

**SOCIO-ECONOMIC EFFECTS OF TRAFFIC CONGESTION ON URBAN
MOBILITY ALONG JOGOO ROAD, NAIROBI CITY COUNTY - KENYA**

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**A Research Project submitted in partial fulfilment of the requirements for the
Degree of Master of Environmental Planning and Management in the School of
Environmental Studies of Kenyatta University**

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DECLARATION

This research project is my own original work and has not been presented for a degree in any other university or any other award. Where text, data, graphics, pictures or tables have been borrowed from other sources, including the internet, they have been specifically accredited and the references cited using current APA system. The research project has been prepared in accordance with anti-plagiarism regulations.

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DEDICATION

This Project is dedicated to my beloved husband, Mr. James Ratemo, who has supported and encouraged me all the way and made sure that I give it all it takes to finish this project. To my daughters, Tiffany and Ruby, who have been affected in every way possible by this quest. And to my parents too for their endless love and care.

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This project was developed by the grace of God and I want to thank Him for good health, knowledge and finances throughout the project research.

I would like to express my sincere gratitude to my project supervisor Professor Caleb Mireri for his valuable guidance and walking with me throughout this project. Thank you for being patient with me. I am indebted to my esteemed classmates (2014-2017) for the encouragement and support rendered to me during the study period.

To my dear husband and daughters, thank you for understanding and bearing with my busy schedule as I worked on this project. And to my parents (Mr. and Mrs. Ndatho), thank you for your unwavering support throughout my academic journey.

This project would not have been possible without the support of my colleagues at the Ministry of Lands (Physical Planning Department) and all those who supported my academic efforts on a daily basis.

Thank you all, and may God bless you!

ABSTRACT

An effective urban transport system should have the ability to deal with the high density that characterizes most urban areas while moving people and goods. However, the high rate of urbanization experienced in most developing countries has resulted into massive traffic congestion, which in turn has hampered effective transportation. The biggest burden of the heavy traffic jam experienced in Nairobi City lies on the commuters who bear with traffic jams that snarl up for kilometers and stay for hours hence accruing social dilemma and huge economic loses in terms of the time wasted, increased travel cost, respiratory diseases associated to the vehicular exhaust emissions in traffic, stress and anxiety, less time with family and other social effects associated with traffic congestion among others. Jogoo Road which was the study area, being a major arterial in Nairobi City experiences heavy traffic congestion. The study sought to investigate the social and economic effects of traffic congestion and to propose the measures that can be employed to alleviate the problem. A pilot study was carried out and the researcher focused on the objectives of the study and determined the parameters which were measured. Based on the objectives, descriptive research was applied to collect and analyze both qualitative and quantitative data. Questionnaires, key informant interviews, focus group discussions, observation and photography were the major sources of primary data. Secondary data sources including online reports, journals, and books also informed the study. Simple random and stratified sampling procedures were employed to select the sample that was studied. Data collected was input into Statistical Package for Social Sciences (SPSS) software, correction of errors was carried out followed by analysis. To determine the social and economic effects of traffic congestion, frequencies and measures of central tendency (mode and mean) were used. Qualitative data was analysed through conceptualization and description. To increase reliability and validity, multiple observers were employed and more random samples were obtained in order to increase external validity. Use of the documented theories in the study also increased the validity and reliability of the research findings. Based on the findings of the study, the researcher ascertains that the major causes of traffic congestion along Jogoo road include increase in population, increased ownership of private cars, limited road capacity with inappropriate design, lack of Non Motorised Transport (NMT) facilities, unreliable public transport, and encroachment of the road space, over-reliability of one mode of transport. The study establishes that traffic congestion results to both economic and social effects including increased travel time, higher travel cost, lost business opportunities, health risks, environmental pollution, stress, fatigue and less time with families associated to leaving home early and arriving late. The study recommends for an effective, reliable and affordable public transport system, expansion of Jogoo road, provision of NMT facilities, exploration of railway as alternative mode of travel, introduction of Bus Rapid Transit (BRT), banning private vehicles from the Central Business District (CBD), teleworking, staggering working hours, effective traffic managements systems among others in order to reduce traffic congestion and the associated socio-economic effects.

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ACRONYMS AND ABBREVIATIONS

BRT	Bus Rapid Transit
CBD	Central Business District
CIDP	County Integrated Development Plan
CO ₂	Carbon dioxide
CODESRIA	Council for the Development of Social Science Research in Africa
EMCA	Environmental Management and Coordination Act
GDP	Gross Domestic Product
GHG	Green House Gas
INTP	Integrated National Transportation Policy
ITS	Integrated Transportation System
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KURA	Kenya Urban Roads Authority
LOS	Level- of- Service
MOA	Matatu Owners Association
MRT	Mass Rapid Transit
MWA	Matatu Welfare Association
NAMATA	Nairobi Area Metropolitan Authority
NCC	Nairobi City County
NEMA	National Environmental and Management Authority
NIUPLAN	Nairobi Integrated Urban Development Plan
NMIMT	Non-Motorized and Intermediate Means of Transport
NMR	Nairobi Metropolitan Region
NTSA	National Transport and Safety Authority
SDG	Sustainable Development Goals
TUDC	Transport and Urban Decongestion Committee
UN-HABITAT	United Nations Human Settlement Program
V/C	Volume to capacity ratios
VTPI	Victoria Transport Policy Institute

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

An efficient urban transport system provides for the movement of people and goods within an urban area as well as linking the city to its environs (KIPPRA, 2005). People's ability to travel to and from their residences to their workstations, shops, schools, health centres and other social places is indispensable for a City to perform effectively. The ability to access such places plays a key role in choosing residential location since it affects household income and expenditure hence the need to facilitate moving people and not cars (Arnott & McMillen, 2006).). Among the other modes of transport, the road transport is the most commonly used globally.

Rapid rates of urbanization pose challenges to the provision of transportation infrastructure in most cities both in developed and in developing countries. The current world's urban population stands at about 50% and is expected to increase 70% by year 2050 (World Bank, 2017) with Africa experiencing the highest urban growth rate at 3.5% per year (ADB, 2012). According to Green Car Reports, there were 1.2 Billion vehicles on the World's roads and the number is projected to over 2 billion by 2035 (Voelcker, 2014), which will have to squeeze into the already congested roads. Without a matching supply of transportation infrastructure, vehicles will literally choke tomorrow's cities, resulting into negative consequences that will undercut the benefits of urbanization. The consequences may include but not limited to lowered productivity; air pollution including rising carbon emissions; road traffic deaths and injuries; rising inequity and social division (World Bank, 2017). Downs (2014) wrote that congestion is found from Calcutta to London, from Caracas to Tokyo, from Cairo to Moscow indicating that traffic congestion is experienced across the globe.

Whereas Africa's vehicle fleets have grown between 5% (Southern Africa) and 67% (Western Africa) from 2007 to 2010 (UNEP, 2013), transportation system in Sub-Saharan Africa is not designed to accommodate the current number of vehicles let alone future growth (Julia, 2013). For instance, despite having some of the best roads on the continent, IBM's Fourth Commuter Pain Survey-2011 ranked Johannesburg fifth worst in

terms of the pain commuters suffer to and from work. Nairobi was ranked fourth worst while commuters in Lagos spend about 40% of their income on transportation (Curnow & Kermeliotis, 2012).

In Kenya, urban population grew from one million in 1969 increasing at a rate of 7.9% (Hope, 2012) per year to 12 million by 2009 (KNBS, 2012). Nairobi's population increased from 350,000 in 1963 to 3.1 million in 2009 as per the 2009 Census (Kenya National Bureau of Statistics (KNBS), 2012), this explains the rising demand for transportation. In addition, there are over two million registered vehicles on Kenyan roads and the numbers are projected to shoot to five (5) and eight (8) million by year 2030 and 2050 respectively (Kenduiwo, 2014). In most Kenyan cities, with Nairobi leading, various means of transport compete for the same road space including buses, *matatus*, private cars, rickshaws (tuk tuk), motorcycle taxis (*boda boda*), bicycles, pedestrians, hand carts among others. The high rate of urbanization coupled with the competition of the same road space by various modes of transport have raised the demand of transportation infrastructure which has not been met adequately hence the traffic jams in most urban areas with the worst traffic congestion being experienced in Nairobi.

1.2 Problem Statement

Nairobi, the capital city of Kenya, provides for 50% formal employment in Kenya and produces over 50% of the country's GDP (JICA, 2014). Nairobi has a high rural-urban migration, hence by 2040 the population is expected to rise from the current 3.5 million to about 8-10 million (Institute of Economic Affairs, 2011). According to CIDP, the population was projected to be 3.9 million by 2014 (Nairobi City County, 2014) and the NIUPLAN projects it to be 5,2 million by 2030 (JICA, 2014).

Nairobi's road network and the general layout of the built environment is still based on the 1948 Nairobi Master Plan which has since been overtaken by development dynamics rendering it obsolete (JICA, 2014). The attempt to re-plan the City by the 1973 Nairobi Metropolitan Growth Strategy yielded little results as the Strategy was hardly implemented until its expiry in the year 2000. The Nairobi Integrated Urban

Development Plan (NIUPLAN) 2014 proposes various measures that can be undertaken to alleviate traffic congestion.

Each and every person living and working in Nairobi, as well as passersby, have had the misfortune of experiencing congestion and its effects. The unreliable and inefficient public transport network has resulted to use of alternative means of transport driven by the market forces. It has also prompted the increase of private cars as they are more reliable and efficient. The City roads carry more than 60% of the over two million registered vehicles in Kenya hence the heavy traffic jams experienced on its roads (KIPPRA, 2015). Nairobi city has a road capacity adequate for only one-third of its population yet about 71% of the commuters drive to work alone in private vehicles (McGregor & Doya, 2014). The 8am to 5pm working hours' culture in Kenya also contributes to the massive traffic congestion experienced on Nairobi City roads since demand is highest between 6am to 9am and 4PM to 7-8pm.

All these factors pulled together, have resulted to massive traffic congestion on the City's roads which in turn increases the travel cost in terms time and money wasted. It was estimated that household expenditure on transport in Nairobi County stood at approximately Kshs. 250 million per day while Kshs.50 million was wasted per day through increased fares and fuel consumption, mechanical damage, stress, diseases and pollution (Henry, 2016) and (McGregor & Doya, 2014). There are various measures that have been put in place to address the issue of traffic congestion in Nairobi City which include; upgrading and construction of new of roads, removal of roundabouts, introduction of traffic lights and marshals among others. Nonetheless, these efforts have yielded minimal results in reducing traffic congestion.

The study focused on Jogoo Road which serves the middle income residential estates in the Nairobi's Eastlands area. The Road has many feeder roads that spill their traffic into it including the busy Outering Road which is currently being upgraded. The high population density in the area coupled with other factors have resulted to massive traffic congestion along Jogoo Road. In an attempt to effectively respond to this drawback,

many initiatives including upgrading the road to a dual carriageway, have been sought over the years only for minimal results to be achieved.

The study was built on KIPPRA'S study gap identified in Policy Brief No.2 of 2015 ((KIPPRA, 2015) by seeking to investigate both the economic and social effects of traffic congestion at a micro-level. Unlike the previous studies on traffic congestion which have always concentrated on the economic effects of traffic congestion, this study assesses both the economic and social effects. It investigates on how traffic congestion affects commuters in terms of the household expenditure allocated for travel costs as well as the social disruption associated with traffic congestion which forms this study's research gap. Based on the findings, the study proposes measures that can be put in place to alleviate the socio-economic effects of traffic congestion.

1.3 Research Objectives

1.3.1 General Objective

The general objective for this research is to examine the socio-economic effects of urban traffic congestion along Jogoo Road, Nairobi City County

1.3.2 Specific objectives

This research has the following specific objectives:

- i. To assess the main causes of traffic congestion
- ii. To examine the social effects of traffic congestion along Jogoo Road
- iii. To assess the economic effects of traffic congestion along Jogoo Road
- iv. To propose measures that can be put in place to reduce the socio-economic effects of road traffic congestion.

1.4 Research questions

- i. What are the causes of traffic congestion?
- ii. How does traffic congestion affect people socially and economically?
- iii. What measures can be put in place to alleviate road traffic congestion?

1.5 Research Premises

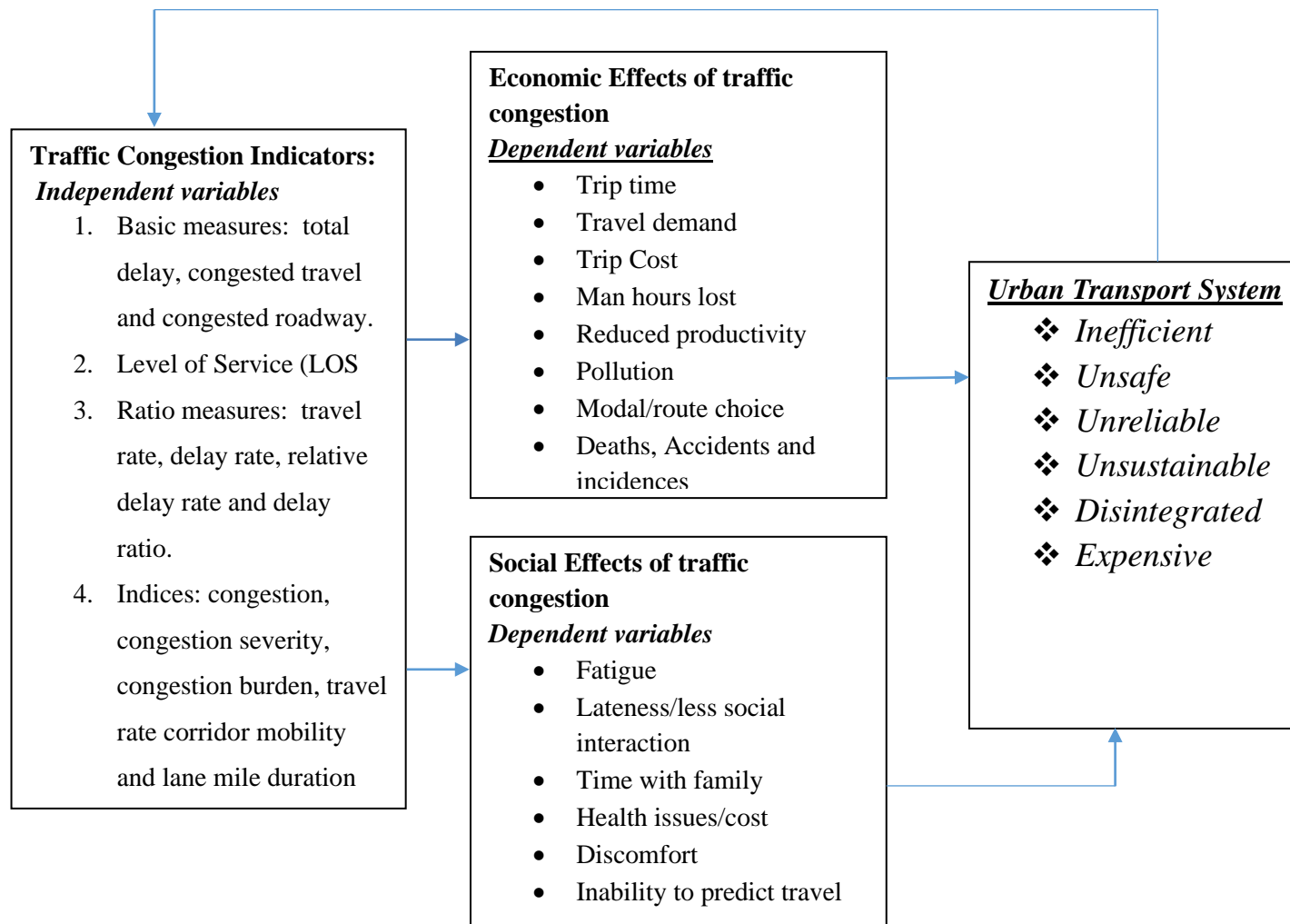
Traffic congestion has negative socio-economic effects on the road users along Jogoo Road, Nairobi City County.

1.6 Significance of the Study

This study purposes to close a research gap identified by KIPPRA by evaluating the socio-economic effects of traffic congestion (KIPPRA,2015). This study therefore seeks to demonstrate how traffic congestion, that most commuters have to endure on a daily basis, affects Nairobi County residents socially and economically. Additionally, there is need for the relevant authorities to understand how congestion negatively affects our cities and their competitiveness as well as the productivity of its citizens, and the benefits of achieving free-flow travel. This study can be used as a reference point by relevant authorities on policy matters that pertain to alleviating traffic congestion not only in Nairobi but also in other cities across the Country. The research also recommends on the areas that will require further investigation in the future to close any knowledge gap that this study may not fill.

1.7 Conceptual Framework

Based on the analysis carried out on the theories discussed in section 2.2, the conceptual framework will be based on only 2 theories: Urban Transport Economic Theory (Arnott R. , 2001) and Systems theory (Falcocchio & Levison, 2015). Figure 2 is a conceptual framework illustrating the various effects of traffic congestion and the overall impact on the transport network. Details on how the dependent variables have been given in table 2.



Source: Author, 2017

(Constructed from The Urban Transport Economic Theory by Beckmann, McGuire, and Winsten, 1956.)

Figure 1 Conceptual Framework

1.8 Definition of Terms

Bus stop: according to the Highway Capacity Manual, a bus stop is a designated area where buses or matatus off load or unload passengers (Transport Research Board, 2000).

Level of Service: A road's level of service defines the functioning of a road by considering factors such as speed, travel time, density, traffic disruptions, ease of movement and intersection delay (Transport Research Board, 2000).

Road capacity: It is the maximum capacity of vehicles or passengers a road can accommodate in a given period of time (Mathew and Krishna 2007).

Traffic Congestion: this refers to a condition where automobiles queue or block each other due to insufficient motorway space having reached maximum capacity (ECMT, 2007).

Traffic density: This refers to vehicular capacity in a specific stretch of a road at a given time period. It is measured in vehicles per kilometers (Raheem, Olawoore, Olagunju, & Adeokun, 2015).

Traffic flow: This is the comparable hourly rate at which vehicles bypass a particular point on a traffic lane or road and is calculated by dividing the total number of vehicles by time interval (Raheem, Olawoore, Olagunju, & Adeokun, 2015).

Travel Delay (vehicle-hours and person-hours): Delay expressed or measured in time per vehicle and per person.

Travel speed: This is average speed calculated as the length of a road section divided by the average travel time of the vehicles crossing the section (Transport Research Board, 2000).

Travel time: It refers to the average time that vehicles spend while passing through a particular road section (Transport Research Board, 2000).

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter is an assessment of various theories and empirical literature relevant to the assessment of the social-economic effects of road traffic congestion in Nairobi and was done relevantly to the conceptual framework presented in Figure 1.

2.2 Traffic Congestion: Definition and History of Congestion

2.2.1 Definition

Traffic congestion occurs when the demand for road space surpasses the supply (Waweru, 2012). In concurrence, Olagunju (2015) postulates traffic jam is experienced when travel demand is immense enough such that the interaction between vehicles decelerates the speed of the traffic flow and is manifested by slower speeds, longer travel times and increased lining up and tailgating.

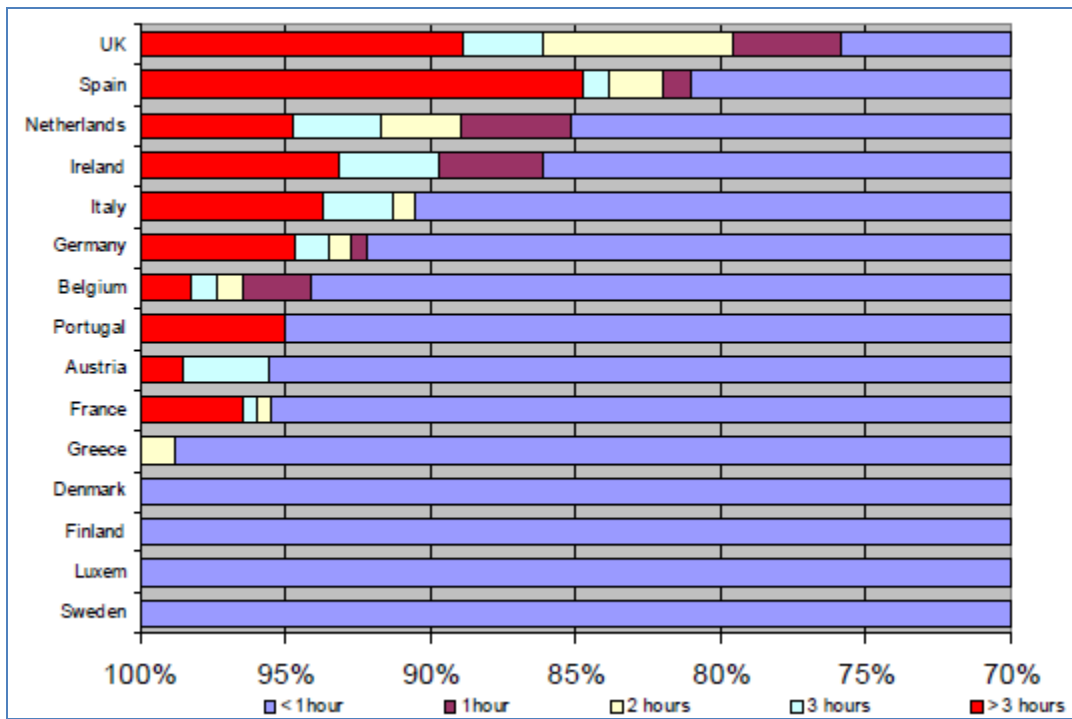
FHWA (2017) relates traffic jam to an overflow of vehicles on a section of a road way at a given time which results into speeds that are slower than the free flow speeds. It means stationary or stop-and-go traffic. ECMT (2007) simply defines congestion simply as a situation in which demand for road space exceeds supply. This definition is often used by transport engineers in a bid to solve congestion issue by expanding/upgrading roads or better still constructing new roads all together.

2.2.2 History of traffic congestion

Congestion is not a new occurrence but predates the industrial revolution, the motor vehicle and modern city. Before the automobile era, traffic jam was characterized by stagecoaches, wagons, and pedestrians contending for business district (CBD) space (Falcocchio & Levinson, 2015). Initially road network in urban areas was designed for walking. Eventually however, towns grew and others means of transport such as horse buses, trams, trolley buses and motor buses were introduced and used the same road space causing congestion. Since there were limited public spaces, roads became areas of concentration for employment, housing and community facilities causing more congestion (Rukunga, 2002)

Morris Eric in his article *“All Roads Leads to Congestion”*, concedes that traffic congestion has plagued man all the way back to ancient Rome where the major causes of traffic were the high population density, the organic street network, narrow streets, the street being used for non-transportation activities and obstacles (stones) placed on the road to avoid stepping in the muck. He further observed that the ancient equivalents of transportation planners and engineers did their best to overcome these problems by banning wheeled traffic within the City during certain hours of the day, requiring the travelers to dismount and walk through city limits and blocking certain streets from vehicular travel. However, little success was achieved from these endeavors (Morris, 2014).

A review by the Commission for Integrated Transport shows that UK is one of the most congested European countries (see figure 2) and can be attributed to the fact that road traffic is growing faster than the road capacity (Commission for Integrated Transport, 2011).



Source: Commission for Integrated Transport, 2011

Figure 2 Congested Links in the Europe

According to a survey done by UN-HABITAT, congestion on roads is the major type of infrastructure insufficiency (96 per cent in Africa; 91 per cent in Asia; 88 per cent in Latin America; and 80 per cent in Arab states) plaguing cities in both developed and developing cities hence hampering free movement and increasing travel times. Defective roads in most African cities hinders free movement and prosperity and are a major cause of traffic congestion. This is aggravated by the poor road maintenance since only 18.5 per cent of experts across African cities believe that infrastructure is systematically maintained (UN-HABITAT, 2012).

2.3 Theoretical Framework

2.3.1 Urban Transport Economic Theory

The many activities and interactions in urban areas result into a variety of externalities which in return make 'pricing' of transport cost difficult. Transportation costs play a critical role in the formation and working of cities. Some the externalities include; traffic congestion, environmental pollution, accidents, noise among others (Arnott & McMillen, 2006). The Federal Highway Administration in USA estimates the average cost of the externalities (Effects) as follows:

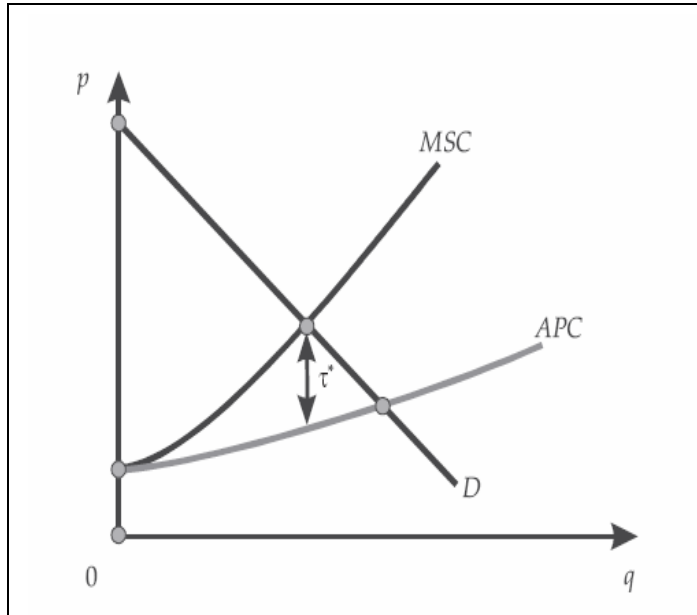
Table 1 Average cost of traffic congestion

Externality	Cost in cents per mile (USD)	
	Urban areas	Rural areas
Traffic congestion for passenger cars	7.7	0.78
Environmental pollution of passenger cars	1.33	
Accidents/crash costs	1.19	

Source: Arnott & McMillen, 2006

To calculate the private and social costs incurred in terms of vehicle running costs (fuel, tires, engine oil, wear and tear etc), cost of time and traffic accidents cost a basic model that examines travel on a single point-input, point-output road is used.

It is assumed that drivers are similar and makes a decision only on the trip rate of recurrence. It is also assumed that traffic jam is netted by a congestion cost function that associates cost of a trip to traffic flow and volume (Arnott , 2001).



Where:

D: Demand curve

Q: Relating the flow of trips demanded

P: Trip price (trip cost and the toll)

APC: Also called trip cost, average private cost, user cost, marginal private cost, and short-run average variable cost

MSC: Marginal social cost of a trip

t : Congestion toll

Source: Arnott, 2001

Figure 3 Basic model of Urban Transport Economic Theory

According to Arnott (2001), the APC curve slants upwards due to congestion because as traffic flow increases so does the trip time and trip cost. With no intervention from the relevant institutions, the equilibrium will be where the demand curve (D) meets with the User Cost curve (APC). On the other hand, the optimum will occur where demand curve (D) meets the Marginal Social Cost curve(MSC) (Arnott, 2001).

When an individual driver takes an extra trip by slowing other drivers down, it imposes external congestion cost which is the APC and MSC. To spread out the social optimum, the appropriate institution can impose a congestion toll, t , in the diagram, equal to the marginal external congestion cost (Arnott , 2001).

However, the Economic theory has been criticized by, among others Richard Arnott, on the following basis:

- i. Pertinent margins of choice are overlooked
- ii. The congestion function captures not only technology but also behaviour: Apart from technology, congestion cost function includes all the behavioral decisions related to travel as well.
- iii. The model considers only one type of congestion i.e. link flow congestion, where a driver's travel time and travel costs on a link are positively related to traffic capacity or flow on the link.

2.3.2 Systems Theory

Von Bertalanffy accentuated that actual systems are open to, and interrelate with their surroundings, and that they can obtain qualitatively new properties through emergence, resulting in recurrent evolution (Heylighen and Joslyn 1992).

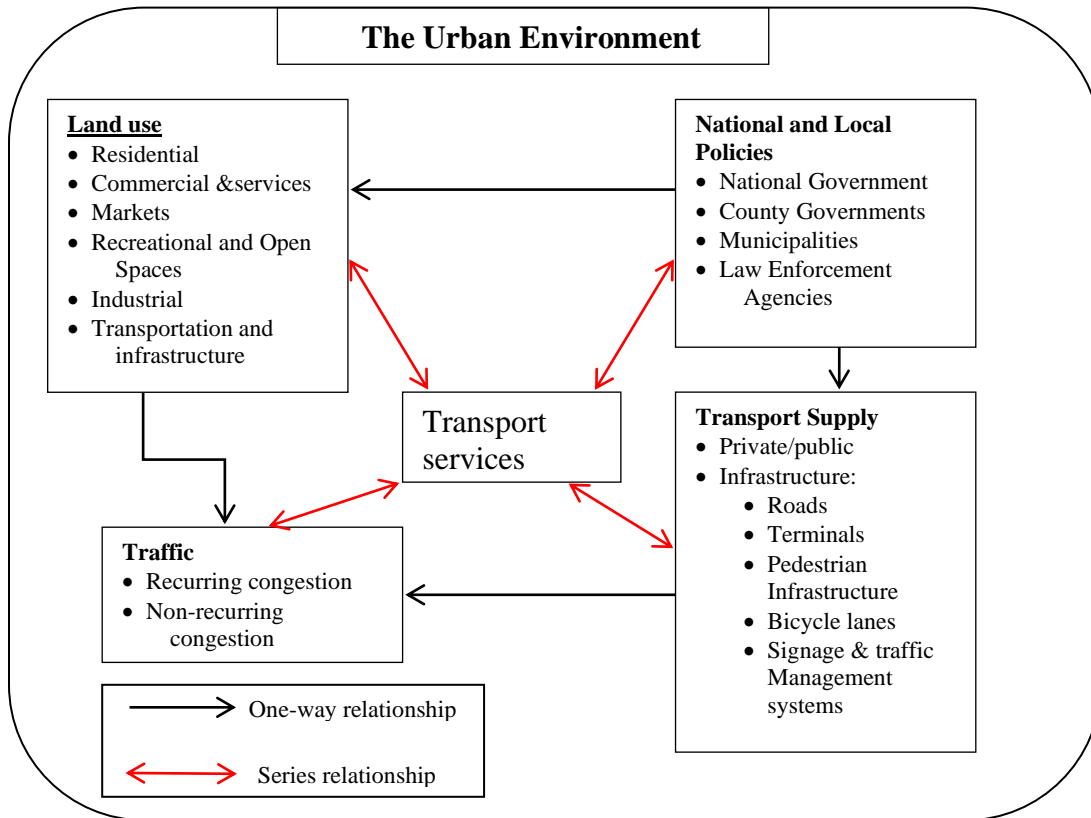
According to Agyemang (2009), studies of systems have always tended to address four key issues:

- i. If a system is closed i.e. has no links to or from an adjoining environs or open;
- ii. Whether the system can be separated into subsystems, or clusters of co-dependent components which are only weakly-connected to the rest of the system;
- iii. Whether the links involve flows, causal relationships or 'black-box' relationship; and,
- iv. Whether there is a feedback in the system such that change in x may stimulate change in y, and this will in turn have an impact on x.

Agyemang (2009) used the general systems theory to analyze the urban transport system (figure 3) and identified three key subsystems namely; land use, transport supply and traffic:

- i. Land use which may refer to the permissible use of land, the nature of structures and socio-economic undertakings.
- ii. Transport supply refers to the capability of transport infrastructures and modes expressed in terms of infrastructures (capacity), services (frequency) and networks. To quantify transport supply, the number of passengers and capacity of freight that can be transported per unit of time and space are used.

iii. Traffic is a direct function of land use and urban transport system and is as a sub-system which is a vital part of the much wider urban system.



Source: Adopted from Agyemang (2009)

Figure 4 The Urban Transport System

Giddens (1984) criticizes the theory for what he refers to as its ‘empire-building’ undertakings by underscoring the prominence of the social-whole over its individual parts (Jonathan,1986).

2.3.3 Structuration Theory

The structuration theory was proposed by sociologist Anthony Giddens in his book “the Constitution of the Society”. The theory is grounded on the principle that the classic actor/structure dichotomy has to be reconsidered as a duality. Giddens proposes that structure must be regarded as the ‘structuring properties’ permitting the obligatory of time-space in social system. Thus, in his opinion, ‘those practices which have the greatest

time-space extension in such entireties can be referred to as institutions' (Agyemang 2009).

The theory also associates those who have resources(structures) with the ability to mobilize power. However, power itself is not a resource but the outcome of owning material and structural facilities This study finds some elements of the structuration theory quite useful and contextualizes the theory to Kenyan Transport System consisting of various actors who in one way or the other use their 'power' through policies to influence decisions on the transportation sector (Jonathan, 19986).

The supply of transport is limited to a large degree by the existing structures or resources available to the provider (the Nairobi City County as well as the National Government). Provision of roads as well as their maintenance has become a political affair not only in the City Capital but also across the country with promises to 'reduce traffic jams during campaigns' by the City County politicians only for their term to end without any change.

The structuration theory has received its fair share of criticism by John B. Thompson who highlights the 'looseness' of the Gidden's explanation of structures as rules and resources. John contends that Giddens has not given sufficient account that will make it 'beneficial and amenable to identify social structure with rules (and resources)' (Agyemang, 2009).

2.4 Causes of Traffic Congestion

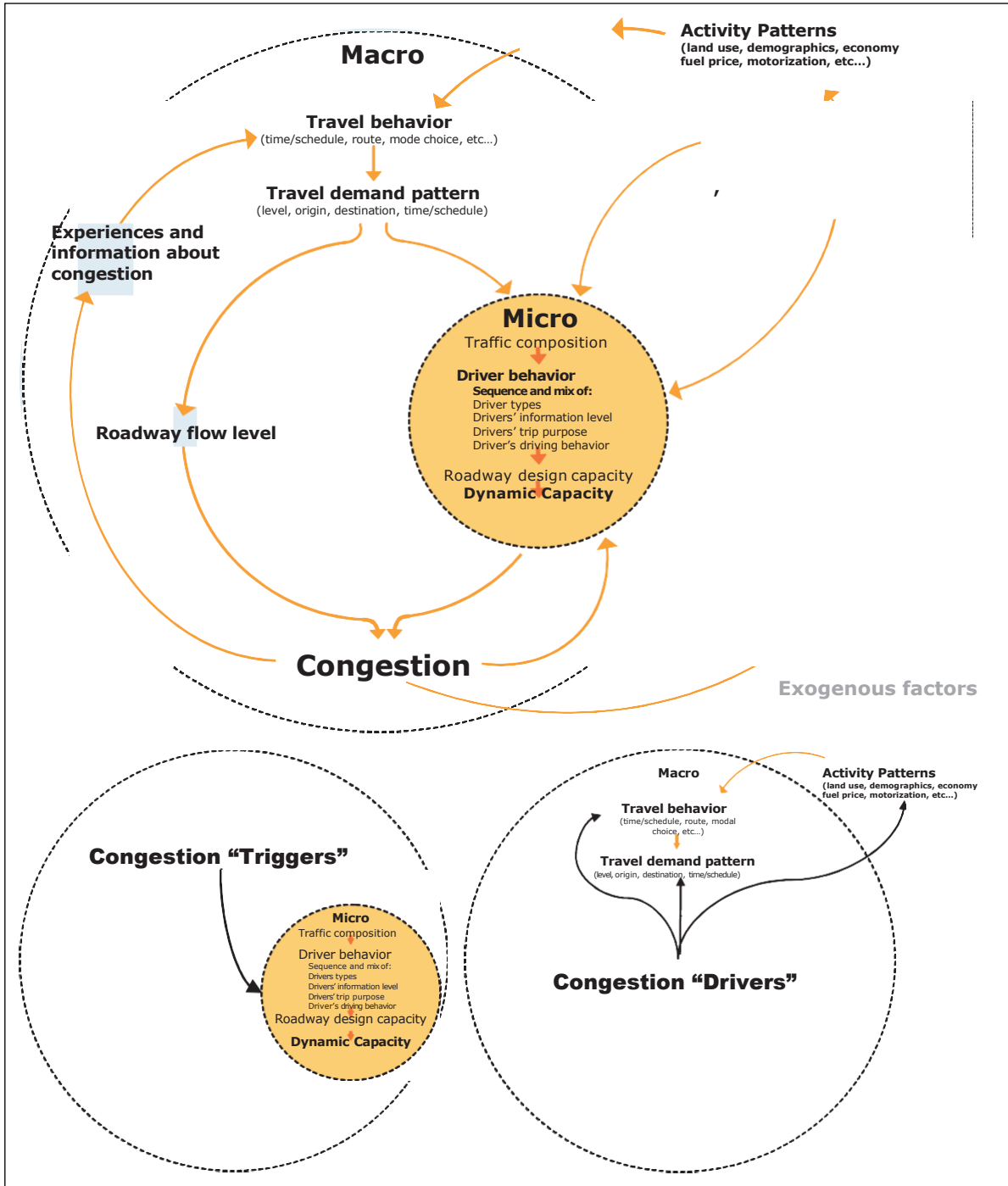
Generally, there are three broad categories of causal factors; micro-level factors, macro-level factors and set of exogenous factors (figure 5). In this context, congestion is "prompted" at the "micro" level, and "driven" at the "macro" level by elements that can lead to congestion and contribute to its severity. This has domineering repercussion for policy since while congestion takes place on the roads, it is not only, nor necessarily, a traffic engineering problem (ECMT, 2007).

Grant & Laird (2006) further categorizes traffic congestion into 3 broad categories: recurrent, non-recurrent and pre-congestion state as elaborated in table 2.

Table 2 Types of congestion

Congestion Type	Definition
Recurrent congestion	<ul style="list-style-type: none">• Happens at unvarying (regular) intervals at a place and can be foreseen by commuters who use those particular roads at those given times of the day.• It is caused by dynamics such as fast increase in population, urbanization and related increase in car possession.• It takes place typically during peak hours and sometimes it can also occur during off-peak hours.
Non-recurrent	<ul style="list-style-type: none">• This happens at varying times (not regular) of the day at a given location.• It is unpredictable and unplanned for by the road users and may be caused by bad weather, accidents, vehicle breakdowns, events as graduation among others.
Pre-congestion	<ul style="list-style-type: none">• Occurs where free-flow conditions are interrupted but complete jamming has not yet happened.

Source: Adapted from Grant & Laird(2006)



Source: Adapted and improved from ECMT (2007)

Figure 5 Macro and micro level factors affecting traffic congestion

As discussed earlier, there are many causes of traffic congestion. From the literature review the most common causes of traffic congestion are:

1. Social economic growth

Social economic growth attracts more people into the urban areas where most activities including employment and business opportunities are located raising the demand for transportation services. When the demand exceeds the road capacity then, traffic congestion occurs (ECMT, 2007). Nairobi City County has expanded from 3.84km² in 1910 to the current area of 696km². Other official physical expansions to the city occurred in 1921, 1926 and 1964(CODESRIA, 2014).

2. Population increase, income rise and vehicle ownership

The world's urban population has more than doubled since 1950 to nearly 3 billion (47% of global population) people by year 2000. Nairobi's population grew from 266,795 in 1962 to 3,242,085 in 2010 and it's expected to rise to over 7million by 2030 (Aligula et al., 2005). As individual income increases, more and more people afford to buy a car given the efficiency, convenience and privacy of using one's car instead of public transport. Unfortunately, vehicles come with their share of physical and environmental limitations and require parking spaces and road space (Kumarage , 2004) resulting to traffic congestion.

By 2011, Kenya had approximately 1.4 million registered vehicles, of which 60% ply the streets of Nairobi. It was also established in the same study that private vehicles transport only 22% of the commuters yet they account for about 64% of the traffic volume (KIPPRA, 2013). Since the public transport is unreliable and ineffective, it is more convenient, commuters prefer using private cars (however uneconomical it may be) because of the convenience and flexibility associated with using of private means of transport.

3. Poor land use planning and management

Poor land use planning and management can result into competition of the same land space by various activities since it reduces the road space that is used by vehicles. Kuzmyak (2012) contends that how land is used affects the volume and character of traffic on the roads. He further notes that traffic volumes on a busy arterial roads are associated with the type and density of activities along the road. Clear linkages between land use planning and urban transport planning are therefore necessary. Zoning regulations that segregate residential areas from commercial (workplaces) area increase the demand for the need to travel hence more traffic congestion compared to compact city where one does not require to use motorized transport to work.

4. Lack of efficient public transportation system (MRT and BRT)

Thwala et al., (2012) in their journal “*Assessing intra-city road traffic in an indigenous African City*” notes that the reason why commuters do not prefer using public transport is because during peak hours there is temporary surge in demand for transportation which creates discomforts for the users. Lack of efficient public transport therefore encourages the use of private cars which are more efficient and convenient leading to competition for the same space by different modes of transport. In Brussels for instance, cars, trams, buses and cyclists share the same one-lane road (Holst, Nygran, & Anderson, 1996).

5. Inadequate road capacity

Schrank, Eisele, Lomax, & Bak, (2015) consent that congestion is the result of a disparity between travel demand and the supply of transportation capacity. In fact, roads in most cities weren't planned for current traffic densities hence they have reached the maximum capacity they can hold at a given time (XEROX, 2016). Building more roads will only increase the congestion levels instead of reducing it. When the Thika superhighway was upgraded, it was believed that the problem of congestion was over. Ironically, the Superhighway is one of the most congested roads in Nairobi today!

6. Longer commuting due to housing affordability

Thwala et al., (2012) concludes that workers are increasingly spending more time commuting from residence to their work place since residential areas located far away from urban areas are more affordable. Lipman (2006) found out that lack of affordable housing close to work increases commuter time hence traffic congestion as working families move far from work to find affordable housing. She adds that commuters start their journeys at higher speeds since there are few commuters from such areas but slow down as they converge on the clogged roads near their work places. Ultimately, the workers end up spending more on transport in terms of both time and money.

7. Incidents, accidents and poorly maintained vehicles

Road accidents results in heavy traffic congestion since they tend to block a section of the road or the entire road. If the accidents scene is not cleared promptly it may lead congestion may occur and can stretch to several kilometres within a short period of time (Rukunga, 2002). Similarly, poorly maintained vehicles breakdown frequently hence blocking the road and causing traffic jams and its related effects, a situation that can be avoided if vehicles are properly maintained (Elisongo, 2013).

8. Uncivil driving behaviour

Elisongo, (2013) and Arnott, (2001) describes uncivil behavior as the tendency to disregard traffic laws and regulations, tailgating, honking at the slightest provocation, making dangerous and excessive lane changes, overlapping, overtaking in undesignated areas, picking and dropping passengers in undesignated areas among others. As a result, vehicles end up blocking each other causing traffic congestion and increased chances of accidents and other incidences.

9. Poor traffic management

Poor traffic management results to traffic congestion as vehicles block each other while trying to overtake or while overlapping. Sometimes traffic lights signals are not optimized since vehicles have to stop more often, increasing travel time hence traffic builds up (XEROX, 2016).

2.5 Social and Economic Effects of traffic congestion

2.5.1 Social Effects of Traffic Congestion

Various researchers have attributed traffic congestion to negative social effects such as:

- i. Health challenges: Of all the other modes of transport, road transport causes more air pollutions as a result of emissions from vehicles. In Europe for instance, road traffic generates 4-5 times air pollution compared to rail (Holst, Nygran, & Anderson, 1996). Fesler (2013) noted that traffic congestion reduces travel speeds below their normal free flow level hence increases vehicle emissions which include Carbon IV Oxide (CO₂), Carbon II Oxide (CO), and Nitrogen Dioxide (NO₂).
- ii. Long commuting time contribute to increased stress levels and aggressive motorists' behavior encouraging road fury (highway/road rage) due to the frustration of slow moving traffic hence increased vulnerability to stress related diseases and poor performance at work (Whittlesea, 2016; Kumarage, 2004)
- iii. Severance: roadways separate communities and constrain societal relations (GTZ, 2009). A lengthy travel time impacts family life and is a renowned factor of work-family conflicts since it decreases the time available for parents to spend with their families (Pocock & Smith, 2006).
- iv. Emergencies where traffic congestion interferes with the flow of emergency vehicles such as ambulances, alarm responses, fire fighters and police vehicles (999) hence leading to more deaths and damage of properties (Phukan, 2014).

- v. Spill-over effect from the congested major roads to minor roads and side streets as motorists attempt substitute routes to evade congestion (Abiola, Adeniji, & Popoola, 2013).

2.5.2 Economic Effects of traffic congestion

Low & Odgers (2012) observed traffic jam as more than just an aggravation or inconvenience which also imposes an actual cost to the economy of a city, a region or a nation. Some of the economic effects of traffic congestion include:

- i. Delays: Traffic congestion delays people to their places of work hence loss of working hours which is a great challenge to the employers. In Kenya where most workers report to work at 8am and leave at 5pm, more delays are experienced during these peak hours as the commuters try to get to work and home early respectively. In addition, buses and other public transport vehicles are delayed in the congestion hence creating a need for more vehicles and drivers to drive them. This in turn rises the fares (Economic Commission for Latin Ameriasca and the Caribbean (ECLAC, 2000).
- ii. Travel Cost: the cost transport increases with the increase in traffic congestion either through hiked fares, increased wear and tear as vehicles brake frequently (Olagunju, 2015). In Egypt, approximately US\$8 billion dollars are wasted annually in the Greater Cairo Metropolitan Area because of traffic congestion. This amounts to over three (3) percent of Egypt's total Gross Domestic Product hence becoming a drain on the national economy (World Bank, 2014).
- iii. In a research carried out by ECLAC, bus transport costs in the Brazilian largest cities are estimated to be 16% more than the usual cost as a result of traffic congestion (ECLAC, 2000). Goodwin (2004) attempted estimate the cost of congestion as follows:

- iv. Inability to estimate travel time: Elisonguo (2013) postulates that a secondary effect of traffic road congestion, is the inability to estimate travel times hence allocation of “just in case time”. The extra time allocated could be used for other activities such as spending time with family. When there is no heavy traffic congestion however, a commuter ends up getting to the destination earlier than anticipated and the extra time may end up being wasted (Morgan, 2018). For instance, an employee, they end up working overtime which is not paid.
- v. Man-hour loss: a lot of productive time (man-hour) is wasted in traffic jams hence a great inconvenience for business persons who end up delaying/missing appointments and have to deliver goods and services on time to customers. The European Conference of Ministers of Transport (ECMT) notes that workers commuting in the course of their work either to attend meetings or make deliveries are unproductive while travelling in excessively congested conditions (European Conference of Ministers of Transport (ECMT, 2007)
- vi. Emergency vehicles: traffic congestion blocks the way for emergency vehicles such as ambulances, fire fighters and 999 police response vehicles. In Kenya, there are no dedicated lanes nor systems to pave way for emergency vehicles which have to manoeuvre through heavy traffic to respond to emergencies. Many lives and properties have been lost due to delay in traffic.
- vii. Increased accidents and incidences: As rogue drivers try to manoeuvre through traffic congestion to get to their destinations as fast as possible, incidences and accidents may occur. This may result to loss of deaths and properties as well as increased cost of repairing vehicles. The cost life lost in an external surpasses the cost of time lost in congestion. For instance, in USA bore accident costs of \$164.2 billion in 2006 (Timilsina & Dulal, 2011). As the drivers of vehicles involved in accidents and incidences wait for the traffic

police to settle the matter, they (the vehicles) block of other vehicles and road users hence causing more traffic congestion.

- viii. Air pollution and Global Warming: Most large cities in developing countries are experiencing high levels of air pollution emitted by automobiles with studies estimating that emissions from public transport would have doubled by the year 2000 (from the 1980 base levels) in large cities (Aligula, et al., 2005). In addition, the release of CO (carbon monoxide) and other pollutants increases when there is traffic congestion and is responsible for environmental problems including global warming (Raheem, Olawoore, Olagunju, & Adeokun, 2015).
- ix. Health cost: The toxic gases emitted from the vehicles such as CO₂, HC emissions, NO_x and particle emissions cause illnesses such as cancer and lung diseases. This has financial implications not only to individuals but also to the country as a whole as the patients have to seek medical attention and the government has to provide the necessary health care needed by its citizens.

2.6 Congestion Reduction Strategies

2.6.1 Research on congestion mitigation strategies

Congestion can be dealt with by supply side or demand-side strategies. Supply-side strategies are intended to expand the means that travelers can use for travelling and other trips. Demand-side strategies aim to trim down the number of persons or vehicles travelling during peak periods for instance charging high tax on gasoline making driving costlier (Downs, 2005). Reducing traffic congestion will consequently reduce the socio-economic effects that commuters experience as a result of congestion.

Table 3 Supply and Demand Traffic Congestion Management measures

Type of measure	Approaches	Measures
Demand Side	Spatial Planning	Rights of way and road grids planning Mixed land use Intermodal nodes Park and ride facilities
	ICT-Based substitutes	Teleworking
	Information service for travelers	Pre-trip information
	Pricing	Congestion pricing Parking pricing Public transport allowances and incentives
	Administrative	Parking management Circulation regulation Incident Management
Supply Side	Road traffic operation	Traffic management Signal movements Incident management
	Preferential treatment	Bus and High occupancy lanes Bicycle and pedestrian infrastructure
	Public transport operation	Ease of transfer between modes Schedule optimization Fare coordination
	Freight coordination	Loading and unloading regulation

Source: UN-Habitat, 2014

2.6.2 Expansion of road network capacity

Scott Darren in his paper “*Overcoming congestion*’ notes that expansion of road capacity provides a only ephemeral relief after which roads start experiencing more congestion (in some cases the congestion is worse than before the expansion was done). New capacity generates new traffic and attracts traffic from other routes; a phenomenon that is known collectively as *generated traffic* (Scott, 2002). UN-Habitat, in its report Urban Planning for City Leaders concurs with Scott and notes that reduced road space for cars prompts drivers to change routes shrinking the traffic. Building wider roads therefore will

definitely create more congestion as most drivers will prefer the same road upon expansion (UN-Habitat, 2014).

Brian Taylor in his article on ‘Rethinking Congestion’, notes that expansion of road capacity is a waste of time and money as more people and more emissions are produced once the widened roads fills up again as a result of latent demand (Taylor, 2002).

The expansion of Thika Superhighway for instance led to increased generated traffic demand hence heavy traffic jams (See plate1). According to a research project carried out Simon Kabui, the stretch between Survey of Kenya and the Pangani Underpass operates at Level of Service F during peak hours (Kabui, 2015).

Construction of the Eastern bypass was envisaged to divert vehicles from Mombasa Road to Thika from passing through the CBD heence reduce traffic congestion. However, the road experiencies heavy traffic congestion and now operates more of a local road. Once the ongoing expansion of Outer ring road is complete, more people may move to the many estates along it and may actually lead to more congestion along Jogoo Road.



Source: Njeru, 2018

Plate 1 Pictorial representation of evening traffic congestion along Thika Superhighway

2.6.3 Travel demand management

Demand management is any effort or action carried out with anticipation to impact the intensity, timing, and spatial distribution of transportation demand in order to reduce traffic congestion (Kumarage 2004). Kumarage (2004) and Scott (2002) make the following proposals concerning travel time management:

- Re-distribution of the spatial form of the demand for transport: includes the urban re-planning and the relocation of certain land uses that may cause traffic congestion.
- Re-distribution of the temporal pattern of the demand for transport: this involves staggering working hours throughout the day so that everybody does not have to report to work and/or school by 8.00am and leave by 5.00pm.
- Re-distributions of demand between the modes of transport: the main objective here is to move commuters from modes of transport that are more likely to cause traffic congestion to other modes of transport that more efficient.
- Push and pull scheme: ‘push’ strategies discourage car use while ‘pull’ strategies encourage the use of alternative modes, including ridesharing as shown in table 4.

Table 4 Push and Pull Scheme

Push strategies	Push strategies
<ul style="list-style-type: none"> • Taxation of cars and fuel • Banning non-commercial traffic from city centres 	<ul style="list-style-type: none"> • High occupancy vehicle (HOV) lanes • Park and ride schemes
<ul style="list-style-type: none"> • Road pricing • Banning on-street parking 	<ul style="list-style-type: none"> • Improved public transport service • Public information campaigns concerning the negative effects of driving
<ul style="list-style-type: none"> • Telecommuting • Jobs-housing balance 	<ul style="list-style-type: none"> • Car pooling

Source: Kumarage, 2004

2.6.4 Linking land use and transport planning

Transportation enables a city’s spatial pattern and development of transport networks give form to cities over time. Urban land use planning should therefore locate people near the transport nodes as well the activities as it reduces dependency on use cars and travel demand altogether (UN-Habitat, 2014). In its report dubbed as Planning and Design for Sustainable Urban Mobility, the UN-Habitat recommends for ‘compact cities’ which will

help shorten travel distances thus reduced emission and fuel consumption (UN-Habitat, 2013)

2.6.5 Efficient and Reliable public transport

An efficient public transport must be affordable to the user, frequent, predictable, safe and integrated within a comprehensive network (UN-Habitat, 2013). Without an efficient public transport, majority of the commuters will find it difficult to commute or will have to spend a huge portion of their income on transport (UN-Habitat, 2014). Introduction of light rail can curb traffic congestion. It can be described as an electric rail-borne transport, which can be developed in stages to increase capacity (UN-Habitat, 2013). However, its installation and operationalization is quite expensive hence most countries opt for a more affordable and flexible BRT.

An efficient BRT can reduce traffic congestion and consequently reduce the travel time. In Bogota, Colombia, the TransMilenio BRT reduced travel time by 34% and fatalities by 88% while Curitiba (Brazil) 70% of the commuters use BRT (UN-Habitat, 2013).



Source: Emblin, (2017)

Plate 2 An illustration of effective mass public transport buses (Trans Millenio)

2.6.6 Provision of NMT facilities

Provision of Non-motorized infrastructure is not only affordable but also reduces traffic congestion especially for short trips, which make the largest share of trips in urban areas. Many cities in developed countries have moved from car-centric urban models and have embraced pedestrianization and cycling within the Central Business Districts (CBDs) (UN-Habitat, 2013). Kenya, just like most African cities, concentrates on moving cars instead of people as very few or no adequate NMT infrastructure are provided during road construction (Nairobi Planning Innovations, 2016). There are limited NMT facilities such as pedestrian walkways and bicycle lanes and the little available are encroached on by roadside traders or rogue matatus. NMT is not only environmental friendly but also reduces incidences of lifestyle diseases related with pollution and obesity. There are reduced cases of fatal accidents where NMTs are used as opposed to the use Motorized transport (Nairobi Planning Innovations, 2016).

2.6.7 Efficient Urban Traffic Management Control (UTMC) Systems

Efficient UTMCs helps maximize the road capacity by changing the timing of traffic lights to match the demand in real time. This in turn reduces incidences of ‘blocking back’ when vehicles are stuck in junctions which is the major cause of traffic congestion especially at intersections (Leigh, 2016).

The non-linearity of the correlation between traffic ‘flow’ and ‘delay’ means that comparatively small cutbacks in flow (say 10-15%) can result in huge decreases in traffic congestion. For instance, in Cambridge, flow declines of below 15% during school holidays result into a virtually gridlock-free peak hour (Leigh, 2016).

2.7 Existing Measures of addressing traffic congestion in Nairobi-Kenya

2.7.1 Measures at National Level

Various policy interventions have been put in place to give insight on sustainable development including traffic congestion reduction at national level. The Vision 2030 proposes for the formulation of a 50-year Integrated National Transport Master Plan which must be linked to the National Spatial Plan. The Master Plan will be expected to

ensure that investment and location of transport infrastructure and services are consistent with other public policies (Government of Kenya, 2007). The Integrated National Transport Policy 2009 (INTP) aims at providing an integrated, efficient, reliable and sustainable road transport infrastructure that meets national, regional and freight transportation goals (Kenya, 2009). However, the proposed measures have not been fully implemented hence the traffic congestion menace not only in Nairobi but also in other towns such as Mombasa, Kisumu, Nakuru, Eldoret among others.

Construction of roads has also been one of the major interventions that both the National and County Governments are using in a bid to increase accessibility of both the rural and urban areas. The LAPSSET corridor is one of the ongoing major projects under the current government.

2.7.2 Measures at Nairobi Metropolitan area level

The Nairobi Metro 2030 Strategy, the Integrated Urban Development Master Plan for the City of Nairobi (NIUPLAN) and Nairobi County Integrated Development Plan are some of the policy interventions that have been set to address traffic congestion within the Nairobi City and the Nairobi Area Metropolitan at large. Other interventions include the formation of Traffic Urban Decongestion Committee which has been preceded by Nairobi Metropolitan Area Transport Authority (NAMATA) whose mandate is to coordinate public transport and ensure efficient, safe, reliable and sustainable transport system within the greater Nairobi Metropolitan Area.

One of the most frequent tactics espoused to handle traffic congestion is the design and construction of new roads or upgrading and expansion of existing ones in order to increase their carrying capacity (Gachanja, 2012). The construction of the Thika Superhighway, ring roads and missing links as well as Northern, Southern and Eastern Bypasses was aimed at easing traffic congestion more especially in the CBD. The ongoing construction of Outer ring road may also calm traffic congestion on Jogoo Road. Several roads are undergoing upgrading including Ngong road.

The recent introduction of newly trained traffic marshals and installation of closed-circuit television (CCTV) traffic cameras at junctions and intersections is meant to facilitate traffic flow and monitor compliance of traffic regulations for enforcement purposes (TUDC, 2014). Other interventions include introduction of the yellow boxes within the CBD, blocking of some roads (roundabouts and U-turns) using the ‘Kidero’ drums use of intelligent traffic lights among others.

2.8 Constitution, Policies and Legislative Framework

2.8.1 The Constitution of Kenya, 2010

The Constitution of Kenya 2010 protects the Kenyan citizens from any form of pollution (including the emissions from vehicles). For instance, article 42 gives every person the right to a clean and healthy environment while article 60 on land and environment, the supreme law states that “Land in Kenya shall be held, used and managed in a manner that is equitable, efficient, productive and sustainable”. In addition, the 4th schedule distributes the functions of the National and County governments as far as transport is concerned as follows:

Table 5 Role of National and County Governments on Transport

National government	County Government
Road traffic	County roads;
The construction and operation of national trunk roads	Traffic and parking;
Standards for the construction and maintenance of other roads by counties	Public road transport;

Source: Constitution of Kenya

2.8.2 Policy Framework

1. The Kenya Vision 2030

The Vision 2030 which is a development road map between 2007-2030 identifies a number of project on transportation, which if implemented can have a major impact by reducing traffic congestion in Nairobi County as a whole.

1. **50-year Integrated National Transport Master Plan:** The master plan will be linked the National Spatial Plan and will be aimed:

- a. Ensuring consistency of investment and location of transportation infrastructure with other public policies;
 - b. Ensure optimal transport infrastructure investment promote nationwide objectives for socio-economic refurbishment and expansion.
 - c. Expedite development and expansion of transportation infrastructure in order to cut transportation expenditures and open new frontiers for economic growth.
2. **Nairobi metropolitan region bus rapid transit:** The Government to develop a Bus Rapid Transport (BRT) System with the following corridors being the pilot projects:
- i. Athi River Town to Kikuyu Town (approximately 38 kms);
 - ii. Thika Town to the Central Business District (approximately 50 kms). The BRT lane has already been marked and special buses are set to start operating soon; and
 - iii. Jomo Kenyatta International Airport to the Central Business District (approximately 25 kms).
3. **Development of light rail for Nairobi and its suburbs:** The Government also plans to construct a light commuter rail along Nairobi Railway Station to Embakasi/JKIA (15.6 km) stretch. It is anticipated that the new light rail services will serve at least 150,000 daily passengers, which is 5% of the future public transportation demand in the Nairobi Metropolitan Area.

2. Integrated National Transport Policy (INTP), 2009

The policy paper is anchored on the maxim ‘moving a working nation’. It identifies challenges besetting transport sector in Kenya as a whole with the most common being poor quality of transportation services, unsuitable modal split, unintegrated transport system, urban environmental pollution among others. The Policy further makes several proposals in order to realize its vision including but not limited to; incorporation of transport with national development priorities, increasing investment in transport infrastructure and operations as well as responding to market needs of transport.

3.National Urban Development Policy

The policy cites the many challenges in urban transportation which include: long waiting hours; poor safety and security standards; high costs for both passengers and freight; limited integration; and unexploited regional potential of the transport system as the major challenges facing urban transportation. To address the above challenges, the policy proposes that both the national and county governments shall: device a suitable transportation strategy focusing on mass transport and provision of NMT facilities; ensure sustainable, interconnected; adequate, reliable and affordable transport; ensure integration of land use planning and transportation planning; apply the user-pays-principle; provide an effective transportation management information system; impose emission testing in all transport modes and harmonize the roles and mandates of all transportation agencies in the urban sector among others.

4. The Nairobi Metro 2030 Strategy

The Nairobi Metro Strategy is a statement of the Nairobi Metropolitan Region(NMR) and aims at making the region a world class African metropolis which is capable of creating sustainable wealth and offer a high quality of life to its citizens and investors and is implementable between 2008-2030 (Government of the Republic of Kenya, 2008).

The Strategy recognizes Nairobi City County as a national, regional and international strategic centre for education, commerce, transport, and economic development while the other areas of the NMR are its dormitory since most of the residents depend on the Nairobi Core for employment and other social services.

To continue playing this role efficiently, an efficient transportation system that minimizes travel time and reduces externalities has been prioritized in the Policy document with the main strategy being decongesting the Core by influencing equitable distribution of employment opportunities as well as other social facilities. The other measures proposed in the document include:

- a. Dualling of the main roads within the NMR
- b. Improvement of intersections and reorganized public transport operations
- c. Introduction of Bus Rapid Transit to give priority to high occupancy PSVs
- d. Construction of bypasses, links and widening of ring roads

- e. An efficient traffic management system

5. Integrated Urban Development Master Plan for the City of Nairobi (NIUPLAN)

NIUPLAN provides an all-inclusive and integrated urban development structure that has been missing since the expiry of the 1973 Nairobi Metropolitan Growth Strategy in year 2000. It will be implemented between 2014-2030 and is in line with the Kenya Vision 2030 and the Nairobi Metro 2030. According to NIUPLAN, the road length density by population for the whole Nairobi City is only 0.22 km/1000 people. This, coupled with the current poor and partial road connectivity explains the reason why most of the roads in the City are congested especially during peak hours. If nothing is done (compared to the existing situation), total vehicle-hours in Nairobi City will escalate by 5.3 times as a result of congestion while total vehicle-km will rise by 2.4 times. Traffic volume therefore will increase rapidly and road level of service will become poorer than the existing condition (JICA, 2014).

It is therefore important to provide counter measures which will ease imminent traffic volumes for the City to remain economically relevant. NIUPLAN made several proposals into achieving effective transport even in the future and has divided them into 3 phases: short term, medium term and long term. General short term measures that can be applied on all roads (including Jogoo road) and have a significant impact in reduction of congestion include:

- i. System signal control: The Integrated Urban Surveillance System (IUSS) should be installed in the entire City and not only the CBD.
- ii. Introduction of bus-exclusive lane: This will encourage the use of public transport since it will be faster and more convenient.
- iii. Staggered working hours: traffic congestion can be reduced by staggering working hours such that everybody does not have to get to work by 8am and leave by 5pm.
- iv. Streamline the freight carrier: Introduction of cooperating distribution system is eminent to cut the number of vehicle trips in the CBD

- v. Development of freight terminal: In addition to excluding heavy trucks from the City Centre, setting up of a freight terminal outside urban area is required in order to ease congestion.
- vi. Relocation of bus terminals: in addition to introduction of sub-centres in the periphery of the major urban areas, disposition of bus terminals that will function as transfer terminal from matatus to larger buses will be required.

The long-term measures proposed by NIUPLAN to reduce congestion on Jogoo road and its environs are:

- Provision of more nodes for Eastland Areas to manage high volume of trips. The proposed nodes are the node of Makadara Railway Station and Jogoo Road and the node of Jogoo Road, Outer Ring Road and Railway
- Widening of 5.2 km stretch of Jogoo road (Lusaka road-Outerring road) in phase 3 (2024-2030)

6. Nairobi County Integrated Development Plan (CIDP)

The Nairobi CIDP (2013-2017) defines Nairobi County's development priorities, strategic policy thrusts and project/programme interventions. It recognizes the fact that the present poor road network is a great hurdle to socio-economic growth since it leads increased transportation expenditure for both passengers and freight. It also identifies the surging number of vehicles as the major causes of traffic congestion in Nairobi City. For instance, in 2012, Kenya had 1.4 million registered vehicles and 400,000 motorcycles with a greater number of 60% being used in Nairobi (Nairobi City County, 2014).

Other transport challenges facing the City include: insufficient means of mass public transport; the fast escalation in the number of private cars; poor implementation of traffic regulations and lack of discipline on the part of both motorists and pedestrians among others.

The government has rolled out several projects that are aimed at reducing traffic congestion which include; expansion of several roads including Thika super highway, Outerring road, Ngong road among others, Construction of the Eastern, Northern and Southern bypasses, ring roads among others. There are also plans to open up more by-

pass roads, eliminate the round-a-bouts, find alternative parking for motorists outside the City Centre and review the Nairobi metropolitan public transport master plan.

2.8.3 Legislative Framework

1 . Environmental Management and Coordination (Amendment) ACT (EMCA), 2015

EMCA 2015 provides a roadmap towards a clean and healthy environment for all. National Environmental Management Authority (NEMA) is in charge of implementing the Act and realizing its main objective. Section 53 of the Environmental Management and Coordination (Amendment) Act, 2015 mandates the Cabinet Secretary in charge of environment to recommend an authority that will set occupational and ambient air quality and standards as well as emission standards. The same authority is given the mandate to set criteria and guidelines for pollution control for both stationary and mobile sources (Government of Kenya , 2015).

2 . Urban Areas and Cities Act (UECA), 2011

The Urban Areas and Cities Act, 2011 charges the capital city to provide efficient transport network connecting to rural areas, towns and other local, regional and international cities. It also establishes boards of cities and municipalities which will be responsible for facilitating and regulating public transport. Finally, the Act mandates counties to prepare integrated city or urban development plans, which shall be the basis for provision of physical and social infrastructure and transportation (Government of Kenya, 2011).

3 . Traffic Act (CaP 403)

For safety and environmental protection, the Traffic Act makes the following stipulations among others:

- **Article 51(1) on fuel:** that vehicles should only use appropriate fuels in order to reduce air pollution,
- **Article 53 (1&2) on obstruction:** that no vehicle should be left on the road and should be towed away with immediate effect in order to prevent any obstruction and dangers associated with it.

- **Article 55(1) on condition of vehicles:** that no vehicle should be operated unless it meets the requirements of this Act.
- **Article 69 (a&b) on power to regulate traffic:** The Act gives the police the power to regulate the traffic and prevent obstruction and to divert traffic temporarily or restrict or even close and deny public access to land.

4 . The Physical Planning Act CAP 286

Enacted in 1996, the Physical Planning Act provides for the preparation and implementation of various types of plans. The Act ensures sustainable and proper physical development on land, and securing appropriate establishment for transportation, public purposes, utilities, and services, commercial, industrial, residential, and recreational areas, including parks, open spaces and reserves among other land uses. In addition, The Physical Planning Manual provides for the regulations and standards to be adhered to when planning for transportation facilities.

2.8.4 Institutional Framework

Institutions are created and enacted through legislations and are responsible for creating the structure of rules for public policy making as well as decision making concerning transport systems. In Kenya, there are various Government institutions involved in road transport and its operations. In one way or the other, they have direct or indirect impacts on managing road traffic congestion. They include:

Table 6 *Legislations and regulation on Urban Transport in Kenya*

Laws and Regulation on Urban Transport	Institution(s) established	Responsibility/Mandate
Kenya Roads Act (No. 2 of 2007)	Kenya National Highways Authority (KeNHA)	In charge of the managing, improvement, rehabilitation and maintenance of national roads.
	Kenya Urban Roads Authority (KURA)	In charge of the management, development, rehabilitation and maintenance of all public roads in the cities and municipalities in Kenya except where those roads are national roads.
	Kenya Rural Roads Authority (KeRRA)	In charge of the management, development, rehabilitation and maintenance of rural roads.

Kenya Roads Board Act (Act No. 7 of 1999)	Kenya Roads Board	To supervise the road network in Kenya and coordinate the maintenance, rehabilitation and development and to advise the Cabinet Secretary on all matters related thereto.
EMCA	NEMA	Responsible for regulating the amount of vehicular emissions and noise levels emanating from vehicles.
Presidential executive order in 2017	Metropolitan Area Transport Authority (NAMATA) Covers 5 counties: Nairobi City, Machakos, Kiambu, Kajiado and Murang'a.	To formulate a sustainable integrated public transport strategy based on the development of a sustainable urban mobility plan that will be the foundation for the organized and structured development of the proposed Metropolitan Area mass-transit system, which incorporates both bus rapid-transit and commuter rail.
National Traffic and Safety Authority ,2012	National Traffic and Safety Authority (NTSA)	To advise and make recommendations on matters relating to road transport and safety; to implement policies relating to road transport and safety; to plan, manage and regulate the road transport sector; to ensure the provision of safe, reliable and efficient road transport service
National Police Service Act, 2011	Kenya Police Traffic department	Regulate and control traffic and keep order and prevent obstructions in public places, roads and streets and above all , prevention of road accidents, and above all enforcement of traffic laws and regulations

Source: Author, 2018

2.9 Measuring Traffic Congestion

The most important measure of congestion is travel time index which refers to the ratio of the total time needed to drive through a certain route during peak periods divided by the time it takes to drive the same route during uncongested periods. It takes 120 minutes (2 hours) to drive from Buru Buru to City Center during peak periods and only 30 minutes when there is no congestion, then the travel time index is 120 divide by 30 or 4 meaning it takes approximately 40% longer to drive during peak periods (Downs, 2005).

Traffic congestion impacts can be measured based on roadway volume to capacity ratios (V/C). A V/C less than 0.85 is considered under-capacity, 0.85 to 0.95 is considered near capacity, 0.95 to 1.0 is considered at capacity, and over 1.0 is considered over-capacity.

Congestion is a non-linear function, so as a road approaches its maximum capacity, small changes in traffic volumes can cause proportionately larger changes in congestion delays.

Table 7 Parameters Used to Measure Traffic

Parameter	Typical Units	Reciprocal	Typical Units
Flow	Vehicles per hour (Veh/h)	Headway	Seconds per vehicle (s/veh)
Speed	Kilometers per hour (Km/h)	Travel time	Seconds per km (s/km)
Density	Vehicles per lane-km (veh/lane-km)	Spacing	Meters per vehicle (m/veh)

Source: Sara and James, 2007.

Roadway traffic conditions are categorized using Level-of-Service (LOS) ratings, a grade from A (best) to F (worst).

2.10 Gaps identified

From the literature review, earlier researches have not yet determined the actual economic, social and environmental effects of road traffic congestion in Nairobi. KIPPRA recommended for a study to be carried out focusing on assessing the economic cost of congestion, the impact of congestion on health and welfare, and the contribution of congestion to climate change through emission of greenhouse gases (KIPPRA, 2015).

This study took up the challenge by focusing on the assessment of the socio-economic effects of traffic congestion in Nairobi County with Jogoo Road being the case study. Based on the findings, the study recommends practical measures that can be employed to reduce the social and economic effects of traffic congestion within the City and the entire Nairobi Metropolitan Area.

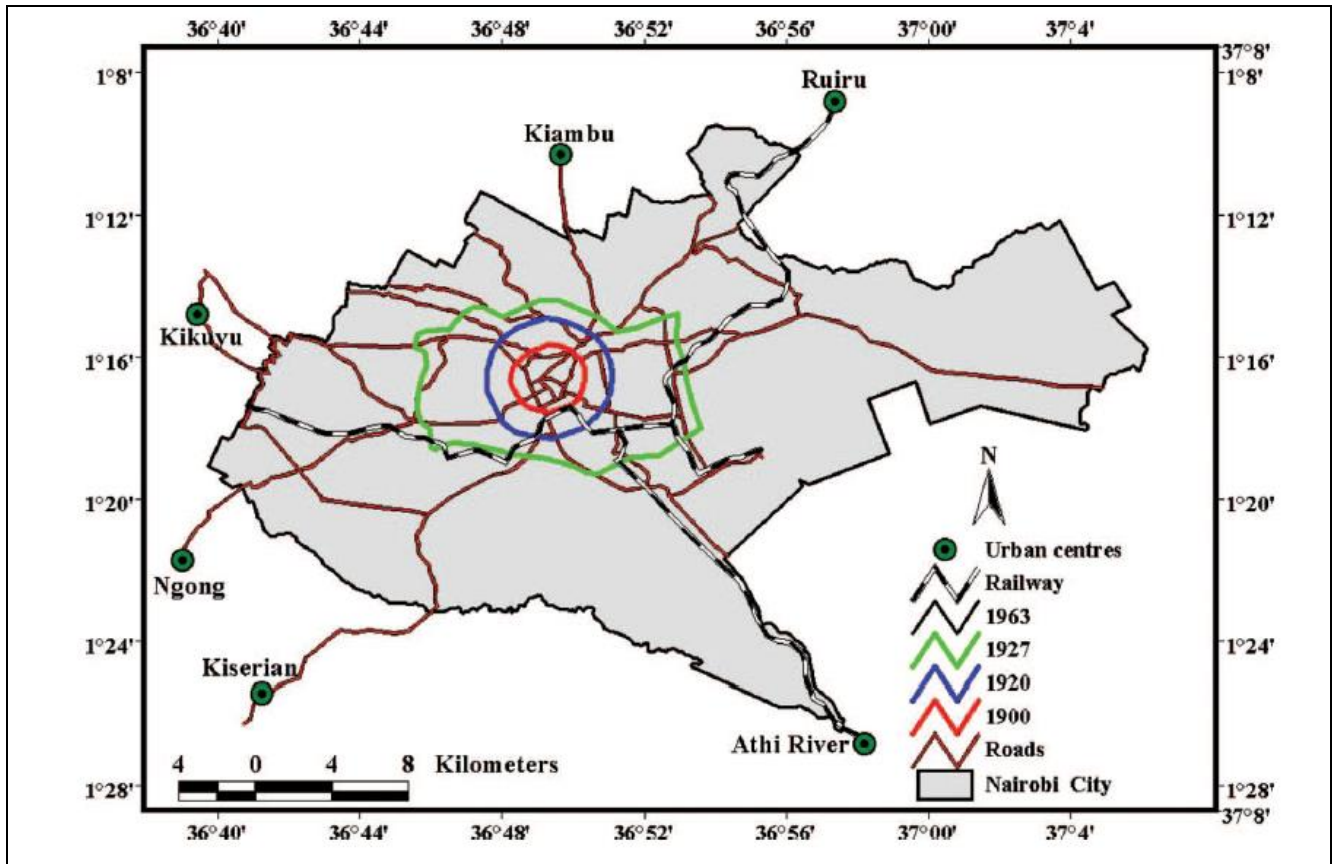
CHAPTER THREE: METHODOLOGY

3.1 Study Area

3.1.1 Nairobi City County

3.1.1.1 History of Nairobi and its Location

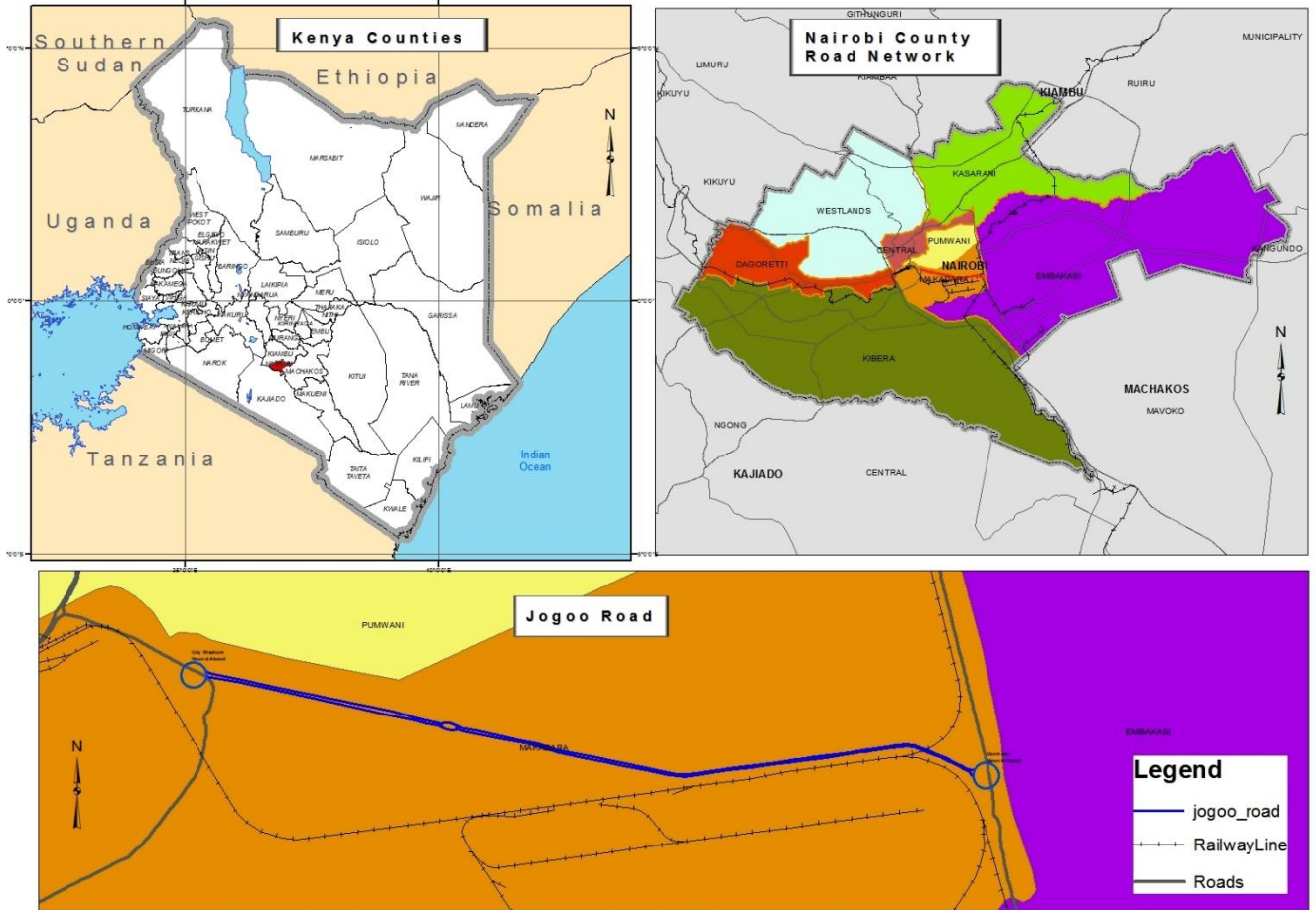
The City of Nairobi developed courtesy of the Kenya Uganda Railway in 1899 when the railway headquarters were moved from Mombasa to Nairobi which resulted in the subsequent growth of Nairobi as a commercial and business hub of the then British East Africa protectorate (Aligula et al., 2005). By 1907, Nairobi had become a flourishing town and became the capital of Kenya and later became a town in 1950. Most of the internal road network of Nairobi town was developed by the year 1909. Due to the rapid population growth and infrastructure investment, the boundary was extended by 1927 and 1948 to cover 25.37km² and 78km² respectively (Makworo & Mireri, 2011). By 1963, Its boundary was extended to cover its current size of 686km² and has not changed since then (Mitullah, 2003). Nairobi's population grew from 11,500 in 1900 to 118,976 in 1948 and 350,000 in 1963 (Makworo & Mireri, 2011). By 2009, Nairobi's population stood at 3.1 million as per the 2009 Census (KNBS, 2012). The physical infrastructure include the road layout borrows heavily from the 1963 Master Plan with minimum expansion to accommodate the increasing population hence the massive traffic jams being witnessed on most of the Nairobi roads today.



Source: Makworo & Mireri, 2011

Figure 6 *The spatial expansion of Nairobi City.*

The city of Nairobi is bounded by Kajiado County to the south and south west, Kiambu County to the north and north-west and Machakos County to the east and south-east (JICA, 2014). Nairobi City County covers a total area of 696.1 Km² and is located between longitudes 36°45' East and latitudes 1°18' South and lies at an altitude of 1,798 Meters above sea level (Nairobi City County, 2014).



Source: Author, 2017

Figure 7 Nairobi City in National and Regional Context

3.1.1.2 Climatic Conditions

Nairobi receives a mean annual rainfall of 786.5 mm with a bi-modal rainfall pattern; short rains received between October and December and long rains received between March and May. Due to its high altitude (of 1,798 metres above sea level), the County enjoys a relatively cool climate with temperature ranging from a minimum of 10⁰C (Nairobi City County, 2014)

3.1.1.3 Population and Demography

Nairobi City’s population was 3,138,369 in 2009 (Kenya National Bureau of Statistics (2012) and is projected to be 4,253,330 in 2017 (Nairobi City County, 2014). Nairobi’s population growth rate is far much higher than the national growth rate. For instance,

between 1999–2009, the growth rate for the City was approximately 3.9% compared to the national average which was about 3.0% (JICA, 2006).

3.1.1.4 Socio-economic characteristics

Nairobi City scores higher than the national average in social pointers such as main source of water, main mode of human waste disposal, main type of lighting fuel, and ownership of household assets (JICA, 2014).

Nairobi City County Nairobi's provides more 25% of both the formal and informal employment in Kenya, which can be attributed to its dominance of the economic affairs of the country (Aligula et al., 2005). The County's highest percentage of the population (68.5%) is aged between 15- 64 years hence increased cases of unemployment. The informal sector has been developing at about 17.2% per annum, compared to the formal sector's 2.23% (Hichert, Rugo, & Nguti, 2011).

3.1.2 Jogoo Road

The study covered Jogoo Road in Nairobi City County for a period of 6 months. The Jogoo road corridor is a major urban road and primary distributor, which starts from Outering road in Donholm and ends at City Stadium on Lusaka/Landhies Road.



Source: Author, 2017

Figure 8 *Jogoo Road - Nairobi*

The Road covers 5.4 km and serves the Nairobi's Eastlands region that comprises of Buruburu, Umoja, Donholm, Jericho, Jerusalem, Makadara, Makongeni, Starehe, Hamza

estates among others (See Figure 8). The study sought to examine the major causes of traffic congestion as well as assess the social and economic effects of traffic congestion on the commuters using public transport along Jogoo Road. Commuters were sampled from Embassava and Double 'M' Saccos. The study also makes recommendations on the possible measures to reduce the socio-economic effects of traffic congestion through reduction of congestion itself.

3.2 Research Design

Based on the objectives of this study, descriptive research was applied to create a better understanding of the socio-economic effects of traffic congestion in Nairobi City. Both qualitative and quantitative research methods and techniques were used to collect the necessary data.

3.2.1 Types and Sources of Data

This study involved collection of both primary and secondary sources of data (see Table 8).

3.2.1.1 Primary sources of data

The main source of primary data for this study were passengers from the Double M and Embassava Saccos, Sacco officials from Double 'M' and Embassava Saccos and officers from NAMATA, KIPPRA, County Nairobi County Government and KURA also provided primary data.

3.2.1.2 Secondary Sources

All the information that was retrieved from the existing literature for the purposes of this study was treated as secondary data. Books, journal articles, newspapers, report and publications of various associations and organization as well as other documentary reviews from internet were reviewed.

Table 8 Nature and sources of data

Independent variable	Dependent variables	Attributes	Data Collection instruments	Source of data	Analytical Framework	
Traffic Congestion Indicators: a) Basic measures: total delay, congested travel and congested roadway. b) Ratio measures: travel rate, delay rate, relative delay rate and delay ratio. c) Indices: congestion, congestion severity, congestion burden, travel rate corridor mobility and lane mile duration indices	Trip time/ Man-hour loss	Hours/minutes	Questionnaires	Passengers	Measures of Central Tendency	
			Traffic counts	KURA	Measures of Central Tendency	
	Pollution/Health effects	Health statistics	Interviews	NEMA, Police	Description and Conceptualization	
			Publications	Media, Police and NTSA		
		Trip cost/ Financial implication	Kenya Shillings	Questionnaires	Passengers	Measures of Central Tendency
				Interviews	Drivers SACCOs	Conceptualization
		Blockage of emergency vehicles	No. of deaths and incidences	Publications	Police NTSA	Measures of Central Tendency
		More incidences and accidents	Kenya Shillings	Publications	Police/media/NTSA	Description Conceptualization
				Observation	Field Survey	
		Pressure on Infrastructure	Kenya Shillings	Interviews	KURA	
			Poor condition of infrastructure	Observation	Field survey	Description and Conceptualization
		Effects on family /social life	Hours/Minutes	Questionnaires	Passengers	Measures of Central tendency
	Stress/Fatigue	Fatigue	Questionnaires	Passengers	Measures of Central tendency	

Source: Author, 2017

3.2.2 Sample Size, Sampling Frame and Sampling procedure

3.2.2.1 Sample size

For the purpose of this study, 2 out of the 9 SACCOs were selected through simple random sampling from a list acquired from the National Transportation and Safety Authority. The projected number of commuters was 59,400 (9 SACCOs *25 buses per SACCO*33 passengers per vehicle* 8 average trips). The sample size was determined using the formula suggested by Nassiuma (2000) as follows:

$$n = \frac{NC_v^2}{(C_v^2 + (N-1)e^2)}$$

Where n= Sample size

N= Population

Cv = Coefficient of variation (take 0.5)

e= Tolerance of desired level of confidence, take 0.05% at 95% confidence level

$$\frac{59,400 (0.5)^2}{0.5^2 + (59,400-1) \times 0.05^2} = 99.8$$

n=100
Approximately 100 passengers

To enhance the reliability and accuracy a sample size of 155 was used with consideration of the various days of the week and peak and off-peak hours.

3.2.2.2 Sampling Frame

The sampling frame for this study were the road users of Jogoo Road in Nairobi County. The main categories of road users sampled included commuters using public transport, operators, managers and policy makers.

There are 9 dominant Transport Saccos registered by NTSA that ply Jogoo Road namely: Double M, Embassava, Umoinner, City Shuttle, City Hoppa, Utimo, KBS, Forward and

Royal Swift. For the purpose of this study Embassava and Double M bus saccoes were randomly sampled.

3.2.2.3 Sampling Procedure

For the purposes of this study, the population was broken down into 3 strata: passengers, managers/operators and policy makers from which both purposive and simple random sampling procedures will be employed.

The field study exercise was conducted for 5 days (3 weekdays and the weekend) in order to get a complete picture of traffic congestion and its associated effects along Jogoo Road (see table 9). The study focused on the morning peak hours when most commuters head to town for various trip purposes, in the midday off-peak hours and in the evening peak hours when the majority of commuters are rushing back home.

From each SACCO, one bus was randomly sampled from the first 5 buses in the queue between 6-8am (from Donholm) and 6-8pm (from Town) after which the 2 research assistants boarded them to conduct interviews. The research assistants could then introduce the topic and request passengers to participate in the study. The passengers were then randomly sampled considering gender and age. Because of the long travel time in the morning, each research assistant could administer a minimum of 5 questionnaires per trip in the morning and evening hours.

During the midday off-peak hours, the research assistants made a return trip (to and from town and vice versa) managing to administer only 2 questionnaires per trip per SACCO. During weekends (Saturday and Sunday), there was less traffic congestion in the morning and the research assistants managed to administer a maximum of 3 questions per trip in the morning and midday off-peak period. However, it was noted that there was a moderately heavy traffic congestion in the evening as the research assistants were able to administer up to 6 questionnaires per trip.

Table 9 Sampling procedure

Day of the Week	Morning (6.00-9.00am)	Midday(11.00am- 2.00pm)	Evening (5.00- 8.00pm)	Sub-Totals
Monday	14	8	12	34
Wednesday	12	7	14	33
Friday	14	6	14	34
Saturday	10	6	12	28
Sunday	8	6	12	26
Totals	50	50	50	155

Source: Author, 2017

Office interviews were conducted by the researcher upon booking appointments with the resource persons who were sampled via purposive sampling procedure.

3.3 Data Collection and Research Instruments

Both quantitative and qualitative data collection methods were used. In quantitative data collection, random sampling was done where structured data collection instruments (questionnaires) and recording well-defined events were used. For the qualitative data collection method, observations and photography were used. The methods of data collection that were employed include:

3.3.1 Interview Schedules

The key resource persons and stakeholders were interviewed for their technical input. They included officials from NTSA, the Nairobi City County, NAMATA, MOA, KIPPRA, KURA, traffic police and traffic marshals.

3.3.2 Questionnaires

Questionnaires were administered to collect information from public transport passengers (Embassava and Double ‘M’ Saccos). Sampling and administration of questionnaires was carried out on Monday, Wednesday, Friday, Saturday and Sunday and 155 questionnaires were administered in the morning, midday and evening between along Jogoo Road as described in table 9.

3.3.3 Observation guide

This method was used to observe the long queues of vehicles in traffic jam, vehicular emissions, and emergency vehicles in traffic among others. Photography was also used to record the observed phenomenon.

3.3.4 Photography

Digital cameras were used to capture real on-site images during the field study to be used during the report writing and data analysis.

3.3.5 Literature review/Local correspondences

Books, journal articles, online documents, reports and publications of various associations and organization as well as other documentary reviews from internet were reviewed for the purpose of this study.

3.4 Data Preparation and Analysis

Due to the huge volume of questionnaires, filled questionnaires were coded and entered into the computer for analysis using Microsoft Access. The data was later exported to Statistical Package for Social Sciences (SPSS) for analysis which was done through both qualitative and quantitative methods. Descriptive methods of analysis were used to summarize data for the researcher to describe distribution of scores. Measures of central tendency, frequency distribution and relationships were also employed as shown on Table 8 above. The data was then summarized into tables, charts, and graphs and has been presented using photographs, tables, figures, pie charts and graphs

3.5 Validity and Reliability Instruments

To increase reliability and validity, multiple observers were employed and more random samples were obtained in order to increase external validity. A pilot study was carried out where the researcher focused on the objectives of the study and determined the parameters to be measured in order to establish the existing relationship among the variables (Elisongo, 2013). In addition, research assistants were recruited and trained on how to collect accurate and reliable data as well as its management.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

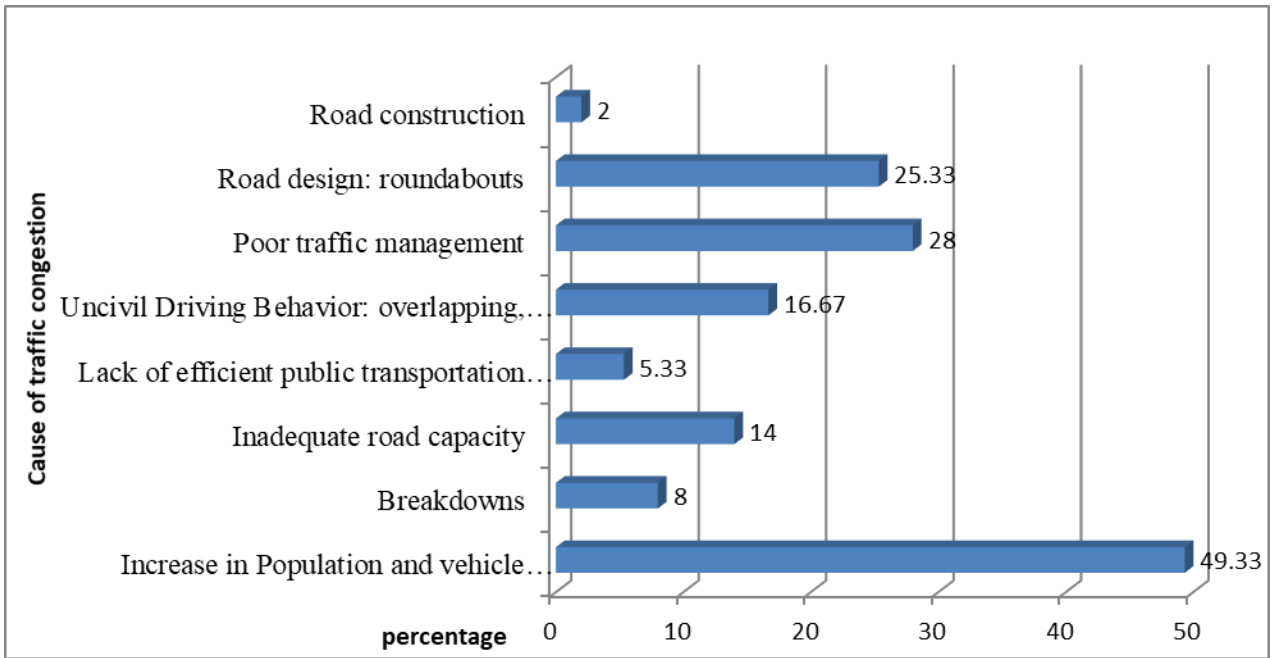
This chapter discusses the findings of the research after the analysis of the collected data. The discussion demonstrates the views of the commuters on the various issues as hypothesized by the researcher and is organized as per the objectives. In addition, the findings from primary data are backed-up by relevant secondary data to highlight the similarity or differences on the same cases.

4.2 Main Causes of Traffic Congestion

4.2.1 Population increase and vehicle ownership

Transport is key for the growth of a country's economy. However, the rapid urbanization rate in Kenya, population surge is being experienced in most of the cities with Nairobi carrying the heaviest burden of both population and vehicle increase (MOSOTI, 2015). A study carried by KIPPRA indicates that of the approximately 2 million registered motor vehicles in Kenya in 2013, about 60% were within the Nairobi Metropolitan Area (KIPPRA, 2015). This authenticates the findings of this study as most commuters blamed increase in population and vehicle ownership (49.33%) for traffic congestion.

From the study, it was established that the high population growth in the Eastlands area which is served by Jogoo road, can be associated with affordable housing and its proximity to the CBD. Increase in private car ownership was linked to the growing economy and the fact that public transport is unreliable, inefficient and inconvenient. The respondents hinted that with a private car, one can easily avoid traffic by changing the route which is not applicable when one is using public transport.



Source: Field Survey, 2018

Figure 9 Possible causes of traffic congestion along Jogoo Road

These findings concur with Elisongo, (2013) and Olagunju, (2015) who attributes traffic congestion to population increase which creates an imbalance in the travel supply-demand a increasing traffic snarl-ups.



Source: Field Survey, 2018

Plate 3 Pictorial representation of Traffic Congestion along Jogoo Road

4.2.2 Poor traffic management and road design

Jogoo road does not have traffic control lights and given the many U-Turns and roundabouts on it, vehicles end up blocking each other as they try to maneuver through. In fact, 28.0% blamed traffic congestion on poor traffic management while 25.33% associated with road design especially roundabouts. Lack of designated market areas and NMT facilities has contributed to the massive invasion of the road space by hawkers and pedestrians which many a time lead to traffic snarl-up and accidents. Poor traffic management includes poor control of the lanes, intersections and approaches to flyovers and underpasses as well as insufficient modern technologies for effective traffic management (World Bank, n.d.). Traffic management measures are urgently required to tame congestion along Jogoo Road. The measures may help lower travel times, increased frequencies, increased patronage, lower fares, or a combination of all these (Transport Research Laboratory, 2002).



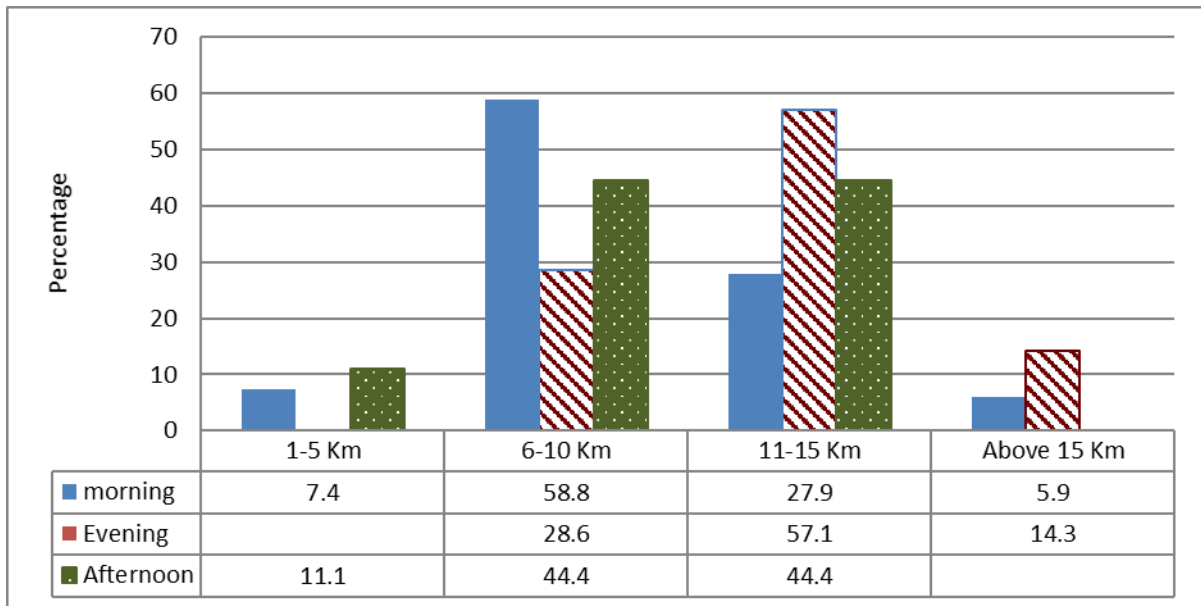
Source: Field Survey, 2018

Plate 4 An example of the causes of congestion - Narrow road stretch at Makadara

4.2.3 Longer commuting due to housing affordability (Travel Distance)

The study found out that the approximate distance covered by the commuters on their journey was 6-10 Km (85.8%) in the morning hours while 27.9% covered 11-15Km. A study carried out by Planner Mairura Omwenga revealed that the travel distance rose from 0.8km in 1970 to 25km in 1998 with the current travel distance averaging between

30 and 40km (Omwenga, 2011). Figure 10 shows that over 50% of the respondents travel for work and business related trips which are concentrated within the CBD. Aligula et al (2005) postulated that concentration of work places in few employment centers as it is the case with Nairobi where all the offices and services are concentrated within CBD tends to increase average trip lengths.



Source: Field Survey, 2018

Figure 10 Distance covered at different times of the day

4.2.4 Inadequate road capacity and uncivil driving behavior

Jogoo road’s carrying capacity has been over stretched due to the surging demand for transportation and the many estate sprouting in its surroundings. The study found out that uncivil driving behavior and inadequate road capacity contributes to approximately 16% and 14% respectively. The many junctions and roundabouts that connect to Jogoo road cause interruption of the fleet flow on the dual carriageway resulting to massive traffic jams. In addition, encroachment of road space along Jogoo Road by illegal roadside markets and rogue *bodaboda* riders not only hampers the smooth flow of traffic but also endangers the lives of pedestrians (Waithaka, 2017).

Uncivil driving behavior also contributes to traffic congestion through tailgating, refusing to let a car merge or letting too many cars merge, sudden change of lanes,

denying pedestrians their right of way, driving on the wrong lane among others (Arnott, 1994). Goodyear, (2012) notes that traffic congestion can be reduced by 25 to 30 per cent by combining the right traffic management systems with disciplined driving.

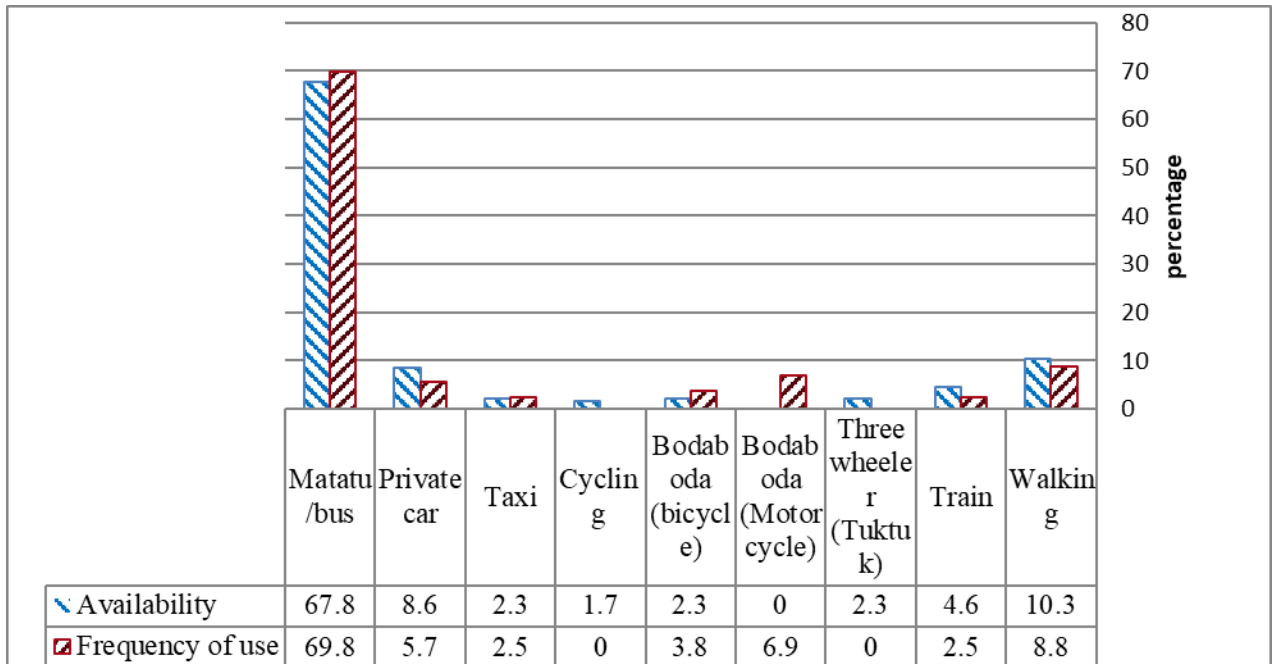


Source: Field Survey, 2018

Plate 5 *An illustration of intrusion of roadside businesses to pedestrian footpath*

4.2.5 Public transportation system and modal choice

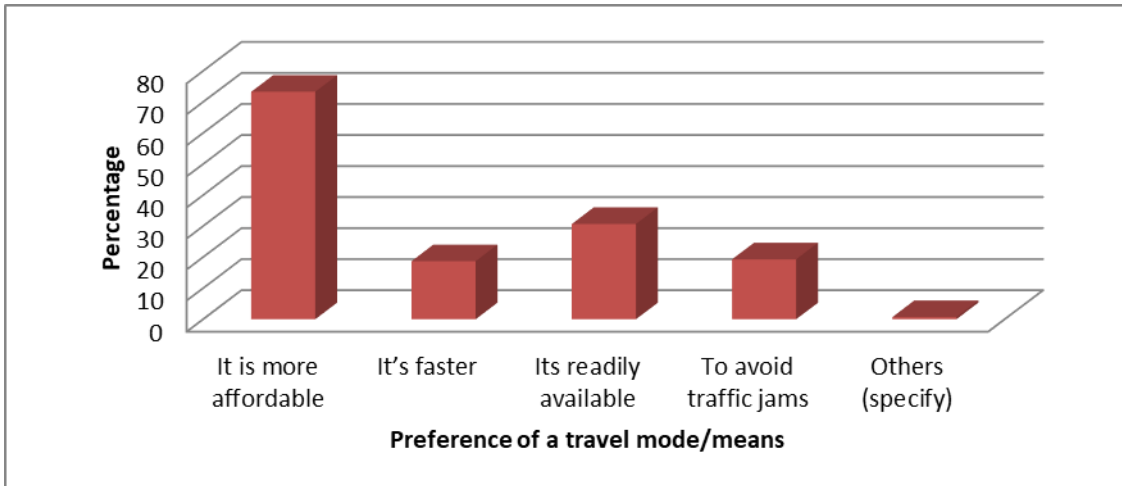
The efficiency and availability of public transport system determines the means of transport that the commuter is likely to choose in order to reach their destination faster. The study found out that the choice of the mode of transport is derived by other factors which include availability, affordability, ability to beat traffic congestion and speed. It was established that *Matatus*/buses were the most readily available means of transport to 67.8% of the commuters with this mode being frequently used by 69.8% of the commuters. The study also found that *bodaboda* was not readily available while *Tuktuk* was almost never used by commuters.



Source: Field survey, 2018

Figure 11 Availability and frequency of transport mode

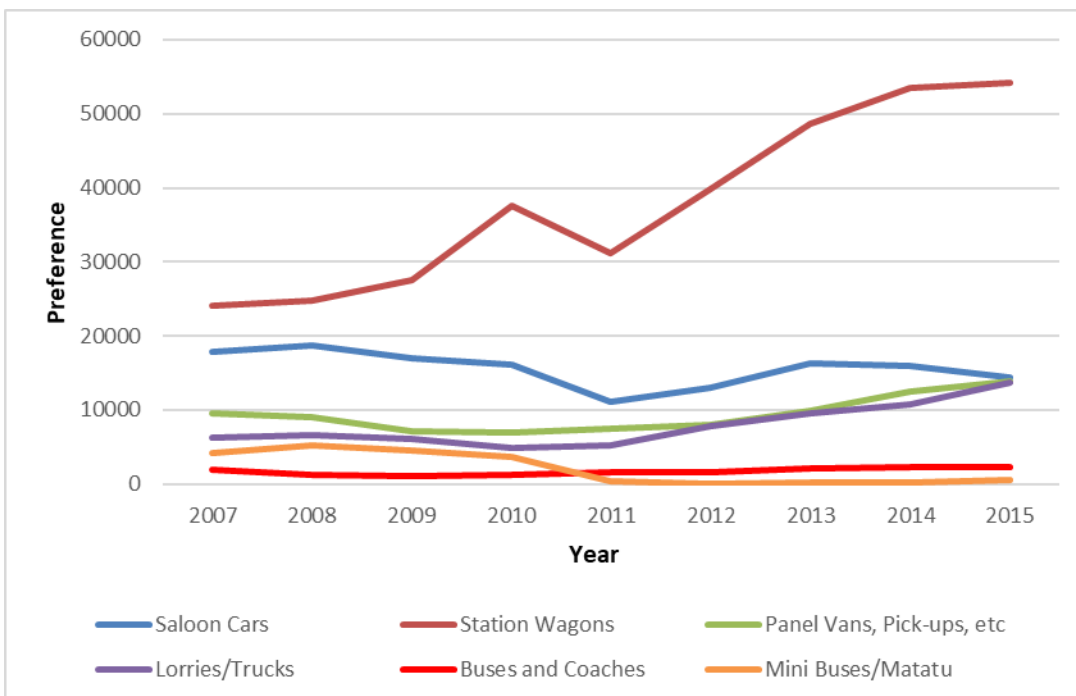
The study sought to understand the reason behind the preferred means of transport, 51.4% of commuters argued that the preferred means of transport was affordable while 21.5% of the commuters said that it was readily available. About 13.6 % of the respondents chose their means of transport based on the ability of the said mode to beat traffic congestion. According to Aligula et al (2005), there is a strong inverse relationship between travel cost and choice of travel mode hence majority of the commuters prefer *matatus* which are not only readily available but also more affordable.



Source: Field Survey, 2018

Figure 12 Reason for transport choice

The findings of this study differ slightly with the Economic Figures between 2007 and 2015 (see figure 13) that shows that Kenyans prefer private cars (with station wagon leading followed by saloon cars) as compared to buses and *matatus*. This could be attributed to the fact that only commuters using public service vehicles were interviewed.



Source: Economic Surveys: Adopted from Ngethe, 2017

Figure 13 Commuters' vehicle preferences

4.2.6 Land use changes in Nairobi

According to a report on Urban Public Patterns in Kenya by Aligula et al, Nairobi has continued to experience major land use changes, which have moved ahead of transport planning and implementation. Based on an analysis done between 2000 and 2003 within the Nairobi City County using instruments like change of use, building plans, amalgamation and subdivision of parcels, majority of land use changes were from residential to commercial and mixed land uses (see Table 10). The commercialization of land uses therefore increases demand for transport network that has not been met (Aligula et al., 2005).

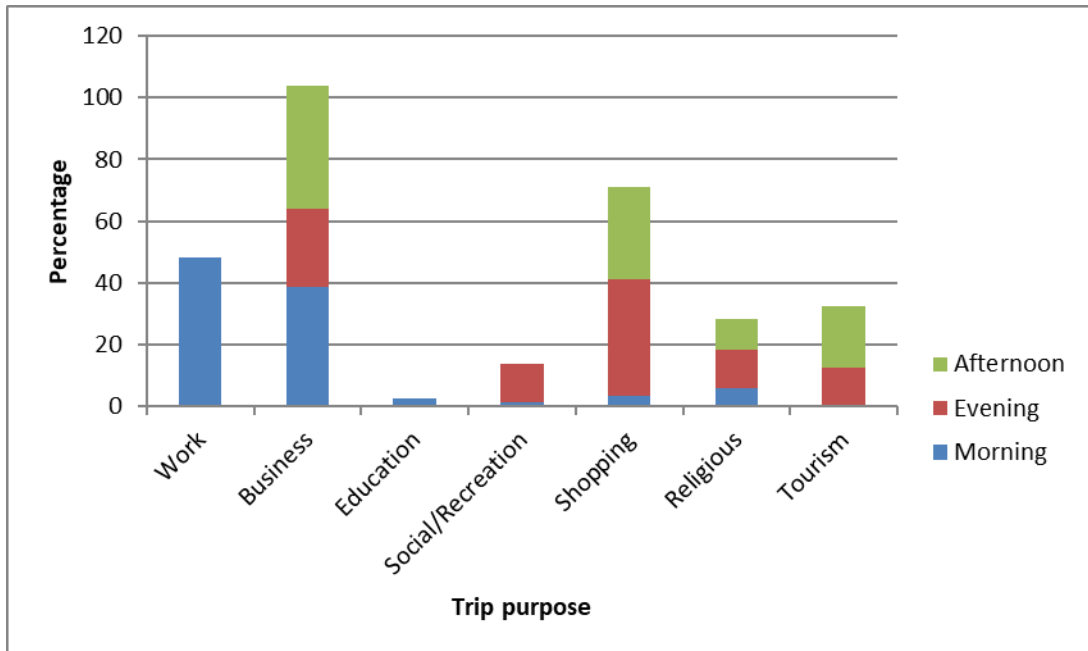
Table 10 Land use changes in Nairobi-Kenya

Land use change	Year				
	2000	2001	2002	2002	2002
To residential	No.	10	7	15	36
	% of total	11.6	6.9	14.2%	24.0%
To commercial (offices, restaurants, etc.)	No.	46	48	47	36
	% of total	53.5	47.5	44.3%	24.0%
To social (religious, school, health etc.	No.	18	23	32	40
	% of total	20.90	22.80	30.20%	26.70%
To mixed land used	No.	12	23	11	38
	% of total	14.0	22.8	10.4%	25.3%
To industrial	No.			1	
	% of total			0.9%	
Total	86	101	106	150	

Source: Aligula et al., 2005

4.2.7 Kenya's Work-Business hours and Trip Purpose

The study found that most commuters who travelled in the morning travelled to work (48.2%) and business (38.8%) with few people travelling during the evening and afternoon hours. The finding tally with James Gachanja's who concluded that the spatial-economic structure of Nairobi increases, to a large extent, traffic congestion as the commuters try access the CBD almost at the same time; 8:00 a.m.–5:00 p.m. for work or business opportunities (KIPPRA, 2012).



Source: Field Study 2018

Figure 14 Trip purpose as per the time of the day

4.2.8 Commuters' origin and destination

The commuters involved in this study travelled from Umoja to Town and Makadara, Town to Umoja and Makadara, Shaurimoyo to town, pipeline to town and Donholm, Kikuyu to town and Umoja, Kayole to Umoja, Town, Juja, Eastleigh and Donholm, Donholm to Town, Ngong, Makadara, Kayole, Gikomba and City Stadium (see table 11). However, most people travelled from Donholm to Town (86.9%) explaining the reason behind the massive traffic congestion along Jogoo road during peak hours.

Table 11 Commuters' Origin- Destination

	Umoja	Town	Shaurimoyo	Pipeline	Kayole	Donholm	Kamarocke
	%	%	%	%	%	%	%
Umoja		66.7			12.5		
Town	89.5		100	33.3	56.3	86.9	
Makandara	10.5	33.3				3.3	
Kayole						3.3	
Gikomba						1.6	
Eastleigh					6.3		
Donholm				66.7	12.5		100

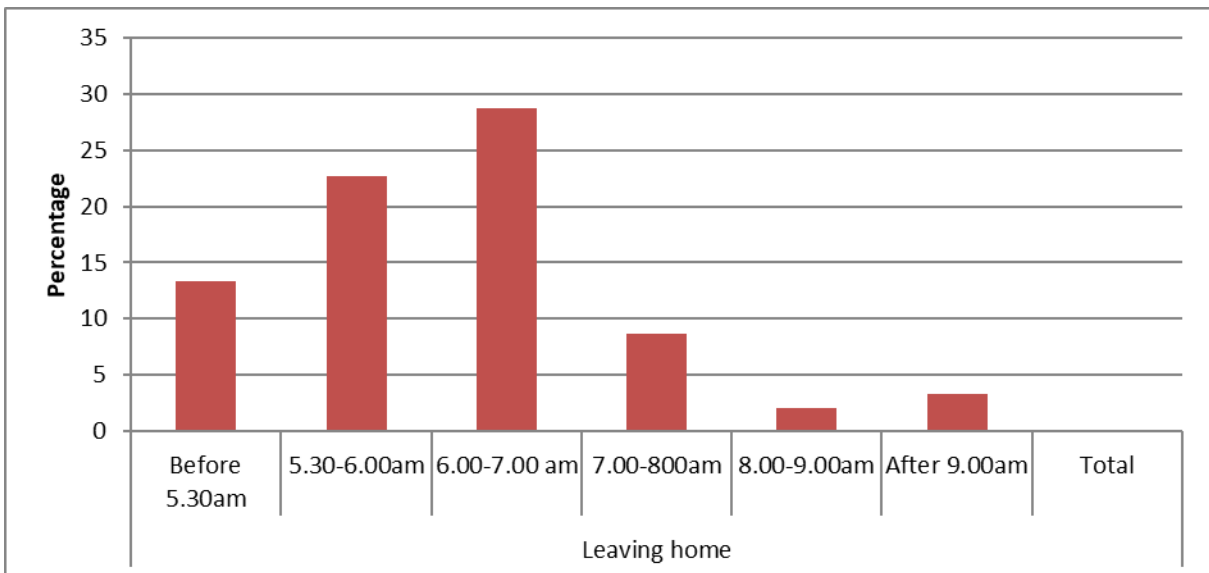
Source: Field Survey, 2018

4.3 Social Effects of Traffic Congestion along Jogoo Road

Effects of traffic congestion on the society were assessed based early departure and late arrival from work, accidents, increased motorcycle accidents, inability to estimate travel times, increased discomfort among special cases such as pregnant women, excessive emission of pollutant, and decreased cardiovascular fitness and greater in body mass index due to long commute.

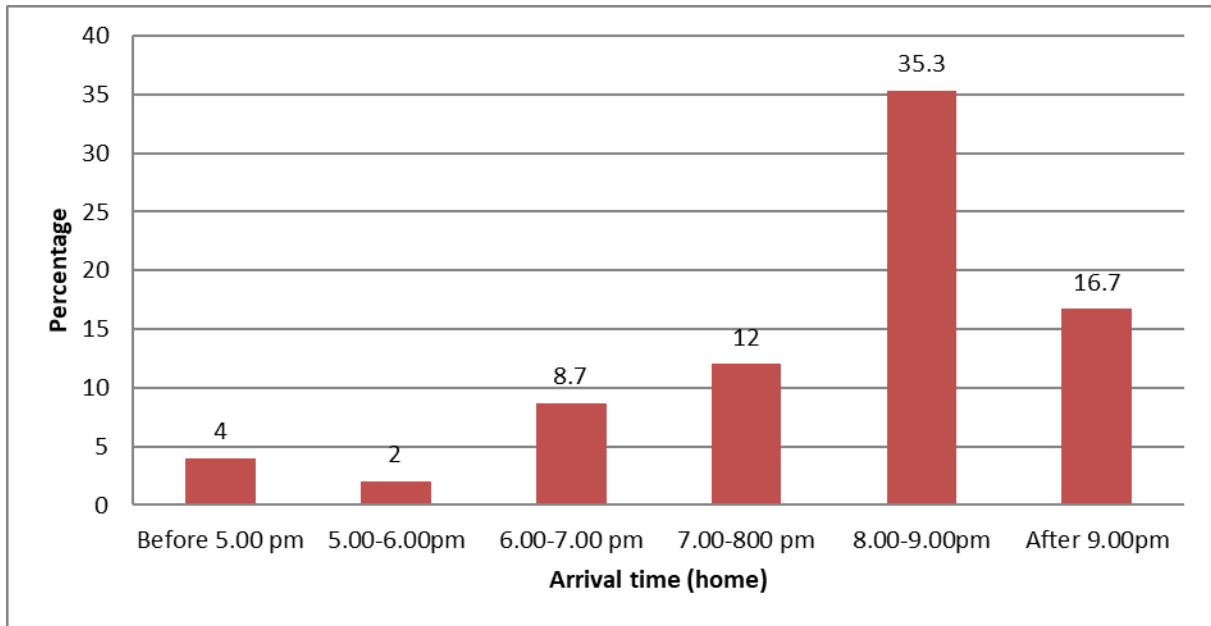
4.3.1 Early departure and late arrival from work

The study found that most people left home between 6.00 am and 7.00 am with more 80.0% of the commuters leaving home before 7.00 am. Further, the study established that most commuters got home between 8.00-9.00pm (44.9%) while 21.2% got home after 9.00pm. This leaves parents with limited time to instill values to their children as accentuated by Barbara & Helen, (2006) who hypothesized that a long commute time impacts family life and is a recognized determinant of work-family conflict since it decreases the time available for parents to spend with their families. One study found that over 10% of working parents spend more time commuting than they do with their children (Ibid). Children are therefore left in the hands of caregivers longer than they are with their parents. This has led to a community deprived of values.



Source: Field Study, 2018

Figure 15 Usual departure Time



Field Study, 2018

Figure 16 Usual arrival time

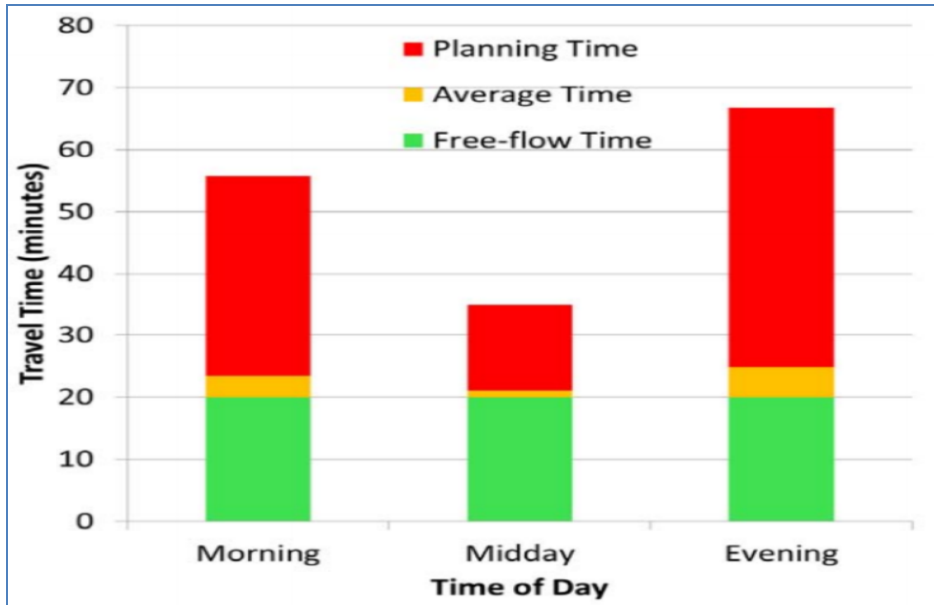
4.3.2 Social disintegration

The study found that traffic congestion affected the commuters adversely on the available time needed to spend with their family. The study noted that commuters could reach home as late as 9pm while most arrived home between 7-8 pm. This implies those parents working from Monday to Friday were left with insignificant time to spend with their families, which could affect parent's life satisfaction. Parents also spend less time with their children which affects children at advanced stage leading to a society devoid of values. Most of the commuters complained of fatigue which they associated to the early waking up and arriving home late and above all, sitting in traffic jam for hours. The study also established that sitting for many hours in traffic congestion could be linked to high stress levels and life style diseases such as diabetes and blood pressure.

4.3.3 Inability to predict travel time

The other shortcoming of traffic congestion is the inability to predict travel time. In the USA, people have to spend a considerable amount of time on trip planning due to congestion as shown on figure 15 (Snyder, 2013). A commuter may end up allocating

more time as they anticipate traffic congestion and end up arriving much earlier. Allocating less time on the other hand will result into lateness hence the associated losses.



Source: Snyder, 2013.

Figure 17 *Extra time to make important trips*

Inability to predict travel time not only leads to allocation of more time but also leads to cancellation of trips. IBM’s Commuter Pain Survey carried out in 2011 shown that 43% of the commuters had to cancel their trips as a result of anticipated traffic congestion (IBM, 2011).

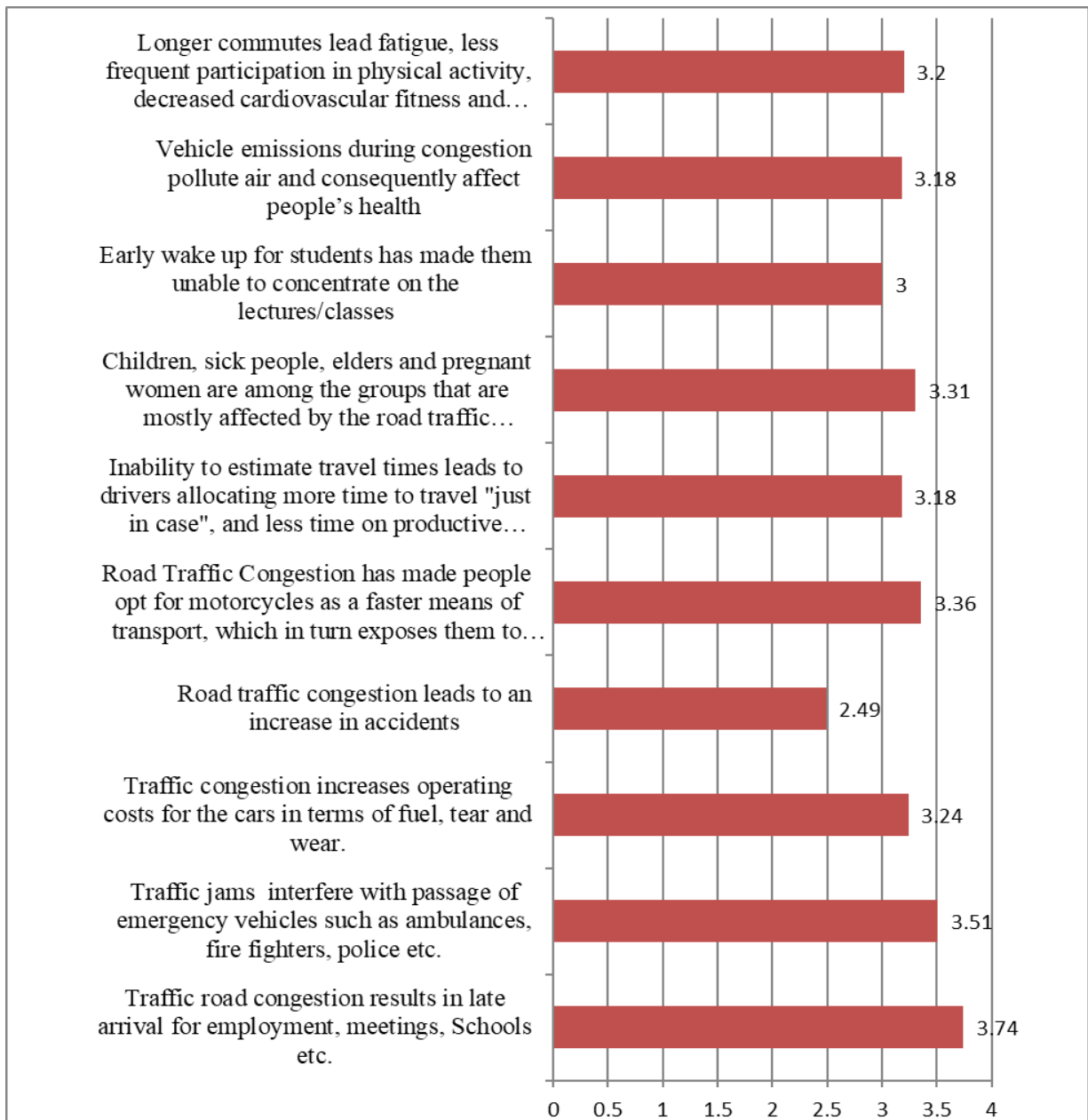
4.3.4 Health Risks

According to a Journal article published by the National Institute of Health, approximately 90% of the urban air pollution in developing countries can be attributed to vehicular emissions (Kinney et al., 2011). This is aggravated by traffic congestion since the emission duration is prolonged. Coupled with high dominance of dilapidated and poorly maintained vehicles as well as low quality fuels in our petrol stations, vehicular emission on Nairobi roads is a common occurrence.

Automobile emissions comprise particulate matter (PM), carbon monoxide, sulfur oxides, nitrogen oxides and other volatile organic compounds which when inhaled over a period of time may lead to both short term and long term health issues such as wheezing,

coughing, shortness of breath, sore throats as well deteriorating respiratory diseases such as asthma (Kinney, et al., 2011).

Increased travel time due to traffic congestion results into decreased physical activity hence less daily caloric expenditure. Due to the long hours spent commuting as well as lack of time for daily physical exercises, obesity sets in increasing the risk of diseases such as hypertension, diabetes, clinical depression, cardiovascular diseases and some forms of cancer (Tolley, 2003).



Source: Field Survey, 2018

Figure 18 Summary of commuters' opinion on the effects of traffic congestion

4.4 Economic Effects of Traffic Congestion along Jogoo Road

Traffic congestion has wide effects on the economy of individuals and productivity of the nation. Some of the parameters that can be used to measure economic effects include time and money wasted in traffic congestion as discussed below.

4.4.1 Travel Time

On average, 43.8% of the commuters spend 1-2 hours every morning in their journey to work and business while 23.3% use $2-3\frac{1}{2}$ hours every morning while 31.9% spent less than an hour. On average, commuters spend approximately 30 minutes in the absence of traffic congestion and at least 2-3 hours when there is traffic congestion. This applies to the evening trip as commuters return home making total hours lost per person per day to 3-4 hours. According to traffic index 2018 by Numbeo, commuters in Nairobi spend an average of 56 minutes in traffic snarl-ups per trip (NUMBEO, 2018) translating to approximately loss of 2 hours per day per person in traffic congestion.

The findings of the study are valid since Aligula et al, (2005) found that on average; Nairobi residents spend 78 minutes traveling, and wait for 12.4 minutes, adding up to approximately 90 minutes spent by each person aged 12 and above traveling to and from their activity points. In addition, INRIX *2017 Global Traffic Scorecard* reveals Los Angeles (USA) is the world's most in gridlock, with drivers spending on average 102 peak hours in congestion, followed by Moscow (91 hours), New York (91 hours), Sao Paulo (86 hours) and San Francisco (83 hours) (INRIX, 2018).

Table 12 Average travel time

	Minimum	Maximum	Mean	S D
Time in minutes when there is no traffic congestion	10	60	29.02	11.066
Time in minutes when there is traffic congestion	60	180	94.91	37.084
monetary value of the hours /minutes that you loose on the way per day	60	30000	2312.62	4928.049

Source: Field, 2018

4.4.2 Travel Cost

An average commuter spends Ksh. 50 on transport when there is no traffic while approximately Ksh.118 is spent when there is traffic congestion. This is because increased queuing due to traffic congestion increases fuel consumption and wear and tear. The *matatu* industry therefore compensates this increased expenditure by hiking fares.

Table 13 Average travel cost

	Minimum	Maximum	Mean	S D
Fare in Ksh when there is no traffic congestion	10	300	50.90	55.539
Fare in Ksh when there is traffic congestion	40	1200	117.84	139.397

Njoroge, (2015), wrote that congestion increases transportation cost and estimated that households in Nairobi County spent on average, Sh250 million (\$2.5m) per day in travel costs in 2013 alone.

Poor urban transport does not only reduce incomes of both firms and households through increased expenditure but also increases the expenditure of the country on treatment of diseases resulting from environmental pollution by vehicular emission. Approximately 63% of Nairobi's population spends more than 10% of their total household expenditure on transport (Aligula *et al.*, 2005).

Traffic congestion menace is a challenge faced by most cities and urban areas across the globe and imposes significant costs on the country's GDP between 1.5 to 4% (Dirks, Gurdgiev & Keeling, 2010). For instance, UK loses 1.5% of its GDP to traffic congestion while France and Germany lose 1.3% and 0.9% respectively (Global Solution Networks, 2014). In the United States, traffic jams in urban areas leads to annual costs of 4.2 billion hours of lost time and US\$87 billion from wasted fuel and lost productivity (Dirks, Gurdgiev & Keeling, 2010).

Table 14 Estimates of the 'Total Cost of Congestion'

Country/City	Estimate	Year	Source
UK (111 Cities)	£37.7 billion	2017	(INRIX, 2018)
USA	\$305 billion	2017	(Schneider, 2018)
South Africa	R1 billion	2015	(Wakefield, 2015)
Nigeria	\$123 billion	2013	(Somuyiwa, Fadare, & Ayantoyinbo, 2015)
Kenya	\$210 million	2016	(Cheeseman, 2016)

Source: As indicated in the table

Approximately 66% of the total costs associated with traffic congestion are as a result of wasted time and fuel (Attri, 2016). In addition, traffic congestion increases wear and tear

on vehicles because of idling in traffic and acceleration and braking which leads to more frequent repairs and substitutes (ibid).

4.4.3 Monetary value of traffic congestion

As the old adage goes “time is money” wastage of time in traffic congestion, has economic implication both to the commuters and to the country at large. In addition, the research revealed that over 50% of commuters who work in turn leave their houses between 5 am and 6.00am to work in time. Some get to work earlier than anticipated even as early as 6.30 – 7.00am and end up wasting 1-1/2 hours waiting for offices to be opened or by working which is not paid. The following is an attempt to estimate the monetary value of time under normal circumstances in the entire Nairobi County. It is based on Eliaongo’s formula on estimation of monetary value as a result of traffic congestion (Elisongo, 2013).

Assumptions

From this study, an average of **2 hours** is lost per day per person

Nairobi’s current population is **3.5million (KNBS projections)**

Nairobi’s working population stands at 47% as per KNBS (**1,645,000** (47% of 3.5million))

Minimum wage per day for Nairobi as announced by the President on May 1st is **Kshs 320** (Kshs. **40 per hour** (320/8 hours))

Normal working hours is **8 hours per day for 5 days** (40hours per week)

Monetary value of the time wasted per day

= Average lost working hours*Wage per hour*the working population

=2 hours*Kshs40*1,645,000 working pop.

=**Kshs 131,600,000 lost day**

Monetary value of the time wasted per week

=131,600,000*5 (working days)

= **Kshs 658,000,000 per week**

Monetary value of the time wasted per year

658,000,000***48 weeks** (8hours per day*5 days a week*4 weeks per month*12 months
per year=1920) ÷ (8hours*5 days)

= **Kshs 31,584,000,000**

Approximately Kshs 31.6 Billion is wasted in traffic congestion per year

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

The purpose of this study was to find out the effects of traffic congestion in Nairobi particularly along Jogoo Road. The objectives of this study were assessing the main causes of traffic congestion, examining the social effects of traffic congestion along Jogoo road, assessing the economic effects of traffic congestion along Jogoo road and proposing measures that can be put in place to reduce the socio-economic effects of road traffic congestion.

Descriptive research was employed in collecting both primary and secondary data using instruments such as interview schedules, questionnaires, observation guide, photography among others. Data was then cleaned and entered and analyzed using the Statistical Package for Social Sciences (SPSS). The findings have been presented in graphs, tables, photos as well as in report writing. The major findings of the research have been summarized as follows:

5.1.1 Socio-economic characteristics

Gender, education, occupation, income and expenses were the socio-demographic characteristics that were investigated by this study. The study found that over 80% of the commuters earned below Kshs. 30,000 with most of the commuters' average earning being recorded at Kshs. 10,000 to Kshs. 20,000. The study also examined respondent's expenses on food, transport, education, housing and health. The study found that most commuters used up to Kshs. 4000 for food, housing, transport and health while education took up to 10,000 of the commuters' income.

On the preferred means of transport, the study found out that matatu/bus recorded the highest number because of their availability and affordability while walking was rated second. Commuters were more inclined on the affordability of the transport means while choosing mode of transport. Availability was also considered as reported by most commuters making availability and affordability two strong factors that influence the choice of transport means.

5.1.2 Causes of traffic congestion

Traffic congestion is caused by factors that include but not limited to human, structural, planning and human errors. The study found that the most rated cause of traffic congestion is the pressure that was resulting from excessive penetration of private cars along the road and the high population of the Eastlands area. Planning challenges such as road designs that incorporated excessive roundabout and inadequate road capacity hampered effort to manage traffic congestion along Jogoo road. Poor management of traffic, uncivil driving behaviour such as overlapping, tailgating, and honking were among factors associated with traffic congestion along Jogoo road. Other factors included weather changes, breakdowns and lack of efficient public transport system.

5.1.3 Social effects of traffic congestion along Jogoo road

The social aspects of an individual are very important as they form one of the main reason an individual adopt various economic activities in effort to meet his/her needs and advance their family affairs. Spending more time in traffic congestion not only leads to social disintegration as one has less time to attend social events but also cuts people off from the cultural and community lives of the services they require. It also exposes the commuters to lifestyle diseases like blood pressure, diabetes and any other disease linked to obesity. Sitting in traffic jam for long hours also exposes one to respiratory diseases due to prolonged intake of noxious gases such as carbon monoxide and nitrogen oxides. The low-income earners bear the heaviest burden because they barely afford to access social services, community recreation and health care (Ragan & Vuong, 2015).

5.1.4 Economic effects of traffic congestion along Jogoo road

The study found that the time and travelling cost differed widely during peak and off peak period. These variations could potentially affect commuters' budgeting, time planning and scheduling of business meetings for those who operated business. From the researcher's calculation based on listed assumptions, approximately Kshs. 31.6 billion is wasted annually in traffic congestion. Traffic congestion also affects delivery of products to desired destination costing business people a lot of money in cases where perishable products such as fruits are delayed from reaching the intended destinations in time.

Other groups that are adversely affected by traffic congestion included teachers, students and emergency vehicles such as fire fighters and ambulances leading to loss of lives and properties if their help is not given in time. During traffic congestion, it the study noted that there is increase cases of accidents and incidences, commuters opt for alternative means of transport such motorcycles (which are very expensive and prone to accidents). From these observations, traffic congestion has a potential to affect the productivity of organizations from which these commuters work as most time is allocated to travelling as opposed to productive activities in the office.

5.2 Conclusion

After thorough analysis of the Socio-economic effects of traffic congestion, it is evident that rapidly increasing population, increase in the number of vehicles and travelers, freight, and development has affected travel demand and re-shaped travel patterns across the globe. Traffic congestion is therefore becoming excruciating in many urban areas in both developed and developing countries. Many countries (including Kenya) have grappled with various mitigation measure to reduce traffic congestion. Nonetheless commuters have continued bearing the social and economic costs of traffic congestion as little success has been realized from such interventions.

If the policy makers do not address the burgeoning congestion timely, the situation is likely to get worse and the associated socio-economic effects will be unbearable. Reduction of traffic congestion is a very expensive investment and therefore not economically sustainable where there are limited resources especially in the developing countries. It therefore requires the government to make commitment and prioritize traffic congestion reduction in terms of resource allocation. However, governments can try and optimally use the existing road spaces (by employing alternative measures such as traffic management) before venturing into more expensive strategies such a construction of new transportation infrastructure.

The research concludes that excessive use of road by private cars along Jogoo road is the main reason behind the heavy traffic congestion. Road design such as low capacity road, roundabouts, and intrusion of footpaths by roadside traders also contribute to traffic congestion along the road. Traffic congestion has adverse social and economic challenges

to people living in estates served by Jogoo road. These include arriving and leaving home late and early respectively hence denying parents time to attend to their children development needs, fatigue, higher stress levels and respiratory related diseases caused by high levels of pollution.

Traffic congestion also results into high operational costs to businesses, low productivity among the employees as a result of lateness or fatigue, hiked fares during peak hours hence increased expenditure on transportation, inability to predict travel time among others. Emergency vehicles such ambulances and fire fighting vehicles are constantly obstructed from reaching their destinations in time leading to loss of life and properties.

Therefore, the research premise that traffic congestion has both negative social and economic effects is validated by the findings of the study.

5.3 Recommendations

1. Effective, reliable, affordable and safe public transport systemThe study found that the most rated cause of traffic congestion is the pressure that was resulting from high population and excessive penetration of private cars along the road. An effective public transport system will ensure mass transportation of people other than transporting vehicles. In order to attract more people to use public transport and for-go use of their private cars specially during peak season, quality service must be provided to the commuters in terms of affordability, reliability, safety, comfort, flexibility and convenience of the various means of public transport.

There are various ways to improve public transport system including:

- Introduction of high capacity buses (60 seaters) instead of the normal 14 seaters to ensure more people are transported per trip hence reduce the number of trips per vehicle in a day.
- Introduction of Mass Rapid Transit (MRT) which includes Bus Rapid Transit (BRT) and Light Rail Transit (LRT) Jogoo Road in order to improve public transport and eventually reduce traffic congestion.

- Banning private cars from accessing the CBD can also entice private car users to opt for public transport, which is more convenient in terms of modal interchange and access to the CBD.
- Provision of NMT facilities such as footbridges, cycle lanes, zebra crossing among others complements public transport system and can reduce congestion and road accident.

The Matatu owners may however oppose phasing out of 14-seater matatus as there are many of them on the roads already. The phasing out process may also take several years making this congestion reduction strategy take time to work. Implementation of BRT and LRT is very expensive and the government may be reluctant to venture into it. Private car users may also protest the move to have them banned from accessing the CBD just as it has happened before.

1. Redesigning and expansion of Jogoo Road

As the study has found out, the nature intersections and junctions along Jogoo road contributes to traffic congestion as it increases waiting time to merge or turn. To address this challenge, the junctions should be redesigned to allow grade separation (aligning a junction of two or more transport axes at different heights) through provision of bridges just as like Thika Superhighway. The main advantage of increasing road volume is that it provides a fast relieve to traffic congestion along overcrowded corridors.

Past researches have however proved expansion of roads as a costly mitigation measure which only relieves traffic congestion for a short period of time after which the roads get fill again by generated traffic.

2. Improved Traffic Management

Poor management of traffic including dysfunctional traffic lights were among factors associated with traffic congestion along Jogoo road. This study recommends the use of an Intelligent Transportation System (ITS) through installation of CCTV and automatic traffic lights can help control traffic flow along Jogoo Road hence reducing traffic congestion. The modernized traffic signals should be able to respond to road situations in real time hence improve traffic flow and eventually reduce congestion and unnecessary

greenhouse gas emissions. A comprehensive policy for development of ITS is also necessary.

The newly founded Nairobi Metropolitan Area Transport Authority (NAMATA) should work round the clock and come up with ways on how congestion can be reduced within the City County. The Ministry of Transport should work on utilization of other modes of transport such as railway transport to ease congestion, the railway could be extended to serve more people from Eastlands as well as increasing its number of trips made per day.

The Traffic Police and NTSA should ensure effective and timely incident management to avoid obstruction of other vehicles and the risks involved such as accidents.

However, use of ITS is an expensive investment and requires trained personnel to operate it. Traffic marshals and police should be withdrawn from the interchanges as they have rendered the current functioning traffic lights useless and use their own cognitive judgement to control traffic.

3. Review of Transport Policy and Rules

This study reviewed the existing transport related policies in Kenya and in Nairobi County. This study proposes that the existing policies on transportation should be implemented and the unbecoming ones reviewed as they ought to emphasize on providing reliable and predictable travel times as well as effective travel speeds. The government should come up with Clean Fuel Advanced Technology initiative in order to reduce transit-related emissions hence better air quality.

A policy should also be formulated to enhance pricing in order to discourage use of automobiles especially during peak hours. Congestion pricing for instance refers to increased price to make the road user cognizant of the costs they inflict when consuming road space during peak hours when demand is highest. Fuel pricing can also reduce traffic congestion as witnessed in the use whereby fuel increase by 28% resulted to reduction of an average national Travel Time Index values by 3%.

There should be a policy to provide guidelines and stipulations on the level of generated traffic and the size and type of developments that necessitate a Traffic Impact Assessment (TIA). The government should also consider staggering working hours in order to manage traffic demand. It can also encourage teleworking and teleconferencing,

which minimizes the need for travelling. However, introduction of any type of road pricing is bound to face opposition just as the introduction of 16% VAT on fuel has been received with a lot of criticism. In addition, the policy making process in Kenya is lengthy and some policies are often overtaken by events.

4. Land-use planning measures

As discussed earlier, one of the causes of traffic congestion along Jogoo road and Nairobi County as a whole is lack of interlinkage between transport and land use planning. The latter, is a very vital instrument to guide development in urban areas as well as attaining an anticipated land use pattern through implementation of plans such as Master plans e.g. NIUPLAN, structure plans and local development plans.

Land use planning also proposes for dense and compact cities with work-housing balance hence reduced demand/need to travel using auto-mobiles. A multi-core sub-centre system for Nairobi Metropolitan Area where services are decentralized can reduce the need to travel to the Nairobi core for such services.

However, the relevant authorities may not play their mandate and implement plans that guide on the best strategies to reduce traffic congestion. In fact, the 1973 Nairobi Metropolitan strategy expired before its full implementation. The same may happen to NIUPLAN yet it has very comprehensive proposals on traffic congestion reduction.

On work-housing balance, housing costs near the Nairobi CBD are very high and this encourages commuters to live far away from town where housing is more affordable. Unless the government provides affordable housing, the demand to travel is bound to rise and so is traffic congestion.

5.3 Further areas of Study/Research

Further research is recommended to assessment how railway transport can be used to reduce traffic congestion focusing Jogoo road and Mombasa road. A study can also be carried out to establish the lack of /inadequacy of implementation of the various plans that proposes traffic congestion mitigation measures including NIUTRANS, NIUPLAN, Nairobi Metro Strategy among others.

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APPENDICES

Appendix 1: Commuter Questionnaire

Dear Respondent,

Thank you for taking part in this study.

I am Mercyleen Nkatha from Kenyatta University. This questionnaire is exclusively meant for gathering information for the study “Social-Economic Effects of Traffic Congestion along Jogoo Road in Nairobi County. This is purely an academic study, which is being conducted as a partial fulfillment for the award of degree on Masters of Environmental Planning and Management. All the information obtained will be treated very confidentially and used for intended purpose only. Please feel free to answer the questions according to your experience and your personal understanding.

Please tick appropriately.

1. Sex: 1. Male () 2. Female ()
2. Educational level: 1. Primary () 2. Secondary () 3. Tertiary () 4. University ()
3. Type of Employment: 1. Employed () 2. Self-Employed () 3. Unemployed () 4. Student ()
4. Salary Scale in Kshs.

Code	Salary Scale (Kshs.)	Tick (<input type="checkbox"/>)
1	Below 10,000	
2	10,001-20,000	
3	20,001-30,000	
4	30,001-40,000	
5	40,001-50,000	
6	50,001-60,000	
7	Above 60,000	

5. Monthly Household Expenditure (in Kshs.) of household on the following items

Item	Codes use the codes provided below
Food	
Housing	
Education	
Transport	
Health	
Others	

$\leq 4,000$	4,000-5,999	6,000-7,999	8,000-14,999	15,000-19,999	20,000-24,999	25,000-29,999	$>30,000$
1	2	3	4	5	6	7	8

6. a) Which of the following means of transport is readily available to you and you frequently use? (tick (√) appropriately)

Code	Mode	Readily available	Frequently used
1	Matatu/bus		
2	Private car		
3	Taxi		
4	Cycling		
5	Bodaboda (bicycle)		
6	Bodaboda (Motor cycle)		
7	Three wheeler (Tuktuk)		
8	Train		
9	Walking		
10	Others (Specify)		

b) Why do you prefer the above checked (√) Mode of transport)

Code	Reason for preference	Tick appropriately
1	It is more affordable	
2	It's faster	
3	Its readily available	
4	To avoid traffic jams	
5	Others (specify)	

7. How many trips did you make yesterday, what are the modes that you used and purpose? (Use the codes provided below)

Trip No	Time of the day	Mode (Code)	From	To	Trip Length (km)	Travel Time(mi n)	Trip Purpose
1							
2							
3							
4							
5							
6							
7							

Mode Code	Matatu/Buses	Private car	Taxi	Cycling	Boda boda	Tuktuk	Train	Walking	Other (specify)
Code	1	2	3	4	5	6	7	8	9

Purpose Code	Work	Business	Education	Social/Recreational	Shopping	Religious	Tourism	Health	Others (specify)
Code	1	2	3	4	5	6	7	8	9

8. From your experience as a frequent user of this road, what is the major cause of traffic congestion?

Code	Cause	Tick Appropriately
1	Increase in Population and vehicle ownership	
2	Breakdowns	
3	Inadequate road capacity	
4	Lack of efficient public transportation system	
5	Uncivil Driving Behavior: overlapping, tailgating, honking	
6	Poor traffic management	
7	Road design: roundabouts	
8	Any other: Specify...	

9. a) Does traffic congestion affect your daily activities?
 1. Yes () 2. No (). If yes answer questions (b), (c) and (d) below.
 b) How much fare (in Kshs.) do you spend when:
 i. There is no traffic congestion.....

ii. There is traffic congestion.....

c) How many working hours/minutes do you lose per day on the way in traffic congestion?

.....

d) What could be the monetary value of the hours /minutes that you loose on the way per day?

.....

10. Other than the hours lost in traffic, how else does traffic congestion affect you personally?

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11. a) What time do you leave home for work?

Code	Time	Tick Appropriately
1	Before 5.30am	
2	5.30-6.00am	
3	6.00-7.00 am	
4	7.00-8.00am	
5	8.00-9.00am	
6	After 9.00am	

b) What time do you get home in the evening?

Code	Time	Tick Appropriately
1	Before 5.00 pm	
2	5.00-6.00pm	
3	6.00-7.00 pm	
4	7.00-8.00 pm	
5	8.00-9.00pm	
6	After 9.00pm	

12. Which alternative means of transport do you use or apply to cope with the prevailing road traffic congestion?

Mode	Matatu/B s	Priva te car	Ta xi	Cyclin g	Boda boda	Tu ktu k	Tra in	Walki ng	Other (specify)
Code	1	2	3	4	5	6	7	8	9

13. Using the scale in each category, please circle the number of the rate that BEST describes the extent of social-economic effects of road traffic congestion along Jogoo Road.

Scale:

1 = Strongly Agree

2 = Agree

3 = neither Agree nor Disagree

4 = Disagree

5 = Strongly Disagree

Extent of social-economic effects	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Traffic road congestion results in late arrival for employment, meetings, Schools etc.					
Traffic jams interfere with passage of emergency vehicles such as ambulances, fire fighters, police etc					
Traffic congestion increases operating costs for the cars in terms of fuel, tear and wear.					
Road traffic congestion leads to an increase in accidents					
Road Traffic Congestion has made people opt for motorcycles as a faster means of transport, which in turn exposes them to more accidents.					
Inability to estimate travel times leads to drivers allocating more time to travel "just in case", and less time on productive activities.					
Children, sick people, elders and pregnant women are					

**among the
Groups that are mostly affected
by the road traffic congestion
due to discomfort.**

**Early wake up for students has
made them unable to
concentrate on the
lectures/classes**

**Vehicle emissions during
congestion pollute air and
consequently affect
people's health**

**Longer commutes lead fatigue,
less
frequent participation in
physical activity, decreased
cardiovascular
Fitness and greater body mass
index.**

14. In your own opinion, what should be done to alleviate the problem of traffic congestion along Jogoo Road?

Code	Solution to traffic congestion	Tick Appropriately
1	Expand the capacity and redesign Jogoo Road	
2	Introduce higher capacity public transport vehicles & BRT	
3	Ban private vehicles from getting to the CBD	
4	Refurbish the train and increase reliability of railway transport	
5	Better Traffic management	
6	Addition of footbridges	
7	Any other (specify).....	

Appendix 2: Interview Schedule (Institutions)

Dear Respondent,

Thank you for taking part in this study.

I am Mercyleen Nkatha from Kenyatta University. This FDG schedule is exclusively meant for gathering information for the study “Social-Economic Effects of Traffic Congestion along Jogoo Road in Nairobi County. This is purely an academic study, which is being conducted as a partial fulfillment for the award of degree on Masters of Environmental Planning and Management. All the information obtained will be treated very confidentially and used for intended purpose only. Please feel free to answer the questions according to your experience and your personal understanding.

1. What is your mandate in controlling traffic congestion?

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2. What are the causes of road traffic congestion in Nairobi?

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3. What are the social-economic effects of road traffic congestion in Nairobi?

i. Social Effects:

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ii. Economic Effects:

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Appendix 3: Focus Group Discussion Schedule – Drivers/Saccos

Dear Respondent,

Thank you for taking part in this study.

I am Mercyleen Nkatha from Kenyatta University. This FDG schedule is exclusively meant for gathering information for the study “Social-Economic Effects of Traffic Congestion along Jogoo Road in Nairobi County. This is purely an academic study, which is being conducted as a partial fulfillment for the award of degree on Masters of Environmental Planning and Management. All the information obtained will be treated very confidentially and used for intended purpose only. Please feel free to answer the questions according to your experience and your personal understanding.

1. How does traffic congestion affect your daily activities?

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2. How many hours/minutes do you spend between Donholm Roundabout and City Stadium when:

- a) There is no traffic congestion at all
- b) There is slight congestion.....
- c) There is heavy congestion.....

3. What could be the monetary value of the hours /minutes that you loose on the way per day?

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4. Other than the hours lost in traffic, what are the other negative effects of traffic congestion?

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5. How many liters of fuel do you use in a day when?
 - i. There is no traffic congestion at all
 - ii. There is slight congestion.....
 - iii. There is heavy congestion.....
6. In your own opinion, what should be done to alleviate the problem of traffic congestion along Jogoo Road?

Code	Solution to traffic congestion	Tick Appropriately
1	Expand the capacity and redesign Jogoo Road	
2	Introduce higher capacity public transport vehicles & BRT	
3	Ban private vehicles from getting to the CBD	
4	Refurbish the train and increase reliability of railway transport	
5	Better Traffic management	
6	Addition of footbridges	
7	Any other (specify).....	

Appendix 4: Focus Group Discussion Schedule – Students/Teachers

Dear Respondent,

Thank you for taking part in this study.

I am Mercyleen Nkatha from Kenyatta University. This FDG schedule is exclusively meant for gathering information for the study “Social-Economic Effects of Traffic Congestion along Jogoo Road in Nairobi County. This is purely an academic study, which is being conducted as a partial fulfillment for the award of degree on Masters of Environmental Planning and Management. All the information obtained will be treated very confidentially and used for intended purpose only. Please feel free to answer the questions according to your experience and your personal understanding.

1. How far is the institution from school?

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.....

2. Which is the common mode of transport used by students/teachers?

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.....

3. How does traffic congestion affect your daily activities in terms of:

a) Waking up time

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.....
.....

b) Time allocated for sleeping/resting

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.....
.....

c) Performance in school

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.....
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4. How many hours/minutes do you spend between your place of residence and your school when:

d) There is no traffic congestion at all

e) There is slight congestion.....

f) There is heavy congestion.....

5. Other than the hours lost in traffic, what are the other negative effects of traffic congestion?

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6. In your own opinion, what are the major effects of traffic congestion on students

Extent of social-economic effects	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Traffic road congestion results in late arrival in schools					
Road traffic congestion leads to an increase in accidents hence absenteeism in schools					
Road Traffic Congestion has made people opt for motorcycles as a faster means of transport, which in turn exposes them to more accidents.					
Inability to estimate travel times leads to students and teachers allocating more time to travel "just in case", and less time on productive activities.					
Early wake up for students has made them unable to concentrate on the lectures/classes					
Vehicle emissions during congestion pollute air and consequently affect people's health					
Longer commutes lead fatigue, less frequent participation in physical activity, decreased cardiovascular, Fitness and greater body mass index.					

7. In your own opinion, what should be done to alleviate the problem of traffic congestion along Jogoo Road?

Code	Solution to traffic congestion	Tick Appropriately
1	Expand the capacity and redesign Jogoo Road	
2	Introduce higher capacity public transport vehicles & BRT	
3	Ban private vehicles from getting to the CBD	
4	Refurbish the train and increase reliability of railway transport	
5	Better Traffic management	
6	Addition of footbridges	
7	Any other (specify).....	