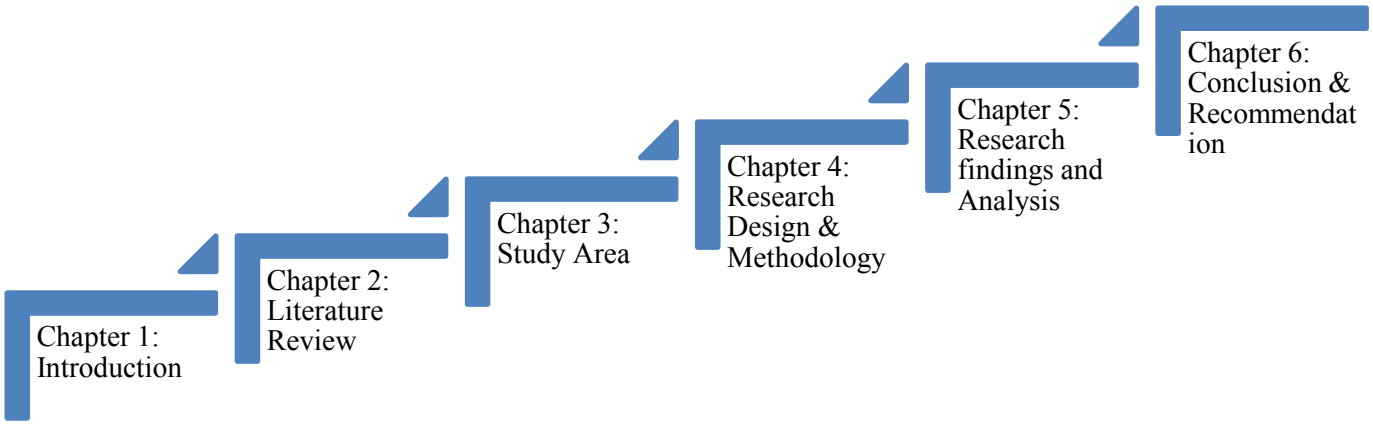


Figure 1: Summary of Thesis Structure

Chapter 1: Introduction

The chapter covers the introduction, background and justification, problem statement and research objectives and questions. It discusses the scope and organization of the study and limitations encountered throughout the research process.

Chapter 2: Literature Review

This section contains literature on various concepts of urban traffic congestion, traffic management as well as various methods used to assess congestion and its related negative impacts. The section also presents case studies that informed the study.

Chapter 3: Study Area

This chapter contextualizes the study area, discuss the justification for the selection of the study area, the historical development and socio-economic status of the area.

Chapter 4: Research Design and Methods

The section also covers key features of the methodology: the research methods and tools that were designed and used for data collection. In addition, the sampling strategy used is outlined.

Chapter 5: Research Findings and Analysis

It mainly addresses the primary data from a field survey of the research. It covers the area of research results, discussions, observations and overall field experiences and findings. This chapter is further organized and tailored in line with the study objectives and likened to the literature reviewed concepts.

Chapter 6: Findings, Recommendations, and Conclusion

This concludes the study by looking at the planning implication, evaluated and critically discussed based on the findings from chapters two, three, four and five about the objectives and research questions, highlighting problems identified during the fieldwork and propose recommendations.

1.7. Limitations of the study

The study encountered the following research limitations:

- Insecurity in the area around Muthurwa Market which is known for pick-pockets, muggers and other criminals
- Difficulty in interviewing private motorists and public transport providers

1.8. Definition of terms and concepts

Eastlands Nairobi: Refers to the larger part of Nairobi City, east of the Central Business District. It includes largely residential area and commercial centres. The area is largely associated with low to middle-income neighbourhoods. These include; The Public owned county, Paratstal, site and service, tenant purchase scheme and private estates.

Public Transport: A means of group travel system used by the general public and typically operated on established routes, fares and sometimes schedules. Public transport vehicles include buses, light rail (trams), trains.

Traffic*:* It is a total aggregation of things, such as pedestrians or vehicles in a particular area or locality during a specified period.

Traffic Congestion: It may refer to a scenario where demand for road space exceeds supply. The deficiency in supply is reflected by slower speeds, longer trips, and motor vehicle queuing. (Institute of Transport Engineers 1989). It is also described as a physical phenomenon where vehicles impede each other's' progression as demand for limited road space approaches full capacity. (OECD & ECMT, 2007)

Urban mobility refers to movement/ access to goods, services, people and information.

Governance: The sum of ways through which individuals and public institutions plan, make decisions, determine public involvements and manage their common affairs. It involves strengthened links between governments and civil society to ensure transparency and accountability. It involves the development of structures for grass root participation in decision making and implementation. (UN-Habitat, 2001)

Vehicles: a passageway that transports people/objects

Queue: is a line of waiting vehicles, such as a street and an intersection.

CHAPTER TWO: LITERATURE REVIEW

The topical issue of traffic congestion is common among urban managers around the globe and especially so in sub-Saharan Africa. This chapter discusses the major concepts within traffic congestion, reviews different approaches to traffic congestion, gives an overview of existing policy and legal frameworks, a case study and the conceptual framework for the research.

2.1. Understanding of Concepts

2.1.1. Urban Mobility

Cities are often termed as engines of social, economic and political growth, they have a high concentration of these activities. It is the need for agglomeration of these factors that has led to urbanization. Globally 54% of the world population resides in urban areas (UNITED NATIONS, 2014). For cities to function properly, their spatial structures have to be complemented by efficient transport systems. Urban productivity is highly dependent on the efficiency of transport systems to move various factors of production (labour, raw materials), goods and services. Urbanization and mobility are thus very closely linked as both support each other. Larger more complex cities have larger mobility systems, while small less complex towns have smaller mobility systems.

Urban mobility has evolved with the levels of human development and urbanisation. During the industrial revolution (1760-1830) rail transport acted as the main form of mobility. During the second industrial development stage (19th & 20th century) around production moved towards mass production of goods and services, urban mobility gravitated towards private car ownership. In the age of information technology, urban mobility trends are leaning towards eco-friendly means of transport such as solar, hydrogen and electric driven cars, planes, buses, trains among others. A lot of emphases is on the incorporation of clean renewable sources of energy.

This age is also represented through various modes of transports such as pedestrian movement, cycling, and scooters among others. This has been promoted in European cities such as Copenhagen, Amsterdam among others. Some of the means are strategies are employed in different to manage congestion.

Urban mobility index

Arthur D. Little a global management consultancy undertook a study christened Future of urban mobility. The study illustrates the urban mobility index across 84 world cities, evaluating their responsiveness to handling urban transport needs. Europe achieved the highest score with an average of 49.8 points. It was observed that Europe had the most mature systems which lead to performance. North American cities indicated average performance with 39.5 points. The orientation of North America towards private car ownership placed them bottom of the world in terms of maturity.

Latin America indicated below-average performance at between 40 and 47 points. Asian pacific cities also indicated below-average performance except for Hong Kong and Singapore which lead the global index. Africa and the Middle East were the lowest performers with average of 37.1 and 34.1 respectively. It was observed that in Africa low car numbers are in existence and the systems are still evolving, thus they are yet to mature. In the Middle East car ownership is high (Little, 2014). These findings are crucial in trying to understand how urban mobility is influenced by various modes, urban form, urban incomes and land uses.

2.1.2. Traffic congestion and its causes

Traffic congestion is a major global issue affecting a majority of cities in the world over as a result of rapid urbanization which has exerted negative externalities in urban areas (Talukdar, 2013). Due to this traffic congestion is a major pre-occupation of urban decision-makers around the world. Nairobi city is no exception and continues o experience similar challenges beginning the 70's.

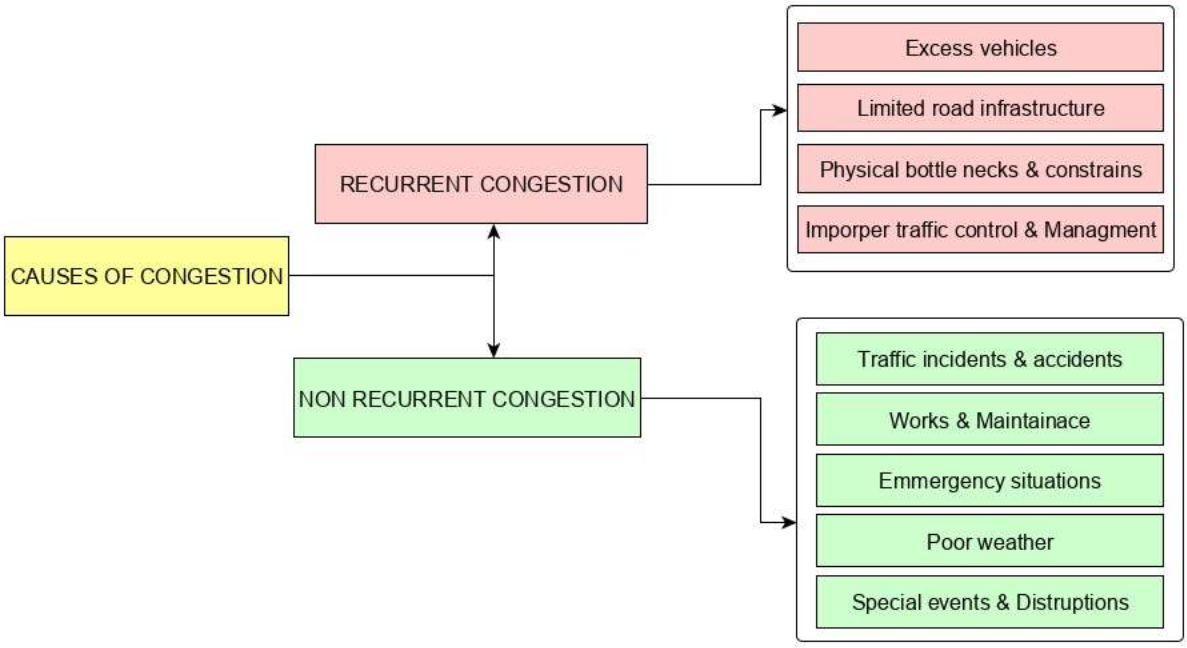
Various transportation experts attest that traffic congestion results when demand by road users exceeds the design capacity of the traffic network, thus creating a supply inadequacy. (Weisbrod, Vary, et al. 2003, p. 1). Traffic congestion is when long vehicular queues are constantly moving and stopping thereby inhibiting travellers from free uninterrupted movement. (Levinson et at., 1997). Congestion is also an imbalance of travel demand and transport system supply (Hon, 2005, p. 24).

Hon (2005, p. 19) categorises causes of congestion as either recurrent or non-recurrent. Recurrent is further defined as excess demand for travel and shortage of infrastructure supply. Non-recurrent are explained as unexpected events such as; maintenance works, accidents, vehicular breakdowns or other emergency events. He observes that improper traffic controls

and management systems representing intervention failure are also a cause of urban traffic congestion

A common cause of congestion includes poor road design, inadequate roads (too many vehicles beyond capacity), lower capacity intersection, poor road user mannerisms, lack of support infrastructure (bus stops), inadequate parking, land use patterns, car ownership trends, quality of public transport, income levels, employment patters among others.

Figure 2: Causes of Congestion



Source: Authors own formulation from Literature review i.e. (Talukdar, 2013; Kibunja, 2005).

Road Impedance Index

The Road impedance index refers to the relationship between road travelling time and traffic load pressure (Luo, Wang, & Wang, 2015) It is a critical component of traffic assignment and route choice among motorists. Traffic load pressure refers to the various elements that impedes the free flow of traffic and has been discussed above as causes of congestion.

The index is derived from comparing uninterrupted basic travel time against travel time with delay times. The Study identified the impedance hotspots and traffic load pressure factors at each point. The BPR function model developed by the Federal Highway Administration is the

most popular applied method of assessing basic travel time around the world cities. (Rodrigue et al., 2007)

Road Impedance is calculated as: $\Delta T = \Delta Tm + \Delta Td$

Where :

T is Road impedance,

Tm is basic travel time

Td is waiting delay time

Basic Travel Time is calculated as follows:

$$\Delta Tm = \frac{L}{U} = \frac{L}{Vf(1-n)}$$

Where :

L is Length of a road section

U is adopted average speed

Waiting Delay time is calculated as follows:

$$\Delta Td = p \sum_{i=1}^{N} \Delta tdi$$

Where :

N is the Number of Motor Vehicles

p is the probability of motor vehicles with a waiting delay time

In summary, Road Traffic impedance ($\Delta T = \Delta Tm + \Delta Td$) is shown as follows:

$$= \frac{L}{v_f\left[1-(1/2)\left(1-\sqrt{1-4qI/v_f}\right)\right]} + \frac{r^2\left[1+(1/2)\left(1-\sqrt{1-4qI/v_f}\right)\right]}{2(r+g)\left[1-(1/2)\left(1-\sqrt{1-4qI/v_f}\right)\right]}$$

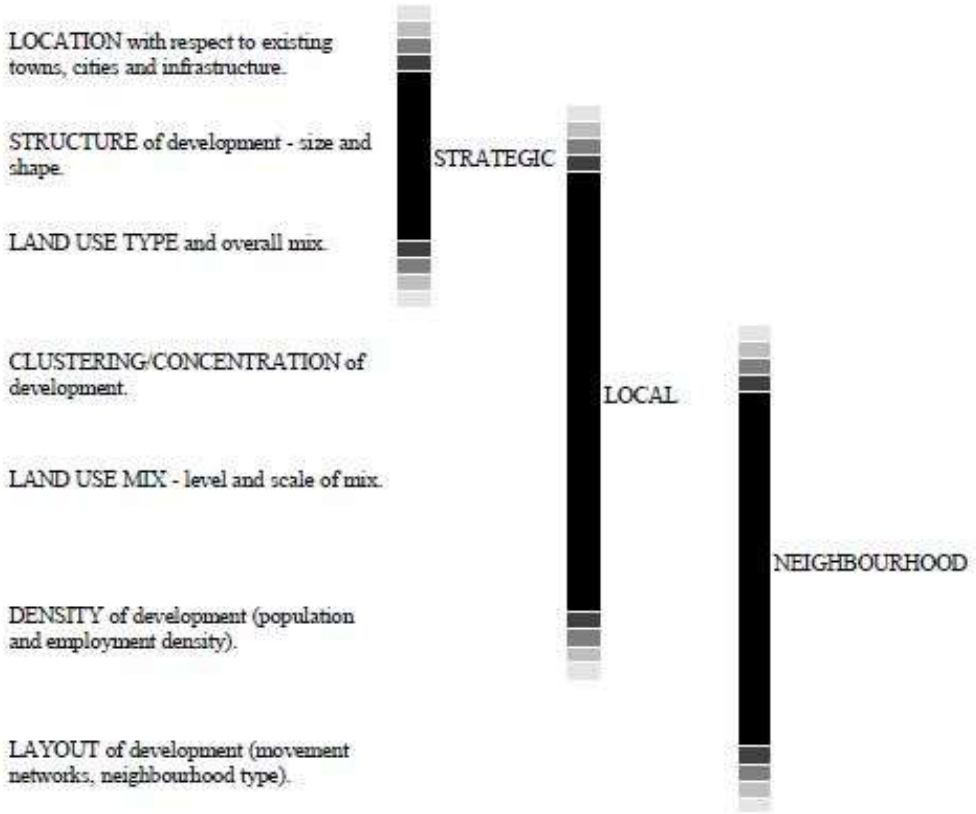
Sourced From (Luo et al., 2015)

Road traffic impedance calculation is an important approach to assist urban managers to make reasonable traffic control decisions.

2.1.3. Urban Structure Relation to Urban Mobility and Congestion

Various studies suggest that urban form varies in geographical scale and location. At the macro level (regional), urban form is concerned with the location, size and shape of new developments in relation to existing urban setting, infrastructure, and surrounding land uses. At Meso level (urban/local area) urban form is concerned with land use distribution based on scales and levels. At this level, land use integration and segregation depending on compatibility is evaluated. At Micro level (neighbourhood) urban form is concerned mainly with the layout development of networks and land use activity sites. Owens, 1986. The diagram below illustrates the same.

Figure 3: Urban structure impacts at different scales



Source: Adapted from Owen, 1986

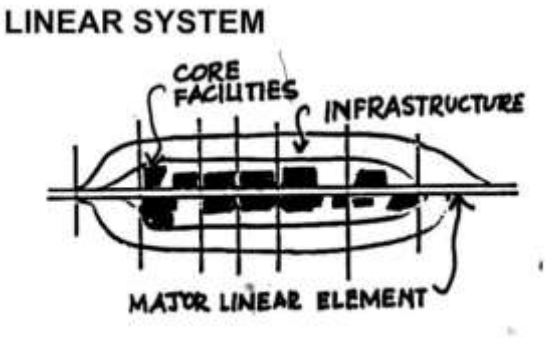
Urban forms influence trip generation patterns. It is a widely accepted concept that cities with higher population densities have a higher trip generation which translates to high use of public transport. Similarly, cities with lower population densities have a lower trip generation which translates to lower public transport use.

Urban forms are also influenced by urban mobility. Before the industrial age, cities were compact settlements whose extents were limited to walkable distances (up to 10km). Urban extents were therefore dictated by the available mode of transport. The introduction of the motor vehicle during the 20th century allowed for larger cities in size and population catchment. Urban citizens could now travel longer distances and the resource frontiers of cities were now larger and wider. Distances of city edge from the centre post industrialisation averaged 20 to 30 kilometres. The impact of this was a transformation of the city's urban forms.

During the 21st century, urban mobility continues to influence urban forms. With mass transport systems, such as commuter trains, BRT systems, and motor vehicles, the urban forms are more complex. The cities have taken polycentric shapes and are now larger, shifting towards metropolitans. Distances of cities from the centre average 50 to 60 kilometres. Cities have seen a transformation with more mixed-use and higher density land use patterns.

The traditional urban structures have influenced the built form and urban mobility in various cities. The linear urban form represents cities that develop along a major transport corridor. The corridor could be in the form of a major road, railway line, and river channel. Within this model urban developments often occur on both sides of the corridor in a ribbon manner. Such cities tend to expand along the corridor. Commercial activities tend to locate along the road as they are most prominent, while residential land uses would locate various rows behind. Land use planning is a challenge in such a model. A linear urban structure is suited for railway public transport. Motor vehicle use within such urban forms leads to heavy traffic presences. A local example of a linear town is Kitengela town which has developed along Namanga road. The town is expanding along Namanga road towards Isinya centre. Vehicular traffic movement is a major challenge along with the town.

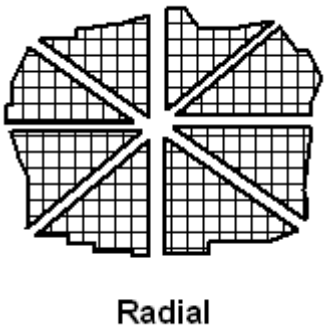
Figure 4: Linear System Urban Form



Source: https://quadralectics.wordpress.com

Radial urban form occurs where various transport corridors originate from the centre and spread out. Radial cities take the form of a star pattern. Within such a model there are various transport routes and directions. Such cities are larger and have higher population densities. Such an urban structure is suited for public transport either buses or trains. They tend to have ring roads that connect major arms. Towns based on such patterns experience heavy traffic congestion during peak hours when concentration occurs at the centre. Nairobi city is a local example of a radial pattern structure. Major transport corridors (Jogoo, Thika, Mombasa, Ngong, Langata and Wayaki way) lead to the CBD.

Figure 5: Radial system urban form

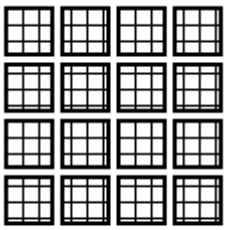


Source: https://quadralectics.wordpress.com

Grid iron urban forms are common in American cities. The grid pattern originates from the Greek and Roman cities. The streets are aligned on the right angles. The roads are referred to as streets or avenues. Such cities are larger and often pose challenges in services provision.

Infrastructure ducts/ channels are often well laid out. Public bus transport provision is a challenge although the use of light rail transit and streetcars is often effective. Grid pattern cities tend to have high rates of non-motorised transport as the roads are convenient. The pattern offers may routes that could act as alternative routes.

Figure 6: Grid system Urban form



Grid

Source: https://quadralectics.wordpress.com

Private car ownership is also common in such a structure due to the expansive nature of the city. Populations that reside within the peripheral areas especially the high and middle income opt to use private cars. The central part of the city is dominated by commercial activities where often the CBD is located.

2.1.4. Land Use Patterns Relations to Urban Mobility and congestion

Distribution of activity centres through land-use patterns influences trip patterns (whether leisure, education, work among others). For example, the location of educational facilities (university campus, secondary or primary schools) in the urban core/CBD would translate to increased student traffic during peak hours. This increasing demand for public transport, volumes of school buses and private cars during this time and often leads to traffic congestion. Such is the phenomenon that during school holidays, there is relatively less traffic congestion observed by motorists.

Land use patterns influence urban mobility. Industrial zones that have a high dependency on road transport will often attract heavy traffic. Trucks, trailers, and pickups are the common vehicular modes within such zones. Like the case of Nairobi, such vehicles form long queues during the supply and delivery of raw materials and goods. Unlike the CBD, industrial zones in Kenya would not attract heavy bus and matatu traffic as the vast majority of industrial employees use NMT.

The location of residential estates also influences traffic patterns. Low- and middle-income estates where residents rely heavily on public transport are often served by bus and matatu routes. Non-Motorised transport (pedestrians and cyclists) are also common. High-density estates often generate high traffic. However, high-income residential neighbourhoods where residents are dependent on private car ownership and taxi service, traffic generated is minimal. Traffic congestion is not common within such neighbourhoods.

2.1.5. Infrastructure development relation to Urban Mobility and Congestion

Infrastructure is the physical link on which vehicles use to enable movement. Infrastructure development is a major expenditure of governments across the globe. Infrastructure development is mainly a preserve of government and local authorities who can finance through taxes, loans, grants, and partnerships. In the developing world where the highest rate of urbanisation is currently experienced, the level of infrastructure development is relatively low, inadequate and sometimes in a poor state. These governments are attempting to develop new and maintain the old infrastructure which has overtime been depleted.

Urban congestion occurs when infrastructure carry capacities are exceeded, which is a common occurrence. Urban roads are, however, not built to deliver free-flow speeds 24 hours a day, 7 days a week, and 365 days a year (***OECD/ECMT cities 2007).*** Developed countries incur major costs and burden in modernising their infrastructure as well as increasing costs of the upgrade. Various road authorities try to upgrade existing infrastructure by expanding road reserves, adding lanes, re-arrangement of road space, modifying intersections or creating one-way streets (***OECD/ECMT cities 2007).*** Continuous infrastructure provision and improvement is an important requirement in managing urban congestion across all global cities.

2.1.6. Private car vs public transport relation to Urban Mobility and congestion

Private motor car is an alternative means of urban mobility. The car offers freedom, convenience, and mobility to users. Unattractive public transport systems, limited network coverage, insecurity and unreliability push commuters towards car ownership. Improved household incomes also encourage the use of private motor cars. However, private motor cars create a much higher demand for road capacities than any other mode. This then results in vehicular congestion (Korir, 1986). Various initiatives have been undertaken towards

moderation of private car ownership (in Kenya) including imposition if vehicle importation taxes. However, Korir postulates that the impact of such tax regimes have not deterred the acquisition of private cars.

Public transport is meant to deliver high levels of urban mobility to large masses in Limited geographical areas, hereby reducing travellers impacts on the limited infrastructure capacity (OECD & ECMT, 2007). It offers affordable, accessible, reliable mobility. Public transport is often a subsidised industry that requires the involvement of local authorities

The public transport sector is a major employer within urban areas. For this reason, it is a vital pillar upon which urban managers consider governance and service provision. Public transport is also important for national currency stability as it helps in the reduction of fuel consumption and crude oil importation.

To effectively manage urban congestion, the adoption of Public transport is essential (OECD & ECMT, 2007). Cities ought to have an efficient and effective public transport system. Public transport is thus a major responsibility of urban managers around the globe.

2.1.7. Parking facilities Relations to Urban Mobility and congestion

Bacon (1998) notes, parking is entirely a product of the car culture. Most streets are publicly owned, while most off-street parking is privately owned. The supply of streets is relatively fixed even as the population increase, as is the case in most African cities or land is redeveloped contributing to traffic congestion.

Parking space provision can be problematic in any part of the city especially the CBD as it thrives on high densities (Kibunja, 2005). Parking spaces are a major determinant of traffic congestion. Increased cruising by a motorist in search of parking space or accessing on-street parking causes congestion. Off-street parking can reduce cruising for parking that often strangles the streets of CBDs (Kibunja, 2005). He, observes that off-street parking is expensive due to the cost of land in the CBD.

The spatial imprint of parking space in urban areas is significant and cannot be overlooked in regard to free movement and congestion.

2.1.8. Congestion relief strategies and Past De-Congestion Attempts

There exists no single approach to urban traffic congestion management. Different cities possess different complexities. Even in the same corridor, dynamics change with urban growth hence the strategies for management ought to change the same way. Common congestion management strategies include new infrastructure and improvements, flexible peak timing, land use planning, public transport operation, Car-pooling, parking management, Congestion controls, and effective traffic controls and management.

Infrastructure improvement by the establishment of new roads, and enhancing roads by expansions, Dualling and intersection development generates positive impacts in mitigating congestion. (Hokao and Sulaiha 2009; Texas Transportation Institute 2005).

Public transportation is a critical component of any urban transportation system. It is important as it reduces Passenger Carrier units (PCU). Mass transit systems are even more effective as they include High occupancy vehicles, Bus rapid transit, Light rail, and Commuter Rail services. (Litman, 2008).

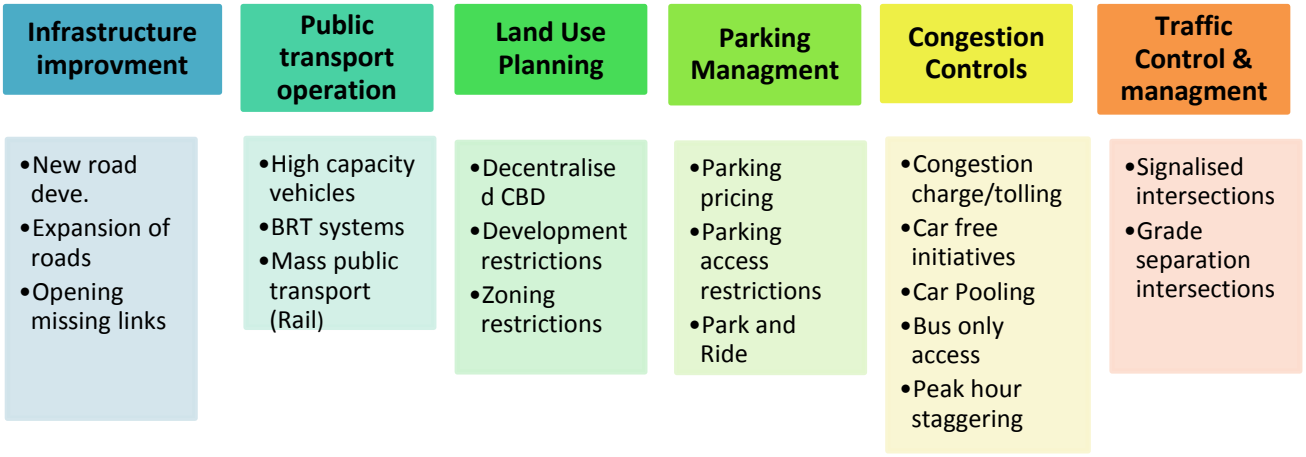
Land-use planning should be integrated with transport planning to address congestion challenges. Land use planning as an aspect of congestion management would involve zoning controls, defining urban boundaries, development policies such as TOD, taxation policies to incentives high-density developments. (Hokao and Sulaiha 2009; Texas Transportation Institute 2005).

Parking management involves actions undertaken towards influencing the supply, price, and regulation of access to parking facilities (VTPI, 2008). Abundant, easily accessible and cheap parking facilities tend to increase automobile use in urban areas (Haregewoin, 2010). The inverse would mean limited, inaccessible and expensive parking facilities would discourage the use of automobiles hereby decreasing traffic congestion. It is, however, important to provide alternative modes of transport to otherwise private car owners. VTPI, (2008) observed that limiting on-street parking of large vehicles that obstructs traffic movement during rush hours would maintain smooth traffic flow.

Other congestion management controls involve the revision of scheduled hours for urban commuters. This involves civil servants, students, self-employed and business persons. Other methods include toll and congestion charges when using specific roads or accessing specific zones.

Attached below is a summary illustrating various globally applied congestion management strategies.

Figure 7: Congestion Management Strategies



Source: Authors own formulation from Literature review i.e. (Talukdar, 2013; Smith & Raemaekers, 1998)

2.2. National Policy and Legal Framework

2.2.1. Policy Frameworks

VISION 2030

Vision 2030 is a guiding policy framework pursued by the Government of the Republic of Kenya to guide socio-economic development. This policy seeks to transform Kenya into a newly industrializing middle-income country providing a high-quality life to all its citizens by the year 2030 (Vision 2030,2008).

Vision 2030 is based on 3 key pillars; Economic Pillar, Social Pillar, and Political Pillar. The economic pillar aims to improve the prosperity of all citizens. The pillar envisions a GDP growth of 10% sustained over a 12 year period.

The social pillar seeks to promote justice and social cohensivness among the citzens. It also seeks to promote equity and clean, safe environments. The political pillar seeks the realisation of good governance, promotion of democracy, a shift from ethnic to issue-based politics, respect for the rule of law, protection of rights and freedoms of all citizens.

The three pillars of Kenya Vision 2030 are anchored on the following foundations: macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation (STI); land reform; human resources development; security and public sector reforms (Vision 2030).

Vision 2030 policy seeks a well linked and connected country through road, railway, ports, airports, water, sanitation and telecommunication networks. The Vision seeks investments in the Nation's infrastructure is given high priority.

Vision 2030 appreciates that to be able to raise productivity and efficiency, there has to be an intensive application of science, technology, and innovation away from the traditional approaches.

The policy recognizes how newly industrializing countries of the world should employ research and development (R&D) as the case of the Asian tigers, to accelerating economic development.

The vision commits the GOK will formulate a STI policy framework to support Vision 2030. The policy will also inform the allocation of additional resources towards scientific research, technical capabilities with a focus on mathematics, science, and technology in academic institutions.

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TRANSPORT SECTOR POLICY

The Integrated National Transport Policy (INTP) drafted by the Ministry of Transport between 2003 and 2004. The policy recognizes a functional transport system is a prerequisite to national and regional integration, promoting internal and external trade, economic prosperity, poverty eradication, job and wealth creation. A functional transport system needs to be effective and efficient.

The policy focuses on matters related to infrastructure planning, development and management, legal, institutional and regulatory frameworks, safety and security, utilization of ICT, and environmental protection, among others.

It aims to create an enabling framework for the development of a modern world class transport system. This means it has to be safe to all ages and genders; effcicient in time and resource use; and affordable to all citizens irregardless of income. World trends aree also movning towards technological advancement such as cashless systems, smart transportation

and mobile applications. The Vision of the Policy is to develop "a world-class transport system that is integrated and responsive to the needs of people and industry".

Strategic objectives

The strategic objectives of the Integrated National Transport Policy are to:

a) integrate transport with national and regional socio-economic demands;
b) establish appropriate institutional systems for transport sector management, coordination, and regulation;
c) develop and maintain an integrated and coordinated transport infrastructure for efficient movement of passengers, freight and mail and support disaster management efforts;
d) develop appropriate transport sector funding/financing mechanisms;
e) integrate transport in land use planning and management systems;
f) deliver efficient and effective sector operations to enhance national productivity;
g) enhance investments in the transport sector;
h) apply ICTs in transport planning, operations, and management to enhance sector efficiency;
i) facilitate regional integration and trade;
j) incorporate environmental protection and resource conservation issues in transport sector activities;
k) ensure enforcement and compliance with sector laws and regulations;
l) develop a national transport information database for effective transport planning and management;
m) enhance public awareness through the use of appropriate information to inculcate positive attitude change;
n) improve safety and security in the transport industry;
o) develop and promote appropriate human resource capacities in the sector;
p) Facilitate public-private partnerships.

Source: INTP

Economic Recovery Strategy

The Strategy for Wealth and Employment Creation for 2003-2007 (ERS 2003-2007) and Vision 2030 sets out the broad principles through which the economy of Kenya can be directed to an economic takeoff.

The transportaion sector was a key pillar of the ERS. A functional transport sector would assist in job creation thereby reducing unemployement and poverty levels by 50% in the year 2015. The sector is also expected to drive achivement of industrialisation by the year 2020. The key objectives of the policies are:

a) To reduce transport costs and travel time by improving the condition of roads, including reducing congestion on urban roads by increasing capacity.
b) To increase accessibility.
c) To optimise the use of available resources.
d) To increase the resources available for investment in the road sector.
e) To enhance the preservation of existing road assets.
f) To create a conducive environment for increased private-public partnership.
g) To enhance road safety and cater adequately to the needs of non-motorized traffic
h) (NMT).
i) To enhance ownership through stakeholder's participation in the road sector.
j) To achieve an optimal institutional framework for effective implementation

2.2.2. Relevant Legislations

KENYA ROADS ACT NO. 2 OF 2007

The Act establishes authorities for road development, sets the powers and functions. The authorities are KeNHA, KURA, and KeRRA. Section 9 of the Act establishes the Kenya Urban Roads Authority. The authority is established as a corporate both with perpetual succession and a common seal. The Authority has the responsibility for the management, development, rehabilitation, and maintenance of public roads in cities and municipalities.

The powers and duties shall be:

a) constructing, upgrading, rehabilitating and maintaining roads under its control;
b) controlling urban road reserves and access to roadside developments;
c) implementing roads policies in relation to urban roads;
d) ensure adherence to the rules and guidelines on axle load control prescribed under the Traffic Act (Cap. 403) and any regulations under this Act;
e) ensure that the quality of road works is in accordance with such standards as may be defined by the Minister;
f) in collaboration with the Ministry responsible for transport and the Police Department, overseeing the management of traffic and road safety on urban roads;
g) monitoring and evaluating the use of urban roads;
h) plan the development and maintenance of urban roads;
i) collect and collate all such data related to the use of urban roads as may be necessary for efficient planning under this Act;
j) prepare the road works programmes for all urban roads;
k) liaise and co-ordinate with other road authorities in planning and on operations in respect of roads;
l) advise the Minister on all issues relating to urban roads;
m) perform such other functions related to the implementation of the Act as may be directed by the Minister.

Source: Kenya Law Reports

Part IV, Section 22 of the Act vest power on the Roads Authority which includes maintenance, operation, improvement, and managing roads; constructing new roads; measure and assess vehicle capacities using any roads and provide compliance rules; provide amenities for persons using services provided by KURA.

The Act also empowers the authority as a statutory body to build public infrastructure; operate equipment on public streets ; to determine, impose and levy taxes (including rates, tolls, charges, dues or fees for any of its services); prohibit, control or regulate services, facilities and usage of any vehicle on road and to enter into agreements with entities to supply, construction, manufacture, maintenance or repair property, services.

Section 22 grants the authority powers to acquire land for purposes of its functions. It grants the mechanism for acquiring public land and private land while respecting land laws such as the Land Acquisition Act, Land Control Act among others. Section 24 and 25 empower the

Authority to enter any land undertake a survey, prevent accidents, preserve safety, alter the position of pipes, remove pipe-borne, waterborne and infrastructure utilities from road reserves. The authority also has the power to abstract water from water sources for the operation of its functional inline with the water Act.

Section 34 of the Act empowers the Minister in charge of the power to prepare a five-year road investment programmes in consultation with Kenya Roads Board. KURA shall prepare annual budgets and work programmes based on the investment. The programmes are financed by the Road fund. The Act also provides for the classification of all public roads. KURA is required to maintain an inventory of all roads under its management with appropriate details such as name, number, and description. The Act grants KURA the authority to grant or deny permission for erection, construction, and establishment of development on, above or below road reserves under their jurisdiction.

NATIONAL TRANSPORT AND SAFETY AUTHORITY ACT

The act of parliament established the National Transport and Safety Authority Act otherwise referred to as NTSA. A corporate body with a common seal and perpetual succession.

The functions of NTSA include:

a) advise and make recommendations to the Cabinet Secretary on matters relating to road transport and safety;
b) implement policies relating to road transport and safety;
c) plan, manage and regulate the road transport system as per the provisions of this Act;
d) ensure the provision of safe, reliable and efficient road transport services; and
e) administer the Act of Parliament set out in the First Schedule and any other written law.

The Act grants NTSA power to establish a county transport and safety committee as per Section 21 of the NTSA Act. The committee is responsible for overseeing the management and regulation of the road transport system at county level; prepare and submit audit reports on the safety, reliability, and efficiency of the county road transport system and advise NTSA on matters affecting the county road transport system.

NTSA has the authority to issue licenses. These licenses include road service license for the carriage of passengers and goods, Carriers license for commercial goods, tourist service license and short-term license. NTSA is also responsible for the issuance of exclusive licenses as per section 28(2). The Act sets out the conditions of the issuance of licenses. The authority has the power to attach conditions on licenses issued such as regulating fares

imposed to ensure they are reasonable and ensure fair competition, attach time tables and fare tables, ensure the safety of passengers in transport terminus. NTSA also has the power to revoke and suspend all licenses issued as per guidelines in section 34 of the Act.

Section 42 of the CT allows police officers in uniform to stop and inspect any vehicle to ascertain compliance of provisions of the Act. Section 44of the NTSA Act provides for rules in respect of working hours of commercial vehicles, journey hours, rates charges and greatest carry loads of different commercial vehicles. Section 44of the NTSA Act authorises the imposition of penalties on offences contravening the Act.

In the performance of its function, NTSA shall :

a) register and license motor vehicles;
b) conduct motor vehicle inspections and certification;
c) regulate public service vehicles;
d) advise the Government on national policy with regard to road transport system;
e) develop and implement road safety strategies;
f) facilitate the education of the members of the public on road safety;
g) conduct research and audits on road safety;
h) compile inspection reports relating to traffic accidents;
i) establish systems and procedures for, and oversee the training, testing and licensing of drivers;
j) formulate and review the curriculum of driving schools;
k) co-ordinate the activities of persons and organisations dealing in matters relating to road safety; and
l) perform such other functions as may be conferred on it by the Cabinet Secretary or by any other written law

Source: Kenya Law Reports

COUNTY GOVERNMENT ACT NO.17 OF 2012

The object and purpose of the County Government Act is to—

a) provide for matters necessary to give effect to Chapter Eleven of the Constitution pursuant to Article 200 of the Constitution;
b) give effect to the objects and principles of devolution as set out in Articles 174 and 175 of the Constitution;
c) give effect to Article 176(2) of the Constitution in respect of further decentralization;
d) provide for the removal from office of the speaker of the county assembly in accordance with Article 178 of the Constitution;
e) provide for the powers, privileges, and immunities of county assemblies, their committees and members under Article 196 of the Constitution;
f) provide for public participation in the conduct of the activities of the county assembly as required under Article 196 of the Constitution;
g) seek to ensure that the community and cultural diversity of a county is reflected in its county assembly and county executive committee as contemplated in Article 197 of the Constitution;
h) prescribe mechanisms to protect minorities within counties pursuant to Article 197 of the Constitution;
i) prescribe additional requirements in respect of the publication of county legislation as contemplated in Article 199 of the Constitution;
j) provide, pursuant to Article 200 of the Constitution, for—
    I) the manner of nomination or appointment of persons to, and their removal from, offices in county governments, including the qualifications of voters and candidates;
    II) the procedure of assemblies and executive committees including the chairing and frequency of meetings, quorums and voting; and
    III) the suspension of assemblies and executive committees;
k) prescribe, pursuant to Article 235 of the Constitution, uniform norms and standards, for—
    I) establishing and abolishing offices in the county public service;
    II) appointing persons to hold or act in those offices, and confirming appointments; and
    III) exercising disciplinary control over and removing persons holding or acting in those offices; and
(l) provide for the promotion, evaluation and reporting on the compliance by county public officers with the values and principles in Articles 10 and 232 of the Constitution.

Source: Kenya Law Reports

Section 5 of the CGA prescribes the functions of county governments as:

a) county legislation in accordance with Article 185 of the Constitution;
b) exercising executive functions in accordance with Article 183 of the Constitution;
c) functions provided for in Article 186 and assigned in the Fourth Schedule of the Constitution;
d) any other function that may be transferred to county governments from the national government under Article 187 of the Constitution;
e) any functions agreed upon with other county governments under Article 189(2) of the Constitution; and
f) establishing and staffing its public service as contemplated under Article 235 of the Constitution.

Source: Kenya Law Reports

The Act also prescribes the powers of county governments as captured in Section 6. The CGA prescribes the membership of the county assembly, the roles of the assembly and members of the county assembly. county assembly shall exercise legislative power through Bills passed by the assembly and assented to by the Governor.

The Act also provides for the functions and responsibilities of a county governor. Among them is the submission of county plans and policies to the county assembly for approval. Itr also assignes roles in the approval and assent of bills, chair meetings of the county executive committee and publication of bills in the County *Gazette*.

Section 36 of CGA 36 provides for the functions of the executive committee. This include supervise the administration and delivery of services in the county and all decentralized units and agencies in the county and perform any other functions conferred on it.

The role of the executive committee in urban area or city planning involves monitoring the process of planning, formulation, and adoption of the integrated development plan by a city; assist a city in the plan making, implementation and review process; cordination and localisation of National, regional, county, local and town level plans.

Section 102 of the Act establishes the principles of planning and development facilitation. and Section 103 provides for the objectives of county planning. This include harmonize the development of county communication system, infrastructure, and related services. Section 104 provides for the obligation to plan by the county. The act also provides for different types of plans which include county integrated development plan; county sectoral plans; county spatial plan; and cities and urban areas plans. Transport and infrastructure related plans are all critical components of each of the plans provided for.

ENVIRONMENTAL MANAGEMENT AND CO-ORDINATION ACT
NO. 8 OF 1999 (EMCA)

Section 7 of the Act established the National Environment Management Authority. The Authority shall be a corporate body with perpetual succession and a common seal. NEMA is established to exercise general supervision and coordination over all matters relating to the environment. NEMA is responsible for:

a) co-ordinate the various environmental management activities being undertaken by the lead agencies and promote the integration of environmental considerations into development policies, plans, programmes and projects to ensure the proper management and rational utilization of environmental resources on a sustainable yield basis for the improvement of the quality of human life in Kenya;
b) take stock of the natural resources in Kenya and their utilisation and conservation;
c) audit and determine the net worth or value of the natural resources in Kenya and their utilization and conservation;
d) make recommendations to the relevant authorities with respect to land use planning;
e) examine land use patterns to determine their impact on the quality and quantity of natural resources;
f) advise the Government on legislative and other measures for the management of the environment or the implementation of relevant international conventions, treaties, and agreements in the field of environment, as the case may be;
g) advise the Government on regional and international environmental conventions, treaties and agreements to which Kenya should be a party and follow up the implementation of such agreements where Kenya is a party;
h) undertake research, investigation, and surveys in the field of environment and collect, collate and disseminate information about the findings of such research, investigation or survey;

i) mobilise and monitor the use of financial and human resources for environmental management;
j) identify projects and programmes or types of projects and programmes, plans and policies for which environmental audit or environmental monitoring must be conducted under this Act;
k) initiate and evolve procedures and safeguards for the prevention of accidents which may cause environmental degradation and evolve remedial measures where accidents occur;
l) monitor and assess activities, including activities being carried out by relevant lead agencies, in order to ensure that the environment is not degraded by such activities, environmental management
m) objectives are adhered to and adequate early warning on impending environmental emergencies is given;
n) undertake, in co-operation with relevant lead agencies, programmes intended to enhance environmental education, public awareness, and public participation;
o) develop, publish and disseminate manuals, codes or guidelines relating to environmental management and prevention or abatement of environmental degradation;
p) render advice and technical support, where possible, to entities engaged in natural resources management and environmental protection;
q) prepare and submit to the Cabinet Secretary every two years, and report on the state of the environment in Kenya and in this regard may direct any lead agency to prepare and submit to it a report on the state of the sector of the environment under the administration of that lead agency;
r) encourage voluntary environmental conservation practices and natural resource conservancies, easements, leases, payments for ecosystem services and other such instruments and in this regard, develop guidelines;
s) work with other lead agencies to issue guidelines and prescribe measures to achieve and maintain a tree cover of at least ten per cent of the land area of Kenya;
t) perform such other functions as the Government may assign to the Authority or as are incidental or conducive to the exercise by the Authority of any or all of the

Source: Kenya Law Reports

Section 24 and 25 of the Act establishes the National Environment Trust Fund and the National Environment Restoration Fund. EMCA establishes the County Environment Committees whose function includes; proper management of the environment within the county; develop a county strategic environmental action plan and perform additional functions as are prescribed.

EMCA provides for the formulation of the National Environmental Action Plan. The Action Plan shall:

a) contain an analysis of the natural resources of Kenya with an indication as to any pattern of change in their distribution and quantity over time;
b) contain an analytical profile of the various uses and value of the natural resources incorporating considerations of intragenerational equity;
c) recommend appropriate legal and fiscal incentives that may be used to encourage the business community to incorporate environmental requirements into their planning and operational processes;
d) recommend methods for building national awareness through environmental education on the importance of sustainable use of the environment and natural resources for national development;
e) set out operational guidelines for the planning and management of the environment and natural resources;
f) identify actual or likely problems as may affect the natural resources and the broader environmental context in which they exist;
g) identify and appraise trends in the development of urban and rural settlements, their impacts on the environment, and strategies for the amelioration of their negative impacts;
h) propose guidelines for the integration of standards of environmental protection into development planning and management;
i) identify and recommend policy and legislative approaches for preventing, controlling or mitigating specific as well as general adverse impacts on the environment;
j) prioritise areas of environmental research and outline methods of using such research findings;
k) take into account and record all monuments and protected areas declared or deemed to have been declared by the Cabinet Secretary under the National Museums and Heritage Act;
l) without prejudice to the foregoing, be reviewed and modified from time to time to incorporate emerging knowledge and realities; and
m) be binding on all persons and all government departments, agencies, state corporations or other organs of Government upon adoption by the National Assembly.

Every County Environment Committee shall on every five years, prepare a county environment action plan in respect of the county for consideration and adoption by the County Assembly. The action plan shall involve adequate public participation and take into consideration every other county environment action plan already adopted. The county environment action plan shall be submitted to the Cabinet secretary for incorporation into the national environment action plan.

Section 56 requires The Cabinet Secretary in consultation with the NEMA to undertake national studies and take into consideration potental activties that may deplete the environmental balance and harm public health.

NEMA is reposnilbe fo issance of guidelines towards the elimination of substances that deplete the stratospheric ozone layer; controlling of activities likely to lead to the degradation of the ozone layer; minimisation of risks to public health and strategy formulaton and implementation.

Section 57 of the Act requires all policies, plans, and programmes for implementation to be subject to Strategic Environmental Assessments. The SEA reports shall be submitted to NEMA for consideration

Section 68 of the Act allows the authority or its agents to carry out environmental audits of all activities that have a significant effect on the environment. Environmental inspectors appointed may enter any land or premises to asses how human activity conforms with the provision of EIA study reports prepared.

Section 72 of the Act prohibits water pollution by any poison, toxic, noxious, obstructing matters, radioactive waste or any other pollutants. Section 78 establishes air quality standards. This includes setting of ambient and occupational air quality standards; emission standards; criteria and guidelines for air pollution control and any other air quality standards. Section 82, regulates emissions by motor vehicles and other conveyances.

Section 101 of EMCA allows NEMA to recommend base standards of emissions of noise and vibration, determine criteria and procedures for measurement of noise and vibration, subsonic vibrations and emission of subsonic vibrations. NEMA is also allowed to determine noise

levels, noise emission standards applicable to construction sites, plants, machinery, motor vehicles, aircraft including sonic bonus, industrial and commercial activities.

Noise and other vibration Pollution Control regulations

These are regulations cited as the EMCA (Noise and excess vibration pollution control regulations, 2009. They prohibit making or causing any loud, unreasonable, unnecessary or unusual noise that annoys, disturbs, injures or endangers conform, repose, health, and safety(EMCA,2009). The Act also lays out the factors to be considered when determining the level of noise pollution.

The regulations prohibit making or causing excessive vibrations that annoy, disturbs, injures or endangers conform repose, health, and safety. Excessive vibrations shall not exceed 0.5 centimetres per second beyond any source property or 30 meters away. Section 5 of the regulations sets permissible noise levels. Section 6 sets the measurements and controls of these noise levels.

Section 12 prohibits loud and unusual noise from motor vehicles. It prohibits sounds excess of 84 dB (A) when accelerating. It prohibits the sounding of horns or other warning devices except when necessary to prevent an accident or an incident. The regulation prohibits the operation of construction equipment that emits excess noise beyond the permissible levels at night.
This equipment includes pile driver, steam shovel, pneumatic hammer, derrick or steam or electric hoist. However, that does not prohibit emergency works, work of a domestic sites, structures or projects undertaken by residents, public works such as construction of public infratsructure, public facilities and utilities works.

The regulation requires all individuals and institutions intending to carry out any development, as defined in the the Planning Act, undertakes Environmental Impact Assessment. The regulation requires that improvement notices be issued to persons who are emitting or likely to emit noise or excessive vibration above the maximum permissible levels, annoying.

Air Quality Regulations, 2009

These are regulations cited as the EMCA (Air Quality) regulations, 2009. The objective of these Regulations is to provide for the prevention, control, and abatement of air pollution to ensure clean and healthy ambient air. The regulations apply to all internal combustion engines, all premises, places, processes, operations, or works to which the provisions of the Act and Regulations made thereunder apply.

The regulations prohibit the emission of air pollution directly and indirectly. Prohibits emission of any substances (gaseous, liquid or solid) exceeding precsribed level of standards. The regulations prohibit Ambient Air Quality pollution, emission of the priority air pollutants, particulate emissions into the atmosphere above-set limits. The regulations allow NEMA to review the list of priority pollutants set out and set limits for ambient air quality levels.

The Authority has the mandate to monitor emissions from all internal combustion engines. The monitoring methods are precsribed under the Eleventh Schedule of the Act.

The Act prohibits any persom from causing or allowing emission of visible air pollutants emanating from stationary vehicles. The act sets forth the emmisions levels as per Kenyan Standards. All owners and operators of mobile emission vehicles are responsible for the control of emmisions. The standards are prescribed in the Second Schedule.

The act also requires that vehicular emissions be tested as per the prescribed standard by NEMA and KeBS. NEMA and NTSA have the joint reponsibility to inspect motor vehicles releasing visible exhaust emissions.

2.2.3. Urban Development Plans

The city of Nairobi since its inception in 1898 has had several development plans prepared. These plans addressed various thematic needs and challenges of the time in the evolution of the city as captured later in this thesis. A summary of all the plans prepared is as follows:

Table 2: Chronology of Nairobi Master Plans

NAME	YEAR	PREPARED BY
1st Plan of Nairobi	1898	Arthur Frederick Church- assistant railway engineer
Plan for a Settler Capital	1927	F. Walton James-cartographer, British East African
Master Plan for a Colonial Capital and Zoning Systems	1948	L. W. T. White- Architect and Town Planner- University of Cape Town Municipal Council of Nairobi
Nairobi Metropolitan Growth Strategy	1973	United Nations Urban Planners of City Council of Nairobi Nairobi Urban Study Group.
Re-Zoning for Upper Hill Area	1993	City Council of Nairobi
Nairobi City Development Ordinances and Zones	2004	City Council of Nairobi
Nairobi Metro 2030	2008	Ministry of Nairobi Metropolitan Development
Revision of the Existing Zones and Regulations	2012	City Council of Nairobi
Nairobi Integrated Urban Development Master Plan	2014	Nairobi City County JICA

Source: Authors Compilation from NIUPLAN 2014

Nairobi Integrated Urban Development Master Plan (NIUPLAN 2014)

The recently prepared Nairobi Integrated Urban Development Master Plan is the guiding strategy to address current challenges evident in Nairobi. The Plan incorporated an integrated approach to planning. The transportation strategies are also integrated as discussed in this section. The key highlight of the plan is illustrated in the table below.

Table 3: NIUPLAN Highlights

Item	Contents
Vision	Development vision is proposed for Nairobi City County to become not only the center of Kenya but also the center of the East African Region.
Sub-center System	Sub-centre system (multi-core development) is proposed, which includes strengthening of the CBD and development of seven sub-centers.
Urban Transport Development	Urban transport development proposes multi-modal development including road network, public transport network, and traffic management.
Infrastructure	Infrastructure covers water supply, storm-water drainage and sewerage, power supply, solid waste management, and telecommunications in which development policy is proposed
Capacity Development	Capacity development proposes to strengthen urban development management from planning, control, and development
GIS Database	GIS database covers land use, infrastructure, and urban facilities
Priority Programmes	Priority programmes are proposed to be implemented in the short term.

Source: Authors Compilation from NIUPLAN 2014

Sub-Centre system

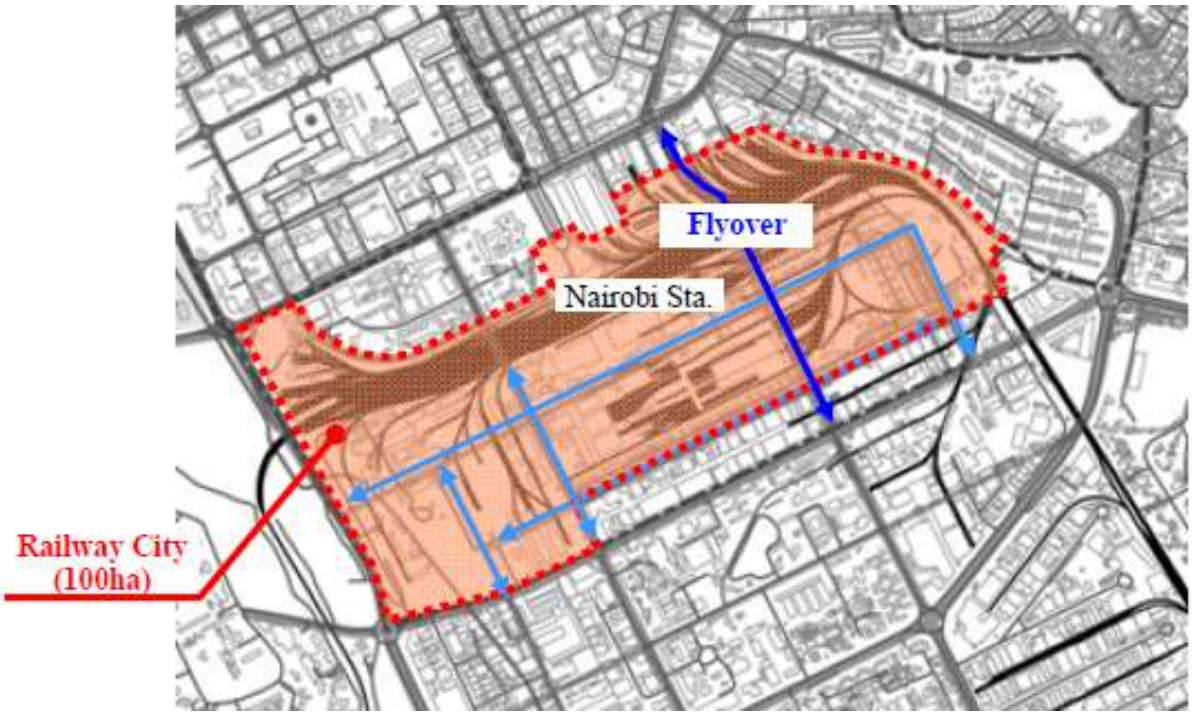
The Plan provided for a broad structure plan to guide the long-term development of the city. The structure plan adopted a sub-centre development system. This system seeks to create alternative commercial districts by creating seven sub-centers.

Urban transport development program

The plan noted that the Nairobi Railway station is an barrier for expansion of the CBD. Kenya Railways Corporation intended to develop this area as "Railway City". It would sit on 100Ha. The Railway city would comprise of the modern railway station,a public square, commercial spaces for lease, staff housing and other Urban renewal projecs.

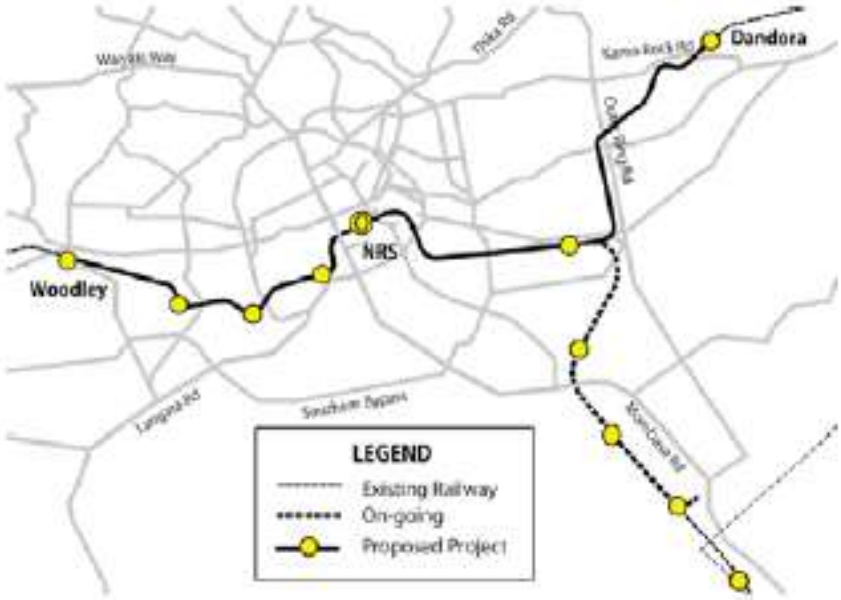
Kenya Railways has also planned the development of a modern commuter train service to connect the different areas and sub-centres of the city. Existing commuter train operation will be improved by replacing with Diesel Multiple units. Other improvements will include signalling and telecommunication system upgrades, rehabilitation of existing tracks and station structures.

Map 2: Proposed Railway City



Source: NIUPLAN, 2014

Map 3: Proposed Commuter Train operation Network



Source: NIUPLAN, 2014

Development of a Modern bus terminal is necessary for the Railway City. The terminal will measure approx. 50,000 m^2 and will have facilities such as waiting rooms, ticketing offices, restaurants, shops, and timetable display stands. This will ease congestion in the CBD. The terminus will attract passenger numbers into the railway city to boost its productivity.

Map 4: Proposed Enterprise road widening

Source: NIUPLAN, 2014

The plan above proposes Widening of Enterprise Road from 2 lanes to 4 lanes on a 4km stretch. This is meant to support development potential in the railway city. The road will assist in dispensing traffic demand on Mombasa Road and Uhuru Highway.

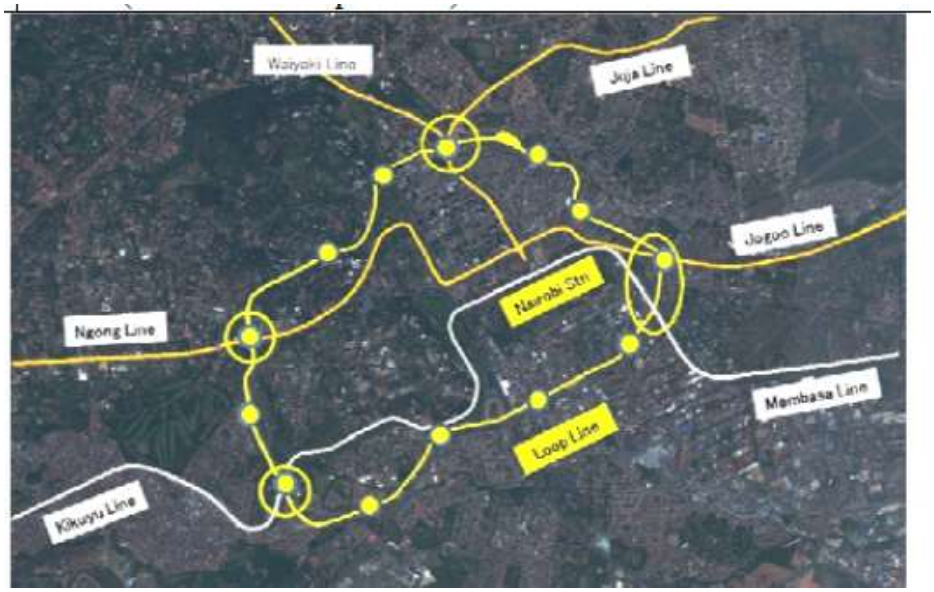
NIUPLAN highlights the construction of the Northern Part of Circumferential Road C-2. The circumferential road was meant to address challenges associated with the radial pattern road networks of Nairobi CBD. The road is to connect Thika Highway-Uhuru Highway Intersection to Mbagathi Way, the road has a length of 3.7km of which 1.5km will be a new road as well as a widening of 2.2 km.

Map 5:Proposed Circumferential Road C-2

Source: NIUPLAN, 2014

The plan observes that the existing MRTS plan indicates that all the MRT/LRT corridors are radiating from Nairobi Railway Station. It observes that such a scenario would not alleviate the problem of traffic congestion in the CBD which would still be the dominant core. NIUPLAN proposes to divert MRT/LRT passengers by the loop line. The plan proposes the need to provide sub-centres around interchange stations and provide train operation plans informed by demand forecasts.

Map 6: Proposed MRT/LRT corridors and loop line



Source: NIUPLAN, 2014

The Plan proposes the formulation of the Intelligent Transport System (ITS) City Master Plan. The aim is development of a comprehensive implementation plan for the ITS which ought to include installation and management of ITS facilities. The plan also ought to include a data centre that will capture traffic congestion data, traffic controls, public transport operations, parking controls, and crime data.

Technological introduction to the transports system will enable smooth traffic flow and reduced traffic concentration into the CBD. Standalone ITS measures have been attempted by the installation of CCTV in certain parts although a comprehensive policy on the development of ITS does not exist.

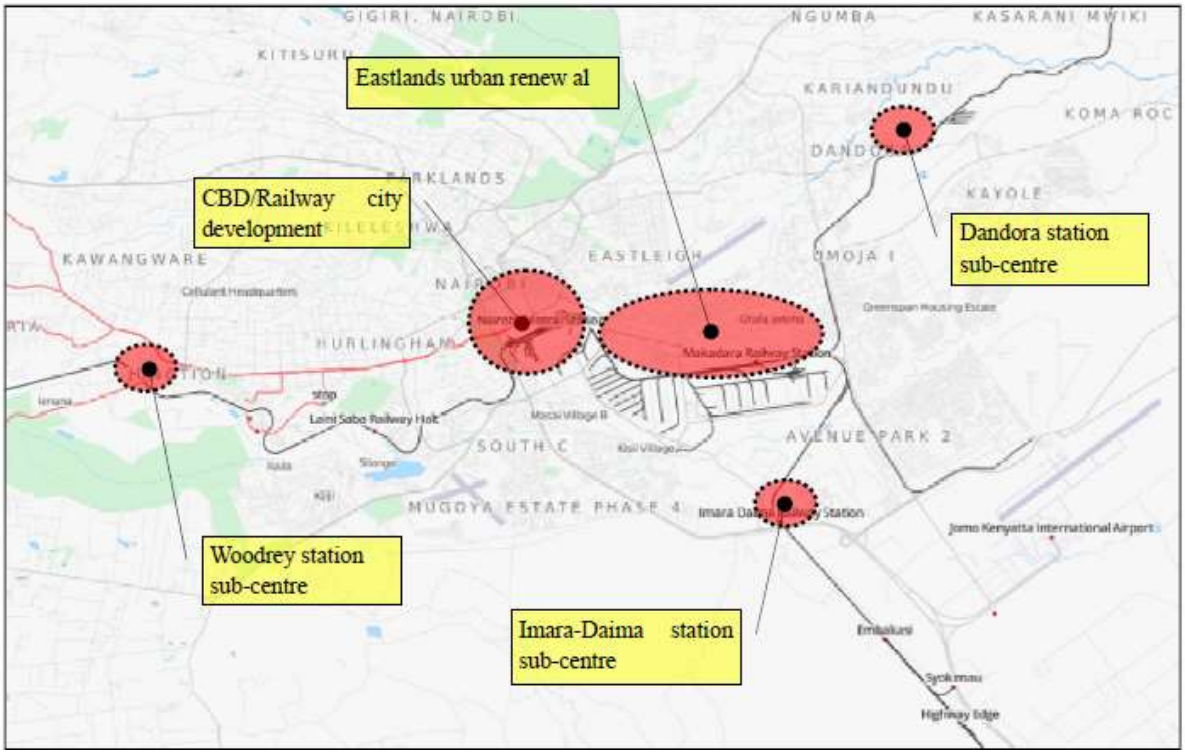
The Plan also proposed various short and medium plan proposals to address traffic congestion in the CBD as follows:

- Reintroduction of signalised citywide traffic control system
- Develop Nairobi city dedicated bus lane network prior to the BRT introduction,
- Different reporting hours to work to ease peak travel,
- Regulate public vehicle assess to CBD by reducing trips and use of external terminals
- Establish bus terminal in the newly planned sub-centres.

Other Relevant projects

The Eastland urban renewal program involves the redevelopment of the independence era local authority estates. This would also involve upgrading existing infrastructure, social facilities, and housing. Other components of the program area a Road network plan and Public transport plan

Map 7: Relevant ongoing project



Source: JICA Study Team (JST)

2.3. Congestion Assessment Methodologies

2.3.1 Approaches to the Assessment of Congestion

Traditional Approaches

Traditional approaches were driven by providing infrastructure in cities where such infrastructure was non-existent or dilapidated and dysfunctional. In circumstances where some form of infrastructure exists, the driving agenda has been the need to maximise the capacities of existing infrastructure to handle current and future projected traffic demand.

The desired outcomes of these traditional approaches have been to *minimise* traffic delays, reduce travel times and associated personal, business and resource impacts. Infrastructure development agencies undertake action plans and programmes as illustrated below:

1. Identification of congestion points and projection of possible traffic bottlenecks.
2. Identification of possible mitigation areas.
3. Project prioritisation guided by Cost-Benefit Analysis (CBA)
4. Proposal for quick wins and immediate term congestion-mitigation measures
5.Identification, prioritisation, and location of long-term corridors improvements

Road Impedance Index

The Road impedance model is a sophisticated and critical approach in urban traffic congestion assessment and diagnosis. Approaches in this model include traditional wave theory and Traffic flow theory. The traffic wave theory has been numerical applied in China while the traffic flow theory has bee applied to theoretical research.

This study applied the traditional wave theory based on the Greensfield linear model.

This approach focuses on:

1. Establishing basic travel time and speeds
2. Establishing traffic load pressures
3. Establishing waiting delay time and impedance hotspots
4. Numerically mitigating the delay time and impedance factors

2.4. Case Studies

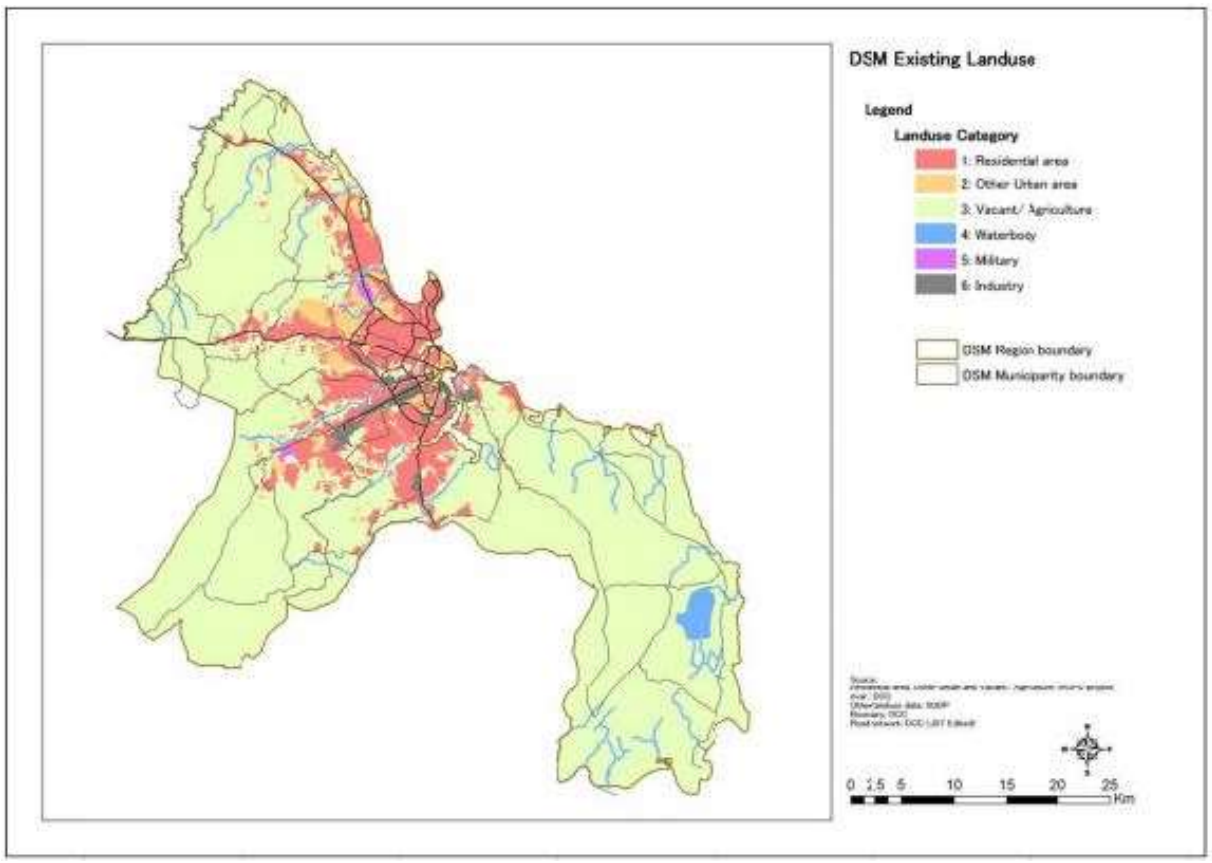
2.4.1 Local Case Study (East Africa): Dar es Salaam City, Tanzania

This section includes a local and international case study on traffic congestion management best practices and benchmarking experiences. The contextual issues, strategies, and lessons learnt are detailed out.

a) Background

Tanzania is amongst the 5 countries in East Africa together with Kenya, Uganda, Rwanda, and Ethiopia. Dodoma serves as its capital city due to its function as the headquarters of Parliament and Government. Dar es Salam served as its capital until 1996. Dar es Salam is the most populated city in Tanzania with a total of 4,364,541 people (2012). 70% of Dar es Salam population lives in informal settlements. It serves as its main economic hub and is the centre of tourism in the country.

Map 8: Map showing the main land uses in Dar es salaam



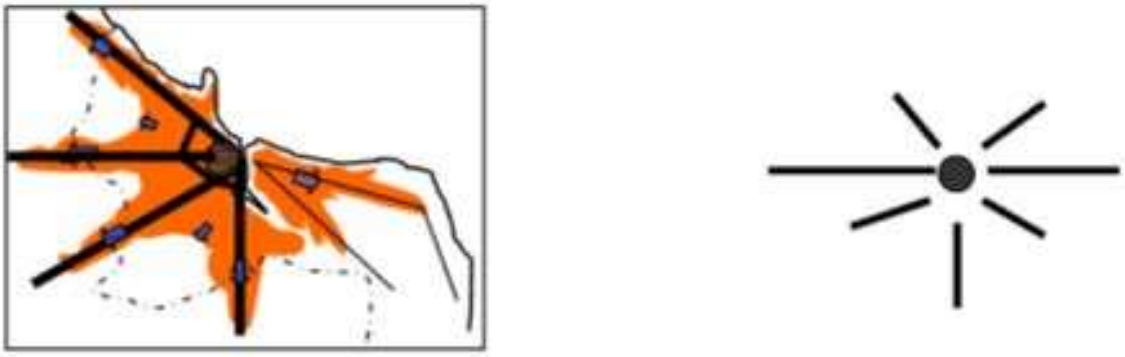
b) Transport Structure

The urban structure of this city is monocentric centred around the Central Business District and the Kariokor area. Dar es salaam has 5 main radial roads which are Kilwa, Nyerere, Morogoro, Bibititi and new and old Bagamoyo road. Mandela road Serves as the outer ring road. The CBD has a concentration of major commercial activities that also extend along major arterials. The Transport structure and organisation is very similar to that of Nairobi.

Table 4: Characteristic of Nairobi and Dar es salaam.

Characteristic	Nairobi	Dar es salaam
City function	capital city/main commercial hub in Kenya	commercial city in Tanzania
Population	Largest city by population with a growth rate of 4.1%	Highest populated city with a growth rate of 5.6%
Urban poor	50% of the population reside in informal settlements	70% of settlements are informal
Urban structure	Monocentric with major highway such as Thika superhighway, Mombasa, Jogoo and Ngong roads serving as inlets into the CBD	Monocentric with the 5 arterial roads leading into the CBD

Figure 8: Illustration of monocentric Centre development



c) *Cause of Traffic Congestion*

Similarly, to the situation in Nairobi, congestion is a major problem in Dar es Salaam. Congestion is caused by;

(a) Rapid population increase

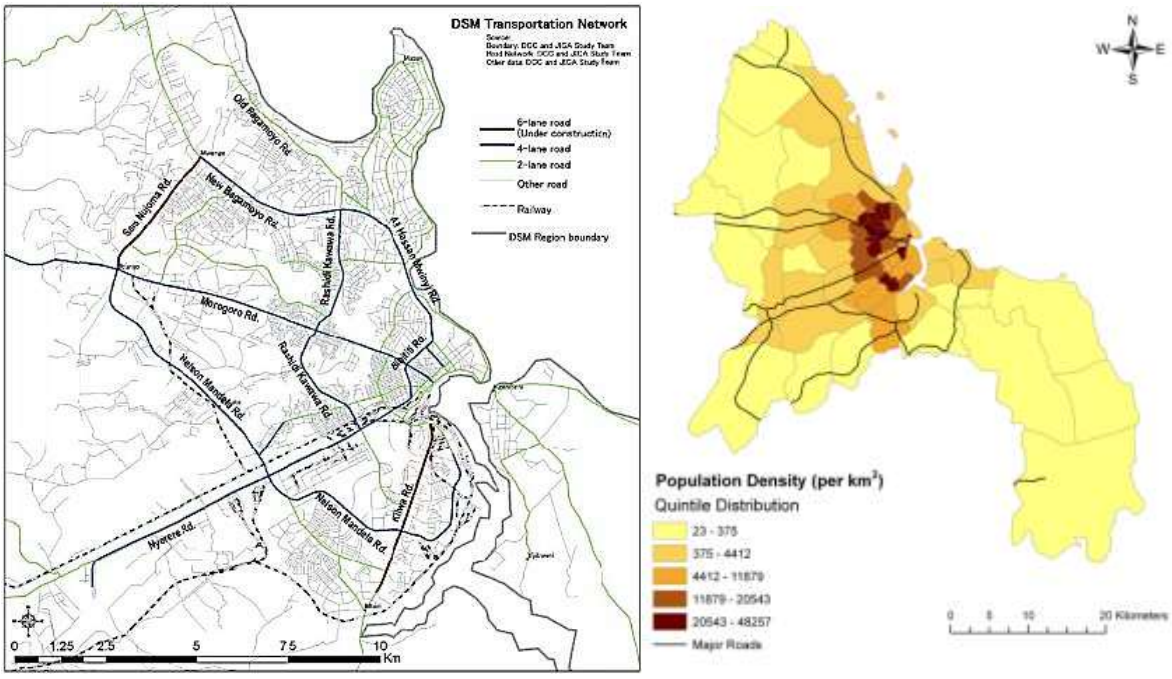
(b) Inadequate infrastructure (the roads and parking facilities)

(c) Monocentric city structure

(d) High vehicle ownership and operation

(e) Urban sprawl

Map 9: Maps showing roads and population in Dar es Salaam city



The image on the left shows the road system and the population (as of 2006) it serves. Morogoro road and Nyerere road serves the highest population catchments.

d) Lessons Learnt: Design and Policy Measures on Traffic Congestion

1. **Urban Trains and Light Rail Transit-**Taking actions to factors that lead to an increase in capacity and efficiency of transport infrastructure by introducing urban trains that are limited from Ubongo to City centre

   Similarly, an LRT system has been proposed on Jogoo-Juja road in Nairobi. This proposal is should be implemented.

2. **Discourage private car use through priority investment in a rapid transit system.** Taking actions in factors that lead to a reduction in the use of cars through the introduction of a rapid transit system. The rapid transit system along Morogoro and Kawawa have dedicated lanes and stations.

   Similarly, this study proposes various strategies towards discouraging private car use and emphasis on rapid transit systems such as the City-wide BRT system and, High capacity vehicles for public transport.

3. **Regulatory incentives and innovations.** The government has set out a policy on innovative such as tax increment financing and transfer of development

a) **Tax Increment Financing** –The TIF generates revenue for the local economy by using a precinct/district. The concept of TIF is to enable reinvestment of a certain percentage of property tax revenues towards a specific precinct/ district. Upon investments of such taxes, property values would increase in the precinct causing a significant increase in property tax revenue as well. These tax increment can be utilised to finance infrastructure improvement or offer subsidies to encourage private sector investments.

   TIF impacts surrounding properties by raising property values. Increased property values translate to available financing towards redevelopment. This method can be used in the Landhies area to generate money for the development of the area.

b) **Transfer of development right (TDR) -**is a regulatory tool conferred by local laws and exercised by local authorities towards desired land use. The concept encourages developers to be able to develop appropriate development in appropriate zones as defined by zoning plans where development potentials are more suitable.

   TDR is different from traditional zoning regulations as it recommends the transfer of ownership interests from one area to another, where the develop is able desired developments.

Likewise, regulatory incentives and innovations in the management of Nairobi public transport sector, would go a long way in increasing public transport ridership and decreasing private car use.

4. **Infrastructure improvements-** Adding new transport facilities, expansion of road reserve to accommodate additional lanes, redesign of roads to include interchanges at congested intersections and construction of ring roads
5. **Parking management measures** and strict enforcement
6. Improving management of existing infrastructure capacity by providing high-quality public transport, promoting Non-Motorised Transport (cycling and walking) and introducing flexible working hours.
7. Prohibiting Low capacity buses (minibuses with a capacity of less than 25%) to offer services to and from the city.

   Similarly, this study has proposed such a strategy in the recommendation section
8. Redistribution of services and community infrastructure by proposal of satellite towns.
9. Creating a transit mall that encourages the development of commercial, business and residential.

BEFORE **AFTER**

Plate 1: Traffic congestion before and after the proposal of the BRT

2.4.2 International Case Studies- Bogota, Colombia

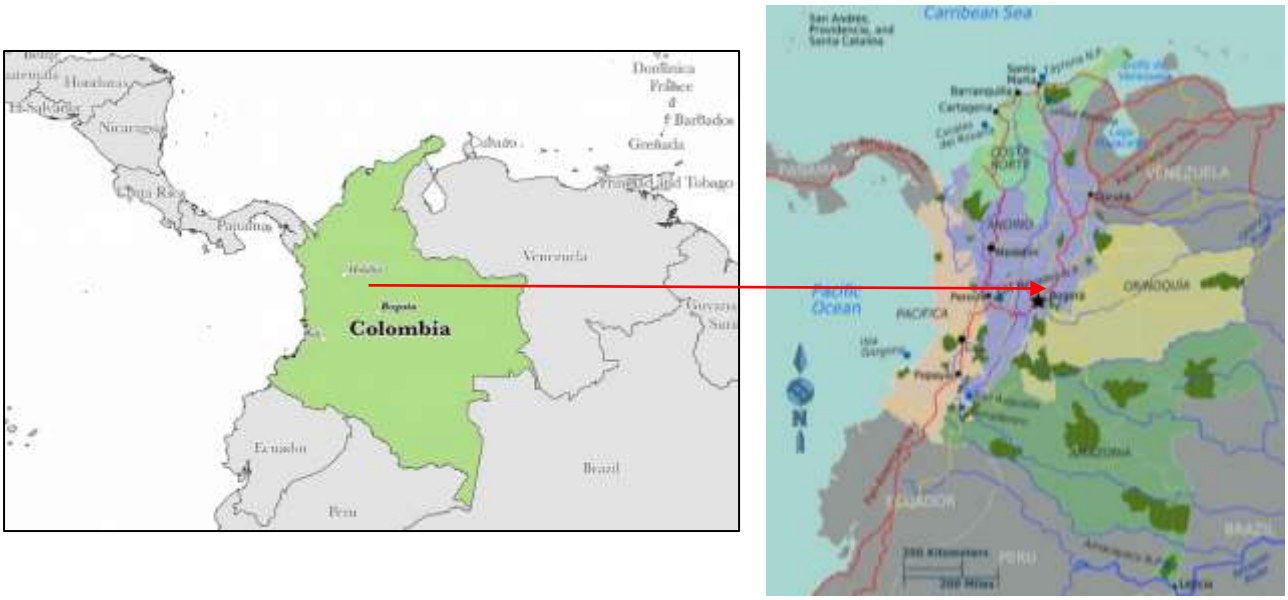


Plate 2: Location of Bogota

a) Background

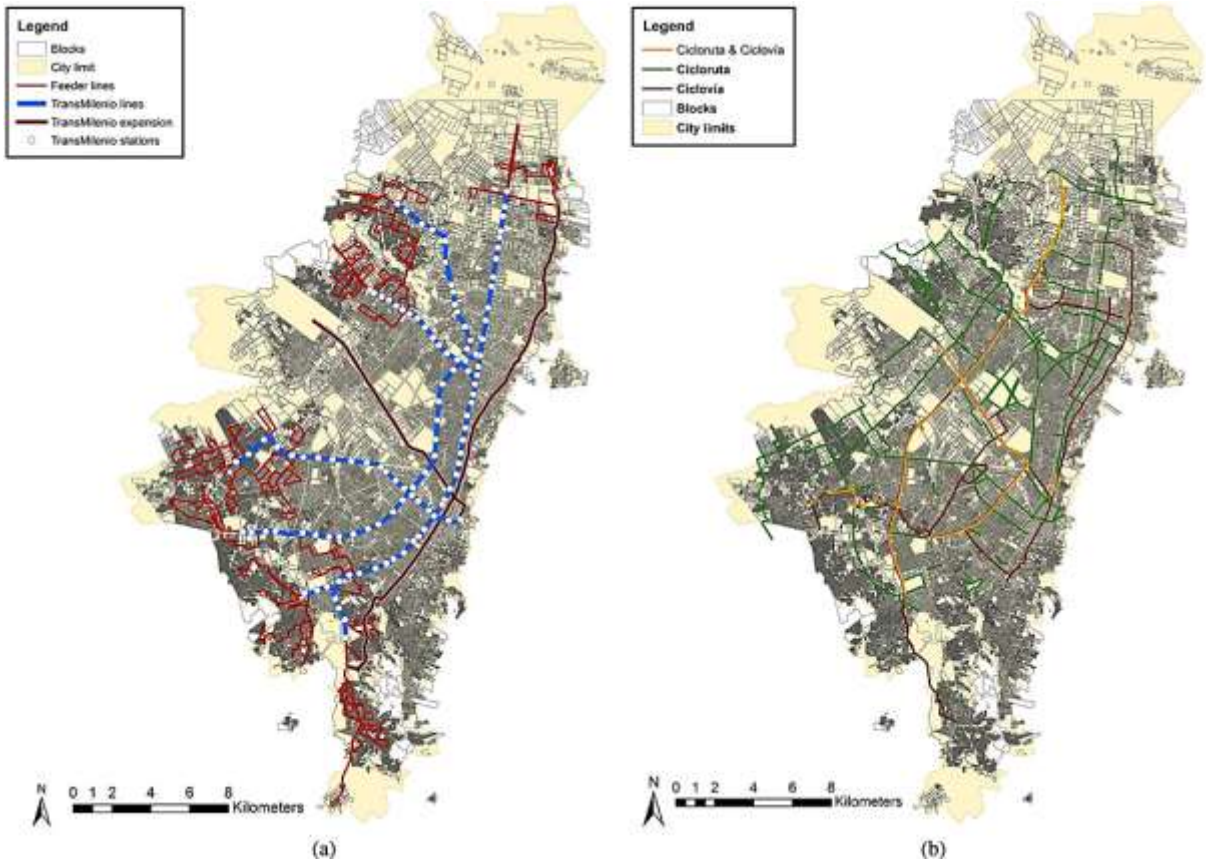
Bogota is the capital city of Colombia located in South America. It sits in the central area on a high plateau named Bogota Savannah. It serves as the financial and commercial hub of Colombia. Bogota has 9,854,722 inhabitants according to the 2016 predictions. Just like Nairobi is to Kenya, Bogota is the largest and fast-growing City in Colombia. The city spans an area of about 307.36Km^2 and has a population of about 8,080,734 with an approximate population growth rate of 2.95 percent as of 2017[1]. The larger Bogota metro region has a population of 10,7000,000 as compared to Nairobi's 6,4,000,000 in the same period. As is the case in Nairobi, Bogota's growth has strained and stretched the capacities of roads and highways. Private Motorists account for a larger part of the congestion, in addition to taxis and buses. However, there are two bus systems in Bogota: the traditional bus system as well as TransMilenio. The traditional systems have various sized buses operated by several private companies.

b) Transport Structure

Bogota is divided into 6 social-economic-strata (SES) which represent the income of the population living in the city. Through this, the planning department is able to access and implement transport challenges according to demand, provision, and use. The subgroups were based on the physical characteristics of households and surrounding areas.

The urban layout in Bogota focused on the centre of the city. The city has two bus systems the traditional system and TransMilenio. The TransMilenio system is a BRT system deployed as an alternative to the absent rail and subway systems. TransMilenio is an 84-kilometer (BRT system with nine lines and 115 stations. It serves 1.4 million people daily and has increased bus speeds from 12 km/h to 26 km/h (Munoz-Raskin 2010). TransMilenio is the best know sustainable transport and combines specialised HCV operating on dedicated busways and smaller buses operating in residential areas that feed the main system.

Map 10:Spatial distribution of Trans Milenio lines, stations, feeder lines, and cycling lanes (Cicloruta), restricted cycling streets



Source: Universidad de los Andes. Authors' elaboration.

Bogotá also introduced bicycle programmes for its citizens, namely:

1. **Cicloruta** which is an extensive bicycle path network measuring 291 km. The bicycle path network connects seamlessly to the TransMilenio.
2. **Ciclovía** is a strategy that encourages periodic NMT use on various streets for a temporary period, in streets which are ordinarily motorised (Sarmiento et al. 2010). The strategy introduced in 1976, focuses on closure of 97 km of main streets from motorized transportation for 7 hours per day during weekends and holidays.
   Benefits of this program include healthy living, reduced vehicular traffic, emissions and accidents (Parra et al. 2007; Torres et al. 2013)

Table 5: Similarities between Nairobi and Bogota

Characteristic	Bogota	Nairobi
Function	Serves as the administrative city and main economic hub of Colombia	It is the administrative centre and main economic hub of Kenya
Urban structure	Has one main CBD	Has only one CBD
Population	Has a high population of 7.1 million	Has a population of 4 million

c) Lessons Learnt: Design and Policy Measures on Traffic Congestion

1. Expand road reserves to accommodate additional lanes to the existing road, redesign to incorporate overpasses and underpasses at congestion intersections.
2. Re-ordering of the land use in the area through integration of the traffic management plan with the urban plan. It is a cost-effective way to decrease congestion.
3. Having Proper and consistent bus stop along the road
4. Restricting private cars in the CBD. The restriction is based on the license number plates by prohibiting the cars in the city every weekday. If your license plate ends with even numbers, the restricted days are the even numbers and vice versa.
5. average bus speed to be 26km/h
6. Banning all forms of trading along the road
7. Phases out minibuses with low capacities- Prohibiting minibuses with a capacity of less than 25% to transport passengers to be passing through the road

8. Prioritization of public transport and NMT such as cycling. 344 km of cycling network was built for daily commuting as well as a 17 km corridor for pedestrian use. The corridor connects the low-income residential areas with CBD. Due to this, the number of public vehicles reduced.
9. Enhancing mobility strategy by the construction of NMT facilities so that the people using the road can shift to other alternative modes of transport such as cycling

Plate 3: Cycling lanes in Bogota, Colombia

2.4.3 International Case Studies-Curitiba, Brazil

Curitiba's transport system in a renowned best practice example of an integrated, efficient and cost-effective transport system. It is anchored on a Bus Rapid transport system which was based on five structural axes.

a) Background

Curitiba is the Capital city of Parana State, Brazil. It is located in the southern parts of the country, approximately 400 kilometres southwest of Sao Paulo. The city measures approx. 430 square kilometres and has a total population of 1.9 Million Persons while the Metropolitan area has approximately 3.2 Million of 2015. The city has 26 municipalities divided into 75 neighbourhoods (IPPUC,2008). Curitiba has among the highest City GDPs in South America at 7,827 US dollars per head and a high Human Development Index (0.856) as of 2010.

Curitiba began in 1693 as a small settlement with its economic activities being cattle trading and agriculture. It gradually becomes a centre for commerce and industry. As of the 1920s, the population was around 80,000 increasing to 130,000 around the 1940s and 400,000 in the 60s (IPPUC,2008).

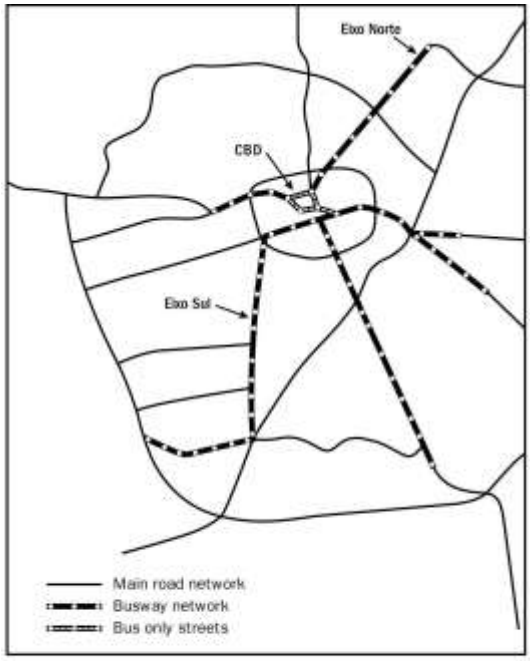
Between 1960 to the early 1980s, the city experienced a high population growth rate at 4% per annum. The rapid growth led to increased demand for urban services and public investment. Beginning 1964 to 1966, the Curitiba Master Plan was prepared to guide city development. The plan major elements included decongestion of the city centre; Promotion liner city growth by integrating public transport and Transit-oriented development; Land use controls and management; Infrastructure improvement; provision of economic incentives to generate employment and preservation of historical city centre. The city also adopted policies on housing, waste recycling, environment, and social matters.

Rapid population growth and increased motorisation necessitated the need for an integrated and highly efficient transport system.

b) Transport Structure

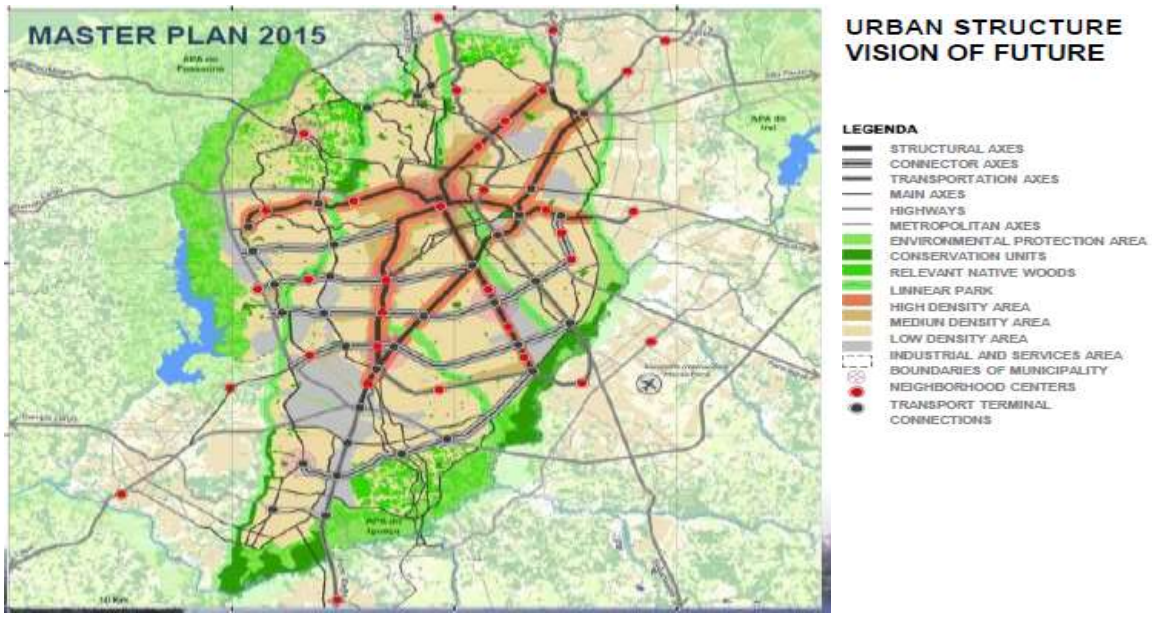
The Curitiba Master Plan prepared in 1966 was the basis of the cities transport system. The systems were established along the city's 5 major radial corridors/structural axes. Each axis has a trinary system made up of three feeder roads. The central road has a busway with evenly distributed terminals. One-way traffic roads of between 3 or 4 lanes are provided, next to the busways, for use by commercial and private motorists. Intensive high-density developments are permitted on either side of the main roads. This creates a high demand for public transport which is met efficiently along the busways. The busways enter and cross the CBD. Bus feeder systems support the busway by transferring traffic volumes to and from the terminals and bus stops. Traffic management in the CBD is achieved through bus-only access. Parking controls and pedestrianisation policy.

Map: System of Bus services



Source: IPPUC,2008.

Map showing the main land uses in Curitiba



Source: IPPUC,2008.

The citywide operation has 340 bus lines covering 1,100 kilometres of bus routes serviced by approx. 1600 buses. The city has 26 integration -interchange terminals of different sizes and 60km of segregated busway. The system carries 11,100 passengers one way during peak periods and approximately 2 million people per day.

Each busway has at least 114 bi-articulated vehicles which are 25 meters long, have 5 passenger doors and a carrying capacity of 270 persons. The average bus speed is 20kph Buses are colour coded by function.

Name	Service area	Colour code
"Troncal or express"	trunk line buses on the axes/busways	red/orange
"Ligeirinho"	express service	grey/silver
"Interbarrios"	inter-district	green
"Alimentador"	feeders to/from terminals and bus stops trunk line or express buses	orange
"Conventional"	regular services on normal roads	yellow
"Circular centro"	CBD	white
"Metropolitano"	out of city destinations	blue

Source: Authors Own Interpretation from IPPUC,2008.

Table 6: Characteristic of Nairobi and Curitiba

Characteristic	Nairobi	Curitiba
City function	capital city/main commercial hub in Kenya	Capital city of Parana State, southern brazil
Population	Largest city by population with a growth rate of 4.1%	Experienced population growth rate of 4% (1960-1980s)
Urban structure	Monocentric with major highway such as Thika superhighway, Mombasa, Jogoo and Ngong roads serving as inlets into the CBD	Initially, a Central core city-based with the 5 major structural axes

c) Lessons Learnt: Design and Policy Measures on Traffic Congestion

1. **Integration of land use planning and transport systems**
2. **Effective Governance and Urban Management:** Curitiba master plan was implemented, monitored and updated by IPPUC which is an independent institute separate from municipal governance and political setup.
3. **Prioritisation of public transport in large cities**. Curitiba prioritised the development of mass public transport as part of its transport management strategy. Buses provide flexible and affordable public transport compared to Light rail Transport which was the other viable option. The Bus system is controlled and regulated by a municipal company (URBS).

   The company also regulates transport terminals and commercial activity areas. The company establishes routes, schedules, and fair pricing. Bus services are outsourced to private bus operators by the route. URBS ensures efficiency by close supervision
4. **Parking policies assist in shaping travel demand**. Parking policies are used to determine the preferred modes of transport in the City. Roadside parking is regulated where one can park and parking durations. This then reduces the preference to have private motor vehicles operated in the city. All developments along the structural corridors must provide off-street parking which is often at a high cost translating to expensive parking spaces. The high costs of parking discourage private vehicle use.

   Parts of the city are partially closed to vehicular traffic and are only accessible via pedestrian or public buses.

5. **Integration of public transport with community development**. The city integrated the larger community development with public transport. This creates a sense of ownership and participative decision making. Bus travel tickets are often issued for low-income earners who in turn are required to collect waste for disposal in the inaccessible areas of the city. Thus, community participation in maintaining cleaner environments.
6. **Development of BRT as a Mass transit system**. The BRT system provided adequate infrastructure to enable mass movement. This included dedicated busways and lanes located along structural axes, separated from local service streets and other motorists. Busway crossing with other roads is grade and signal-controlled intersections to minimise delays at junctions and interruptions of smooth flow.

   Interchange terminals located at the end of each of the 5 structural axes. Smaller terminals located after every 2-kilometre interval. These are used as feeder bus interchanges. Tube stops are located 500 meters apart and target pedestrian traffic. Tubes provide weather protection and are raised platforms. They have PWD facilities. All fares are collected at terminals which have manned turnstiles
7. **User-friendly efficient buses and facilities:** Buses have five doors that are wide enough to enable ease in boarding and alighting. All fare payments made at the terminal and no fare collection in buses. Numerous interchanges, terminals, and tube stops are well built against harsh weather and to include PWDs' needs. bi-articulated buses with 270 passenger capacity (57 seated). The system is also a safe and secure method that is used by all generations (young and old) and is gender-sensitive.

   Colour coding of buses is done for user recognition. This assist to identify buses by routes and function.
8. **Signalised traffic controls and busway enforcement**: Traffic control is signalised and busways are given priority. Signalised traffic controls are more effective and fairer.

   Few left turns are permitted to ensure minimal disruptions to the normal traffic flow.
9. **The transport system operates without subsidies**. Earnings to operators from fares charged is able to meet operations costs, and profits. URBS periodically reviews fares to cover administrative costs and capital replacements. Fares are moderated to ensure the average worker incurs a maximum 10% of their income on transport.

10. **BRT system reduced the dependence of private car use.** It contributed to a decrease of Approx. 27 million private car trips per year as of the year 1991. This translates to 30% less fuel per capita.

11. **Cycling and Pedestrianisation of key streets**. The city encourages the high use of pedestrian and cycling means of movement. Certain sections of the CBD are only accessible via pedestrian means.

    The historic core of the city and the high amount of green spaces encourage the development and use of Non-Motorised Transport.

2.5. Conceptual Framework

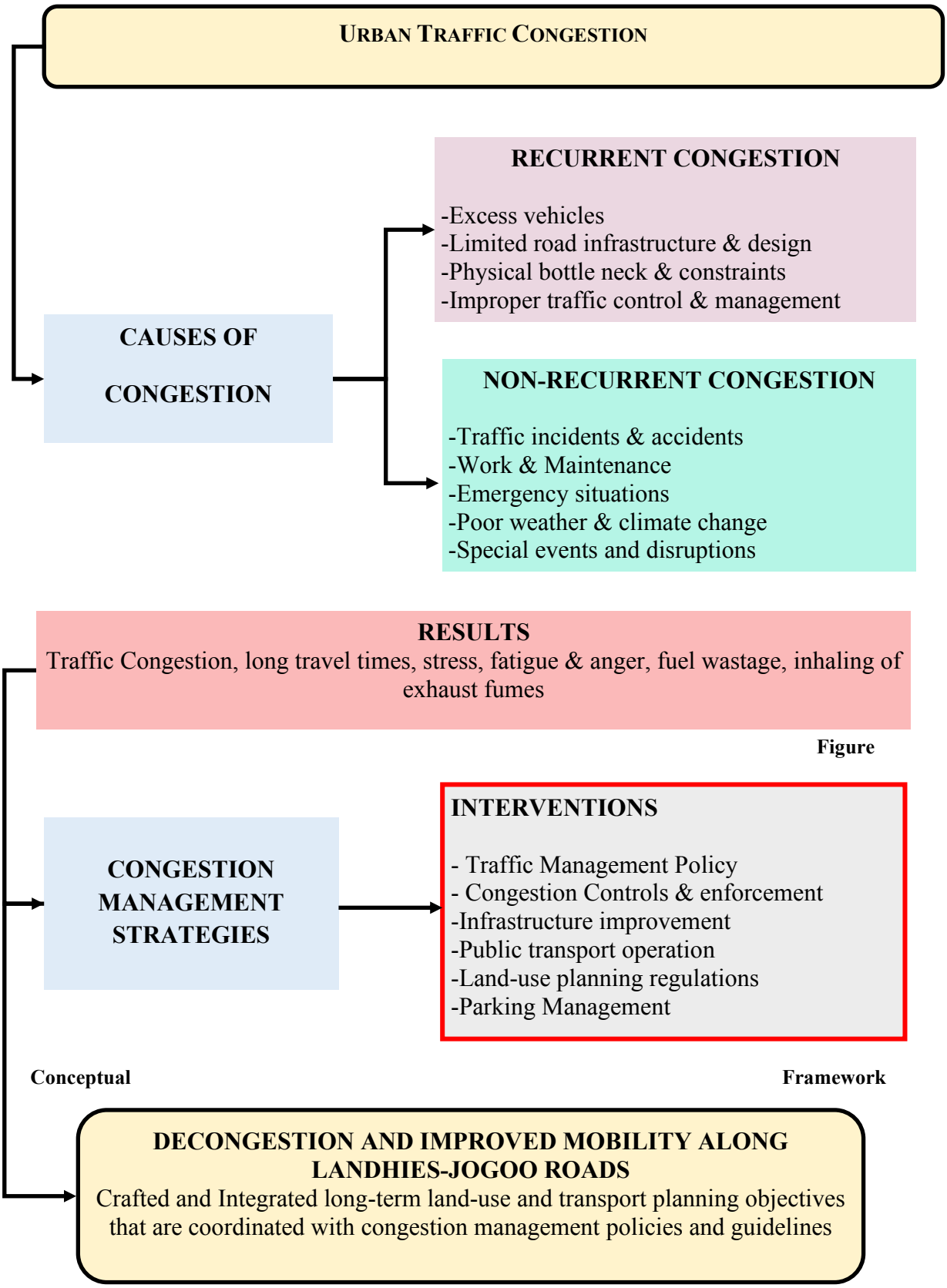


Figure 9: Conceptual Framework

CHAPTER THREE: STUDY AREA

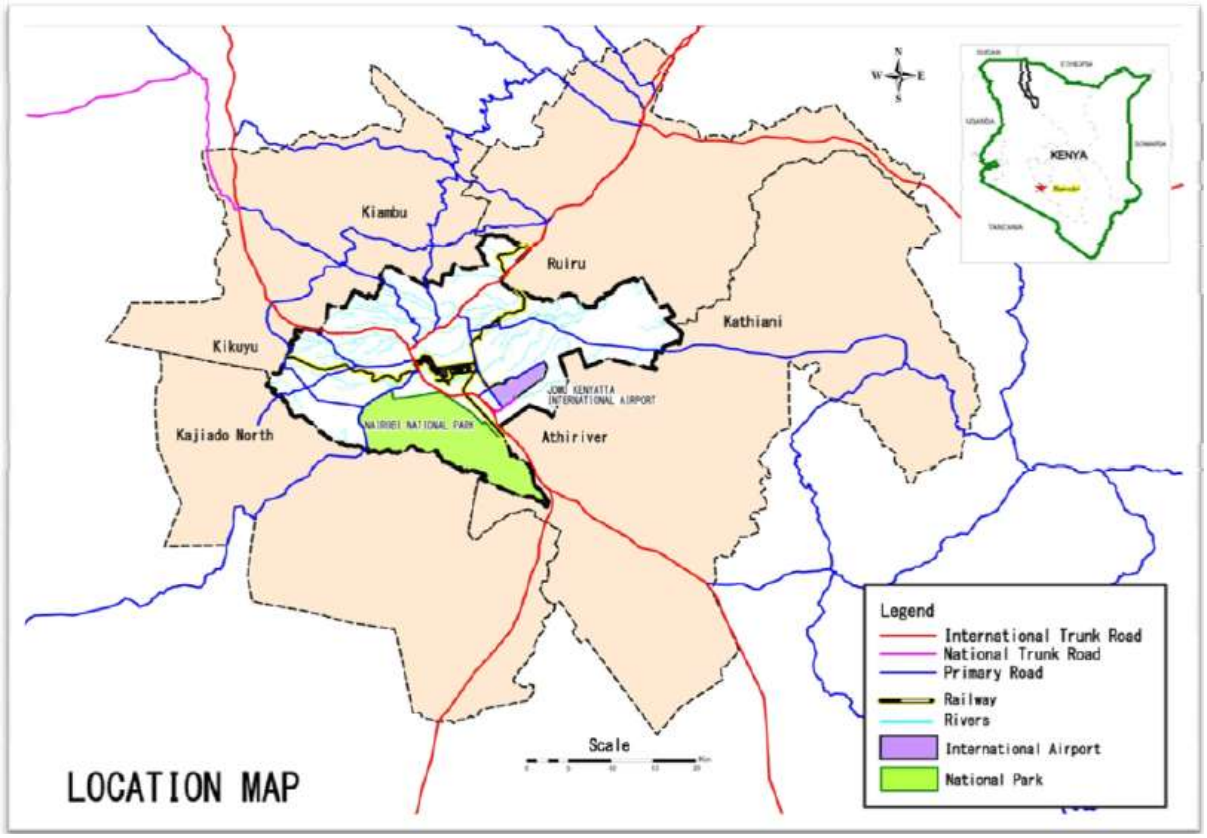
3.1. National, Regional and Sub Regional Context

The area of study is located in Nairobi City, Nairobi City County, Kenya. Nairobi is Kenya Capital City. Nairobi is located approximately 140 kilometers south of the Equator. It lies at an altitude of 1,661 meters above sea level and covers an area of 696 km^2 (NIUPLAN,2014).

Nairobi hosts the headquarters of the Legislature, Judiciary, and Executive arms of government. Nairobi serves as a regional hub in the financial, commercial, medical, educational and social sectors. It provides vital services to Eastern African citizens from Uganda, Tanzania, South Sudan, Rwanda, Burundi and the Democratic Republic of Congo.

Locally Nairobi serves the immediate metropolitan region which includes the counties of Machakos, Kiambu, Kajiado, and Muranga. It also has vital links with all other counties in the Republic.

Map 11:Nairobi City Context Map



Source: NIUPLAN, 2014

Nairobi has approximately 4,174,952 residents as per the 2018 projections (NIUPLAN, 2014). Its population constitutes about 8% of the National population (NIUPLAN, 2014).

The study area, Landhies-Jogoo Road Corridor, is a major transit corridor within the City. The other major corridors include Ngong road, Mombasa road, Wayaki Way, Thika Highway, Limuru road.

3.2. Study/Focus Area

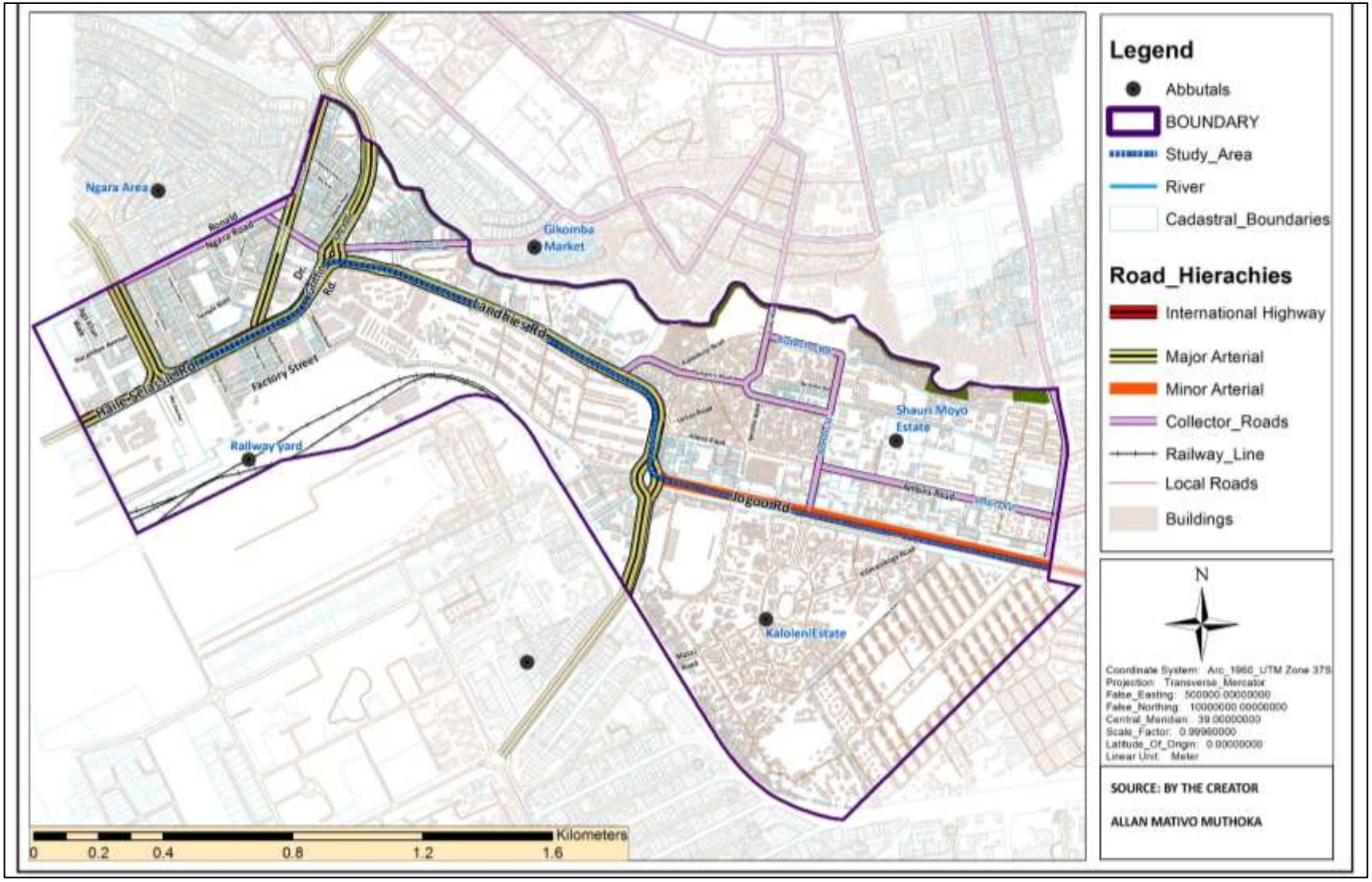
The corridor begins along Jogoo Road at the round-about connecting to Likoni Road. It stretches to City Stadium Roundabout and connects to Landhies Road. It moves past Muthurwa Market and connects to Halie Selassie Avenue at Ring Road-Landhies Road Roundabout. The study area stretches along Halie Selassie Avenue up to the Railways Bus Terminus as illustrated in **Map 12 below**.

The study area abuts various significant land-use sites which include: Burma Market, City Stadium, Kamukunji Jua Kali Market, Muthurwa Market, Ukulima Market, Machakos country bus terminus, Easy Coach Bus Terminus and the Railways Station Bus Stop.

This study area has been selected since it is a major entry corridor to the Nairobi Central Business District (CBD). The corridor carries significant traffic volumes to and from the CBD. It thus illustrates the larger picture of the other similar corridors (Mombasa Road; Wayaki Way; Ngong Road and Thika Road).

The study area is also affected by traffic congestion as a result of multiple factors. These factors include poor road and intersection design, infrastructure bottle-necks, non-road congestion occurrences, and land-use patterns. Poor road and intersection design are manifested in the number and arrangement of these roundabouts, the number of entry and exit lanes and the overall traffic management system (traffic lights and traffic police). Additionally, the non-road congestion occurrences are caused by inadequate roadside parking which has caused parking and turning on road reserve, conflicting uses of handcarts on the road as well as parking and queuing of delivery trucks as they access the markets. Thus, an ideal location to assess the management of urban traffic congestion and its related impacts.

Map 12: Extent of Study Area



3.3. Physical Features: Climate, Drainage, Major Features

Nairobi was originally part of a swampy area prior to its establishment in the year 1899. Nairobi was traversed by the Nairobi River which passed through it. Athi River is another major river which was located to the south. Present-day Nairobi has a National park within its boundaries.

Nairobi lies at 1,661 meters (5,450 feet) above sea level. It experiences warm tropical highland climatic conditions. During the cold season, temperatures drop to a low of 9 °C while during the hot season the rise to 32°C. The mean maximum temperature per year is 24 °C. Nairobi experience two rainy seasons like most parts of the county. The average annual rainfall is 875 mm, with a varied range of 500-1500 mm.

3.4. History and Population

The word Nairobi can be traced from Maasai vocabulary "Enkare Nairobi" which means a place of cool waters. The name is in reference to Nairobi River.

Nairobi was established by colonial authorities as a rail depot in the year 1899 during construction of the Mombasa- Kisumu railway line. Nairobi was established due to its favourable temperate climate, high elevation and flat ground before the steep ascent of Limuru. The choice of the railway depot was criticized since the site was infertile and poorly drained

The population of Nairobi has been on s steady rise since its inception. In 1901, Nairobi had 8,000 inhabitants increasing to 16,000 persons by 1910 and 24,000 persons by 1921. By 1948, the population had increased to 118,000 and by 1962, a further increase to 343,500 (Cap, 2014). After Kenya's independence in 1963, Nairobi was established as the Capital of independent Kenya. By the year 2009, the population of Nairobi was at 3.1 million persons (Census, 2009).

Table 7: Historical population Profile, Nairobi

YEAR	1969	1976	1989	1999	2009
Kenya	10,942,705	15,327,061	21,445,636	28,686,607	38,610,097
Nairobi	509,286	827,775	1,324,570	2,143,254	3,138,369

Source: Various Population Census, (KNBS 1969,1979,1989,1999,2009)

During the colonial period, Nairobi expanded towards the Native areas which caused friction between the colonial government and native communities. After independence, Nairobi grew much rapidly with the African government in charge. However, the population growth began to exert pressure on the limited infrastructure capacities of Nairobi. Nairobi's population growth stands at 4.7% annually, which is a much high growth rate than the 3.4% annual average for developing cities (Omwenga, 2011). The primacy of Nairobi continues to be felt in the Nairobi metropolitan region.

3.5. Housing and Demographics

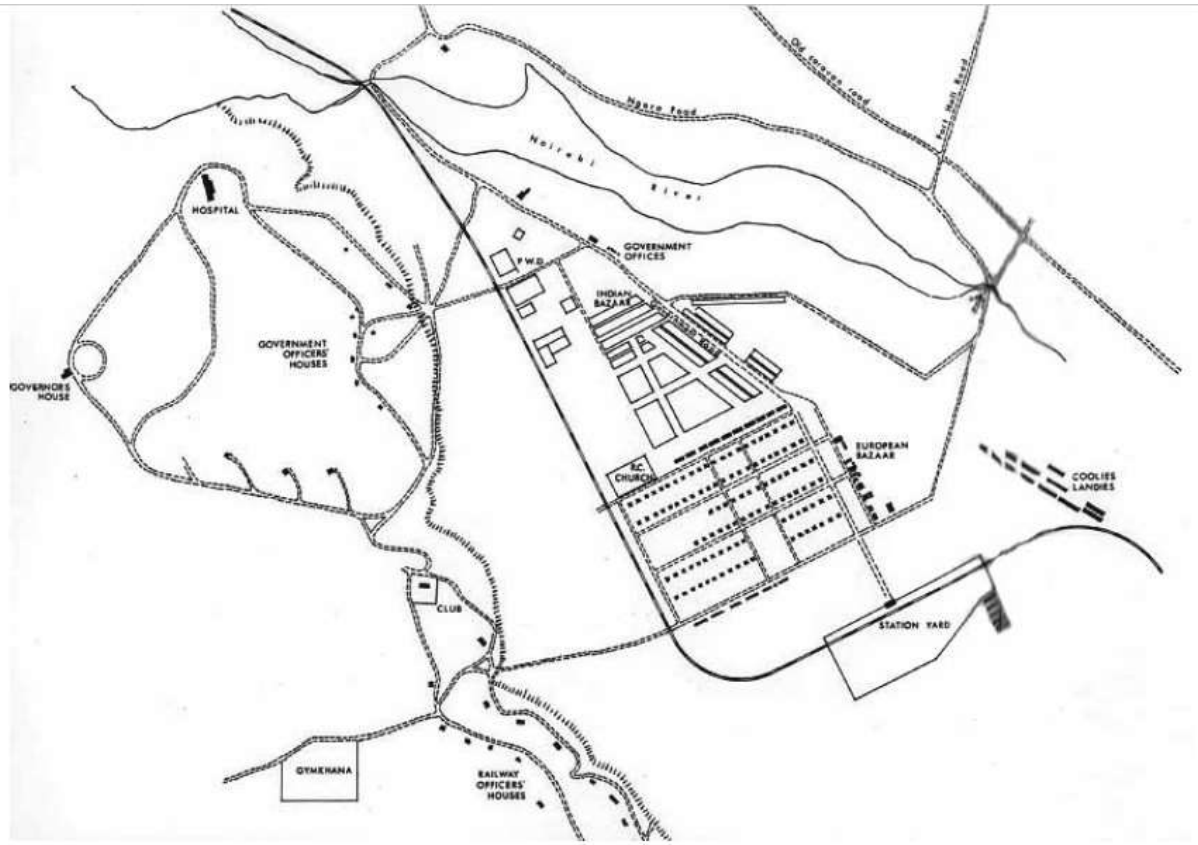
Nairobi is home to approximately 4,174,952 persons as of 2018 (NIUPLAN,2014). According to NIUPLAN, 2014 over 50% of the city's population lives in low income and informal settlements. The majority of these population segments reside in the larger Eastlands area which is served by Jogoo road- Outering road and Juja road circuit. Jogoo road-Landhies road serves immediate residential areas such as Shauri Moyo, Bahati, Ofafa, Jericho, Maringo, Uhuru, Lumumba Kaloleni, Makongeni, and Mbotela.

Other residential areas served by the corridor include Buruburu, Donholm, Fedha, Kairobangi south, Dandora, Kayole, Umoja, Komarock among many others. It is this target population that utilises the corridor in accessing the CBD.

3.6. Urban Planning in Nairobi

Nairobi's first plan was drawn during its establishment as a rail depot around 1898-1899. The plan was drawn by an assistant engineer Fredrick Church who was an assistant to George Whitehouse. The plan had a railway station, the main street from railhead (Tom Mboya street), Station Road (Moi Avenue) which had 13 commercial plots (NIUPLAN, 2014). Off Victoria street were 10 streets here rail workers houses were built. Upper-grade houses for senior railway officers were located at present-day Railway golf course.

Map 13: 1st Nairobi plan of 1898

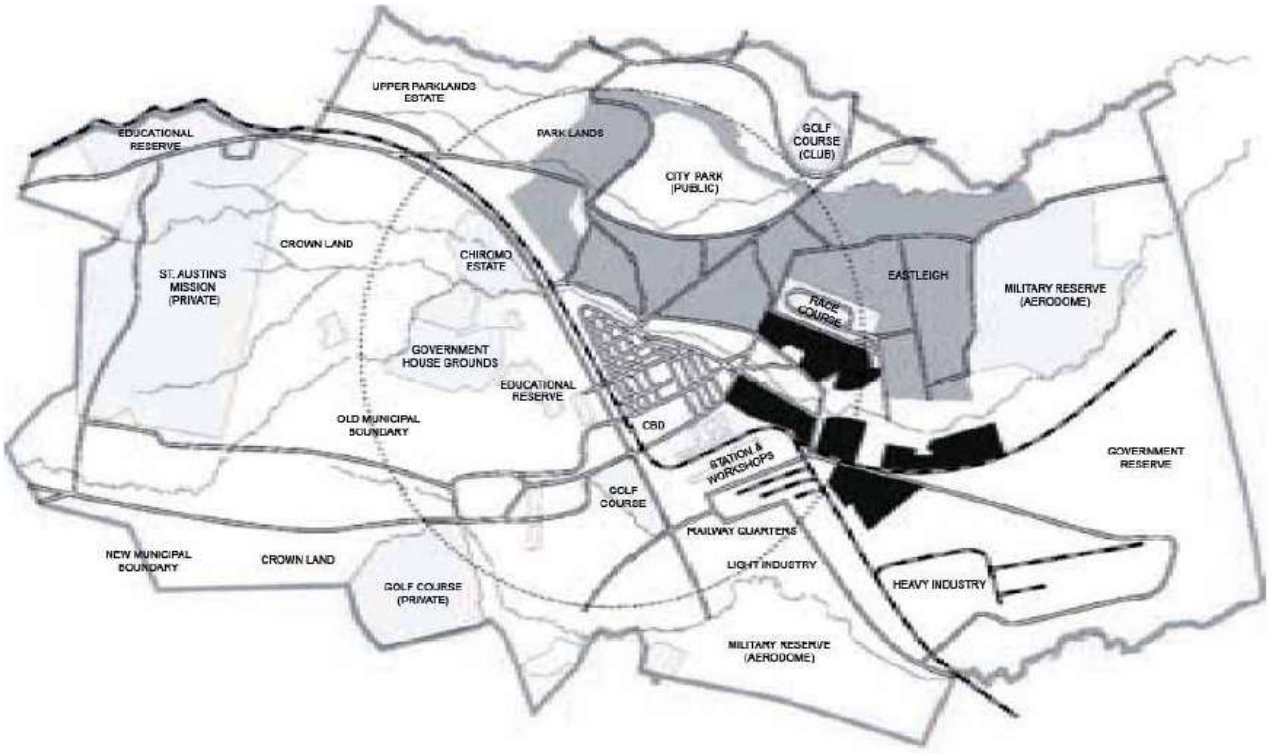


Source: S. Mills, Railway to Nowhere – The Building of the Lunatic Line, Nairobi, 2012

The Plan was approved on 30th November 1898, the Name was changed from Nyrobi to Nairobi.

In 1927, The Settler capital plan was prepared by F Walton James and Eric Dutton. The town boundary was revised to 77 km2 to anticpate future growth and developments. It adrressed the problems of stagnant swamp water, lack of drainange and unregulated densities (NIUPLAN, 2014). It also created racial segregation of residential areas as well as introducing traffic control measures.

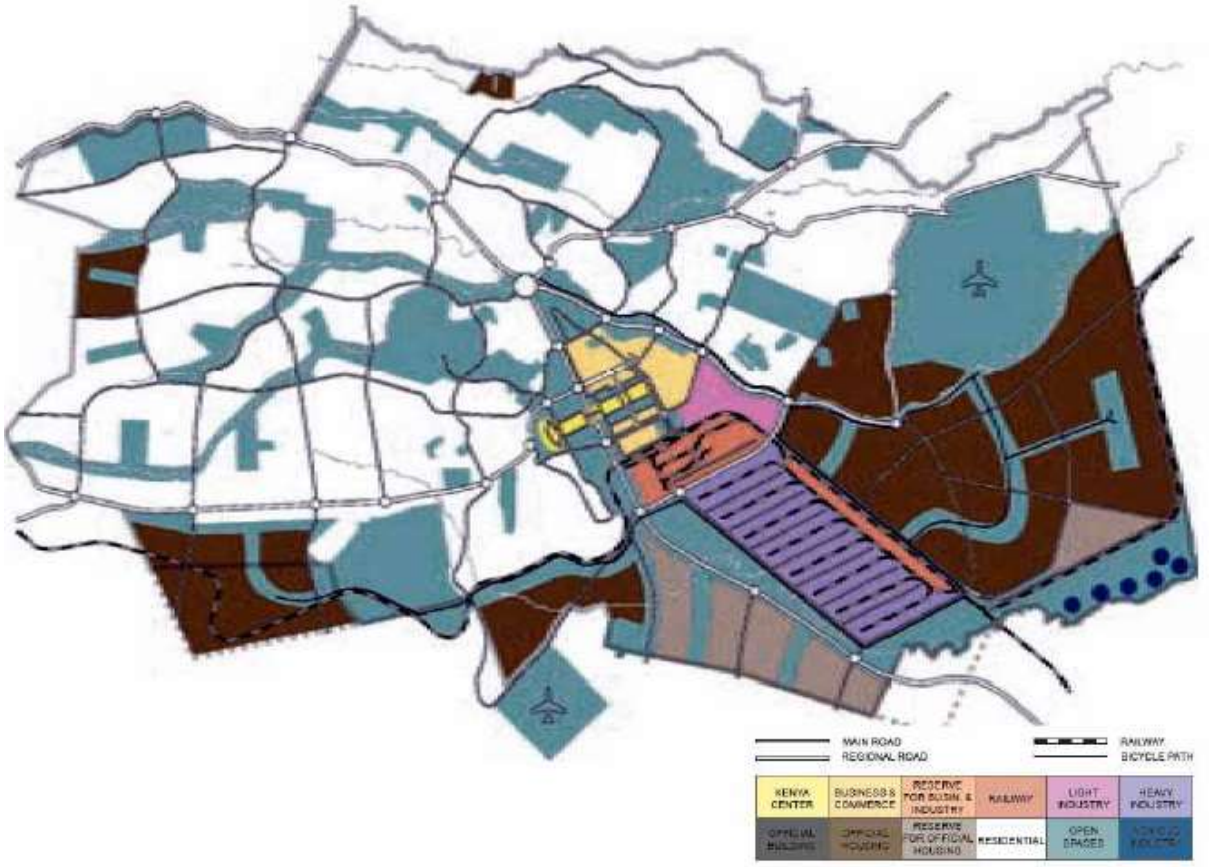
Map 14:Settler Capital Plan of 1927



Source: ETH Studio Basel, History of Urban Planning in Nairobi City, 2008

In 1948, a colonial capital master plan was created. The plan was a zoning plan that designated industrial, commercial, residential, official buildings, staff accomodation, open spaces, parks, and forests. It aimed to establish neighbourhoods, and attract industrial investments. It was financed by the then Municipal Council and Railway Authorities.

Map 15: Master Plan for a Colonial Capital of 1948



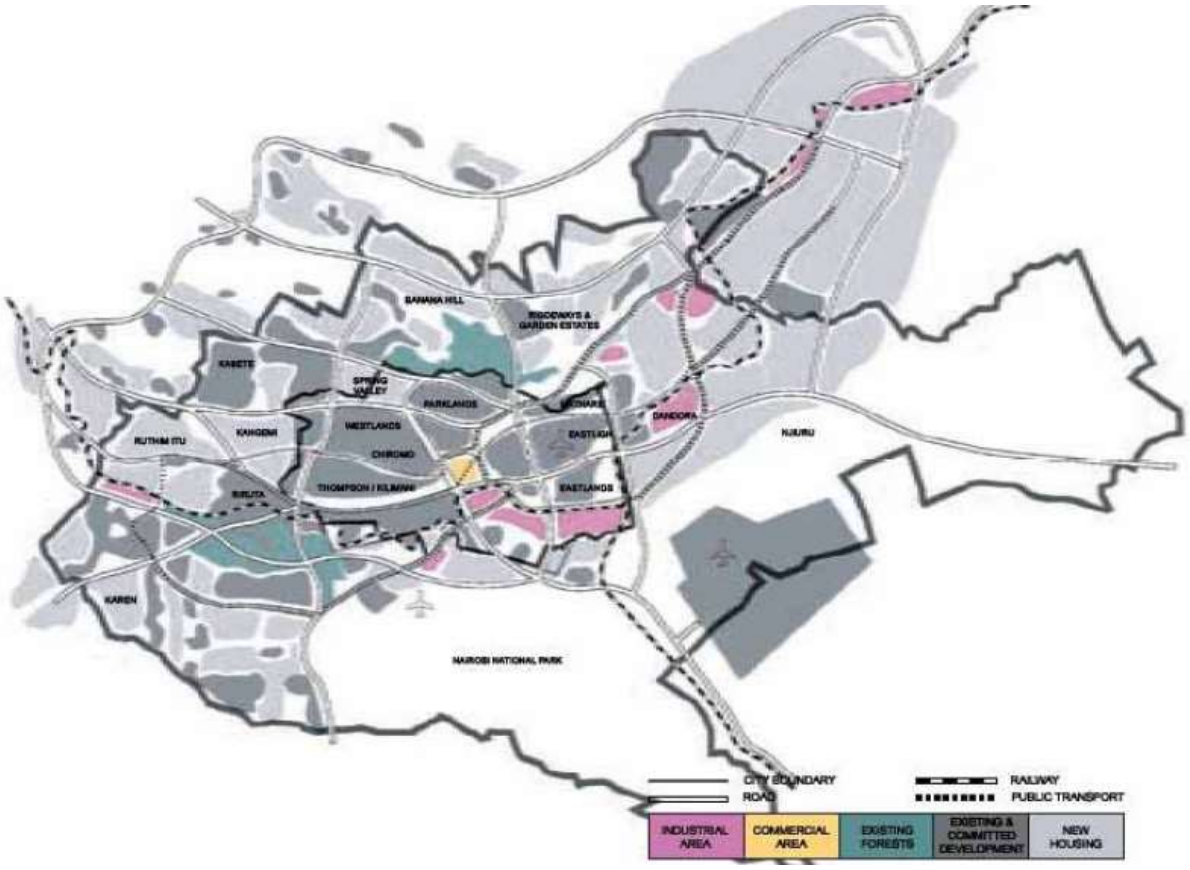
Source: ETH Studio Basel, History of Urban Planning in Nairobi City, 2008

In 1973, the Nairobi Metropolitan Growth Strategy was developed. The plan preparation began in 1971 with the assistance of United Nations experts, City Council professionals, and Consultants. The planning horizon for the Plan was the year 2000 with a projected population of 2.88 million persons. The plan was a long-term policy plan that established areas such as the Central Business District (CBD), industrial area, northern city coffee plantation and estates, Southern parts to be used to house low and medium-income population. Other areas included the Dagoretti area to serves as an employment zone with commercial and residential areas, eastern parts set to serve low to middle-income estates and Karen Langata as middle and high-income estates.

The plan provided development guidelines. It required strengthening and streamlining of Council decision-making and enforcement. Thie measuers were to enable easy plan implementation.

However, the plan did not fully guide development as it was intended. Market forces driven by private sector players led to land speculation and investment in a bid to maximise on profits. Developments were undertaken in complete disregard for the limitation of existing infrastructure, transport, and utilities. This is the case that led to developments towards Eastlands Nairobi which are served by the Landhies Jogoo road corridor.

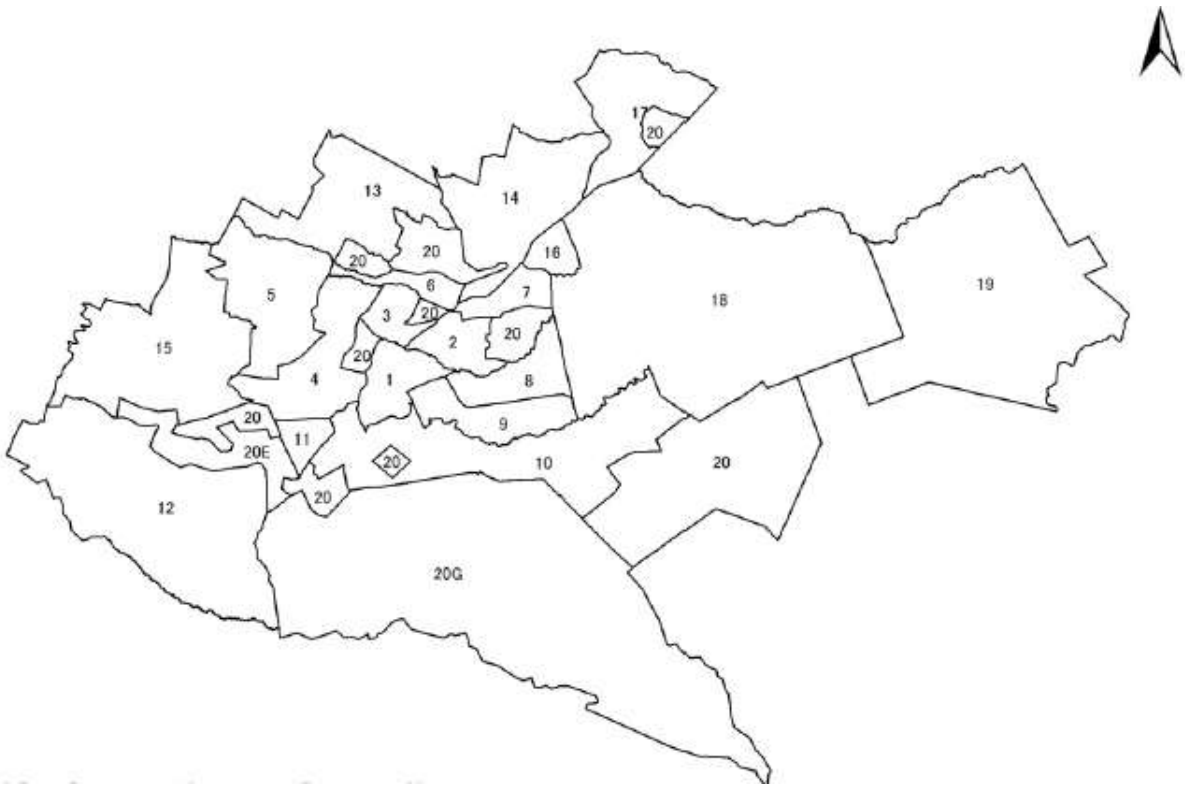
Map 16: Nairobi Metropolitan Growth Strategy Plan of 1973



Source: ETH Studio Basel, History of Urban Planning in Nairobi, 2008

Various Nairobi City Development Ordinances and Zoning ordinances have been prepared over the years. The 1948 master plan designated 20 zones. In 1968, a zoning ordinance was introduced to give guidance on desired use and appropriate land sizes. The Plan is illustrated by map 17 overleaf.

Map 17: Nairobi City Development Ordinances and Zoning ordinance



Source: JICA Study Team (JST)

In 1993, NCC in conjunction with the Physical Planning Department undertook the Upper Hill Rezoning Plan. The plan was informed by an urban transformation in the area towards office developments that required infrastructure improvements. The plan provided the widening and expansion of roads.

In 2004, a review of the zoning ordinance was undertaken. The output was a further subdivision of the initial 20 zones. The plan also proposed ground coverages and plot ratios in addition to minimum plot sizes and land use. In 2012, NCC conducted studies towards the revision of the 2004 zoning ordinance for select zones in line with emerging development trends.

In 2008, the Nairobi Metro 2030 Plan was drafted. In 2013 the Spatial Planning Concept for Nairobi Metropolitan Region (NMR) was prepared as well. Nairobi Metro 2030 is a suport element of the Vision 2030 (NIUPLAN 2014). It aims to optimize he role NMR in national development. The vision of the Metropolitan 2030 is "to be a world-class African metropolis, supportive of the overall national agenda articulated in Kenya Vision 2030".

The Planning Concept was prepared for the metro-region with a target population of 15.1 Million persons by 2030 (Planning Concept, 2013). The plan created a settlement hierarchy of six levels including Regional complex, sub-regional centre, priority town, growth centre, market centre, central village, and basic village.

In conclusion, the city today is a depiction of the success and failures of these planning activities highlighted above. The different plans have had an impact on different land uses distributed within the city and especially in Eastlands Nairobi. This land uses have therefore generated the traffic demand experienced in the City and by extent the study area. The study area as per current Physical planning and development control guidelines lies along Zone 7, a high-density residential area and with proximity to the CBD. The Corridor also serves Zones 8 and 10E which make up Eastlands area.

3.7. Transport System

Nairobi is served by a railway line that operates within limited areas. Nairobi has a dense road network. Previous governments have invested significantly in improving connectivity within the City. These initiatives include road expansions, construction of city bypasses, opening up of link roads, road, and intersection improvements. 2 airports are located within Nairobi, namely Wilson Airport and Jomo Kenyatta International Airport.

The city of Nairobi's transport system experiences various evident challenges including inadequate public transport, long commuter distance, long travel times, unaffordable transport costs compared to low incomes, environmental pollution, inadequate NMT provisions, poor transport network integration.

The travel demand rate for Nairobi is 2.5 trips/person/day (Kingori, 2007). With an average population of approximately 4.2 Million persons, this translates to a travel demand of 10.5 Million trips/day for the city.

Jogoo road- Landhies road is an important part of the Nairobi urban transport system. The provide linkage to vital city services, locations and connectivity to major transport corridors.

3.8. Emerging Issues

The following are deductions made from the background of the study area:

- The Landhies-Jogoo road corridor plays a critical role in the regional and sub-regional connectivity of the city. It links parts of Machakos, Kajiado and Kiambu Counties. Such as Tala-Kangundo area, Utawala-Eastern By-pass, Mlolongo-Athi River-Kitengela areas, and Thika Road-Ruiru Areas.
- The corridor serves a broader residential area. It is a conduit that links the larger Eastlands of Nairobi City to the CBD.
- There have been attempts to bring order in the growth and expansion of Nairobi city. These have been done through various master plans and supporting policies. All the above attempts have not adequately addressed traffic congestion and urban mobility.
- Landhies-Jogoo Road is part of the designated BRT corridors within the city. If the proposed policy is implemented, decongestion will be actualized.

CHAPTER FOUR: RESEARCH DESIGN AND METHODOLOGY

This chapter describes the methods and research design framework on how the study addressed the formulated research objectives and subsequently the questions. The section briefly describes the research study area, data sources and software requirements, sampling procedures employed, methods and a synopsis flowchart of the workflow. It concludes with a research design matrix of specific data needs, methods and expected output per research objective.

4.1. Overall Research Methods

A combination of quantitative and qualitative methods were employed. Research instruments were developed to relate to the research questions as illustrated in Table 7. The study employed a cross-sectional study design that comprises survey research (Bryman, 2012). The survey was based on data collected primarily by questionnaires and structured interviews of sample cases drawn from a wider population.

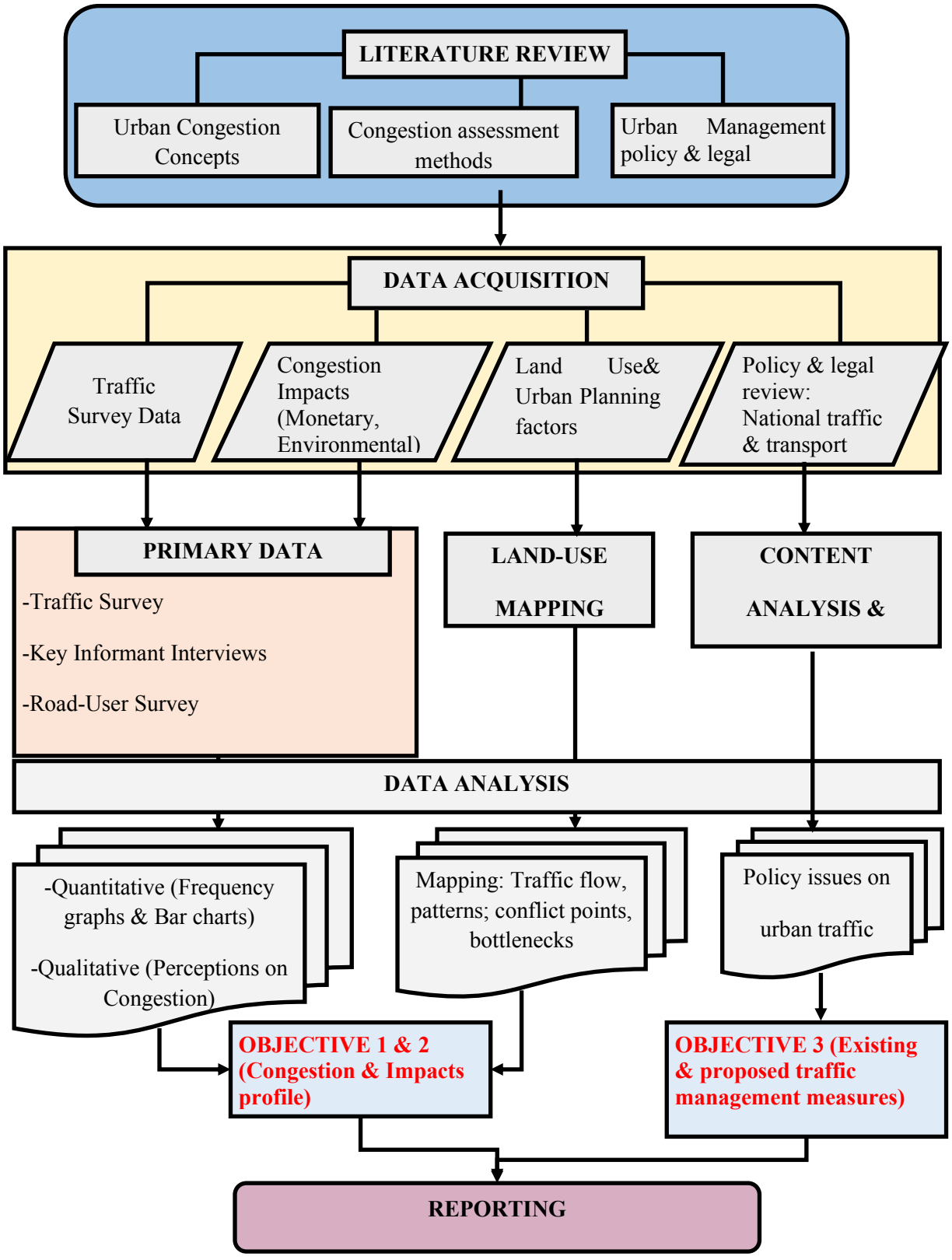
Quantitative and qualitative data were collected in connection with several variables examined to detect patterns of association (Bryman, 2012); (Kothari, Kumar, & Uusitalo, 2014). Thus, for this study, this approach used determined nature and related impacts of urban traffic congestion as well as evaluating the existing traffic management strategies and their operationalization. The approach combined a case study approach in which the research investigates the Landhies-Jogoo Road Corridor in Nairobi City as an illustration in which this phenomenon occurs.

Table 8: Overall Research Strategy

Objective	Questions	Method	Data Collection	Data Analysis
Objective 1: Nature and extent of traffic Congestion	• Causes of traffic congestion • Modes of transport affected by congestion *(Taxi, Rickshaws, "Boda Boda" Motorcycle", personal and public transport vehicles)* • Occurrence of congestion *(time, predictability)* • Location of congestion • Level of congestion (*speed, flow, queue length, duration)* for both traffic flow and road user • Negative impacts *(time, monetary, opportunity, environmental, land uses)*	Mixed	• Transport Survey • Semi-structured interviews (*Road user. Operators, regulators and users survey)* • Key Informant Interviews (KII) • Mapping • Interviews *(frequent road users)* • Transport Survey- NIUPLAN Document review • Semi-structured interviews	• Content and Descriptive analysis • Spatial analysis
Objective 2: Existing traffic management strategies and their operationalization	-Current traffic management measures -Shortcomings of the existing strategies -Proposed traffic management measures -Key actors of management measures	Qualitative and Quantitative	• Policy and legal framework review • Key Informant Interviews (KII)	• Content/Thematic analysis
Objective 3: Recommend policy framework for effective traffic management	-Improvement measures for more effective existing strategies -Necessary actors to mitigate traffic congestion -Possible institutional arrangement to address Congestion	Qualitative and Quantitative	• Policy and legal framework review	• Content/Thematic analysis

The *figure10* below illustrates the overall methodological research framework. It details the steps taken to achieve the research objectives and respond to the research questions.

Figure 10: Research design



4.2. Data Source and Tools

Primary and secondary data was collected to provide both first hand and second-hand information.

4.2.1. Transport Survey

a) Photography

Photography formed a major part of data collection methods. Digital cameras were used to capture relevant real-life traffic congestion types, causes, and impacts where possible. Photography was used for observation of actual transport situations.

b) Videography

Videography was used to capture traffic-flow patterns, bottlenecks and opportunity locations for improvement. This data was used for problem modelling and analysis purposes.

c) Document review on Traffic Survey data

The study reviewed the Traffic survey data generated from the NIUPLAN traffic counts. The NIUPLAN traffic survey adequately captured the modal splits, traffic volumes and traffic constrain among other variables which informed this study adequately.

Analysis and inferences will be drawn from the raw NIUPLAN data.

d) Road User Survey

A combination of both open-ended questions and closed-ended questions were included in four road-user questionnaires. In addition to the literature review, field data collection was done to collect qualitative and quantitative data on causes of traffic, levels of congestion and impacts of this congestion. The data collected was used for statistical analysis through the coding of responses. This was quantified by indicating the frequency of occurrence to determine traffic congestion prevalence. Content analysis was undertaken to postulate emerging issues about causes of congestion, levels, impacts and bottlenecks based on road-user perceptions and experiences.

3.3.2 Satellite Imagery

The study focused on remote sensed urban imagery to capture the locational and contextual issues of traffic congestion in the Landhies Road-Jogoo Road area. The images used for spatial analysis of traffic bottlenecks as well as an assessment of land use compatibility or incompatibility varied in situations.

3.3.3 Key Informant Interviews

Also known as expert sampling, a total of 33 no. KII were carried out. This comprised 1no.Traffic commandant, 30 no. Transport Operators Sacco, 1 no. Market Enforcement officer from the Nairobi City County (NCC), 1no. Road Engineer department officer NCC.

With their consent and full understanding of the usage of data and research outcomes, their knowledge provided insight and experience in matters related to traffic congestion and its management in an urban context and particularly on the Landhies Road- Jogoo Road. Table 8 provides a rationale for stakeholder choice and their contribution to the project.

Table 9: Rationale for Stakeholder choice and data to be acquired

Who?	**Why/What?**	**How? -Qualitative Method**
Traffic Commandant	-Profile congestion by causes, level, and location of traffic congestion -Traffic management measures existing and proposed -What are the existing policy and legal frameworks on traffic management and what are the limitations?	-Key Informant Interviews (KII) - Mapping
Transport Operators Sacco (Matatu)	-Causes and location of congestion -Occurrence of congestion -Costs and impacts of congestion on their business -Efficacy or not of the existing traffic management strategies	- Transport Survey -Key Informant Interviews (KII) - Mapping
NCC Roads Department engineer	-Causes and state of congestion -History of the study area -Institutional challenges on Traffic management -Plan and proposed traffic management strategies	-Policy and legal framework review -Key Informant Interviews (KII)
NCC Market Enforcement Officer	-Improvement measures for more effective congestion management strategies What are the existing legal guidelines on addressing traffic management and what is the level of efficacy	-Policy and legal framework review -Key Informant Interviews (KII)

3.3.4 Policy and Legal Framework

Relevant policy and legal frameworks were reviewed to identify existing and proposed traffic management strategies. Some of these include Vision 2030, Constitution of Kenya of 2010, Traffic Act Cap 403, Nairobi Integrated Urban Development Master Plan (NIUPLAN), National Transport and Safety Act of 2012, Traffic Amendment Bill (No. 32 of 2014) and Traffic (Amendment) Rules (2004) among others.

4.3. Ethical Considerations

The research endeavors were ethically conscious. Informed consent from all affected research stakeholders was sought from the onset and throughout the project. Respondents were informed about the nature of the project, outcomes, and usage of the data availed. Confidentially was guaranteed as well as respondents' expectations were managed.

4.4. Data Matrix

The data matrix (Table 9) gives an overview of the sequence of the research including methods to be carried out and the required data for analysis as per the data needs of the specific research objectives and questions.

Table 10: Summary of Data Needs Based on Research Objectives

Objective	Questions	Data Needs	Data Sources	Data Collection Method	Analysis	Expected Outcome
Objective 1: To determine the nature and extent of traffic congestion along Landhies-Jogoo roads.	• What causes traffic congestion • What modes of transport are affected by congestion? • When and where does congestion occur? (place, time, predictability) • How much congestion is experienced? (speed, flow, queue length, duration) • What are the negative impacts of congestion? (time, monetary, opportunity, environmental, land uses)	• Drivers/triggers of congestion • Traffic Demand per given lane/ highway per unit time • Travel times • Land-use mapping of surrounding activities	-Traffic Survey -Key Informants: a. NCC enforcement officers b. Transport Operators (Matatu, Boda Boda) c. Traffic commandant -Literature Review -Satellite Imagery	Mixed-Method • Transport Survey- Cordon and screen line survey • Semi-structured interviews (Road user. Operators, regulators and users survey) • Key Informant Interviews (KII) • Mapping • Interviews (frequent road users) • Observation • Photography/ Videography • Spatial data collection	• Content and Descriptive analysis • Spatial analysis • Thematic/Content and Descriptive analysis	• Characterization of congestion by mode of transport, location, causes, type, level, and frequency • Congestion impacts based on trigger and drivers of congestion • Map of incompatible land uses that are driver congestion
Objective 2: To evaluate existing traffic management strategies and their operationalisation	-What traffic management measures are employed? -What are the shortcoming of existing strategies? -What traffic management measures are proposed? -Who is responsible for traffic management?	• Existing traffic management practices • Currently proposed traffic management measures • Key actors of traffic management	-Key Informants: a. NCC enforcement officers b. Transport Operators (Matatu, Boda Boda) c. Traffic commandant -Literature review -Note-taking	Qualitative • Policy and legal framework review • Key Informant Interviews (KII)	• Content/Thematic analysis	• Current traffic management measures on Landhies-Jogoo Road • Currently proposed traffic management measures • Key actors of traffic management
Objective 3: To propose a policy framework for effective traffic management	-How can existing strategies be made more effective -What improvement measures are required? -Which actors are necessary to mitigate traffic congestion? -Are Institutional arrangement adequate to address congestion	**Analysis based on Data collection** • Gaps for improvement • Required actors in traffic management • Necessary Institutional review on traffic management	-Key Informants -Literature Review	• Policy and legal framework review • Key Informant Interviews (KII)		• Proposed traffic management improvement measures • Proposed institutional framework on Traffic management • Proposed Policy framework for effective traffic management

4.5. Training and Pilot Testing

Enumerators were identified after consultation with the Nairobi City County Engineer. The selection criteria included previous experience in transport surveys and related studies. The enumerators underwent a half-day session. This training included:

1) The entire scope and content of the study

2) handling of data collection tools for both user surveys and operators.

After training, the questionnaires were pilot-tested using a small number of respondents (4-transport operators and 3-users). The pilot tests revealed some unforeseen challenges on the questionnaires. This included issues related to question-wording, instructions, perspectives and understandings. The pilot testing enabled refinement of the tools to be more responsive.

4.6. Sampling Plan

The study purposively sampled the Jogoo -Landhies road corridor as a case study into the CBD. It is representative of the other major corridors into the CBD which similarly experience high traffic congestion. The average number of vehicles moving along the route is 6234 per day.

With a sample population greater than 10,000 per day, the sample size was determined as follows. This method has been applied in various transport-related studies by authors such as (Haregewoin, 2010).

$$n = \frac{z^2 * p*q}{d^2}$$

Where:

Z= standard normal variable at required level of confidence
p= proportion in the target population to have characteristics being measured
q= 1-p (opposite of p above)
d= Sample error

Therefore, for purposes of this study:

Desired Level of confidence is 90% (z value is 1.645)

p= 0.5
q= (1-0.5) = 0.5
d= 5%

Hence

$$n = \frac{(1.645)^2 (0.5) (0.5)}{(0.05)^2}$$

n=270 individual's respondents.

A sample size of 270 respondents was selected. This sample size was distributed among different clusters through Stratified Sampling. The clusters were defined based on the road user categories who include Public transport, Pedestrians and private car motorists. Public transport respondents were divided among transport operators (drivers and conductors), and commuters.

Below is a distribution of the different categories:

	Sampling unit	**Sample size**	**Percentage**
Public transport	Sacco Managers	30	11
	Public Operators	60	22
	Commuters	80	29
Pedestrian	Pedestrians	75	27
Private Car	Private Cars	30	11
	TOTALS	**275**	**100**

The validity of the data was assured by applying a purposive non-probability sampling technique targeting the major operators and road users along the corridor of study. Public transport users were at 62 % cumulatively representing all Commuters in the City, 27% representing pedestrian travel and 11% representing private motorists. Private motorist questionnaires were the most difficult to administer, followed by pedestrians.

Additionally, Key informant interviews were conducted targeting Traffic Police Commandant at Kamukunji police station, Market Enforcement officer, NCC and the office of Director of Roads and Infrastructure, NCC.

4.7. Data Collection

Both qualitative and quantitative methods were used. This included the administration of Structured questionnaires and key informant interviews. Non-participant field observations over different days of the week were used. The observation was guided by checklists as well as photography for recording.

4.8. Data entry, Cleaning and Editing Procedures

Data collected was coded and keyed into Statistical Package for Social Sciences(SPSS) IBM statistics version 24 and Excel data. The data was then cleaned and edited to minimise error in analysis and enhance overall output.

4.9. Data Analysis

An inductive approach to data analysis was utilised. This is where the results were directly derived from specific data and used to obtain a broader understanding of particular phenomena (Lichtman, 2014). The anaylisis for this study included quantitative and qualitative methods.

Quantitative data analysis which was the bulk of the data analysis was undertaken on the SPSS and Microsoft Excel data processing platforms. SPSS analysis generated frequencies and cross-tabulations.

Maps and photo images were used to illustrate problem areas, constrains and other data. The in-depth interviews, reviews of policies and regulations detailing transport and congestion were analysed and organized as well. The findings were interpreted and synthesized to inform the research documentation.

4.10. Data Presentation

The synthesized information was presented in standard format such as frequency tables, comparative tables, scanned sketches, charts, and graphs. These data presentation form part of the research report.

CHAPTER FIVE: RESEARCH FINDINGS AND ANALYSIS

5.1. Overview

This chapter reflects the statistical findings and analysis on managing urban traffic congestion Landhies-Jogoo road corridor. The field survey was carried out to assess the traffic congestion inbound to the CBD.

The study sought to examine traffic congestion experienced by Public Transport Operators (drivers and touts), public transport commuters, pedestrians and private car users. Further information was obtained from transport Sacco management and traffic management authorities through administering questionnaires and conducting interview schedules. The questionnaires were in the form of both open and close-ended.

The findings were an indicator of the challenges of traffic congestion. Jogoo road being a primary access road and the most affected providing access to the people residing from the high-density residential areas of Eastland's area commonly known as "Nairobi's dormitory".

The data analysis was classified into different sections related to the theme of the study which are the nature, impacts, emerging issues of traffic congestion and strategies towards urban traffic management.

5.2. Nature of traffic Congestion along Landhies-Jogoo Road stretch

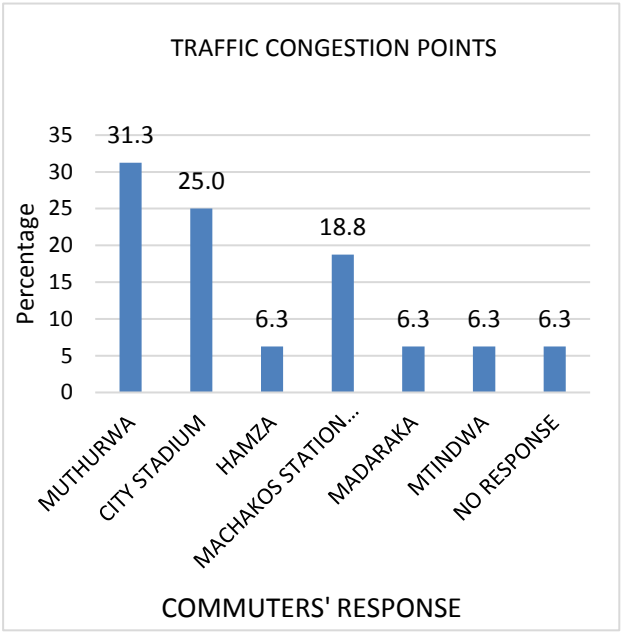
5.2.1. Location and causes of traffic congestion

In an attempt to understand the location and causes of traffic congestion, the administered questionnaires set out to highlight the points of conflict and bottleneck zones along the corridor. The road impedance index is derived from comparing uninterrupted basic travel time against delayed travel time due to traffic. The traffic impedance hotspots have been identified with corresponding impedance factors (traffic pressure loads). The road impedance is 90 minutes against a basic travel time of 30minutes. Expressed as a ratio it is 3:1 index. This is generated from figures 14 and 15 further below.

According to commuters, traffic congestion occurs at Muthurwa area, City stadium area, Machakos country bus station, and Makadara hamza areas. Muthurwa, City stadium, and Machakos country bus areas are the most prevalent congestion areas with statistics of 31.3%, 25%, and 18.8 % respectively. According to transport operators, the highest points of traffic congestion are City stadium (38.5%), Landhies road stretch (19.2%) and Muthurwa roundabout (15.4%). The analysis of figures 11 (a and b) below of this indicates that the

highest amount of traffic congestion is experienced along Landhies road up to Muthurwa market area. This was indeed validated by findings from the field observation exercise.

Figure 11: Traffic congestion points



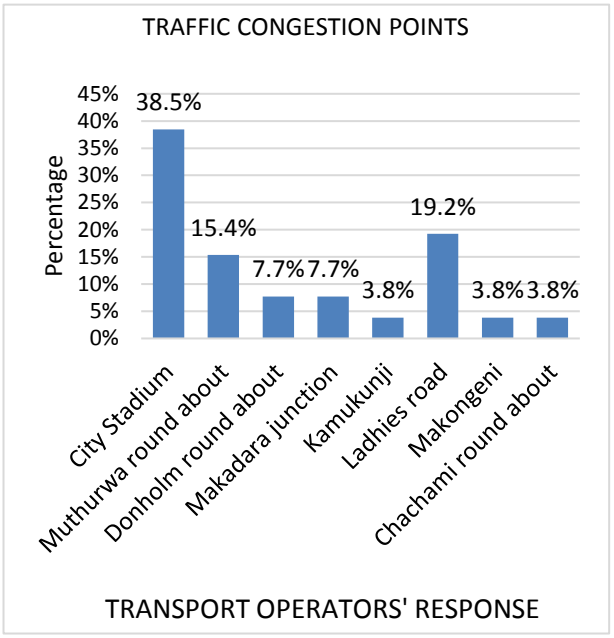


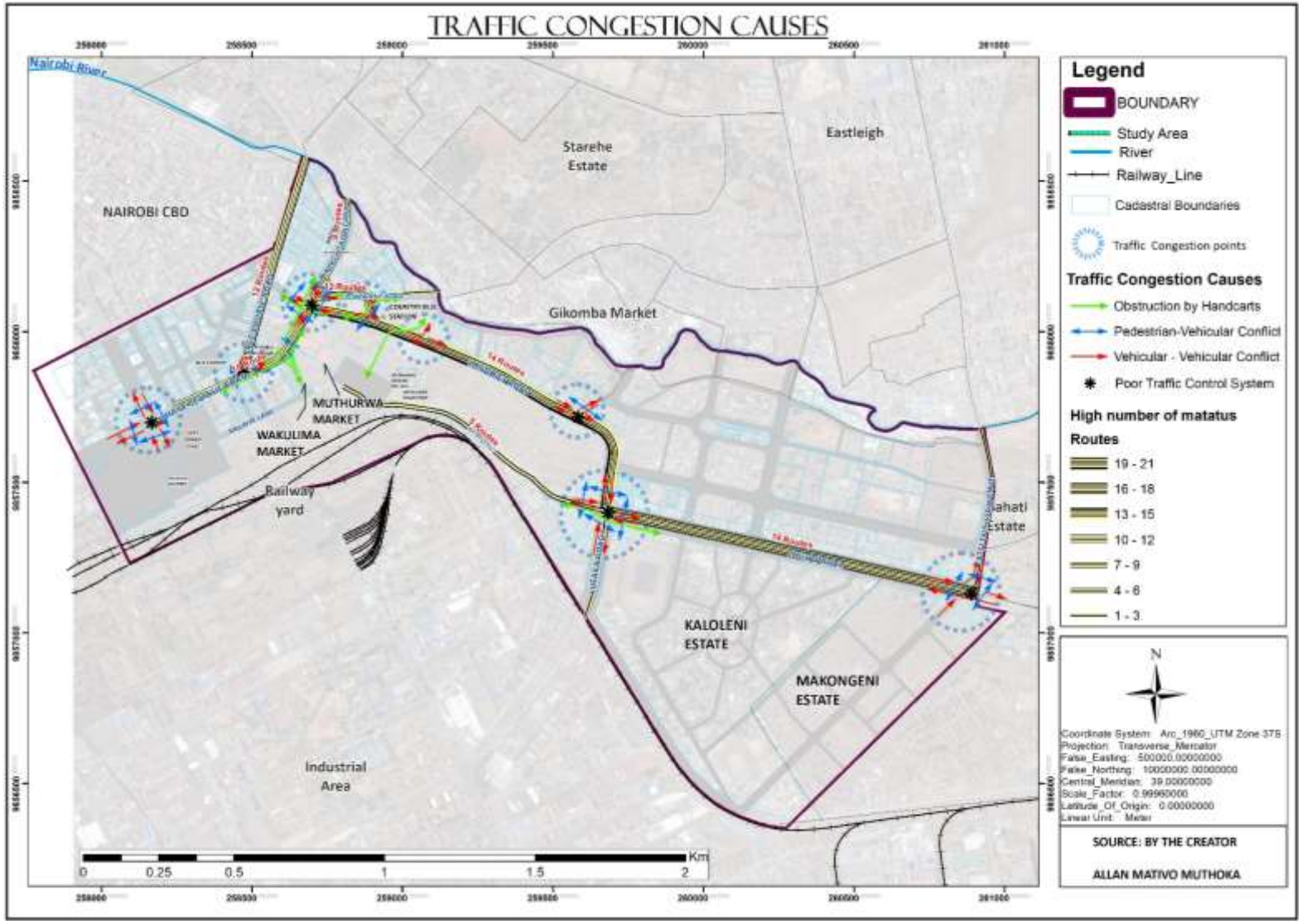
Plate 4: **Traffic Congestion along Jogoo Rd** (Top Left)

Plate 5:Traffic Congestion at Muthurwa Market area (Top right)

Plate 6: Traffic Congestion along Landhies road into CBD (Left)

Plate 7: Traffic Congestion at Haile Selassie Rd (Right)

Map 18: Spatial Depiction of Congestion Bottlenecks and Congestion Causes



Source: Authors Own

The main causes of traffic congestion vary according to the locations as established during the study. At the city stadium, traffic congestion is caused by a high number of both public and private vehicles. Jogoo Road is a four-lane road that is feeding into Landhies Road a three-lane road. Additional traffic from Lusaka road towards Landhies road increases the demand for road infrastructure resulting in snarl-ups. The ideal number of lanes ought to be four.

At Muthurwa roundabout area, traffic congestion is due to obstruction by trolleys and handcarts crossing Landhies road. This section also experiences traffic congestion due to obstruction by public vehicles dropping passengers before the zebra crossing and at un-designated points. Cases of pedestrians crossing the busy Landhies road and walking on the road reserve are common despite the existence of a footbridge in the area.

Muthurwa market traffic congestion is also caused by activities emanating from the operations of the Wakulima market. According to the NCC Roads, the engineer Wakulima market was originally designated as a wholesale market. However, over the years the market operates as a wholesale and retail market. This led to an increase in the number of traders as well as suppliers. This has led to inadequate space and congestion around the market. This congestion is a critical factor in congestion around the area.

According to commuters, a high number of private cars (40%), a high number of matatus (24%) and poor traffic control systems (16%) were perceived as the main causes of traffic congestion. According to Public transport operators, a high number of private cars (46.2%), a high number of matatus (19.2%) and poor traffic control systems (15.4%) were also perceived as the main causes of traffic congestion in the same order. According to the Public transport SACCO managers, the 3 main causes of traffic congestion were a high number of private cars (27.3%), poor traffic control systems (13.6%) and obstruction by handcarts/trolleys (13.6%).

Analysis of these responses indicates that high private car use does significantly contribute to traffic congestion along the corridor. On Landhies road private vehicles along the route account for 61% which is approximately 10,982 vehicles against a total of 17,757 vehicles daily. On Jogoo road, private vehicles along the route account for 58% which is approximately 9,471 against a total of 16,686 vehicles daily (NaMSIP Urban Renewal, 2017).

Other causes of congestion from the analysis include the high number of matatus, poor traffic control systems. However, from the observation the high private car and matatus use is one of the considerations but not the main issue contributing to traffic congestion on the route. The main issue is the impact of surrounding land uses and activities. This can be illustrated by plates.

Figure 12: Causes of Traffic Congestion

Fig 12 a

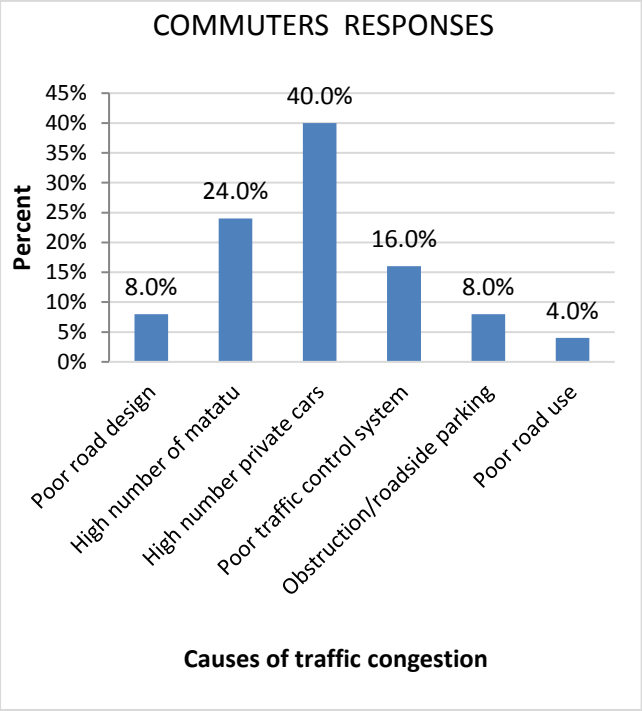
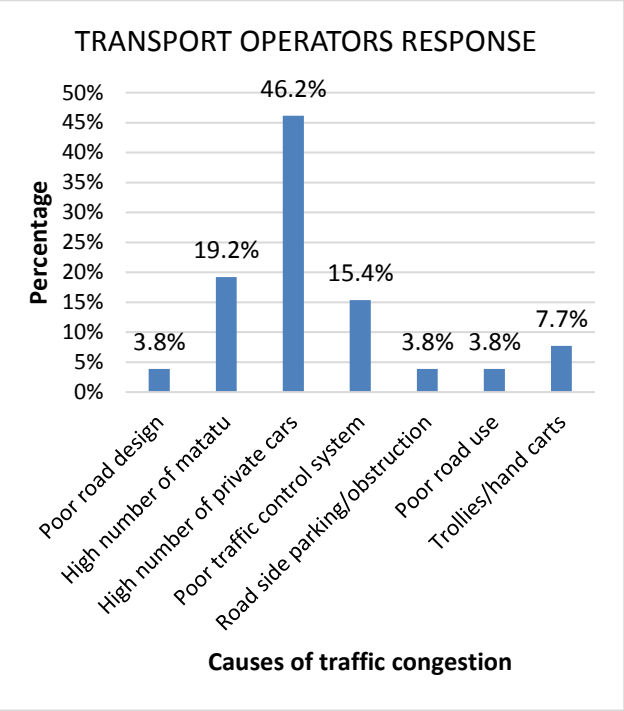


Fig 12 b



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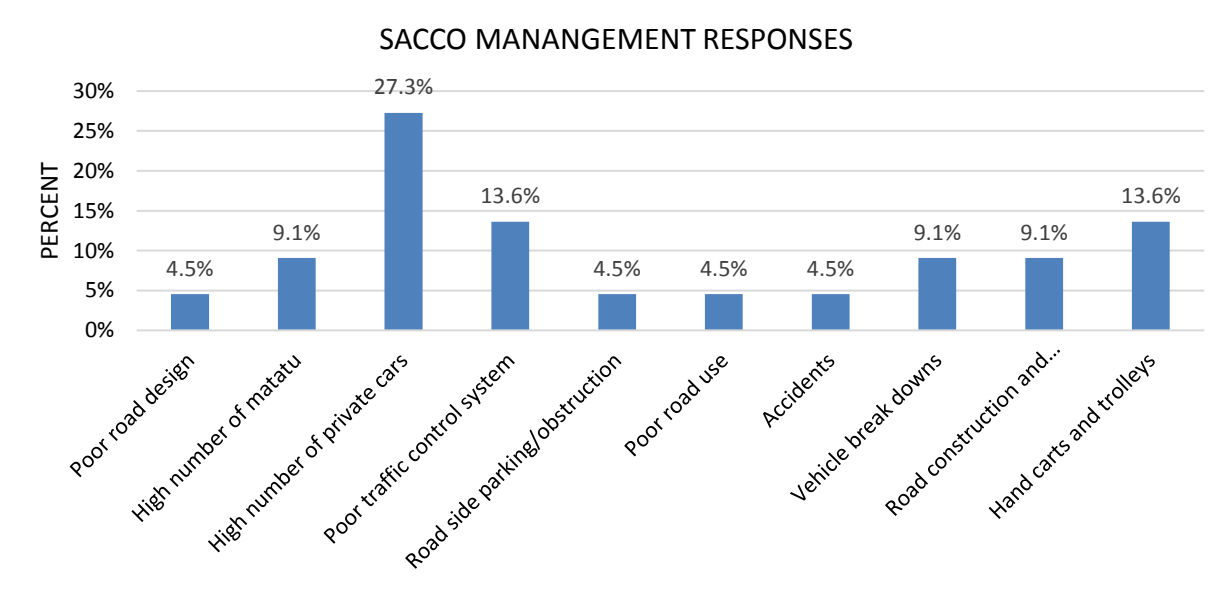


Causes of congestion plates

Plate 8: Hand Carts Obstructing vehicles

Hand carts are a major cause of congestion as they obstruct vehicles. These leads to slow movement speeds as well as dead stop traffic

Plate 9:Illegal picking of passengers at undesignated points

Illegal dropping and picking of passengers by public transport operators, as shown above in Plate 9, leads to disruption in vehicular movement. Handcarts also further complicate matters as they use road reserves whilst moving on opposite directions. Use of hand carts on road

reserves, handcarts road crossing at undesignated areas obstructs free vehicular movement leading to unnecessary congestion.

Plate 11: Irregular Pedestrian crossing, Hand cart and Trolley obstruction

Plate 10: Road side parking and Illegal off loadings

Plate 12: Vehicular traffic at a roundabout with dysfunctional traffic lights

Plate 14:3 Lanes at Beginning Landhies rd. inbound

Plate 15:2 lanes on Landhies Rd after Sakwa rd. Junction

Plate 13: Only 1 of 3 functional lanes along Haile Selassie rd., Wakulima market

These images illustrate poor road design as one travels from Jogoo road to the CBD through Landhies road. At the Beginning of Landhies road after City stadium roundabout the road has 3 lanes (*illustrated by Plate 13*), which reduces to 2 lanes at the junction of Landhies road and Sakwa road (*illustrated by Plate 14*). Landhies road feeds into the 3 lane Haile Selassie road fronting Wakulima market. However, during peak and off-peak hours, only 1 lane is active due to obstruction by hand carts, illegal parking of delivery trucks and hawkers (*illustrated by Plate 15*).

Traffic obstruction by public transport operators, hand carts, pedestrians, delivery trucks and at times private motorists represent road user attitude problems. Various road users will fail to observe traffic rules greatly inconveniencing other road users. Other common road use misbehaviour includes overlapping in traffic, aggressive driving, obstructing and failure to give way at road junctions. These behaviours can be related to poor initial road use training, lack of constant driving and road use training and lack of discipline among others.

5.2.2. Modes of transport affected by congestion

Traffic congestion affects virtually all modes of transport. Public and private vehicles are affected by traffic congestion as they are stuck in long queues of snarl-ups.

Regarding motorised transport, the affected modes are private cars, 14-seater matatus, minibuses, buses, light, and medium goods vehicles and heavy goods vehicles. Private cars constitute 61%, followed by Public transport vehicles at 28% and Commercial vehicles at 11% in the modal split (NaMsip Urban renewal, 2017).

Figure 13: Modal Split on Jogoo Road

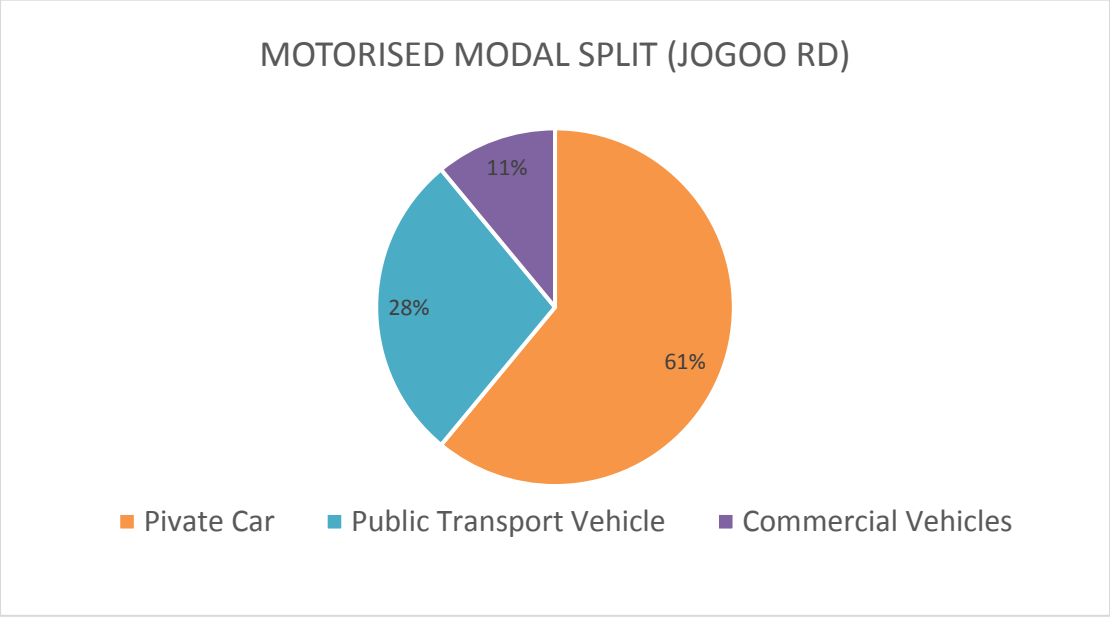


Table 11 below illustrates a full day traffic count for Vehicles moving along Jogoo road towards city stadium roundabout and Landhies road towards Muthurwa roundabout.

Table 11: Traffic Counts Statistics

FULL DAY TRAFFIC COUNT (5.45 AM-8.00 PM)							
Direction of movement	**CARS**	**MATATUS (<14)**	**MINIBUSES (14-33)**	**BUSES (>33)**	**LGV/MGV**	**HGV**	**TOTAL**
Jogoo road to Round about	9,471	1,351	3,274	1,618	736	236	**16,686**
Landhies road to round about	10,982	1,070	2,956	879	1,651	219	**17,757**

Source: Modified from Traffic Count Data, NaMSIP Urban Renewal, 2017.

From the table above the majority of the traffic from Jogoo road gets its way to Landhies road. The Jogoo road roundabout has a total of possible exists (Lusaka road, Factory road, Landhies road, and Jogoo road). Landhies road has a higher daily traffic volume than Jogoo road at 17,757 against 16,686.

Public transport vehicles operating on Jogoo and Landhies roads are approx.6243 and 4905 respectively. They represent 37% and 28% of total vehicles on these routes. Private vehicles represent 58% and 61% on Jogoo and Landhies roads respectively.

Pedestrians are affected by traffic congestion since matatus and motorcyclists tend to drive along the pedestrian walkway as a means to overcome traffic. Although this practice is illegal, these motorists do this. This brings about pedestrian vehicular conflict and sometimes poses as a risk to pedestrians. The poor state of pedestrian walkways encourages pedestrian usage of road reserves as depicted in Plate 18 below.

Cyclists who are part of non- motorized transport are affected by traffic congestion. This is because there are no designated cycling lanes, making it difficult for them to manoeuvre through traffic. This leaves them competing for pedestrian walkways with other modes of transport. The lack of cycling lanes also exposes them to the risk of accidents.

Hand cart and trolley operators are affected by traffic congestion. These operators have no designated road reserves for them. Ordinarily, they operate from the vehicle carriageways. During traffic congestion hours these operators take over pedestrian walkways thereby disenfranchising other road users.

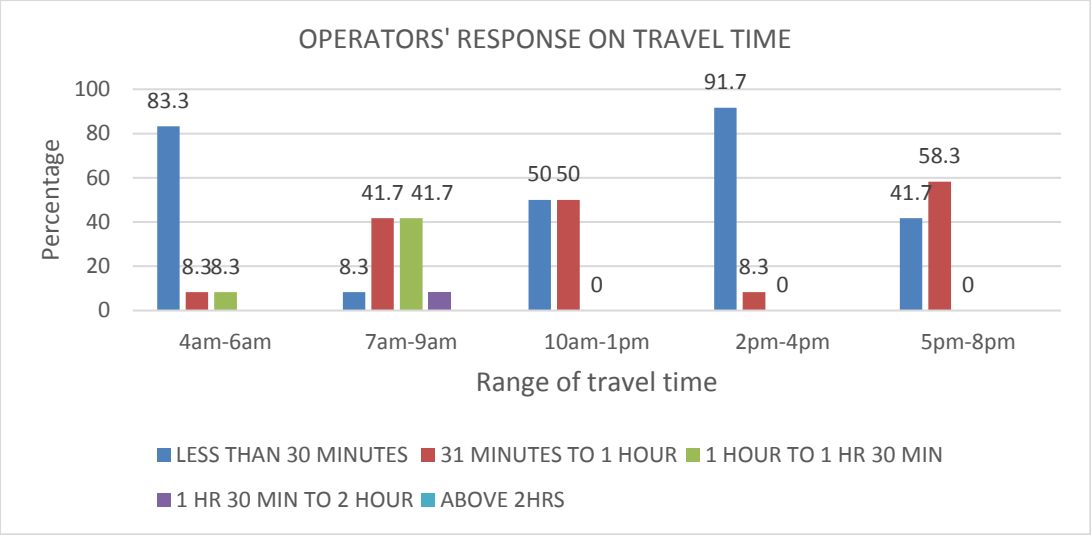
Plate 16: cyclists along Landhies road trying cycling through traffic

Plate 17:Poor state of pedestrian walk ways

5.2.3. Congestion predictability-

The study evaluated the occurrence and predictability of traffic congestion as experienced along Jogoo road- Landhies road. According to the study findings, 83.3% of the operators acknowledged that there's no traffic congestion during the morning off-peak between (4 am and 6 am) along the route. Similarly, 91.7% of the respondents acknowledge no traffic congestion during the afternoon off-peak period. 82% of the respondents acknowledge traffic congestion in the morning peak between (7 am and 9 am) and 58.3 % acknowledge traffic in the evening peak (5 pm-8 pm).

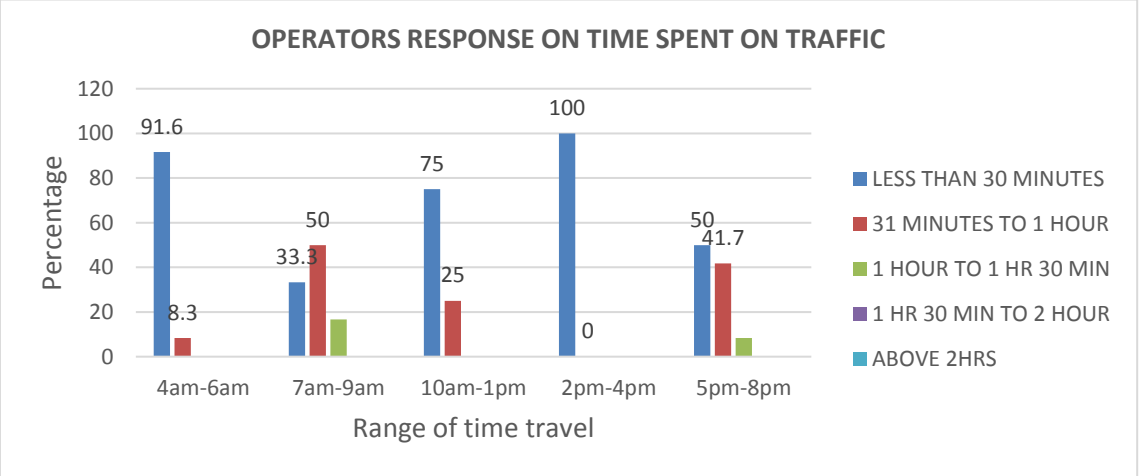
Figure 14: Illustration of Time of Travel



The study further indicates that the Morning peak (7 am-9 am) and evening peak (5 pm-8 pm) experience the longest periods of traffic congestion. During the morning peak, 33.3% of the respondents indicated a time loss of upto30 minutes and 50% of respondents indicated a loss of 31 minutes to 1 hour in traffic. This is collaborated by information from the Traffic police interviews which indicated the highest traffic congestion is experienced between 8 am to 9 am. At this time traffic speeds are below 30kph (bumper to bumper traffic).

During the evening peak, 50% of respondents indicated vehicle traveling along the route towards the CBD experience a delay of 30 minutes while 41.7% of respondents indicated delays of 31 minutes to an hour. Morning off-peak (4 am-6 am) and evening off-peak hours (4 am-6 am) experience the least amount of time in traffic congestion i.e. less than 30 minutes. These findings are illustrated in figure 15 below.

Figure 15: Time spent in traffic By Pubic Transport Operators



The study also investigated the occurrence of traffic congestion by different days of the week. Weekdays had the highest amount of traffic congestion, with Monday having the highest amount of traffic. The weekend had the least amount of congestion, with Sunday having the least amount of traffic

The traffic counts for vehicles from Landhies road to Haile Selassie Avenue data indicate that between 8.30 am - 8.45 am vehicle flow rate is highest at 861 vehicles per hour. This is followed by the period between 6.15 am-6.30 am at 806 veh/hr, then 7.00 am -7.15 am at 801 vehicles per hour.

Similarly, vehicle flow data from Landhies road to Pumwani ring road is highest between 8.30 - 8.45 am at 328 vehicles per hour, followed by 307 and 305 veh/hr between6.15- 6.30 am and 6.45 am -7.00 am. Table 12 below shows an excerpt from the analysis.

Table 12: Traffic Count statistics in the morning peak period

Period	Landhies Rd East- Haile Selassie Av.	Landhies Rd East - Landhies Rd West	Landhies Rd East - Pumwani Ring Rd
6:00 AM	547	517	208
6:15 AM	705	667	268
6:30 AM	806	763	307
6:45 AM	693	656	264
7:00 AM	801	758	305
7:15 AM	748	708	285
7:30 AM	736	696	280
7:45 AM	767	725	292
8:00 AM	779	737	297
8:15 AM	718	680	274
8:30 AM	772	730	294
8:45 AM	861	815	328

Source: Traffic Count Data, NaMSIP Urban Renewal,2017.

During the afternoon vehicle flow movement from Landhies road to Haile Selassie is highest between 12.15 pm-12.30 pm at 763 veh/hr, followed by the period between 11.45 am -12.00 pm at 667 veh/hr and between 12.00 pm-12.15 pm at 574 veh/hr. The table below shows an excerpt from the analysis.

Table 13: Traffic Count statistics in the afternoon period

Period	Landhies Rd East- Haile Selassie Av.	Landhies Rd East - Landhies Rd West	Landhies Rd East - Pumwani Ring Rd
12:00 PM	667	631	254
12:15 PM	574	543	219
12:30 PM	763	722	291
12:45 PM	29	28	11
1:00 PM	229	216	87
1:15 PM	198	187	75
1:30 PM	309	293	118
1:45 PM	536	507	204

Source: Traffic Count Data, NaMSIP Urban Renewal,2017.

During the evening hours, the vehicle flow movement from Landhies road to Haile Selassie is highest between 6.00 pm-6.15 pm at 761 veh/hr, followed by a period between 3.45 pm to 4.00 pm at 708 veh/hr and between 5.30 pm -5.45 pm at 703 veh/hr.

Similarly, vehicle flow data from Landhies road to Pumwani ring road is highest between 6.15 pm at 290 vehicles per hour, followed by 270 and 268 veh/hr between 3.45 pm -4.00 pm and5.30 pm -5.45 pm. Table 14 below shows an excerpt from the analysis.

Table 14: Traffic Count statistics in Evening peak period

Period	Landhies Rd East- Haile Selassie Av.	Landhies Rd East - Landhies Rd West	Landhies Rd East - Pumwani Ring Rd
4:00 PM	708	670	270
4:15 PM	459	434	175
4:30 PM	395	374	151
4:45 PM	677	641	258
5:00 PM	519	491	198
5:15 PM	425	402	162
5:30 PM	638	603	243
5:45 PM	703	665	268
6:00 PM	562	532	214
6:15 PM	761	721	290
6:30 PM	562	532	214
6:45 PM	321	304	122

Source: Traffic Count Data, NaMSIP Urban Renewal,2017.

Traffic congestion by Day of the week

According to Transport operators, Monday (33.3%), Fridays (18.2%) and Tuesdays (18.2%) have the highest-level traffic congestion experienced. Within the week Thursdays have the lowest amount of traffic congestion. This is collaborated by a common perception among urban commuters in Nairobi. The least congested days were on the weekends.

Figure 16: Transport operators' response of Traffic congestion by day of the week

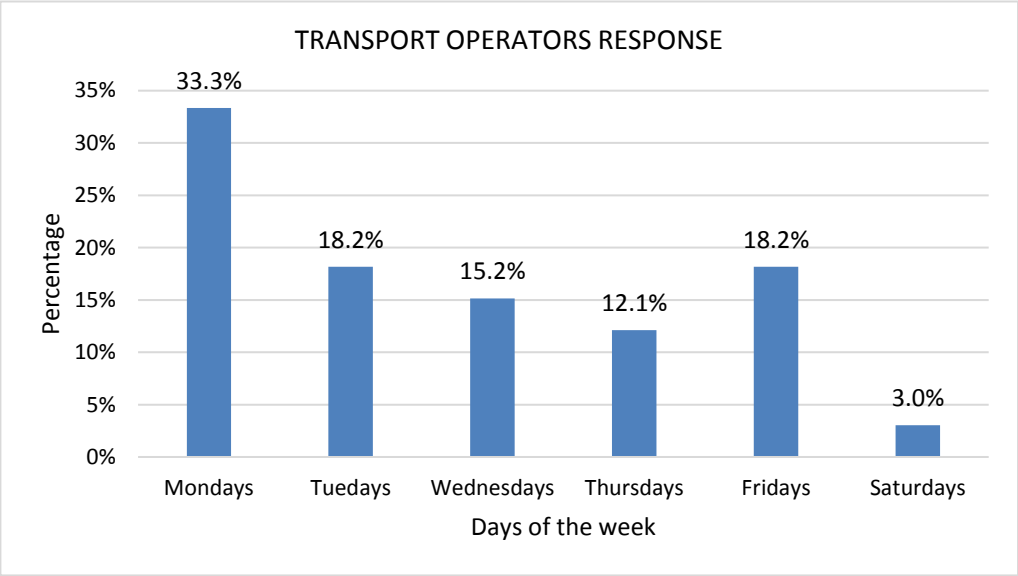
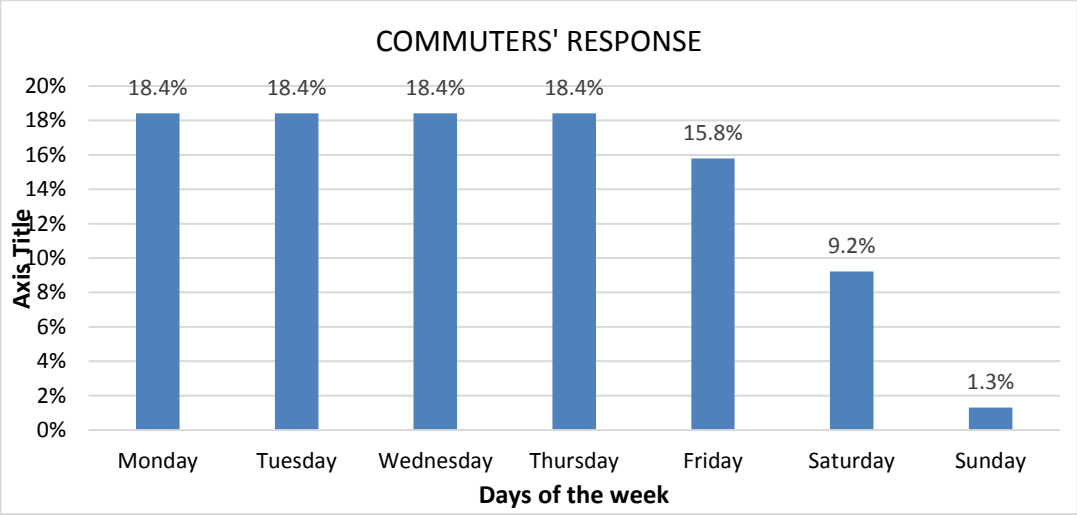


Figure 17: Commuters response of Traffic congestion by day of the week

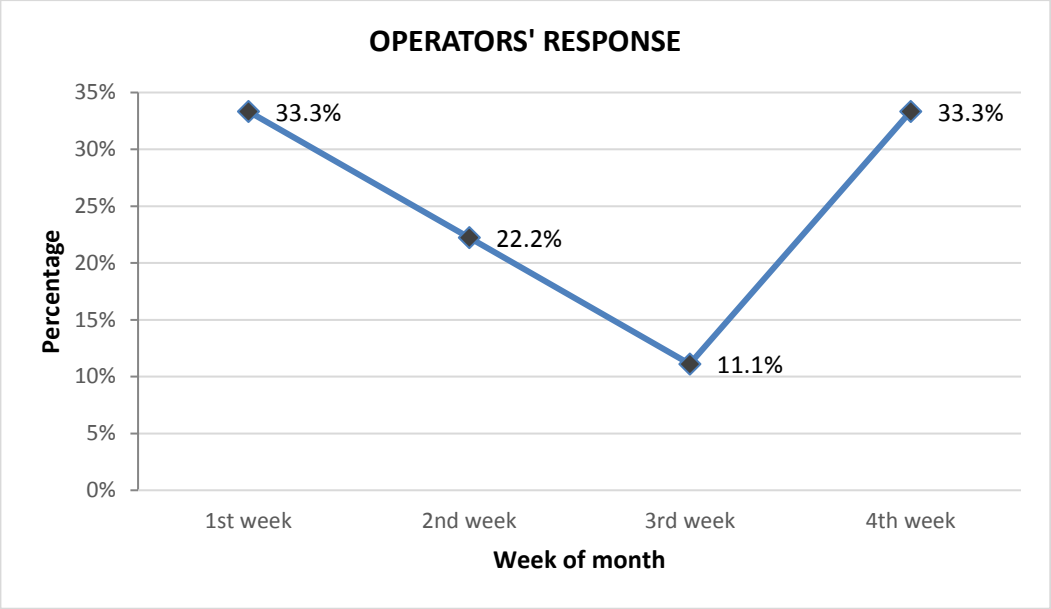


Traffic congestion by a week of the month

The study established that the first and fourth weeks of the month experienced the highest levels of traffic congestion. This can be attributed to an increase in private car use. The use of private cars was established to be influenced partly by the availability of funds to spend on fuel expenses which vary within the month.

The study also established that the 3rd week of the months had the least number of vehicles along the corridor.

Figure 18: Transport operators' response of Traffic congestion by weeks of the month



This finding implies that the availability of disposable income influences the use of private motor vehicles. In the absence of disposable income, a significant number of private motorists would opt for public transport as an alternative. This means that public transport does and should offer an affordable transport option to fully attract private motorists to consider it an alternative. With improved quality of public transport that is hustle free and convenient, this group would potentially use public transport as a 1st choice.

5.3. Impacts of Urban traffic congestion

5.3.1. Positive impacts

Congestion serves a benefit to small scale vendors (hawkers and newspaper vendors) and petrol stations businesses. The small-scale vendors along the corridor sell their goods to a motorist during traffic congestion. The vendors also target members of the public who walk during rush hour avoiding vehicular traffic as shown on plate 18. Some of the traders are allowed to enter vehicles and sell their wares by the operators.

Petrol stations benefit due to an increase in fuel consumption. The most lucrative times of hawking are morning and evening peak hours. This being the most congested timings of the day.

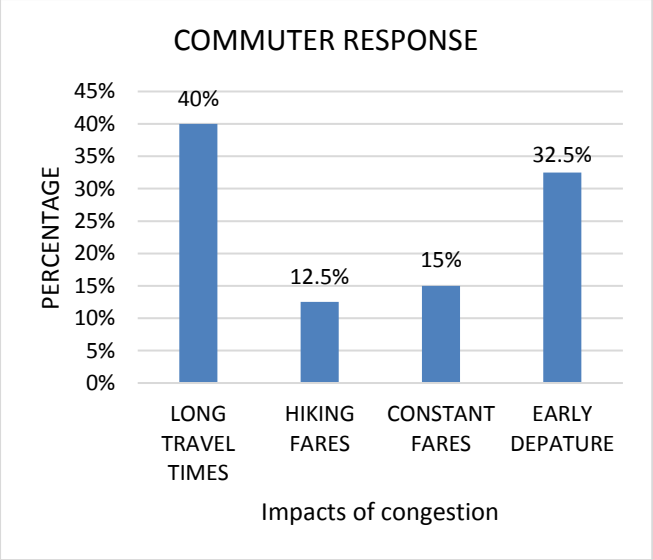
Plate 18: Hawking along Pedestrian Walk ways

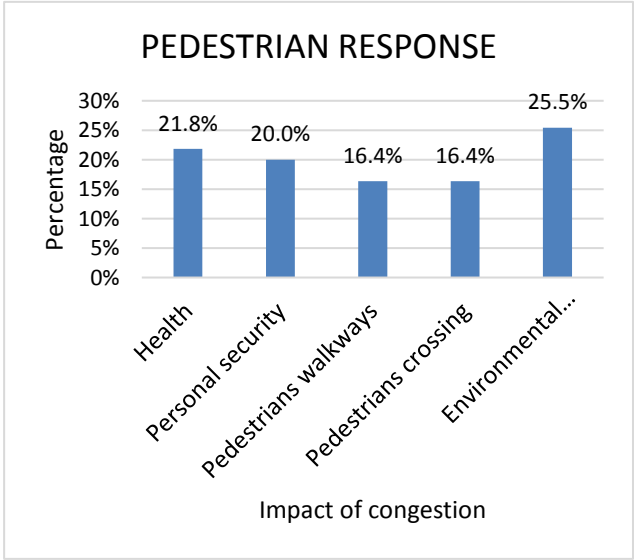
Negative impacts

Transport operators, private car users and Sacco managers indicated that travel times from their origin to destination increased at peak hours of the day and peak weeks of the month.

The extended travel time occasioned by traffic delays and congestion inconvenience different persons at different scales and have different implications. 40% of commuters said long travel time was the major impact of traffic congestion. 32.5% of Commuters interviewed had to depart earlier from their points of origin to get to their destinations in good time. This is illustrated in the figure below.

Figures 19: Impacts of Traffic congestion by commuters and pedestrians





25.5% of pedestrians indicated Environmental pollution was the major impact of traffic congestion, followed by 21% noted health concerns from vehicle emissions, 20% cited the risk of personal security. Personal security is compromised due to petty criminals who roam the streets targeting passengers and commuters in traffic to rob. These criminals also target pedestrians.

A combined 32.8% of pedestrians cited pedestrians' walkways and crossing points as having been affected by traffic congestion. This category also cited pedestrian road crossing does obstruct vehicle movement inhibiting smooth traffic flow at times.

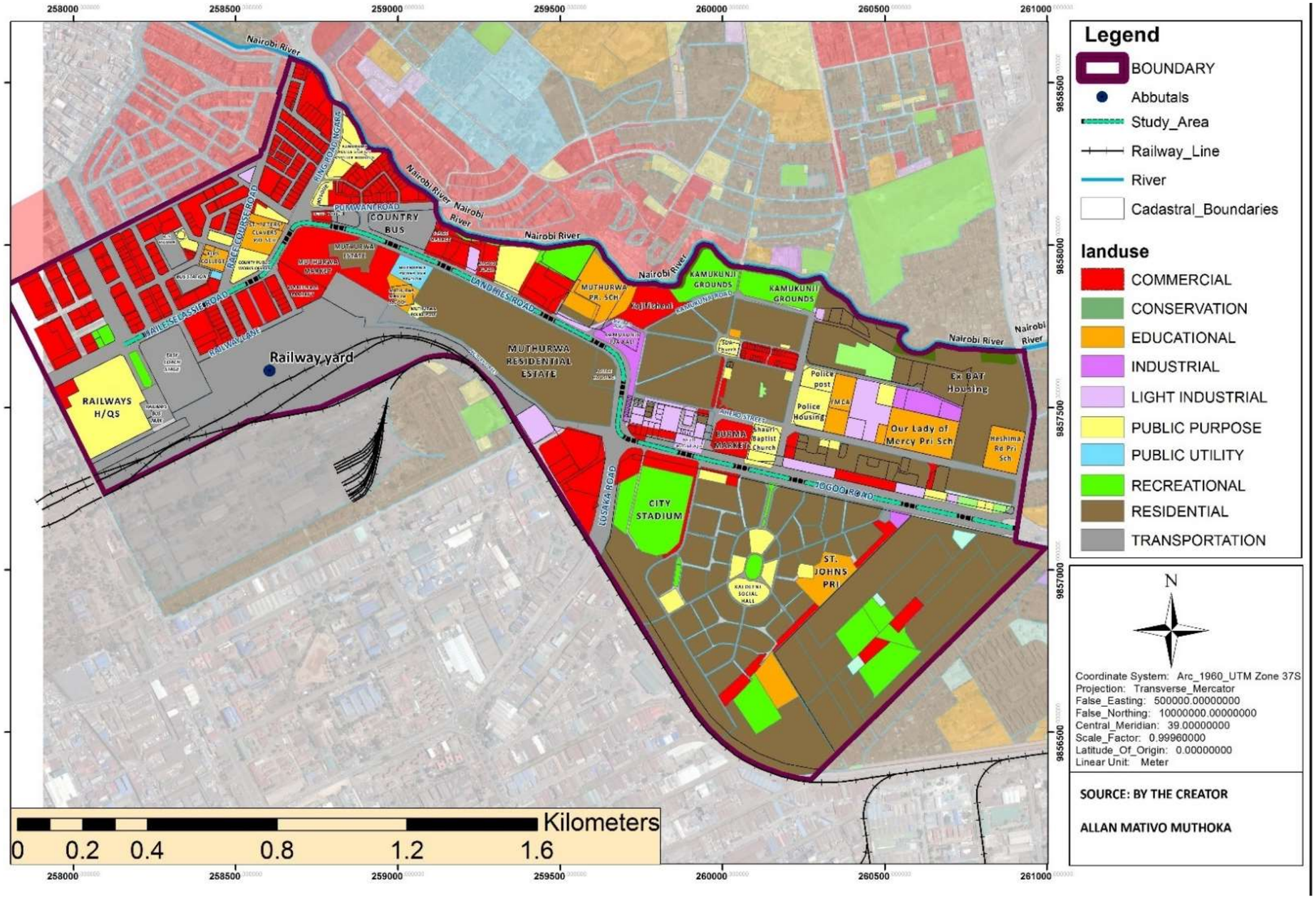
Private car owners and Transport operators cited increased fuel consumption due to traffic congestion. This combined with the fluctuating fuel prices which are reviewed monthly leads to unpredictable costs of travel. Public transport operators also cited longer working hours to attain targets due to congestion and ultimately high levels of fatigue.

Traffic police officers noted fatigue and difficult working conditions as an effect of traffic congestion. They noted that the difficult working conditions expose them to health risks from environmental pollution, mental stress, and depression at times.

5.3.2. Impact of surrounding land-use activities to traffic congestion

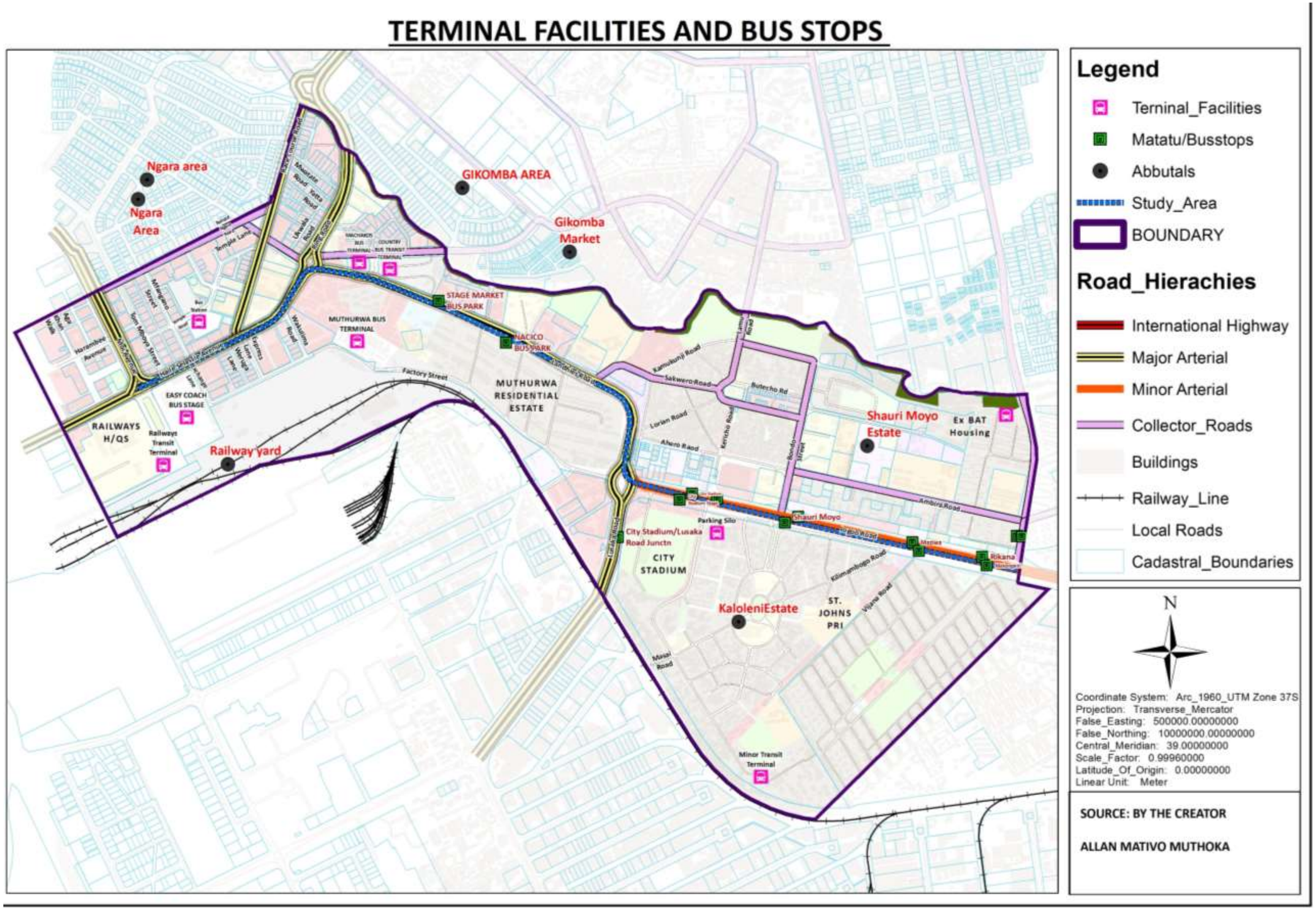
Land uses are a major determinant of the amount of traffic originating from an Origin point towards different destinations. Certain land uses to generate higher levels of traffic than others. This study identified major surrounding land uses in and around the study area as illustrated below. Similarly, Transport terminals and buses are located (where planned) or occur (when not provided for) adjacent to the origin and destination points. They may be used to illustrate the highest traffic volume points. This is illustrated further below.

Map 19: Existing Land use Activities along the Study area



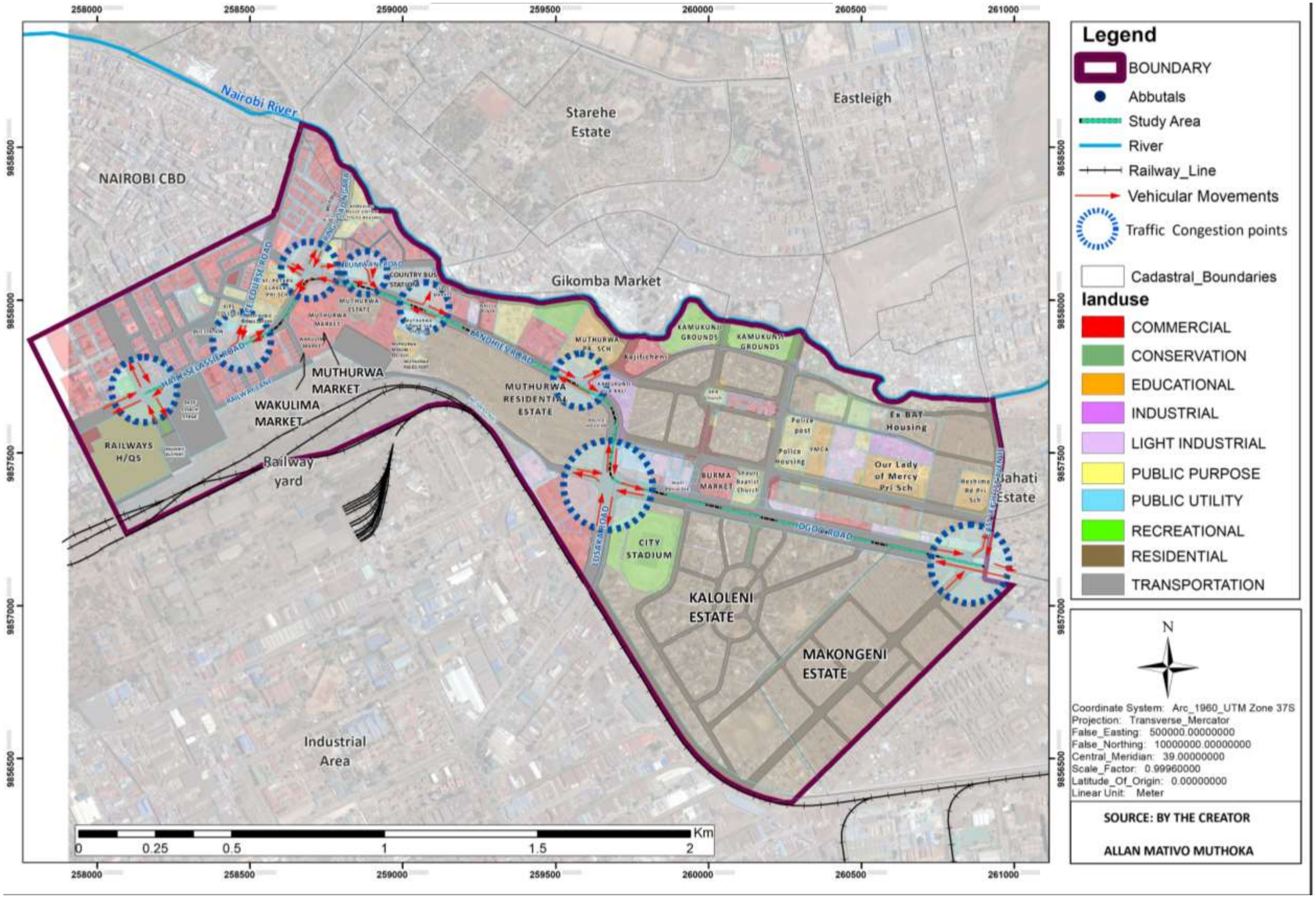
Source: Authors Own from Field Survey Mapping

Map 20: Location of Terminal facilities, Bus stop, and influence of surrounding land uses



Source: Authors Own from Field Survey Mapping

Map 21: Traffic Pressure point Influenced by Surrounding land use Activities.



Source: Authors Own from Field Survey Mapping

a) Impact of Muthurwa Market

From the field surveys, it was observed that the Muthurwa market is a beehive of all manner of activities. The market traders deal in the sale of household items, clothes, foodstuffs, and few hardware items.

The food section of the market faces hygienic challenges due to limited cleaning water and sanitation areas. This section due to poor drainage results in liquid waste leakage on pedestrian walkways along Landhies road.

The market generates a good amount of pedestrian movement between itself, Machakos country bus station, Gikomba area, and the larger Kamukunji commercial district. There is a pedestrian footbridge connecting the market and the bus station and the market and the opposite side of the road. However, the design of the footbridge though considerate of persons with disabilities fails to serve its purpose due to very long walking vertices to cross the road.

The county enforcement of the cleanliness and security of the footbridge is problematic as major sections of the bridges have street urchins asleep, human and other kinds of waste disposed of. Other sections of the bridge are used by hawkers to sell second-hand shoes.

Due to these factors close to 90% of pedestrians crossing this section of the road do not use the footbridge but instead, walk along the road reserve. This leads to massive traffic disruptions during peak hours. However, during off-peak hours this area is prone to accidents since public vehicles speed along the route.

Plate 19: Poor Pedestrian road use despite the availability of pedestrian infrastructure

Muthurwa market generates a high amount of hand cart movement as different buyers and sellers deliver goods. The Traffic police commandant notes that these handcarts are a major problem causing traffic obstruction, especially during the morning hours. The commandant notes that control or eradication of the hand carts is difficult as the operators are among the lowest income earners in the city.

According to public transport operators, 41.7% of the respondents implied that the Muthurwa market had no impact on congestion in their view. 25% of respondents said that handcart/trolleys obstruct traffic. 16.7% of the respondents said that traffic congestion is caused by narrow roads around the Muthurwa market and 8.3% of respondents said that traffic congestion is caused by pedestrian-vehicular and vehicular-vehicular conflict.

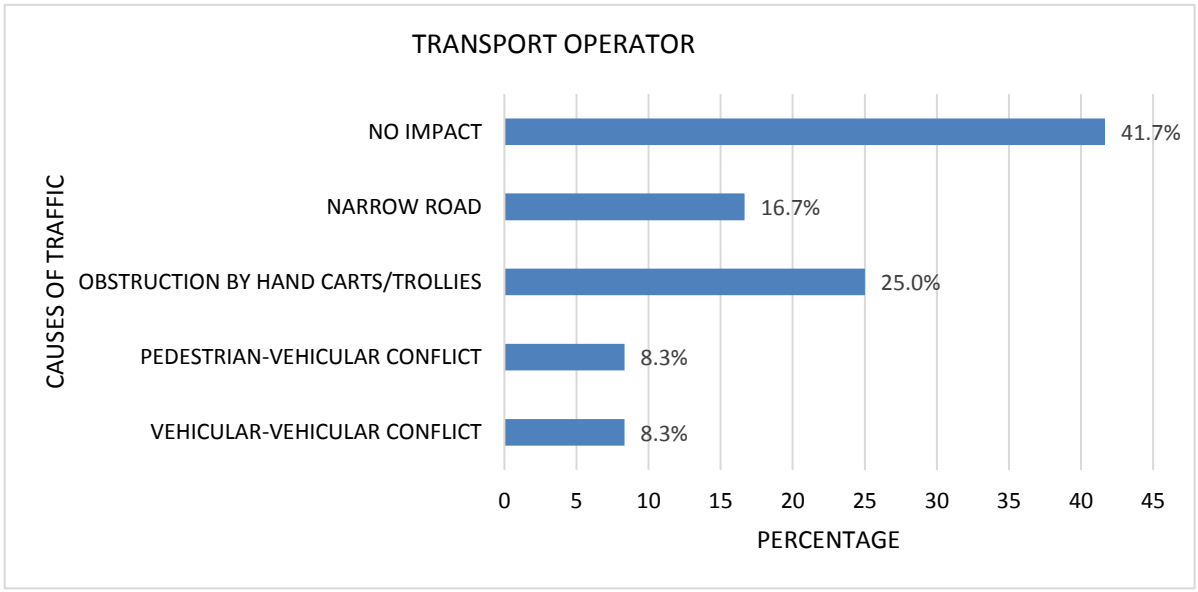


Figure 20: Transport Operators response on Causes of Congestion

Transport operators noted that the alternative routes they use to town are narrow hence they experience more traffic congestion. Vehicular-vehicular conflict is also encountered at the Muthurwa roundabout. Vehicular-pedestrian conflict is encountered when pedestrians are crossing Landhies road accessing the Muthurwa market.

b) Impact of Wakulima Market

Wakulima market operates as a retail and wholesale market-fresh foodstuff, vegetables and fruits. The market attracts suppliers from all the food production counties in Central, Eastern, and Rift valley regions. The market also attracts traders from neighbouring Tanzania. The market is currently overpopulated beyond its initial carrying capacity as a wholesale market.

The largest and most evident impact of the market is the hawkers and small-scale traders who sell goods at the doorstep of the market. These traders target pedestrians and sell the items on pedestrian walkways and road reserve of Haile Selassie road. (inbound). The trader displays their goods on hand carts, carton boxes or polythene bags on the ground. These activities obstruct traffic movement, contribute to untidiness and poor waste disposal. The area is generally chaotic.

The market is also responsible for the illegal parking by traders who operate from the market. These traders park pickups, trucks and personal cars along the road reserve due to limited parking and accessibility at the market. After a thorough analysis, this is the main cause of traffic congestion along the corridor. Only one lane of the three lanes is functional on this section of the road.

According to the market officer, the market also generates obstruction from delivery trucks which form queues as they seek to access the market. The majority of the delivery trucks result in the selling of the goods in the trucks along the road reserve in complete disregard to traffic and county market rules. The county government, however, charges market access fees for these sales. The county government acknowledges its limited parking space as a factor contributing to the queues.

Plate 20: Road reserve invasion by handcarts, pedestrians, Illegal Road side parking and Hawkers outside Wakulima market

Obstruction by the delivery truck as they park on the roadside and hand carts disenfranchises other road users. This limits functional lanes along Haile Selassie section to 1 lane instead of 3. Hence only30% of road efficiency/ volume is utilised.

c) Impact of Country Bus Station

The Country bus station is a major terminal located within the study area. The station serves rural bound passengers towards different counties. The station attracts heavy pedestrian movement arriving and departing the station. A good number of passengers use pedestrian means to access the station. Very few persons use the designated pedestrian bridges as evident from the field survey.

The bus station attracts a large number of trolleys who ferry goods to and from the station. The trolleys are a contributor to traffic congestion. The bus station has several retail outlets surrounding the parking area. These operations sell all manner of commodities. Hawkers are also present in and around the bus station.

Plate 22: Congestion in and around Country Bus Station

5.4. Urban traffic Management: Actors, Strategies and their operationalization

5.4.1. Traffic management actors and their roles

The information obtained from the traffic management demonstrated that the traffic police wardens are responsible for controlling traffic within designated sections depending on the proximity to the access roads. For the case of Kamukunji police station; they have been designated the Landhies road stretch covering some parts of downtown CBD area, while other sections along Jogoo road have been dedicated to other police stations depending on proximity to their jurisdiction.

The role of the traffic officers is as follows;

i. Arresting and charging traffic offenders who include the motorist operators, hand cart/trolley operators and pedestrians who don't obey traffic rules. They are also responsible for guarding the footbridge against muggers for the users.
ii. Control traffic flow at traffic congestion nodes such as junctions and roundabout for the case of points where traffic lights are not functioning or reckless motorists who do not follow the traffic rules.
iii. Clear obstruction from vehicles involved in accidents. They act as arbitrators between the parties involved and also record accidents for Insurance claims.
iv. NTSA officials assist pedestrians to cross by directing motorists along Landhies road. This is, however, a complete contradiction to pedestrian footbridges provided.

Plate 23:NTSA Pedestrian Crossing Marshall

5.4.2. Current traffic management measures

The measures applied on traffic management by the traffic officers are such as;

i. Restrictions on turning movement-this are whereby the U-turn lanes are restricted to allow smooth flow of traffic during peak hours.
ii. One-way street –a pilot project has been done on some streets in the CBD which is meant to facilitate one-way traffic, therefore, reducing the conflict.
iii. Road signs-to guide the motorists hence managing traffic and avoid using the wrong lanes while approaching exit points or roundabout.

Traffic police control traffic by means of observation allowing vehicles to exit intersections towards clear roads. The traffic police also study traffic patterns by time of the day and season to be able to predict the direction of traffic flow. They are assisted by the use of two-way radios to communicate with other police officers manning adjacent intersections.

Although there are modern traffic lights and modern CCTV cameras linked to the police command centre and Nairobi City command centre, the traffic lights are not working. The majority of the lights are unmaintained. The Road Engineer notes that the county government has failed to repair some of the equipment since traffic police are in charge of traffic control even when the traffic lights are in working condition.

Plate 24: Comparable Existing Traffic Management Measures

Traffic Light Infrastructure

Traffic Police officer

The traffic commandant notes that other frequently used measures include diverting traffic and manual traffic facilitation. They also monitor traffic movements where traffic lights are working. The traffic polices also inspect vehicles, inspect driving licenses/unlicensed driver and controlling drunk drivers among others.

5.4.3. Shortcomings of existing strategies

The limitations experienced from the strategies on traffic management include;

i. **Obstruction by Public transport vehicles-** caused by matatus and minibuses from picking and dropping off passengers at undesignated bus stops. This will delay approaching traffic and might also lead to accidents

ii. **Hand carts and trolleys** -are also a consequence of obstruction due to being driven on the wrong side thus obstructs oncoming traffic. The handcart operators operate within the Muthurwa market and country bus station offering transport of goods for the traders.

iii. **Reckless crossing of pedestrians** also obstructs motorists. The existing bridge is not safe for pedestrians because of the muggers hence they opt to risk crossing the road at random points not designated as crossing lanes

iv. **Lack of consultation and proper communication** between the county and police traffic department has led to conflicting opinions regarding the allocation of bus stops within the CBD. Such a case is the Easy coach bus terminal where there are long queues to access the terminal by local and upcountry vehicles. This leads to long queues and local vehicles end up dropping passengers while queuing to access.

However, the traffic police note that the Easy coach terminal is one of the highest revenues generating terminal for the County government based on their estimation of public vehicles operating from there.

5.5. Towards effective traffic management

5.5.1. Improvement of existing traffic management measures

The existing traffic lights at Muthurwa roundabout do not function. The Road engineer recommended the need to ensure that the traffic light system is used appropriately. The system has been applied in other parts of the city such as Kilimani.

5.5.2. Recommendation from road users

The pedestrian respondents recommended the introduction of speed bumps along Jogoo road. This would assist in the reduction of traffic speeds during off-peak traffic periods when they cross the road.

The pedestrian respondents having identified the shortcomings of the footbridges, they recommended redesigning to meet their needs, make them user friendly and appealing. They recommended cleaning of footbridges, installation of lights for use during early morning and evenings and securing by city council askaris against criminals and idlers.

Once the footbridges are functional, it was suggested that there would be less traffic interruption due to pedestrian crossing.

Facing out private cars from the CBD was among the proposals by public transport operators and commuters. Their opinion was that the major cause of congestion was private cars which continue to increase by the day. The traffic counts indicate private cars account for between 56- 61% of vehicles into the CBD along Landhies road-Jogoo road corridor. Some commuter respondents noted that the majority of persons desire to own and use personal vehicles which eventually leads to increased traffic.

Both pedestrians and public transport operators support the reduction of private vehicles and redesigning of the footbridge as the main interventions that would decongest the traffic.

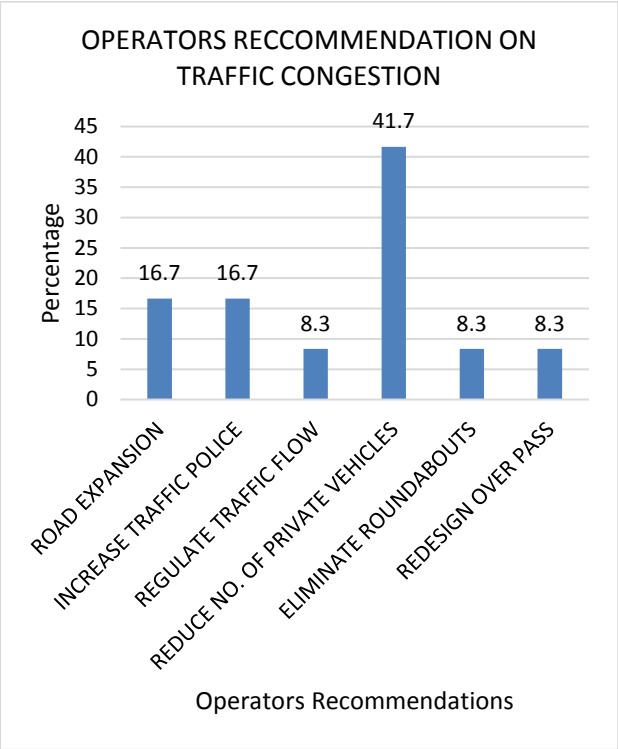
Private motorist did acknowledge their contribution to the presence of increased vehicles on the roads. However, motorists identified other causes of congestion such as breaking of traffic rules by public vehicles, hand carts, and pedestrians.

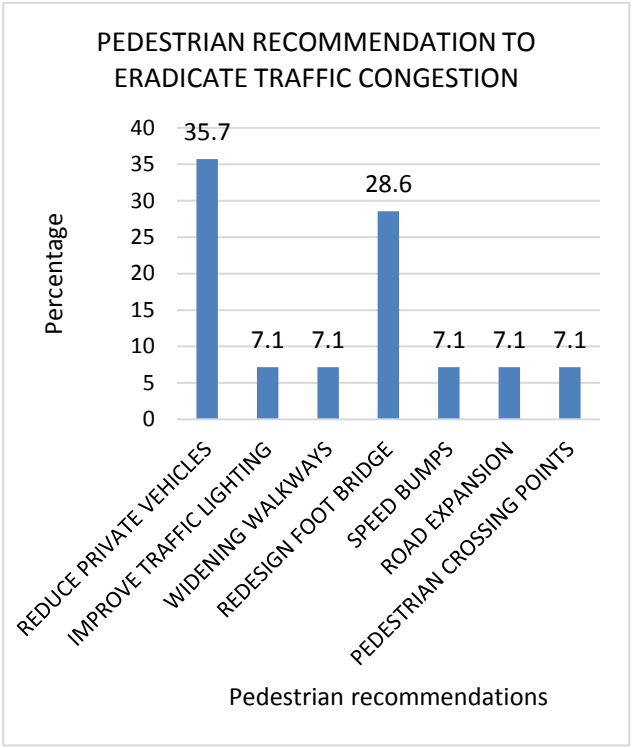
Private cited their preference for private vehicles due to lifestyles, convenience purposes and the poor state of public transport. 80% of private motorist respondents suggested the development of attractive and improved public transport which they would gladly use in

place of private vehicles. This would, in turn, reduce the number of vehicles on the corridor and roads.

15% of private motorists indicated that they would not use public transport as an alternative due to their lifestyles (multiple commuting location, nature of work/ business deliveries and social standing).

Figure 21: Transport operators and Pedestrian recommendation





41.7 % of operators recommended the reduction of private vehicles. 16.7% recommended road expansion and an increase in traffic officers. 8.3 % proposed regulation of traffic rules, elimination of roundabouts and redesigning of overpasses.

The Figure above indicates that 35 % of pedestrians recommended the reduction of private vehicles. 28% recommended a redesign of footbridges among other measures such as Improving the functioning of traffic lights, widening walkways, installation of speed bumps and increase of pedestrian crossing points.

5.5.3. Recommendation from Traffic Police

The traffic police department recommended facing out of low capacity public vehicles (matatus) and un-roadworthy vehicles operating to and from the CBD.

The police also advocated for sensitization on the need for the observance of traffic rules especially regarding the picking and dropping off passengers. Its contribution to unnecessary traffic congestion is high. The reason for this behaviour was identified as profit-driven behaviour which disregards rules and focuses on making increased trips, reducing delay time and staying ahead of other public vehicles who target the same commuters.

The police observed that private motorists/vehicles observe traffic rules fairly well. This implies that their contribution towards traffic build-up due to poor road use if false as claimed by public transport operators.

The Roads department engineer noted that the traffic situation along the corridor requires a Governance perspective to resolve the non-mobility traffic contributors. These governance issues are more difficult and complex than infrastructure improvement. They touch on livelihoods, tax and revenues and political structures. He noted that appropriate infrastructure amid poor administration and governance would not resolve the traffic nightmare.

5.5.4. Road user Behaviour and Attitude change

An attitude change among road users would significantly improve traffic management. Observance of traffic rules on the part of Public transport operators such as appropriate use of designated road terminals to pick and drop passengers, respect for the highway code and road use rules. This would mean that their vehicles should park fully within the layby without obstructing and interfering with motorists on the carriageway. This obstruction problem is recurrent in other parts of the city including congestion on Mombasa road due to the General motor and City Cabanas stops. Attempts to have compliant use of bus terminals result in smooth traffic flows.

An attitude change among motorists in favour of the use of Public transport and Non-motorised transport would assist in managing traffic by decreasing the demand for Passenger carrier units. Appropriate restructuring of public transport operations towards orderly, secure, reliable and affordable public transport would facilitate change of attitude by motorists towards chaos associated with public transport. Motorist road user behaviour improvement

including giving right of way, respect of lane discipline, observation of road signs, use of appropriate speeds and vehicle queuing to avoid overlapping.

Appropriate Pedestrians behaviour towards road use would assist traffic management by reducing the interruption of traffic flow. Appropriate road behaviour includes the use of pedestrian walkways, footbridges, observation of street lights and pedestrian crossings

5.5.5. Design improvements

Improving the design of intersections making it safe for pedestrians and handcart users to navigate freely. Over 25% of pedestrians recommended redesigning the footbridge to allow pedestrian an option of either going into the market or on the other side of the road.

17% of Public transport operators (as per fig 21) recommended road design improvements as a measure to reduce traffic congestion. Road design improvements include the expansion of road reserves to accommodate increased traffic volume as learnt from the three case studies reviewed.

5.5.6. Policy recommendations

Continuous training and proactive involvement of the traffic police department in traffic management strategies of importance is the use of traffic police to be part of the management of Transport operators Sacco's so advice and streamline public transport operators. This would enable the Saccos to govern and regulate themselves. A good example is forward travellers Sacco, where Ex-police officers are involved in the management of the Sacco. It is the best managed Sacco according to the Kamukunji police department.

Restriction of private car access into the CBD. According to the survey, a high number of private cars is the leading cause of traffic congestion.

Key stakeholder involvement during the planning process and design of transport action plans. The traffic department feels that they are not adequately involved in the process of traffic planning which leads to inappropriate traffic control measures.

5.6. Emerging issues: Urban Management and planning implications

Uncoordinated Institutional Frameworks

The study was able to identify that the transportation domain within the city has numerous actors who include KURA, KeNHA, Different Departments within the City-County, Ministry

of Transport, Metropolitan Department NAMATA, NTSA, Traffic police, Kenya Railways and Transport operators amongst others. Based on their mandates these institutions undertake divergent programmes that often are not guided by similar visions. NAMATA which was recently established will hopefully coordinate all matters transport to ensure unified efforts towards congestion management.

Urban sprawl

Intensive urban growth along the Landhies-Jogoo road and beyond has led to a greater number of commuters along the stretch. The county government is therefore unable to provide enough infrastructure to meet the rapid demand.

Inadequate modes of transport

Lack of diverse transport modes limits commuters to either public service vehicles, private car and walking. No cycling lanes are dedicated to the stretch making it unsafe.

Poor Enforcement and Lack of Plan and policy implementation

The inability to implement various policies available to different agencies is a concern with congestion management. Similarly, there are various action plans completed while others are in development prepared towards solving various challenges. However, inadequacies in technical, financial and institutional capacities to implement is a concern. This includes plans such as the Nairobi Commuter Train masterplan, BRT system, The Light Rail system, NIUPLAN multi-modal centre strategy among many others.

The lack of enforcement of traffic rules, market trading and delivery trucks guidelines, hawking rules, parking rules, road user rules for pedestrians, hand carts, motorcycles among others is an issue that inhibits decongestion measures. The level and success of Enforcement are influenced by governance and political directions.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

This concludes the study by looking at the implication of the findings. This chapter reviews issues identified and discussed in chapters two, three, four and five in the context of the findings. The chapter provides an urban management framework or guidelines through recommendations for consideration.

6.1. Summary Of Findings

Objective 1: Nature and Extent of Congestion

Traffic congestion along Landhies-Jogoo road is caused by a number of factors. The main factors are poor road intersection management; land-use conflicts resulting from the Wakulima market, Muthurwa market and Machakos Country bus activities; Obstruction by hand carts and trolleys; Pedestrian obstruction and the poor state of NMT facilities; roadside hawking; illegal parking and Obstruction. These challenges require specific intervention for each of them as well as a comprehensive strategy to manage the traffic congestion at a macro level. The Comprehensive strategy would require a strong management and governance framework. This is detailed out in the recommendation section below.

The Jogoo road-Landhies road experiences peak hour congestion as well as traffic snarl-ups around identified bottlenecks during off-peak hours. PSV are the main mode of transport used along this route as well as private motor vehicles. The impacts of congestion are massive and severely dent the economic, social and political fabrics.

Objective 2: Existing traffic management strategies

Traffic control systems

The existing human traffic police centred system operates with high levels of inefficiency and human error. The human-operated system is vulnerable to traffic changes where police officers are exposed to harsh weather including scorching sun, rainfall which inhibits effective traffic control. This system is also exposed to human bias, traffic flow estimation, and perceptions where human emotions against certain operators, motorist agitation (hooting at the roundabout and lane switching) influence effective decision making.

Terminal Development

Terminal facilities are inadequately provided within the CBD. Existing bus stations (Railways and Country Bus station) cannot adequately accommodate all public vehicles. Country Bus station was initially developed to serve countryside vehicles for the entire Nation, however, the vehicle operators have since increased and diversified leading to the inadequacy of the bus stations.

A good number of bus stops have been irregularly located such as Odeon cinema area, Khoja Mosque, Ronald Ngala, Nyamakima Stage, Coast Bus, GPO, KenCom, Accra road/Tea room, Tom Mboya street, Fire station lane, Timboroa lane, St peters church OTC and National archives. None of these are designated terminals. The county government is unable to provide properly designed bus terminals which would address the congestion menace.

Key actors charged with Traffic management have not had coordinated working frameworks. Often at times, they have initiated individual measures without the full involvement of the other. These actors include the Traffic police, Nairobi City County roads and traffic department, NCC market department, NTSA, KURA and Ministry of Transport and Infrastructure. Recently, NAMATA was established to bring about a coordinated working formula for transport management in the city. The authority's initiative will soon be evident commencing with the BRT system.

Objective 3: Recommend policy frameworks for effective traffic management

The Transport management system in the city is not fully integrated but operated by dis-integrated traffic command stations operated by a police officer in proximity to the closest police station. Landhies-Jogoo road is controlled by the Kamukunji Police station traffic division, while Hailee Selassie road is under Central police station traffic division. The current system through functional is not completely effective and has large gaps for improvement.

Breaking of traffic rules, unregulated trading, hawking, and conflicting land-use activities are major inhibitors of smooth traffic flow along the corridor. Enforcement of traffic rules, illegal hawking, and land use control measures is difficult in the corridor. The nature of land use planning and layouts in close proximity and the congesting vibrancy of each activity site

leads to a chaotic situation. This situation is unmanageable by even the most committed enforcement.

Implementation challenges

Implementation of existing rules and by-laws is a challenge. This is evident from hawkers and traders of the Wakulima market on the road reserve, obstruction of lanes by delivery trucks, rad side parking among others.

Implementation of decongestion measures faces opposition by various stakeholders within the public transport sector. Implementation of transportation project faces severe finance challenges, adherence to implementation timelines. Transportation projects like many infrastructure projects are highly capital intensive.

6.2. Recommendations

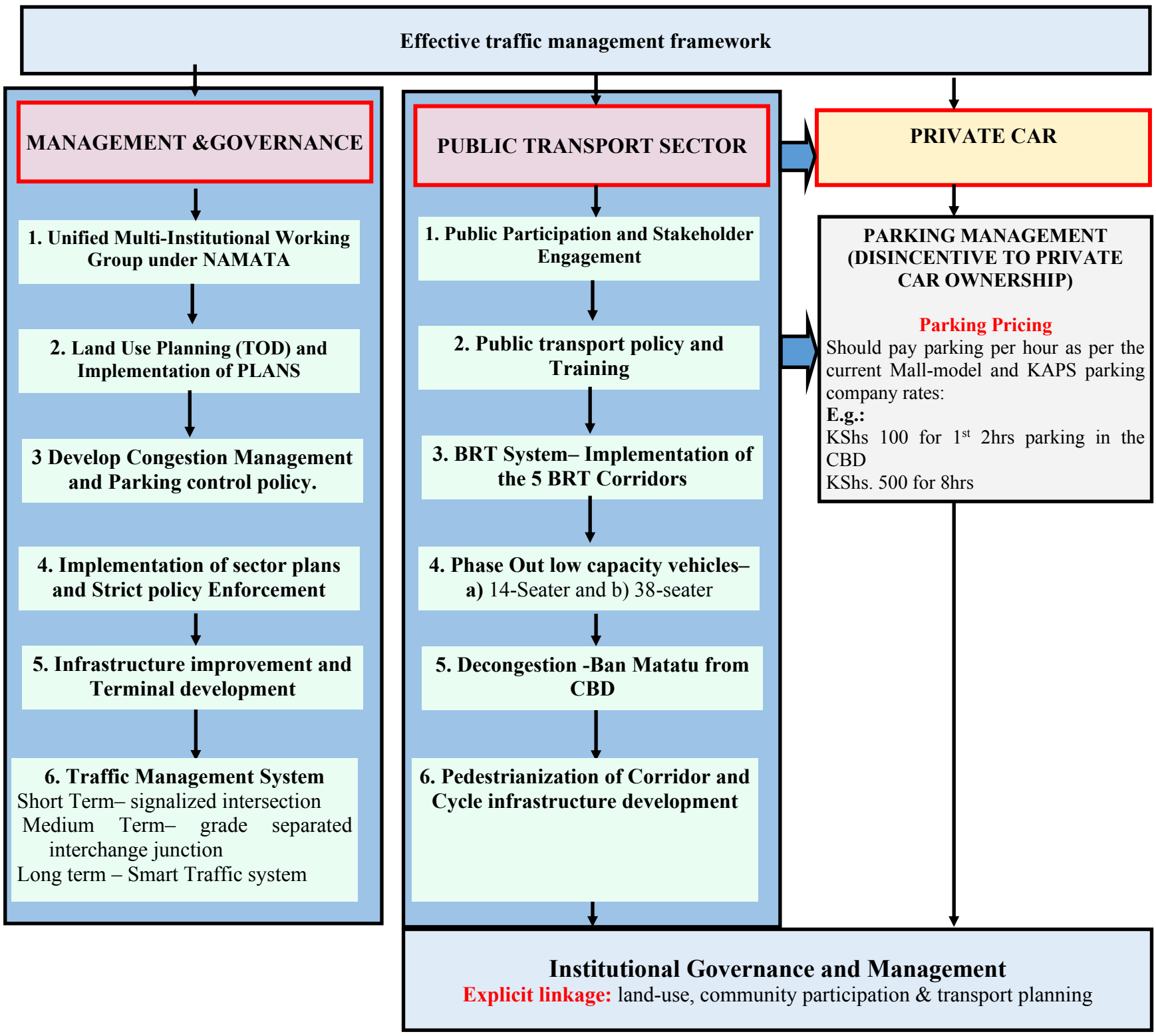
This study proposes various recommendations towards the effective traffic management along the corridor and by extent within the CBD. A strategic framework developed to consolidate various congestion management measures is recommended. The bias of this recommendation is more towards urban management and governance. Urban managers are presented with numerous congestion management measures but how they are employed, in what order and to what effect is the difference.

Past frameworks have focused on infrastructure expansion and little on-demand management. Demand management focuses on influencing and regulating the choice of transport modes from available transport options. Demand management involves the provision of cheaper, efficient and convenient public transport alternatives, activity pattern regulation, time pattern regulation (time scheduling), fuel pricing, Congestion tolls, Parking space availability and pricing, mobility behaviour among others.

Figure 22 below proposes a management framework for effective congestion management. The framework is developed as a summary of the recommendations discusses in the section further below.

The research objectives as established to guide the study have generated various findings that inform the recommendation and eventual management framework proposed.

Figure 22: Diagnostic framework



Policy Recommendations

Terminal Development

There is a high level of inadequate terminal facilities currently within the CBD. Existing bus stations are not adequate to accommodate all public vehicles, Relocation of terminal outside the CBD will not also fully address the inadequacy. There is a need for continuous improvement and investment in the development of transport termini. The funds collected from Bus station parking fees have not been appropriately used towards terminal developments. Occasionally improvements on select stations have been done. This study proposes the development of a terminal facility at City stadium to serve the current country bus station which needs to be relocated.

Enforcement measures

The Biggest challenge along the corridor is enforcement on the part of the county government and Traffic police. The County should strictly control the trading and market-related activities along Haile-Selassie avenue next to Muthurwa and Ukulima markets, obstruction, hand carts use, illegal parking outside the markets and on road reserves. The Bogota city case study approach banned all forms of trading along roads to deal with hawking, illegal parking by vehicles and hand carts. This approach would be effective in the study area.

Nairobi County government needs to enforce the appropriate use of pedestrian footbridges. This involves maintaining cleanliness, eradicating hawking, idlers, and criminals operating from the bridge.

The County Government has banned the use and operation of public transport motorcycles (Boda boda) within the CBD. These measures have assisted in decongestion corridors such as Landhies- Jogoo road. The strict enforcement of these measures in the future is important towards effective decongestion of the corridor and CBD.

Low Capacity Vehicle Phase out

Based on the lessons learned from the Dar es salaam and Bogota Case studies, there is a need to urgently phase out 14-seater matatus and replace them with High capacity vehicles. Bogota was able to achieve this through the TransMileno system.

The phase-out of 14 seater matatus has been delayed over the years due to protracted resistance from transport operators and political interests. In 2014, the court granted the

banning of licensing of 14-seater matatus via Legal notice no.179 of 2014 which became effective on 1st January 2019. NTSA has attempted to enforce this ruling however, the High court issued temporary stopping orders in 2019. Ultimately, for effective traffic management, the 14-seater matatus need to be phased out to enable higher efficient passenger carrier units.

This study also proposes the subsequent phasing out of 38-seater minibus to over five years to have a minimum of 62 passenger capacity. High capacity buses typically have a capacity of 62-100 persons. This study proposes partnerships between matatu owners and local vehicle producers and banks for access to higher capacity vehicles. The Transportation Sacco could act as guarantors to the financing model. This model has been successfully applied by the digital taxis providers where commercial banks have been able to provide financing with various car dealers i.e. Uber, NIC bank and CMC Motors; Taxify, Stanbic Bank and Renault Kenya.

Parking Controls Policy

As informed by the Dare es salaam case study, there is a need for strict parking management and controls policy. They ought to cover parking pricing, parking access controls in CBD, decongestion in CBD and parking provision outside CBD.

The Nairobi City County parking policy requires a review of a long-term development vision. The fluctuating parking fees require consistency. The Study proposes continuous parking review upwards inline to discourage parking within the CBD. Currently, daily parking costs KShs 200 after reduction by the County leadership in 2018 to allow for transparency in the collection. There is limited evidence to suggest reduced parking fees lead to less misappropriation /channelling of collection by traffic marshalls.

The study proposes commercial parking fees charged incrementally per hour with traffic meters. A base charge of KShs 200 for the first two hours is recommended and KShs 50 per hour thereafter, this translates to KShs 500 and 700 for 8 and 12 hours respectively. These are measures used by private parking operators (KAPS) in the CBD to discourage full-day parking. These fees will discourage unnecessary private car use. Additionally, enforcement of automated parking payment systems should be done to eradicate cash handling. Although automation has already been implemented there are numerous loopholes for loss of revenues and non-compliance. There is a need for strict prosecution and penalties to ensure full compliance with automated payment and reduce the loss of funds through fraud.

New commercial developments in and around the CBD should also strictly adhere to parking requirements as established by various development control manuals. This will ensure adequate off-street parking for employees and target clients. Parking offenders causing obstruction and irregular parking should face stiff penalties including suspension from CBD parking for 3rd-time offenders within a stipulated timeframe.

This study proposes the development of high-rise parking facilities at Makongeni estate and City stadium for motorists originating along Jogoo road and Lusaka road. Upon use of the parking facilities, a motorist may use the BRT system or cycling to access the CBD.

Public operators' training policy

There is an urgent need to develop an appropriate mandatory curriculum for public transport operators (Drivers, conductors, stage managers). These personnel are an integral part of the operation of the public transport system. There is need for a behavioural change in the industry from road user behaviour, operational conduct, sensitization on ethics and public operator etiquette. This will also assist in alleviating accidents among other public transport challenges

This training should be continuously undertaken within mandatory evaluation Bi-annually. This is best operationalised as a pre-condition for the renewal of Public transport driving license.

Land-use Planning recommendations

Lessons learnt from the Bogota City Case study indicates that reorganising land use is one of the most effective means of congestion reduction. This can be achieved through the integration of traffic management plans and urban plans. Lesson learnt from the Dar es salaam city congestion management strategy indicates the reorganisation of land use plan towards Transit-oriented developments where commercial activities and Malls are developed at major transit points thus reducing unnecessary movement.

Land use planning involves regulation on locations, densities, and rate of development. The overcrowded Wakulima market has a detrimental effect. This study supports the County Government's proposal to relocate it away from the CBD and along the corridor. The proposal is to relocate it to Kangundo road. This relocation would eradicate hawking, hand carts, obstruction by delivery trucks and illegal roadside parking by traders and brokers.

Muthurwa market is a dilapidated market that is hazardous to the health and environment along the corridor. The market attracts hand carts, street urchins and trolley operators who obstruct the road as the cross towards the country bus station and Gikomba -Kamukunji market. Muthurwa market interface with Landhies road needs a redesign to minimise direct interaction with the road and motorists.

The County government recently attempted to relocate major bus terminals away from the CBD. The terminal along Landhies-Jogoo road will be at Muthurwa terminus next to the market. Relocation of the terminal will encourage the decongestion of public vehicles into the CBD, and encourage pedestrianisation. This study proposes the implementation of this proposal in consultation with transport operators. However, support services such as BRT systems and Non-motorised transit facilities need to be adequately provided for.

This study proposes the decentralisation initiative from the CBD to satellite commercial nodes. This includes the development of the Makadara area along Jogoo road as an alternative commercial centre. This initiative should be supplemented by home offices which is more practical with appropriate services such as reliable electricity and internet connectivity. This initiative will reduce the need for travel along the corridor unless necessary.

Public transport recommendations

The phasing out of 14-seater matatus is recommended as the entry point towards effective traffic management via public transport investment. Subsequent phasing out of 38-seater minibuses to only allow high capacity carriers of above 62 passengers. A BRT system will enable the implementation of the phase-out and shift to higher capacity buses.

Implementation of the Nairobi City BRT system is urgently required to enable effective urban traffic management. 5 BRT corridors have been proposed for the city which will operate 950 high capacity buses reducing travel time and costs by up to 70%. (GALGALLO, 2019). Funds have already been availed (5 Billion representing 50%) by partner agencies such as the European Union towards this.

However, the Government (Ministry of Transport) began importing high capacity buses (in December 2018) which is self-defeating to other government policies such as the Big 4 Agenda on manufacturing. The Government out to encourage local production and assembly of the buses to promote local job creation and industry.

The County Government in 2019 implemented the banning of all public vehicles access to the CBD. However, due to inadequate preparation, the initiative was a flop. This study recommended the reintroduction of this ban upon operation of the Bus Rapid Transit system. A ban of the ordinary public vehicles would reduce the amount of vehicular traffic on the corridor and CBD. Pedestrian facilities such as walkways, footbridges and street furniture with then complement the pedestrianised CBD in line with global standards of appropriate urban design and liveable cities.

Pedestrianisation proposal will not be effective with the current state of unlimited and uncontrolled access to the CBD by all public transport operators.

Vital lessons learnt from the Dar es salaam case study promote the improving management of existing infrastructure through providing high capacity public transport, promotion of NMT and flexible working hours.

Support Urban Transport facilities

A major success of Bogota city case study was the use of Cicloruta which is a 344 km Cycling network that connects to the public transport system. The availability of cycling lanes, designated bicycle parking points at the public terminal encourages cycling and the use of public transports. The Bogota success story also includes proper and consistent bus stops along the road.

The study proposes the development of support urban transport facilities including pedestrian walkways, pedestrian footbridges cycling lanes, parking station, and regular planned bus stops. The study also proposes strict enforcement measures on the designated bus stops. Failure to observe ought to be prosecuted.

Road /infrastructure Improvement

Lessons learnt from the Dar es salaam case study promote infrastructure improvement by adding new transport facilities, expansion of road reserve to accommodate additional lanes, redesign of roads to include overpasses and underpasses.

The study proposes the improvement of Landhies road and its expansion from the current two/three lanes to four lanes. Four lanes are the fundamental lanes required for such a corridor since it receives traffic from Jogoo road and Lusaka road. Currently, the section between Sakwa road and Racecourse road roundabout leading into the CBD is two lanes.

Alternatively, this proposal recommends a proposal for the creation of an alternative slip road from City Stadium roundabout along Factory road terminating at the old railway station avoiding Landhies road. This slip road will reduce the traffic demand from Lusaka and Jogoo road toward Haile Selassie road. Lessons learnt from the Bogota City case study indicates that expanding road reserves to accommodate additional lanes is an effective congestion measure.

This study proposes the eradication of roundabouts at City stadium and Muthurwa market. This is informed by study findings which indicated the highest congestion points along the study area. City stadium roundabout is proposed as an interchange that would raise traffic from Lusaka road to the CBD above ground. Traffic from Jogoo road into the CBD would filter through the slip road (factory road) towards Haile Selassie at Railway station while the rest of the traffic would use Landhies road.

At the Muthurwa market, the study proposes replacement with an interchange, raising traffic from Racecourse road to Haile Selassie above ground to ensure continued uninterrupted flow. This would ensure that traffic volumes on Landhies road into the Haile Selassie road would have continuous movement via a slip road to the left. Traffic volumes towards Ronald Ngala and Racecourse road would have uninterrupted flow as well from Landhies road. This proposal has been adopted from the Bogota City case study of road residing to improve traffic management by the use of underpasses and overpasses at congestion intersections.

For the implementation of this proposal, a detailed feasibility study would be required to inform the viability of the proposals as well as assess the cost-benefit analysis. The actors necessary for this proposal include KURA, County and National government, and Financing partners. The feasibility will give way to the project design phase where the design preparation, route placement, actual financing, and construction would be undertaken. Due to the busy nature of the route the use of precast technology is proposed to reduce the construction period.

Traffic Management System

The existing human traffic police centred system operates with high levels of inefficiency and human error. The City requires an effective traffic control system. An effective intelligent transport system that uses analytical data and traffic pattern mapping is necessary. The ITS integrates traffic lights, traffic cameras, traffic sensors, and a data centre. This would enable the redeployment of traffic officers to man the control room and traffic police riders to move

around addressing incident points. Traffic cameras ought to be used to identify traffic offenders for ticketing or presentation to the court.

Implementation Recommendations

Within the course of this study, the NIUPLAN was extensively reviewed. The plan proposes various city-wide transport improvement strategies that would address challenges of traffic congestion along the Landhies-Jogoo road corridor. The timely implementation of the plan will improve the management of traffic congestion. Lessons learnt from the Bogota case study indicate re-organization of land use through the integration of the traffic management plan with the urban plan is one of the most cost-effective ways to reduce congestion on the roads.

The County Government of Nairobi experiences various difficulties in implementing projects, programmes and plans related to the transportation system. Adequate stakeholder participation has been a challenge as well as divergent visions. Case in point is Phasing out of low capacity vehicles, decongestion of CBD, relocation of bus stops among other incidents. This often results in court decisions challenging various plans and programmes to the detriment of the city residents. The Citizen forums need to come on board as stakeholders to guide and share their desired futures and services as far as public transport is concerned.

Areas of further study

Further research should be undertaken to investigate the implementation challenges experienced once different plans and programmes have been developed. There is a general delay in project implementation in the City and County in large as well as low success rates in timely implementation.

The area of governance and supporting policy is an area that requires research towards simplified operational frameworks that are easy to implements, time and cost-effective.

6.3. Conclusion

The primary objective of the study was to assess how traffic is managed in Nairobi City, along the selected corridor of Landhies-Jogoo Road corridor. The research set out to critically evaluate the existing and proposed management of urban traffic congestion within a selected transport route of Nairobi CBD and its environs and the resulting impacts on the road users and surrounding land-uses.

To this end, data on nature and causes of traffic congestion, modes of transport affected, peak timings (predictability) and impacts of congestion were sort by way of fieldwork through the administration of semi-structured interviews with the commuters, public transport operators, pedestrians, and private car owners. The impedance index of 90 Minutes (3:1) was established to collaborate with the congestion. A comparative evaluation through literature reviews and expert interviews in the field, of the existing traffic management strategies and their operationalization based on the various stakeholders responsible. Finally, based on the assessment of the existing status of traffic congestion along with the case study site, the study recommended possible congestion management policy measures.

The results of the study indicated that there is a need for a governance and management outlook in addressing the urban traffic congestion challenges. This approach may be used in the formulation of different congestion management strategies. The study concluded by developing a probable traffic congestion mitigation and management framework. An important lesson derived from this research study is the need for future traffic congestion studies to shift towards a more holistic approach to transport studies. These should explicitly link land-use policies, community expectations, and transport planning issues as a strategic measure of urban management and governance. General conclusions should be discouraged, rather, traffic congestion models require detailed context-specific analysis.

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APPENDICES

UNIVERSITY OF NAIROBI

DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE

MASTERS OF URBAN MANAGEMENT

RESEARCH PROJECT

*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

TRANSPORT SACCO QUESTIONNAIRE

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only*

Questionnaire Code ☐

Name of Interviewer_____

SECTION 1: RESPONDENT'S DETAILS

1. Name of Sacco

   _____

2. Position in the Sacco

   _____

3. Name of respondent (Optional)

   _____

4. Age: _____ years
5. Gender: Male ☐ Female ☐
6. Mobile No_____
7. How many years have you been in the public transport industry? _____
8. How many years have you been in the Sacco**?** _____

SECTION 2: TRANSPORT OPERATIONS

9. How many Vehicles do you operate in the Sacco? _____
10. State the type and number of vehicles you operate on this route?

Vehicle Type	Tick	Average no. of vehicles	Capacity of each
Matatu			
Mini Bus			
Bus			
Other (Specify			

11. How long does a single-vehicle stay in traffic along this route during the following hours (tick appropriately)?

Time Measure	Peak	Off-peak	Off-peak	Peak
	6am-9am	10am-1 pm	2-4pm	5pm-8pm
Less than 30 minutes				
31 minutes to 1 hour				
1 hour to 1 ½ hour				
1 ½ to 2 hours				
Above 2 hours				

12. Are the travel times above indicative of the traffic patterns?

- ☐ Yes
- ☐ No

13. How many trips do the vehicles make per day?

Type of Vehicle	No. of Trips on Weekdays	No. of Trips on Weekends

14. How much do you spend for fuel per day per vehicle (indicate route)?

_____

Average amount	Tick Appropriately	
	Weekdays	Weekends
Less than 1000		
1001-2000		
2001-3000		
3001-4000		
4001-5000		
5001-6000		
Above 6,000		

15. In your view, what causes traffic congestion?

Causes	Tick Appropriately
Poor road design	
High number of vehicles (specify) • Matatu • Private cars • All	
Poor Traffic control system	
Roadside parking/obstruction	
Poor road use	
Accidents	
Vehicle break downs	
Road construction and maintenance works	
Other (Specify)	

16. What is the effect of traffic congestion on your operations?

Causes	**Tick Appropriately**	
	YES	**NO**
Long travel times		
Reduces trips		
High cost of travel/fares		
High vehicle maintenance		
Environmental pollution		
Staff fatigue (drivers and conductors)		
Accidents		
Other (Specify)		

17. What traffic congestion management measures need to be put in place?

Management measure	**Tick Appropriately**	
	YES	**NO**
Build new roads		
Re-design and expand existing roads		
Control private car use		
Control matatus access to CBD		
Better traffic control system		
Prosecute Roadside parking and obstruction		
Enforce Traffic rules		
Schedule Road works for night times		
Other (Specify)		

18. What role should transport operators play in congestion management?

_____

_____

_____

UNIVERSITY OF NAIROBI

DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE

MASTERS OF URBAN MANAGEMENT

RESEARCH PROJECT

*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

PUBLIC TRANSPORT OPERATOR QUESTIONNAIRE

Disclaimer*: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only*

Questionnaire Code ☐

Name of Interviewer_____

SECTION 1: RESPONDENT'S DETAILS

1. Name of respondent (Optional) _____
2. Age: _____ years
3. Gender: ☐ Male ☐ Female
4. Mobile No_____
5. Highest level of Education level

   ☐ None

   ☐ Primary school dropout

   ☐ Completed primary school

   ☐ Secondary school graduate

   ☐ Tertiary:

   ☐ Certificate ☐ Diploma ☐ Degree
6. Occupation_____
7. How many years have you been in the public transport industry? _____
8. How many years have you been in the Sacco**?** _____

SECTION 2: TRANSPORT OPERATIONS

9. Type of Vehicle operated

- ☐ Matatu
- ☐ Mini Bus
- ☐ Bus
- ☐ Others (specify)

10. Transport route operated (name and no) _____

11. How many trips on average do you make per day along this route?

No. of Trips	Weekdays	Weekends

12. What time do you start work in the morning? _____

13. How long does it take you to get to town in the following times?

Time Taken	**Off-peak 4am-6am**	**Peak 7am-9am**	**Off-peak 10am-1 pm**	**Off-peak 2-4pm**	**Peak 5pm-8pm**
Less than 30 minutes					
31 minutes to 1 hour					
1 hour to 1 ½ hours					
1 ½ to 2 hours					
Above 2 hours					

14. Do you experience traffic congestion (jam) on this route?

- ☐ Yes
- ☐ No

14.1. If yes above, how long do you stay in traffic jam (standstill/slow movement)?

Time Taken	**Off-peak 4am-6am**	**Peak 7am-9am**	**Off-peak 10am-1 pm**	**Off-peak 2-4pm**	**Peak 5pm-8pm**
Less than 30 minutes					
31 minutes to 1 hour					
1 hour to 1 ½ hour					
1 ½ to 2 hours					
Above 2 hours					

15. What are the traffic speeds during peak hours?

- ☐ No movement traffic (bumper to bumper)
- ☐ Slow movement traffic (below 30kph)
- ☐ Moderate movement traffic (30 to 50kph)
- ☐ Fast-moving traffic (above 50 kph)

16. Do Traffic patterns vary at different times of the month?

TIME OF THE MONTH	**LEVEL OF TRAFFIC (High =1, Medium =2, Low=3)**
1st Week	
2nd Week	
3rd Week	
4th Week	

17. Which areas/point does traffic congestion occur along the route?

_____

_____

_____

18. In your view, what causes traffic congestion?

Causes	**Tick Appropriately**
Poor road design	
High number of vehicles (specify) • Matatu • Private cars • All	
Poor Traffic control system	
Roadside parking/obstruction	
Poor road use	
Accidents	
Vehicle break downs	
Road construction and maintenance works	
Other (Specify)	

19. Which days of the week is traffic congestion experienced?

Days	Tick Appropriately	Relative measure (High, Medium, Low)
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
Saturday		
Sunday		

20. What is the impact of Muthurwa market on traffic congestion?

_____

_____

21. What is the impact of Ukulima market on traffic congestion?

_____

22. Do you use alternative routes to avoid the traffic?

☐ Yes

☐ No

21.1. If yes above, which routes are these?

_____

What is the impact of traffic congestion if any, on?

Travel times_____

_____

Commuters

_____

_____

Transport operators (Driver and conductor)

_____

_____

Fuel Consumption

_____

_____

Other road users_____

SECTION 3: TRAFFIC MANAGEMENT

23. Do traffic lights function in traffic management along the route? If Yes are, they effective?

_____

_____

24. How effective are traffic police in traffic management on the route?

_____

_____

25. In you view, what should be done to address traffic congestion?

_____

_____

_____

_____

UNIVERSITY OF NAIROBI

DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE

MASTERS OF URBAN MANAGEMENT

RESEARCH PROJECT

*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

COMMUTER QUESTIONNAIRE

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only*

Questionnaire Code ☐

Name of Interviewer_____

SECTION 1: RESPONDENT'S DETAILS

1. Name of respondent (Optional) _____
2. Age: _____ years
3. Gender: Male ☐ Female ☐
4. Mobile No_____
5. Highest level of Education level

   ☐ None

   ☐ Primary school dropout

   ☐ Completed primary school

   ☐ Secondary school graduate

   ☐ Tertiary:

   Certificate ☐ Diploma ☐ Degree ☐

6. Employment status

   Employed ☐ Self Employed ☐ Unemployed ☐ Student ☐

7. Period of Stay in Nairobi (in years)

   _____

8. Period of commuting along Landhies Jogoo road (in years) _____

SECTION 2: Traffic Congestion

9. Do you use any of these modes of public transport? (tick appropriately)

- ☐ Matatu
- ☐ Bus
- ☐ Motor cycle
- ☐ Others (specify)

10. Which mode of transport do you prefer most?

- ☐ Matatu
- ☐ Bus
- ☐ Motor cycle
- ☐ Others (specify)

11. Why do you prefer this mode of transport?

_____

_____

12. How much do you spend daily on fare? (to and from)

Average amount	**Tick Appropriately**
Less than 100	
101-200	
201-300	
301-400	
401-500	
Above 500	

13. Trip Origin (residence)_____ Trip Destination (work/school) _____

14. How often do you use this route within a week?

DAY	**Tick Appropriately**
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

15. What is your Trip Purpose (tick appropriately)?

- ☐ Work
- ☐ Personal needs / Shopping
- ☐ Leisure
- ☐ School
- ☐ Other (specify)

16. What times of the day do you use this route?

_____

_____

17. How long does it take you from Home to CBD during the following hours?

Time Measure	**Off-peak**	**Peak**	**Off-peak**	**Off-peak**	**Peak**
	4am-6am	**7am-9am**	**10am-1 pm**	**2-4pm**	**5pm-8pm**
Less than 30 minutes					
31 minutes to 1 hour					
1 hour to 1 ½ hours					
1 ½ to 2 hours					
Above 2 hours					

18. Do you experience traffic congestion (jam) on this route?

- ☐ Yes
- ☐ No

18.1. If yes above, how long do you stay in traffic?

- ☐ Less than 30 minutes
- ☐ 31 minutes to 1 hour
- ☐ 1 hour to 1 ½ hours
- ☐ 1 ½ to 2 hours
- ☐ Above 2 hours

19. Which areas/point does traffic congestion occur along the route?

_____

_____

20. In your view, what causes traffic congestion?

Causes	**Tick Appropriately**
Poor road design	
High number of vehicles (specify) • Matatu • Private cars • All	
Poor Traffic control system	
Roadside parking/obstruction	
Poor road use	
Accidents	
Vehicle break downs	
Road construction and maintenance works	
Other (Specify)	

21. Which days of the week is traffic congestion experienced?

Days	**Tick Appropriately**
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

22. In your view, what is the impact of traffic congestion (if any), on?

Duration of Travel _____

Time of departure from home _____

Commuting costs (fares) _____

Transport operators (Driver and conductor) _____

SECTION 3: Traffic Management

23. What is your view on the role of traffic police in managing traffic congestion on the route?

_____

_____

24. In you view, what should be done to address traffic congestion?

_____

_____

_____

_____

UNIVERSITY OF NAIROBI

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RESEARCH PROJECT

*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

PEDESTRIAN QUESTIONNAIRE

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only*

Questionnaire Code ☐

Name of Interviewer_____

SECTION 1: RESPONDENT'S DETAILS

1. Name of respondent (Optional) _____

2. Age: _____ years

3. Gender: Male ☐ Female ☐

25. Employment status

Employed ☐ Self Employed ☐ Unemployed Student

SECTION 2: Movement patterns

26. Trip Origin (residence)_____ Trip Destination (work/school) _____

27. What is your Trip Purpose (tick appropriately)?

☐ Work

☐ Personal needs / Shopping

☐ Leisure

☐ School

☐ Other (specify)

28. How often do you walk along this route within a week?

DAY	**Tick Appropriately**
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	
Once in a while	

29. How long does it take you to walk to your destination (Home to CBD)?

Time Measure	**Tick appropriately**
Less than 30 minutes	
31 minutes to 1 hour	
1 hr. to 1 ½ hrs.	
1 ½ to 2 hrs.	
2 hrs. to 2 ½ hrs.	
2 ½ hrs. to 3 hrs.	
Above 3 hrs.	

30. In your view, do pedestrian contribute to traffic congestion when crossing the road? (Yes/No, Explain) _____

_____

31. In your view, does traffic congestion have an impact on pedestrian in the following areas?

Impact	**Tick Appropriately**		**Describe/Explain**
	YES	**NO**	
Health			
Personal security			
Pedestrian walkways			
Pedestrian crossings			
Environmental pollution			
Other (Specify)			

32. Are there adequate pedestrian facilities as listed

Impact	**Tick Appropriately**	
	YES	**NO**
Pedestrian walkways		
Pedestrian crossing & footbridge		
Pedestrian benches		
Other (Specify)		

33. In you view, what should be done to address traffic congestion?

_____

_____

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*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

PRIVATE CAR QUESTIONNAIRE

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only*

Questionnaire Code ☐

Name of Interviewer_____

SECTION 1: RESPONDENT'S DETAILS

1. Name of respondent (Optional)

   _____

2. Age: _____ years
3. Gender: ☐ Male ☐ Female
4. Highest level of Education level

   ☐ None

   ☐ Primary school dropout

   ☐ Completed primary school

   ☐ Secondary school graduate

   ☐ Tertiary:

   ☐ Certificate ☐ Diploma ☐ Degree
5. Employment status

   Employed ☐ Self Employed ☐ Unemployed ☐ Student ☐
6. How many years have you been driving along the route (years)**?**

   _____

   ___

SECTION 2: TRANSPORT OPERATIONS

7. How often do you use this route within a week?

DAY	Tick Appropriately
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	

8. Travel route

Trip Origin (residence)_____ Trip Destination (work/school) _____

9. What time do you begin your journey? _____

10. How long does it take you to get to town along the route?

Time Taken	Off-peak 4am-6am	Peak 7am-9am	Off-peak 10am-1 pm	Off-peak 2-4pm	Peak 5pm-8pm
Less than 30 minutes					
31 minutes to 1 hour					
1 hour to 1 ½ hours					
1 ½ to 2 hours					
Above 2 hours					

11. Do you experience traffic congestion (jam) on this route?

☐ Yes

☐ No

28.1. If yes above, how long do you stay in traffic jam (standstill/slow movement)?

Time Taken	Off-peak 4am-6am	Peak 7am-9am	Off-peak 10am-1 pm	Off-peak 2-4pm	Peak 5pm-8pm
Less than 30 minutes					
31 minutes to 1 hour					
1 hour to 1 ½ hours					
1 ½ to 2 hours					
Above 2 hours					

12. What are the traffic speeds during peak hours?

- ☐ No movement traffic (bumper to bumper)
- ☐ Slow movement traffic (below 30kph)
- ☐ Moderate movement traffic (30 to 50kph)
- ☐ Fast-moving traffic (above 50 kph)

13. Do Traffic patterns vary at different times of the month?

TIME OF THE MONTH	**LEVEL OF TRAFFIC (High =1, Medium =2, Low=3)**
1st Week	
2nd Week	
3rd Week	
4th Week	

14. Which areas/point does traffic congestion occur along the route?

_____

_____

_____

_____

15. In your view, what causes traffic congestion?

Causes	**Tick Appropriately**
Poor road design	
High number of vehicles (specify) • Matatu • Private cars • All	
Poor Traffic control system	
Roadside parking/obstruction	
Poor road use	
Accidents	
Vehicle break downs	
Road construction and maintenance works	
Other (Specify)	

16. What is your view on public vehicles and traffic congestion?

_____

_____

17. Which days of the week is traffic congestion experienced?

Days	Tick Appropriately	Relative measure (High, Medium, Low)
Monday		
Tuesday		
Wednesday		
Thursday		
Friday		
Saturday		
Sunday		

18. Do you use alternative routes to avoid traffic?

☐ Yes

☐ No

42.1. If yes above, which routes are these?

_____

_____

19. What is the impact of traffic congestion if any, on?

Travel times_____

_____

Fuel Consumption

_____

_____

Personal Health_____

SECTION 3: TRAFFIC MANAGEMENT

20. How effective are traffic police in traffic management on the route?

_____

_____

21. Would you use public transport (buses) as an alternative to personal car to address traffic congestion?

_____

_____

22. In you view, what should be done to address traffic congestion?

_____

_____

_____

UNIVERSITY OF NAIROBI
DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE
MASTERS OF URBAN MANAGMENT
RESEARCH PROJECT

*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

NAIROBI CITY COUNTY ROADS/TRAFFIC MANAGEMENT DEPARTMENT

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only.*

Name of Interviewer_____

Respondent Name (optional)_____

1. What traffic management techniques are employed along the Route and the larger CBD
2. How many public vehicles/routes operate within the corridor?
3. What is the estimated capacity of the following bus terminus?
    a. Machakos Country Bus
    b. Railways Station
    c. Easy coach Station
4. Your view, on traffic congestion along the route
5. Comment on the behaviour patterns of the following in regard to traffic movement and congestion
    a. Matatu
    b. Buses
    c. Private Cars
    d. Motorcycles
    e. Hand carts
    f. Pedestrians
6. Comment on road design and capacities (lanes, intersections, and roundabout) in regard to traffic congestion
7. Does the route have NCC traffic Marshalls?
8. How are the roles shared between NCC traffic marshals and the Traffic police department?
9. What is the impact of the bus terminal on traffic congestion along the corridor?
10. What is the impact of markets (Muthurwa, Ukulima, Gikomba) on traffic congestion along the corridor?
11. Have there been Previous attempts to decongest the corridor
12. What lessons can be drawn from these attempts (if any)
13. What institutional arrangements are required to effectively manage traffic congestion?
14. What measures need to be put in place to fully manage traffic congestion
15. What proposals are in place (if any) towards decongestion of the CBD along the corridor

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RESEARCH PROJECT
*(Managing Urban Traffic Congestion (traffic Jam) along Landhies-Jogoo Road Corridor***)**

TRAFFIC POLICE AND NCC TRAFFIC WARDEN DISCUSSION POINTS

***Disclaimer**: This questionnaire is being administered to inform a Masters Degree for an Academic Project. Any information provided is confidential and will be used for this purpose only.*

Questionnaire Code ☐

Name of Interviewer_____

Respondent Name (optional) _____

Station of officer within route

1. Which is the traffic congestion points along the route
2. Your view, causes of traffic congestion
3. When does traffic congestion occur (time)?
4. How long does traffic congestion occur (peak periods)?
5. Comment on the behaviour patterns of the following in regard to traffic movement and congestion
    a. Matatu
    b. Buses
    c. Private Cars
    d. Motorcycles
    e. Hand carts
    f. Pedestrians
6. Comment on road design and capacities (lanes, intersections, and roundabout) in regard to traffic congestion
7. How do you manage congestion into the terminals i.e. Easy coach, Railways?
8. How do you manage to pick and drop off passengers by matatu on road reserve?
9. How do you manage hand carts on road reserves?
10. Effects of Traffic congestion
11. How do you manage traffic congestion?
12. How can traffic congestion be eradicated
13. What measures need to be put in place to fully manage traffic congestion
14. What institutional arrangements are required to effectively manage traffic congestion?